Stress and ill health associated with fungi, indoor environmental factors and personal factors in hospitals

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Abstract

The current research investigated hospital staff biopsychosocial stress reactions, indoor environmental factors, air conditioning system outlets and inlets as a source of fungi, surface fungal contamination, air borne fungal spores and other indoor allergens, sick building syndrome, odours, hospital staff smoking habits, dampness, temperature and relative humidity, air movement, carbon dioxide levels and particulates.

A stratified random sample of six (6) Durban hospitals representing 30% of hospitals in Durban was selected. There were two provincial (public) hospitals, two missionary hospitals and two private hospitals in this study. In each hospital nine sections were studied: the administration section, intensive care unit (ICU), three general wards including related section such as the laundry, pharmacy, central sterilizing and supply department (CSSD), the kitchen and the theatre. Respondent selection included all hospital staff who agreed to participate. Total respondents were 280 of which 123 agreed to take part in the allergy skin prick test.

An allergy questionnaire was developed and an indoor environmental questionnaire was refined for use in the hospital survey. All hospitals participating in the study had certain work areas where the carbon dioxide levels exceeded 1000ppm suggesting that ventilation systems in those sections were not performing adequately at the time of this research. Sick building syndrome (SBS) symptoms reported by > 20% of the 280 staff were lethargy, blocked nose and headaches. Significant psychological stress reactions were reported by > 50% of hospital respondents. Chi-square test indicated no association between reported biopsychosocial stress reactions and the various hospital type ($p = .224$). However, there was an association between physical stress reaction reporting and staff in missionary hospitals which suggested that missionary hospital staff may have been experiencing more physical stress ($p = .029$) than the other hospital types.

The Hospital Environmental and Personal Stress Assessment (HEPSA) questionnaire results suggested that high proportions of hospital respondents were concerned about stuffy air, smelly air and temperature variations. Discomfort relating to high relative humidity was a concern in most sections of hospitals. Relative humidity standard of ≥ 60% was being exceeded. A particulate ranking technique was developed which assisted in classifying hospitals and their work areas in terms of hospital cleanliness. Private hospitals appeared to have lower particulate levels with higher levels being found in provincial (public) hospitals.

All hospitals had sources of fungal growth. Many ceilings and walls had contaminated areas > $3m^2$. Predominant organisms were *Aspergillus spp.*, *Cladosporium spp.* and *Penicillium spp.* One missionary hospital had 5 out of 9 areas with higher fungal indoor levels compared to outdoor levels followed by a provincial hospital with 4 of the 9 areas with high fungal levels.

Skin prick allergy tests indicated that 40% of the 123 participants tested were allergic to dust mite, 25% to cockroach allergen and 10 to 12% reacted to the three mould mixes. The allergy questionnaire that was developed for this research was found to be useful for screening potentially allergic respondents in the current study. Psychological, allergy and SBS binary logistic regression multivariate models were developed.

The current research does not conclusively establish causality of hospital respondent stress and health concerns. However, the biopsychosocial, allergy and SBS models suggest possible associations between the many psychological and indoor environmental factors investigated.

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Preface

This study represents original work by the author and has not been submitted in any form to another university. Where use was made of the work of others it has been duly acknowledged in the text. The American Psychological Association format was applied to this document (American Psychological Association, 2002). The research described in this thesis was carried out in the Department of Behavioural Medicine, under the supervision of Professor L Schlebusch, Professor and Head of the Department of Behavioural Medicine, Faculty of Health Sciences, Nelson R Mandela School of Medicine, University of Natal, KwaZulu-Natal, Durban, South Africa. Dr Nceba Gqaleni, Director, Centre for Occupational & Environmental Health, Nelson R Mandela School of Medicine, University of Natal, KwaZulu-Natal, Durban, South Africa acted, as co-supervisor.

The project was inspired by previous research into indoor air quality and the important role that hospital workers have in the community. According to the International Society of Indoor Air Quality and Climate (2000) hospitals are complex environments, which necessitate ventilation for comfort and control of hazardous emissions for all occupants and visitors. The researcher concurs with this statement in that many potential stressors may exist in hospital environments. It has been noted in the literature that "the work environment can feature prominently in stress at all levels of all job descriptions" (Schlebusch, 2000, p. 81). It was assumed that hospital staff may be experiencing psychological stress and have concerns about their physical indoor work environment. An initial pilot study was conducted in the basement of the Medical Research Council clinic in KwaZulu-Natal Durban South Africa where HIV/AIDS patient research was conducted (Shadwell, Schlebusch, & Gqaleni, 2000). The pilot study investigated fungi, indoor air quality and biopsychosocial factors, analysis of carbon dioxide, temperature and relative humidity levels, respirable particulates and air movement. This study assisted in the design of the current research.

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Finally I would like to acknowledge with gratitude, my wife, for her support, patience and understanding.

Glossary

A/C	air conditioning
ACFM	actual cubic foot per minute (calibration of the Grasbey Andersen microbial sampler)
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
^0C	Celsius
cfu/m^3	Colony forming units per cubic meter of air
CSSD	Central sterilizing and supply department in the hospital
DG18	Dichloran glycerol 18 agar
EPA	Environmental Protection Agency of America
g/m^2	Grams per square meter
HEPA	High-efficiency particulate air filters
HEPSA	Hospital Environmental and Personal Stress Assessment Questionnaire
HVAC	Ventilation equipment that provides heating, cooling, filtering of outdoor air, and humidity control to maintain comfort conditions in a building.
ICU	Intensive care unit
ISIAQ	International Society of Indoor Air Quality and Climate
m^2	Meters square
M	mean
MEA	Malt extract agar
Mdn	median
mls	Milliliters

mm	Millimetres
m/s	meters per second
NIOSH	National Institute for Occupational Safety and Health of the United States of America
OR	odds ratio
OSHA	Occupational Safety and Health Administration of the United States of America
Percentage	%
PDA	Potato dextrose agar
ppm	parts per million
PSYSOM	Psychosomatic ailments questionnaire
SBS	Sick Building Syndrome
SD	Standard deviation
SPT	Skin prick test
SSCL	The Stress Symptoms Checklist
spp	Species
TESI	Tension and effort stress inventory
UCT	University of Cape Town South Africa
USDA	United States Department of Agriculture
µ	Microns
WHO	World Health Organisation

STAFF STRESS AND ILL HEALTH ASSOCIATED WITH HOSPITALS ENVIRONMENTS

Introduction

Purpose of the research

The literature reviews suggested that only two published South African multidisciplinary studies had included hospital staff respondents. These studies were conducted by Shadwell et al. (2000) and Schlebusch et al. (2000). According to Levi (1990) action-orientated multidisciplinary research on socioeconomic and environmental determinants of health is required to identify cost-effective intersectional health actions and train health professionals making them aware of relationships between environments, lifestyles, and health. Previous research has provided information on "the psychosocial occupational environment-stress-health system, but only in bits and pieces" (Levi, 1990, p. 1143).

The current cross-sectional descriptive study was conducted at six KwaZulu-Natal South Africa hospitals, investigating the biological, psychological and sociophysical factors that may contribute to hospital staff concerns. Adkins (1999) concludes that occupational health psychology includes public health, psychological, medicine management, and occupational health and safety. The present study has links to occupational health psychology.

Schlebusch (1998) and Stokols (1992) suggest that stress which is inordinate, prolonged and severe may overwhelm an individual's adaptive capabilities resulting in psychological, biological (disease) and sociocultural problems. The current research also follows the theory that human functioning is an interaction of biological, psychological and social factors.

A previous study undertaken in the city of Valencia in Spain, evaluated nursing staff stress and indicated that a higher-level exposure to work stress factors lowered the psychological welfare among nursing staff (Escribà, Más Pons, & Cárdenas Echegaray, 2000). O'Leary (1990) and Schlebusch (1998) suggested that acute and chronic stress has the potential to impact on the immune system. Schlebusch (2000) suggested that when people fail to cope with stress, their health and performance might be negatively affected.

According to Harris (2001) tobacco smoking can be included as a link to health compromising behaviours due to stress. The incidence of tobacco smoking by hospital staff was also considered important to include in the current research as it is a major cause of lung cancer (Behera, 2004; Chest X-ray, 2004; eMedicine consumer health, 2004; American Lung Association, 2004). Farrow and Samet (1991) reported that smokers may be more susceptible to cancers, cardiovascular, and nonmalignant respiratory diseases. Furthermore, more than 4500 toxic compounds exist in tobacco smoke aerosols of which sixty are known or suspected human carcinogens (Gold, Naugle, & Berry, 1993). According to Sextro, Reijula, and Hyvärinen (2000), environmental tobacco smoke is a common indoor pollutant and a major source of particles and non-radioactive carcinogens. The Surgeon General of the USA has recently added acute myeloid leukemia and cancers of the kidney, cervix, stomach and pancreas to the list of diseases caused by tobacco smoking (Keepmedia, 2004). This current research intended to establish the proportion of hospital staff that smoked tobacco at the time of the study.

Burton (1991) suggested that poor indoor air quality may also have a psychological association but did not clarify this conclusion. As long ago as the 1970s, buildings had been associated with illnesses which related to poor indoor air quality (London Hazard Centre, 1990). The London Hazard Centre (1990) suggests that people become tense when they are unable to control their environment.

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1948). The World Health Organisation (2000) reported that, "Indoor air quality (IAQ) is an important determinant of population health and wellbeing" (p. 1). Gaynor (1993) suggested that evaluation of indoor air quality includes physical, chemical, biological and social effects. Physical factors consist of temperature, humidity, air movement, noise, light and dust. The present research attempts to investigate certain of the potential influences in hospital environments.

Durban experiences climatic conditions consisting of high relative humidity and temperatures. These may assist in fungal growth proliferation. Fungal growth may cause allergies and is a building contaminant indicator. Previous research had reported fungal contamination of air filters in American hospitals and confirmed the colonisation of filters by various species of fungi that included *Aspergillus, Cladosporium*, and *Penicillium* spp (Simmons, Price, Noble, Crow, & Ahearn, 1997).

Singh (1994) suggested that setting fungal air quality standards for buildings may not be possible as not all organisms have the same allergic potential and some may not be harmful to health. Singh (1994) concludes, "Constitutional predisposition to allergy in the exposed person may be more important than the concentration of spores to which they are exposed." Flannigan and Miller (1994) suggested that fungi such as *Cladosporium, Aspergillus* and *Penicillium* spp have caused allergies in the indoor environment. Bryant (2001) suggested that the common allergy provoking moulds in South Africa includes *Cladosporium, Aspergillus and Penicillium* spp. These moulds may cause relatively mild allergic responses that can lead to more serious health effects. Fouad, Baird, Donn, and Isaacs (1996) reported that mixtures of fungi up to 150 CFU/m^3 from indoor sources should be acceptable unless *Aspergillus* spp are present. Not all allergic reactions are caused by mould alone. House dust mites cause the most allergies in South Africa followed by pollen, cats and cockroaches (Bryant, 2001). In the current study dust mite and cockroach allergy were also investigated. Gill and Wozniak (1993) suggested that bacteria and fungi could spread through air supply systems and may be aggressive to people with reduced immune system resistance. Even though the current study was limited to hospital staff fungal data would be of general interest to hospital infection control personnel.

Apart from using visible dust as an indicator of maintenance and hygiene it was deemed important to use respirable particulate levels as a clean room indicator for the hospital environments. Gaynor (1993) suggests, "The cost of one sick day due to an indoor air quality problem can equal the cost of energy for that one person's space for up to six months."

There are many possible stressors that may be present in hospital environments. The following four hypotheses will form the basis for the current study:

(a) It was hypothesised that hospital staff in provincial type hospitals would experience more biopsychosocial stress than hospital staff in missionary and private hospitals. More than 50% of all hospital staff would report that they were experiencing more biopsychosocial stress reactions.

(b) It was hypothesised that a greater proportion of provincial hospital staff would express concerns about indoor environmental factors than hospital staff in the missionary and private hospitals. More than 50% of all hospital staff would be concerned about indoor environmental factors with more than 20% reporting SBS symptoms.

(c) It was hypothesised that air conditioning ventilation inlet and extraction outlets would be the main source of indoor fungi when compared to other surface fungal sources.

(d) It was hypothesised that certain viable fungi isolated from indoor hospital environment surfaces and hospital indoor air would be potential allergens, pathogenic (disease causing) or mycotoxin producing (immune suppressive and toxic) and would be a potential health concern to allergenic hospital staff.

The objectives of this research included the following procedures.

Biopsychosocial aspects

- To establish whether respondents from all hospitals are reporting significant proportions of stress reactions.
- To establish whether there are stress reaction associations between the hospital types.
- To establish the reliability of the South African the Stress Symptom Checklist (SSCL).
- To validate the Stress Symptom Checklist and to consider its usefulness as an instrument for hospital research.

Fungi and allergy aspect

- To sample surface and airborne fungi using an indoor monitoring system that was designed to establish the presence of fungal contamination and the sources of fungi in hospitals. The methodology could be used in future hospital research and for improvement of maintenance programs.
- To assess allergy as a potential health issue for hospital staff.

Staff indoor air quality perceptions and indoor air monitoring

- To establish hospital staff perceptions and concern regarding hospital indoor environmental conditions and the effectiveness of building maintenance programs.

- To establish a methodology for assessing air quality in hospitals which could be used for future hospital research and hospital maintenance programs.
- To assess particulate levels by real-time analysis and develop a method of classifying hospital air cleanliness.

In conclusion, this research may assist in promoting a better understanding and awareness of biopsychosocial stress reactions in hospital staff. It may assist in establishing hospital staff concerns relating to poor indoor air quality including poor ventilation, discomfort due to temperatures, relative humidity, air movements, lighting, noise and lack of control over the indoor environment. Furthermore, it considers allergies caused by indoor pollutants such as fungi, dust mites and cockroaches.

Scope of research

"The work environment can feature prominently in stress at all levels of all job descriptions" (Schlebusch, 2000, p. 81). "Psychological stress is neither solely in the environment itself or just the result of personality characteristics, but depends on a particular kind of person-environment relationship" (Lazarus, 1999, p. 28-29).

This current descriptive research was aimed at establishing staff concerns regarding biopsychosocial stress reactions and physical indoor environmental staff concerns relating to indoor air quality, discomfort and the potential health implications of fungi. As a cross-sectional study, it aims at establishing associations between variables at a point in time. It does not attempt to establish causality.

Stress may lead to various illnesses such as depression, headaches, anxiety, tension and heart disease, which in turn can result in various behavioural effects such as irritability, tendency to over-indulge in smoking, alcohol and/or drugs, difficulty in sleeping, concentration loss, lack of ability to deal calmly with everyday situations, deteriorating relationships at home or work, impaired perceptions, concentration, memory, judgment, decisiveness, accuracy, motivation and creativity (Harris, 2001; Schlebusch, 2000; Schlebusch et al., 2000; Stokols, 1992). Implications of this are that there would be impacts on work performance in hospitals should this research find that staff are experiencing discomfort in their work environments. Staff concerns may be as a result of poor indoor air quality including poor ventilation, discomfort due to temperatures, relative humidity, air movements, lighting, noise, lack of control over the indoor environment and allergies caused by indoor pollutants such as fungi, dust mites and cockroaches. Particulate levels were also used as an indicator of hygiene (London Hazard Centre, 1990; Gaynor, 1993; American Society of Heating, Refrigerating and Air-conditioning Engineers [ASHRAE], 1992; American Society of Heating, Refrigerating and Air-conditioning Engineers [ASHRAE], 1999).

In the present study, a stressor can therefore be any event, situation person or object that a person perceives as being stressful and has difficulty in coping with that can result in negative stress (Schlebusch, 2000; Lefton, 2000). For the purpose of this research, stress was defined as "a multifaceted construct encompassing a person's physiological, psychological and behavioural responses when seeking to adapt and/or adjust to internal and/or external pressures or demands associated with change and its perception" (Schlebusch, 2004, p. 326).

The researcher also recognises the importance of gathering tobacco smoking data as smoking is widely considered an important lifestyle concern and a serious health impactor (Stokols, 1992; Schlebusch, 1990; Behera, 2004; Shadwell, Schlebusch, & Van Niekerk 1996a).

From this study, the development of a cost effective indoor air quality/hygiene survey method for South African hospital environments would be possible.

General limitations of the research

There are many potential impactors existing in workplace environments. The number of hospitals chosen, work areas in the hospitals selected and the range of stressors were limited for practical and economic reasons. Six hospitals were used in this research: 2 public hospitals, 2 missionary type hospitals and 2 private hospitals. Initially control venues were the provincial hospitals. It was presumed that provincial hospitals would have a poorer maintenance program and provincial hospital staff would report a greater proportion of indoor environmental and biopsychosocial stress reaction concerns than the other 2 hospital types. This hypothesis was proposed after the researcher had conducted personal observations during preliminary inspections of hospital environments. However, research results would indicate that this hypothesis could not be unilaterally applied due to the complexity of indoor environments and varying perceptions of the staff. In this research, it would not always be possible to suggest specific cause and response relationships. For example, sick building syndrome symptoms may be caused by various indoor environmental factors that have a synergistic affect on building occupants (Burton, 1991).

Allergy tests were conducted using commercially available allergy test kits. Ideally, it would be more accurate to produce allergens from locally found fungal sources. However, this was not practical or financially feasible.

During the planning of this descriptive study a maximum of 300 respondents were considered as desirable. However, based on logistics, cost of the project, time and availability of respondents, 280 were acquired.

Review of literature

Search basis

The overall aim of this literature review was to illustrate indoor air and psychological stress research previously undertaken in hospitals and other similar environments. In part, this review was to underpin the present research but also to consider shortcomings of previous research. The literature was used along with methodologies previously developed by the researcher to design a multidisciplinary approach.

Databases included books, technical reports, journal articles, conference proceedings, agency publications, equipment manuals, magazine articles and personal communications. Search sites included Medline, Sabinet, and Internet searches.

Information searches were initially conducted using the following appropriate key words:

- Biopsychosocial factors, emotion, human immune functions, health psychology, stress, occupational health nursing and occupational stress, nursing stress, stress in hospital staff, perceptions of indoor environments, perceptions of stress, hospitals, and psychological stress.
- Allergy, skin prick test, dust mites, cockroaches, asthma, hospital infection control, and the Allergy Society of South Africa.
- Fungi, mould, mold, fungal colonisation of air conditioning systems, air monitoring of fungal spores, mycotoxins, fungi and allergies, moisture control in buildings, temperature and relative humidity.
- Indoor air quality, carbon dioxide levels, temperature, relative humidity, air movement, air filters, air conditioning systems, building maintenance plans, respirable dust, indoor comfort, particulates and sick building syndrome.
- Attempts were made to link these key words to hospitals.

Indoor air quality literature was acquired from recent indoor air conference proceedings and books. Limited resource material was reported on hospital environments. Psychological literature was gathered from books and journals focusing on biopsychosocial stress.

In summary, it appeared that limited multifactor research has been undertaken in hospitals and no published South African articles were found which covered research of this nature at the time of this research.

Scope of information

Table 3 describes personal and environmental factors in health and illness considered in this project. Other factors may have existed that could have been included in the current study but this was not possible due to costs and practical reasons. For example, volatile organic compounds emissions occur when ductwork and surfaces are highly contaminated with mould. Chemical analysis was out of the scope of this research. There are many other micro-organisms that may be present indoors. Fungal contamination was viewed as an indicator that other microbes may also be present.

Relevant literature

A cross-section of literature was consulted. The literature review included:

- A discussion on basic theories of the major focal research areas.
- Recent research findings that support the necessity for this research.
- Limitations of earlier studies.
- Key literature inputs for research design.

Theory of stress

The use of the term 'stress' tends to be imprecise (Sharpley, 1996; Malim & Birch, 1998). Schlebusch (2000) states that in physics, the original meaning of 'stress' was 'force'. The terms 'stress', 'strain' and 'load' are used to describe physical force. Application of continuous physical force leads to increased stress. This concept has also been applied to the study of stress in humans. Schlebusch (2000) concludes that stress comes from outside as well as internally and these effects, if not controlled, may impair psychological and physical well-being. Stress can therefore be considered as a relationship between an individual and the environment (Lazarus, 1999; Schlebusch, 2000). Stress can be perceived as "a non-specific response to real or imagined challenges or threats" (Lefton, 2000, p. 488). For stress to be experienced the individual needs to consider that the environment poses a threat to well-being (Lefton, 2000; Schlebusch, 2000). Furthermore, the effect of stress on one's well-being can occur when environmental demands exceed a person's means of coping (Schlebusch, 2000; Lazarus & Folkman, 1984). When this occurs the impact of stress can eventually "lead to discomfort, mental or physical disorders" (Schlebusch, 2000, p. 4). In addition, adverse environmental conditions may have negative implications for an individual's health and for the workplace (Schwarzer & Schulz, 2003). Stressful life events can be associated with tobacco smoking, increased alcohol use, lack of exercise, sleep deprivation; cardiovascular and endocrine reactivity; depressed moods, increased anger and anxiety (Schwarzer & Schulz, 2003). Furthermore, when stress becomes chronic it may lead to health effects such as immune suppression, cardiovascular problems, hormonal imbalance and gastrointestinal problems (Schlebusch, 2000).

The current hospital study considers respondent perceptions of indoor odours, stuffy air, SBS symptoms, temperature, humidity, air movement, lighting, poor cleanliness, ventilation system maintenance, life events, daily hassles and work that may affect well-being (Legeron, 1993; Schlebusch, 2000; Malim & Birch, 1998). These conditions may disrupt human behaviour and reported concerns may be an indication that disruption has occurred (Van Egeren , 2000). In the present study, a stressor can be any event, situation, person or object that the respondent perceives as being stressful and has difficulty in coping with resulting in negative stress (Schlebusch, 2000; Lefton, 2000).

Wyon, Fisk, and Rautio (2000) suggested that good working environments provide well-being, inspiration and comfort for users. When this does not occur, a person may perceive that control of the situation or environment has been lost (London Hazard Centre, 1990). Hence, the hospital research is based on the belief that there may be a strong link between stress appraisal and coping (Lazarus & Folkman, 1984).

In conclusion "knowledge of stress is one of the most powerful tools you can have, along with adequate stress management skills" (Schlebusch, 2000, p. 3). Gaining an understanding of both the psychological and indoor environmental routes that may tax coping abilities may assist in providing a better understanding of hospital staff needs in the current study. For the purpose of this research, stress was defined as "a multifaceted construct encompassing a person's physiological, psychological and behavioural responses when seeking to adapt and/or adjust to internal and/or external pressures or demands associated with change and its perception" (Schlebusch, 2004, p. 326).

Theory of fungal growth

Gill and Wozniak (1993) indicated that microbiological indoor air quality is an emerging field. Mould can grow on a natural substrate and manufactured materials or on laboratory culture media (Onions, Allsopp, & Eggins, 1981). In the early stages, visible growth cannot be seen with the naked eye (Onions et al., 1981). Mould colonies observed under a low powered microscope will show a network of fine filaments, each filament is termed a hyphae or tissue (Onions et al., 1981). According to Onions et al. (1981) hyphae are collectively called mycelium (a fungus or wart). Some hyphae grow along the surface of substrate, some penetrate the surface and others may stand above the surface giving a hairy fluffy appearance (Onions et al., 1981). Microscopic examination will show reproductive bodies on the hyphae, called spores (Onions et al., 1981).

Spores can affect human health. A.L. Pasanen, P. Pasanen, Jantunen and Kalliokoski (1991) suggested that air movement aids the release and dispersal of fungal spores into the air. *A. fumigatus and Penicillium* species spores are released in great numbers at .5m/s, with a higher number of *Cladosporium* species spores being released at 1m/s. Other indoor climatic factors that influence the germination of the spores are relative humidity and temperature levels (Singh, 1994). Singh (1994) suggested that water is critical for the development of fungi in buildings. Water damaged surfaces such as ceilings and wall surfaces are major growth points. Bathrooms and sections of the ceilings where there is a lack of adequate air circulation encourages fungal growth (Singh, 1994). Relative humidity above 65% supports fungal growth. In general, fungi enjoy 70% relative humidity and temperature ranges from 15 to 20^0C but many will grow in temperatures up to 30^0C and as low as 10^0C.

Nevalainen, Johanning, Reponen, Reijula, and Husman (2000) and Trechsel (1993) concluded that indoor air complaints, linked with moisture damage, may result in unpleasant odours due to mould release of volatile organic compounds. Ninomura and Cohen (1999) suggested that odour is not something that a person can get used to. In hospitals, odours may not be just related to mouldy conditions and may be related to human body wastes.

In conclusion, there may be many non-specific health complaints associated with indoor moisture and mould. Causal agents may include *Cladosporium, Aspergillus, Penicillium, Mucor, Fusarium, Trichoderma and Rhizopus.* Mycotoxins are toxic metabolites of fungi and their health effects are gaining more recognition (Nevalainen et al., 2000). Health effects may include cold and flu-like symptoms, tiredness, sore throat, headache, fatigue, diarrhea, dermatitis, and skin irritation, impaired immune function, neuromuscular disturbances, rhinitis and pneumonia (Nevalainen et al., 2000).

As previously stated this research focuses on hospital staff reactions. However, its importance to hospital patients needs to be mentioned. Bex, Mouilleseaux, Causse, and Squinazi (2000) and Singh (1994) suggest that immunodepressive patients can be severely threatened by nosocomial infections. These could be from pathogens such as invasive *aspergillosis*. Govender, Rajoo, Goga, and Charles (1991) reported that *A. fumigatus* can cause osteomyelitis of the spine. Singh (1994) advised that A. *fumigatus* had colonised pigeon droppings in an exhaust duct of an air conditioning system and had blown into a renal unit and wards. A higher than normal level of this fungus was found in patient sputum. Pigeons have also been responsible for causing alveolitis (Husman, 1996). It is interesting to note that pigeons were found harbouring in an open ceiling immediately adjacent to a ward in missionary hospital 2.

Theories on the health effects of poor ventilation and discomfort

Smoky effects of fireplaces in sealed rooms were considered a health problem during the 1700's (Burton, 1991). Burton states that during the last half of the 70's and during the 80's buildings were designed to minimise air handling costs by reducing outside air which tended to result in discomfort and health complaints by building occupants. Shaughnessy and Truter (1995) concluded that studies indicated the quality of indoor air to be poorer than outdoor air. This is important to consider as the majority of people spend up to 90% of their time indoors. Furthermore, the importance for businesses to ensure that indoor air quality is acceptable can be related to three economic reasons: lost productivity, direct medical costs and damage to materials and equipment (Shaughnessy and Truter, 1995).

To conclude, the London Hazard Centre (1990) suggests that SBS may result from non-specific causes present in the work environment. SBS symptoms include eye and nose irritation, runny or stuffy nose, fatigue, headache, nausea, sore throat and general respiratory problems (London Hazard Centre, 1990). Microbes and/or chemicals can exacerbate indoor air concerns. In the case of microbes, an effective or allergic reaction can occur in sensitive individuals (London Hazard Centre, 1990). The most common microbial caused health reactions are itchy, congested or runny nose, itchy watering eyes, and occasionally wheezing, tight chest or flu-like symptoms (London Hazard Centre, 1990). London Hazard Centre (1990), ASHRAE (1999) and ASHRAE (1992) provide criteria for assessing indoor quality. Along with health symptoms, poorly controlled indoor climatic conditions can effect human comfort and cause conditions that favour microbes. In both ASHRAE documents it is stated that that 80% or more of the occupants must be satisfied with environmental conditions for acceptable indoor air quality and thermal comfort to exist.

Current research findings

Psychological stress

Schlebusch et al. (2000) suggested that stress is a major problem in South African society and stress levels are exceptionally high. This phenomenon was reported as being similar in the USA where it is estimated by the National Institute of Mental Health that about 25% of the Americans aged 25 to 55 (the prime working age) suffered psychological disorders with hospital staff having to cope with stressful work situations NIOSH (1988) and Schwam (1998). Quine (1998) suggests that stress is an inevitable part of life in hospital service and prolonged stress may lead to mental and physical health problems. In South Africa, psychological disorders, health risk behaviours, suicide and unhealthy lifestyles are the major risks (Schlebusch et al., 2000). Individuals not coping with stress may experience reduced immune response and this may make individuals more prone to colds and influenza (Bower, 1999; Glaser, 2000; Mikkelsen & Saksvik, 1999). Stress was also linked to job dissatisfaction, poor performance, high absenteeism and a range of illnesses such as skin rashes and asthma (Quine, 1998).

Payne and Firth-Cozens (1987) cited in Quine (1998) reported that health professionals have to deal with extremely stressful situations involving death and suffering. This appears to indicate that health professionals face demands that other occupations do not (Quine, 1998). Kipeläinen, Koskenvuo, Helenius, and Terho (2002) stated that there may be associations between stressful life events with asthma, allergic rhinoconjunctivitis and atopic dermatitis.

Harris (2001) and Schlebusch (2000) suggest that poor physical work environments may increase staff stress levels. A study by Berglund and Gunnarsson (1999) concludes that individuals who are psychologically stressed may be more sensitive to environmental stressors. Berglund and Gunnarsson (1999) proposed that new Sick Building Syndrome models need to be developed that explain SBS as a function of interactions between environmental (e.g. physical and chemical), individual (e.g. allergy) and psychological factors.

Lahtinen, Huuhtanen, Kähkönen, and Reijula (2002) concluded that solving an indoor air problem is not only a technical question but must establish group concerns, encourage social interaction and co-operation, and recognise strong emotions with interpersonal conflict that may exist.

This research and previous research has highlighted the importance of evaluating stress using the biopsychosocial model. However, the research will also examine other potential indoor air staff concerns that may add, or cause stress as was suggested in previous research (Shadwell et al., 1996a; Shadwell, Schlebusch, & Van Niekerk, 1996b).

Previous South African indoor air research had suggested that respondent stress may be caused from exposure to excessive indoor pollution and noise (Schlebusch, 1998; Shadwell et al., 1996a; Shadwell et al., 1996b).

In conclusion, hospitals are complex environments, having various indoor conditions that may affect occupants and visitors (International Society of Indoor Air Quality and Climate, 2000).

Fungi and other allergens

Several studies by Garrett, Rayment, M. A. Hooper, Abramson, and B. M. Hooper (1998), Whillans (1996), Must, Möller, and Land (1996), and Morey (1996) concluded that the impact of micro-organisms in buildings can be increased due to design problems, leakages, water damage and poor ventilation system maintenance. Malveaux and Fletcher-Vincent (1995) consider it important to initiate and maintain surveillance of individuals and groups who may be at risk of exposure to allergens and irritants. Bryant (2001) reports that the Allergy Society of South Africa list the following fungi as the most common allergy provoking moulds in South Africa: *Alternaria*, *Cladosporium*, *Epicoccum*, *Aspergillus*, and to a lesser extent *Penicillium*. Immune systems of people who are allergic to moulds release histamines and a number of irritative and nonspecific symptoms may occur such as breathing difficulties, stuffy nose and mucous membrane irritation, sneezing, dry cough, irritation of the eyes, skin or nasal itching and dryness, prolonged sore-throat, hoarseness, chest discomfort, vomiting, backache, joint pains, and low-grade fever. Various fungi are known allergens, which can cause type-1 allergic rhinitis, asthma and allergic conjunctivitis (Nevalainen et al., 2000). There may be more severe reactions such as headaches, nausea, fatigue, weight loss, asthma, inability to concentrate and respiratory failure Bryant (2001). Poor health may result in increased absenteeism and a lower performance in hospital workers. Nevalainen et al. (2000), state that indoor fungi do not normally cause primary infections but may facilitate secondary type infections by reducing immune response. Although this research focuses on staff stress it is important to mention the findings of Neumeister-Kemp, Floss, Kemp, Nickelmann, and Martiny (1999) that fungi are able to survive, grow and possibly even proliferate in hospital mattresses which can elevate the incidence of *A. fumigatus* infection in patients. Table 1 describes examples of various fungal species along with other allergens and their potential health effects (Gill and Wozniak, 1993; Nevalainen et al., 2000; Husman, 2000; Smedbold et al., 2002; Smedbold, Ahlen, Norbäck, & Hilt, 2001; Harrison, 1999).

Table 1

Examples of fungi species and their potential health effects.

Organism	Health Effects
Cladosporium	Allergic response, atopy is common. May cause bronchospasm production in asthmatics, saprophytic, allergic conjunctivitis, type-1 allergic rhinitis.
Aspergillus	Allergic responses; Produce mycotoxins; A *flavus* produces at least 4 aflatoxins, demonstrated to be mutagenic. A *niger*, A *versicolor* and A *flavus* are considered pathogenic. Their presence in significant volume >500 cfu/m^3 is sufficient to render a building dangerous for routine habitation. *Aspergillus* can causes allergic conjunctivitis, type-1 allergic rhinitis.
Penicillium	Allergic responses.
Fusarium	Keratinogenic and compromised skin. For example, burn patients may develop *Fusarium* infection. Opportunistic infections.
Rhizopus	Allergic reaction.
Mucor	Allergic reaction.
Dust mites	Are ubiquitous. Atopic allergic response.
Cockroaches	Atopic allergic response to microscopic parts released though natural metabolism.

The potential allergen related health effect, listed in Table 1 support the suggestion by the Allergy Society of South Africa (2002a) that mould should be removed from indoor environments as much as possible.

Dust mites are usually associated with dust from beds, upholstered furniture and carpets. Dust mite faecal fragments are sized at 10 to 40μm, which can be suspended in the air following cleaning and other dust raising actions (Flannigan & Morey, 1996; Masuda, 1996). Dust mite faeces are rich in allergens. It has been proposed that microbial studies should concentrate on indoor dust that can harbour large numbers of microbes and dust mites (Flannigan, Vicars, S. Pasanen, & P. Pasanen, 1994). According to Allergy Society of South Africa (2002b), mites grow readily in humid areas such as the South African coastal areas. Papale, Draicchio, Baccolo, and Palmi (2000) undertook a study of the allergic effects of indoor air in a mechanised sorting office and concluded that most forms of asthma and rhinoconjunctivitus were linked to mites. Skulberg, Skyberg, & Kruse (1999) also suggested that dust mites can cause mucous membrane complaints amongst office staff.

Cockroaches, according to the Allergy Society of South Africa (2002c), are recognised as being important indoor allergens and cockroach allergies are common in South Africa. "In the Durban area, cockroach allergy is present in 80% of asthmatic children" (Allergy Society of South Africa cockroach allergy, 2002c, p. 1). Furthermore, the Allergy Society of South Africa suggests that 40% of allergy patients in KwaZulu-Natal and the Western Cape of South Africa are allergic to one or more inhalant allergens and sensitive to cockroach allergens. These allergens are linked to proteins found in the cockroach's body, saliva, remains and dried faeces. The Allergy Society of South Africa (2002c) also advises that cockroach antigens can cause ongoing airway inflammation in certain asthmatics. The Allergy Society of South Africa (2002c) recommends that people who are allergic to cockroaches should take steps to avoid exposure in their home and workplaces.

In the light of these findings, the current research included allergy testing. An allergy questionnaire was developed to establish the incidence of allergy amongst the hospital staff. The current research assumed that dust mites and cockroaches may have been present in the hospital environments studied. The current research recognised that humid warm environments in Durban may have supported these allergen sources.

It was the contention of the researcher that mouldy conditions existing in hospitals could have been avoided and therefore were an unnecessary potential health risk to all occupants. Mouldy surfaces may also be a possible indication that maintenance personnel were not aware of or had not prioritised the removal of this risk. Mould presence was a confirmation, in part, of a poor maintenance program. According to Morey, Hyvärinen, and Meklin (2000) dampness and mould growth may be strongly linked with health symptoms of people occupying water damaged buildings. If a building is suspected of being moisture or mould damaged, a building inspection is a hands-on means of locating problem areas. Flannigan and Morey (1996) suggest that normally buildings with HVAC systems should have lower concentrations of indoor mycobiota than outdoor air and naturally ventilated buildings. A problem occurs when the balance changes or there is a presence or dominance of toxigenic or allergenic species which can lead to a deterioration of indoor air quality (Flannigan & Morey 1996). Their report suggested that attention be given to removing damp materials such as carpets, ceiling tiles, gypsum board, and wet ducting insulation that will sustain mould growth. Flannigan and Morey (1996) state "microbial aerosols emanating from growths on wet or moist materials in the HVAC system may thus be an important factor associated with the etiology of some sick building syndrome symptoms" (p. 26). Nordström, Norbäck, and Wieslander (1999) concluded in their hospital study that common complaints were reported about dry and stuffy air along with SBS symptoms that were found to be more significantly related to damp buildings.

Flanningan and Morey (1996, p. 41) highlighted the importance of mould control and removal criteria are presented in Table 2.

Table 2

Guidelines for Cleanup of mould on surfaces in buildings

Extent of visible contamination	Type of cleanup activity
< .2 m^2	Remove contaminated material with minimum dispersal of spores; use disinfectants locally.
.2- 3.0 m^2	Local containment is required; use HEPA vacuum cleaner to contain dusts and spores.
> 3.0 m^2	Fully contain and negatively pressurize contamination area; use personnel trained in handling of hazardous materials for cleanup.

When the removal of small areas (.2- 3.0 m^2) of mouldy water damaged material occurs, building maintenance personnel must wear appropriate respiratory protection (Flanningan & Morey, 1996). They emphasis that the urgency of a cleanup depends on toxigenicity of moulds present on surfaces. For example, *Aspergillus versicolor and Trichoderma* contamination would require immediate removal as they produce mycotoxins (Husman, 2000). Safety measures are also necessary when immunocompromised, asthmatics or people with respiratory disorders occupy these areas (Flanningan & Morey, 1996). Eradication of mouldy conditions in hospital environments would therefore need prioritising to protect staff and patients.

Gill and Wozniak (1993) stated that there are over 2000 recognised air borne pathogens and suggest that visible microbial growth such as fungi, mildew, and the accumulation of dust are sure indicators of other sub-micron sized pathogens such as bacteria and viruses.

The current research was aimed at developing a cost effective building survey method using fungal contamination as a maintenance and microbial indicator. Identification of common moulds existing in Durban hospitals and the development of a detection method were deemed to have practical applications in highlighting conditions that need attention and facilitating a safer hospital environment. These methods can be applied to similar work places.

According to Bryant (2001) one in five South Africans suffer from some type of allergy. The Allergology, Diagnostic and Clinical Research Unit of the UCT Lung Institute South Africa estimates that approximately 30% of the people referred to the unit are affected by mould allergies. Bryant (2001) concludes that the mould problem in South Africa is unclear as not all sufferers seek medical advice or have easy access to medical care. Water damaged work environments have a potential to support allergens which may aggravate this ailment.

In conclusion, the importance of providing hospital staff with a safe work environment is also an ethical issue. Many patients are immunocompromised and awareness of the hazards related to the release of fungal spores during repair, maintenance and construction times in hospitals is important (Kalliokoski, Luscuere, & Mc Carthy, 2000). A clear understanding of the types of fungi present, their sources and the potential for physical and psychological impacts on humans will provide a better understanding of the need to implement intervention methods to reduce allergy potential.

Indoor air quality and discomfort

Lack of control of the work environment and indoor environment concerns need consideration as people are spending more time indoors and are becoming progressively more sensitised to indoor environmental issues (Patterson, 1991). Although workplaces are designed with the intent to provide health and comfort there are factors that impact on occupants. According to Patterson (1991) the most important factors may be comfort, ergonomic issues and poor air quality. These factors may include a lack of control of temperature, lighting, air supply systems and indoor pollutants (London Hazard Centre, 1990). Levi (1990) suggests that workplaces have been designed considering, almost exclusively, efficiency and cost, which has resulted in the long-term disadvantages of staff dissatisfaction, alienation and ill health. According to the London Hazard Centre (1990); Burton (1991); Hodgson and Storey (1994) environmental stressors may have a subtle indirect effect in that when people cannot control their environment, they may become tense.

Raw (2000) suggests that the primary concern should be the impact that an indoor environment may have on people. He suggests that there are ways to establish problems such as health reactions that may be identifiable illnesses or non-specific responses, comfort and/or productivity issues. The current research followed the principles suggested by Raw (2000) that "criteria for good IAQ will often find expression in objective measurements such as pollutant levels or ventilation rates, but the basis for the criteria is human response" (p. 41).

In a non-industrial work environment pollutants and comfort issues are normally less pronounced and effects are subtle. Hospital workers dissatisfied with their work environment become instruments for problem detection. In addition to considering staff concerns, indoor air quality monitoring was used to provide baseline data for Durban hospital environments. Raw (2000) suggests that although it is not always possible to discover specific causes of health symptoms in non-industrial buildings, acquiring knowledge through studies assists in establishing preventative and remedial measures to improve hygiene practices. Inadequate maintenance in hospitals may also be a factor that raises staff concerns (Gill & Wozniak, 1993). The Swedish Government Commission also suggest that poor hospital working conditions can affect staff health (Levi, 1990). Koran, R.H. Moos, B. Moos, and Zasslow (1983) were able to improve a burn unit work environment by encouraging nursing staff to assess and change their work environments by reporting both on conditions causing concern and those which were acceptable. According to Stokols (1992) "several studies suggest that individuals' physical and emotional well-being are enhanced when environments are personally controllable and predictable" (p. 9). Stokols (1992) describes a complex model of personal and environmental factors in health and illness, which includes biogenetic, psychological, behavioural, geographic, architectural and technological, and sociocultural items that have the potential to impact on workers and cause stress. This approach follows the biopsychosocial principles that are the basis of the present research. Kalliokoski et al. (2000) state that while hospitals may have sophisticated, expensive ventilations systems, the overall designs are often poor and are not effectively maintained. The current hospital study included assessments of ventilation performance and considered air conditioning systems as a possible source of fungi and dust.

Flannigan and Morey (1996) state that the air-conditioning process is consistently associated with increased prevalence of work-related symptoms such as headaches, lethargy and upper respiratory irritation. They reported that a previous study concluded that gram-negative bacteria in building dusts have also been linked to symptoms such as headache, lethargy and upper respiratory irritation. Research has indicated that there are sufficient nutrients in dust to support bacteria and fungi growth under high humid conditions (Flannigan et al. 1994). Howieson and Lawson (1999) concluded that although higher ventilation rates may restrain mite colonies, in their lifespan they produce 60 times their body weight in dry faeces which accumulate and can still have an allergy impact. According to Nevalainen et al. (2000), toxic secondary fungal metabolites (mycotoxins) can be carried in the air by spores, mycelia fragments, toxins absorbed on to suspended dust particles and by settled dust. Skulberg et al. (1999) confirm that dust can cause mucous membrane complaints and found that cleaning operations reduced complaints. It was reported by Skyberg, Skulberg, Kruse, Huser, Levy, and Djupesland (1999) that cleaning intervention reduces nasal congestion. Bex et al. (2000), emphasis the importance of cleaning, disinfection and regular maintenance of indoor hospital installations which will reduce the opportunity for fungi multiplication or contaminated dust accumulation. The current research considered visible dust and monitored respirable particles in hospital environments.

Limitations of earlier studies

There were limited papers that provided a holistic approach to hospital staff and indoor environment evaluation. Most papers reviewed were useful reports focusing on specific indoor variables. The following papers assisted in developing and refining the current research approach.

The Swedish Government Commission concluded that the stressful nature of nursing working conditions could affect the health of nurses (Levi, 1990). Levi's paper reinforced the need for hospital environment research. Schwam (1998) concluded that nurses can be prone to emotional overload and may experience compassion fatigue emphasising the stressful role that hospital personal perform. Quine (1998) suggested that stress is an unavoidable part of hospital life and prolonged stress in these environments may lead to mental and physical health problems. Stress reduces immune response making individuals more prone to colds, influenza and other diseases (Bower, 1999; Glaser, 2000; Mikkelsen & Saksvik, 1999). The SSCL questionnaire was the instrument used for establishing the potential for stress reactions in hospital staff in the current study.

Apart from psychological factors, environmental contributors were considered an integral part of the current hospital research. A paper by Koran et al. (1983) suggested ways to improve a burn unit work environment through nursing staff assessments of their work environments. Apart from undertaking air quality measurements of hospital indoor air, the paper by Koran et al. (1983) confirmed the need to use questionnaires to establish hospital staff concerns.

Research by Simmons et al. (1997) reported on fungal contamination of air filters in hospitals in the United States of America and confirmed the colonisation of filters by various species of fungi. Gill and Wozniak (1993) suggested that bacteria and fungi can spread within the air supply systems in hospital environments and may impact on people with reduced immune system resistance. The research by Simmons et al. (1997) and Gill and Wozniak (1993) led to the consideration that air conditioning systems would be a major source of fungi in Durban hospital environments. Bex et al. (2000) reported that regular fungi sampling and collaboration between physicians, hygienists and building work engineers is important for hospital research. This emphasised the need to consider *Aspergillus* as an important fungi indicator in hospital environments, not only for staff but also for patient health.

A hospital study by Nordström et al. (1999) confirmed that common complaints were about dry and stuffy air and SBS symptoms relating to damp buildings. These findings emphasised the need to consider the occurrence of SBS in Durban hospitals and to establish the perceptions of hospital staff regarding the quality of air in their work environments. Odour evaluation was also included as part of the air quality assessment as according to Ninomura and Cohen (1999) odour is not something that a person can get used to. Although Ninomura and Cohen's study was conducted in nursing homes it was considered likely that similar odour problems may exist in hospital environments.

In conclusion, these findings were used for making assumptions for the present research. Kalliokoski et al. (2000) concluded that "Indoor air quality is more critical in hospitals and other health care facilities than in most other indoor environments. Nevertheless, its importance is not yet unanimously recognised" (p. 107). Kalliokoski et al. (2000) included the following recommendations, which are considered relevant to the present research:

- Expand existing research to include hospital specifics.
- Investigate the important issue of building related problems.
- Control opportunistic bacteria and fungi in rooms for immunosuppressed patients.

Key literature inputs to the survey design

This literature review and previous research (Shadwell et al. 2000) assisted in refining methodology.

- Use questionnaires for the evaluation of biopsychosocial stress, environmental stress including sick building syndrome and staff perceptions about their work environment and allergy assessment.
- Cold and influenza occurrence may be a useful indicator of health.
- Establishing the proportions of hospital staff that smoked tobacco as a lifestyle indicator would be useful to include.

- Particulate level assessment would be useful in establishing comparisons between various sections in hospitals and between the various hospitals in respect of air quality.
- Establishing a clear understanding of the types of fungi present by taking surface and air samples, locating potential fungal growth sources and evaluating the potential for physical and psychological impact on humans.
- Developing a cost effective building survey method for hospitals.
- Allergy testing would be necessary to establish the proportion of staff with allergies to fungi, mites and cockroaches in the hospital environment.
- Monitoring of humidity, temperature, air movement and ventilation performance in hospitals would be useful both from staff comfort and microbial growth perspectives.

Stokols (1992) provided several categories of personal and environmental factors that play a moderating role in human health. Personal factors included biogenetic, psychological and behavioural processes that can either promote or undermine wellbeing. The environmental factors included geographic, architectural and technological and sociocultural factors that influence health. Stokols (1992) considered it important not just to focus on modifying individual health habits and lifestyles but also to promote enhanced well-being amongst building occupants. Improving ventilation systems is an example of this approach (Stokols, 1992). Factors in Table 3 suggest that both the physical and social environment can function as media for disease transmission and as stressors (Skoloks, 1992). This model enabled the researcher to present the primary issues investigated in this study (see Table 2 of Stokols, 1992, for complete data). This information is summarised in Table 3.

Table 3

Personal and environmental factors in health and illness

Biopsychobehavioural			Sociophysical Environmental
Biogenic	Psychological	Behavioural	Architecture and Technological
Fungi	Lack of environment control	Smoking	Fungal surface and air contamination
Allergies	Biopsychosocial stress		Temperature and relative humidity
Physical discomfort			Poor air movement
			Indoor air pollution e.g. Sick Building Syndrome
			Carbon dioxide levels
Colds and influenza			Particulate levels
			Odour concern

Method

General approach

As discussed, there are likely to be many psychological and physical factors that can impact on hospital staff. Research indicates that these stressors may have a synergistic impact on hospital staff that may vary from individual to individual. Psychological and physical indoor air quality data were collected using questionnaires, by environmental monitoring and observations. Biopsychosocial stress reactions and indoor air quality questionnaires were administered to 280 respondents. Allergy tests and questionnaires were administered to 123 willing staff members.

- Questionnaires were selected and modified to acquire the perceptions of hospital staff as to their levels of psychological and indoor environmental concerns. A questionnaire was also developed to establish to potential for allergy in hospital workers.
- A monitoring system was designed to establish levels of carbon dioxide, temperature, relative humidity, air movement, particulate levels, and fungi as surface contaminants and their concentrations in indoor air and outdoor air.
- Observations were made regarding staff attitudes and general comments as well as recording visual impressions of hospital work environments. Photographs were taken of various unhygienic conditions.

Ethical approval to conduct the study was obtained from the Ethics Committee of the Nelson R Mandela School of Medicine (Ref: H115/99).

Hospital selection

Basic principles of hospital selection

Durban has 23 hospitals of which 30% (7) are provincial (public), 13% (3) are missionary and the remaining 13 (57%) are private. Approaches were made to all Durban hospitals that were in relatively close proximately to each other so that climatic conditions would be reasonably similar and psychosocial issues would be related to the Durban and greater Durban residential areas. During the initial approach, one private hospital refused access and one provincial hospital showed lack of interest. These two hospitals were not included in the final sampling frame. Six hospitals (30%) were randomly chosen and stratified from the eligible hospitals: two provincial (public) hospitals, two missionary type hospitals and two private hospitals. In each hospital the following areas were chosen to undertake the research: administration section, ICU, three general wards including the laundry and other related sections, pharmacy, CSSD area, kitchen and a theatre. The findings from this research may be applied to other hospitals in the Durban area. These findings will also provide useful baseline data for research in other hospitals in South Africa, irrespective of the climatic conditions. Furthermore, the methodologies developed will assist researchers in other parts of the world to set up methods for investigating hospital environments.

Control venues

The choice of control venues was initially based on the principle that private hospitals may have better maintained work environments and staff with lower stress concerns. Provincial hospitals were thought to have had a poorer maintained work environment with staff with a higher proportion of stress concerns. However, as the investigations proceeded it was found that these assumptions did not always hold true. The extensive numbers of variables demand that controlled conditions need to be carefully considered or artificially created to define and separate the various situations that occur in a hospital environment. In practice this was difficult to achieve. Although this was a limitation, the findings and methodologies developed in this research will assist greatly in designing future research proposals for South African hospitals.

Method of gaining entry to hospitals

Letters of introduction were designed explaining the purpose of the research and advising that data would be confidential (see Appendix A). Appointments were made with the management of each hospital and the research proposal was discussed. At the meeting it was requested that the researcher be permitted to arrange a preliminary walk-through survey of the hospital to obtain background information and pre-plan the monitoring program. A second letter was provided regarding this request (see Appendix B). Gaining access to each hospital required much negotiation and in certain cases there were delays of up to a month before final permission was granted.

Although the letters clarified the basic purposes of the research, conditions such as dampness and improving ventilation are not factors that are easily rectified and accordingly intervention methods in a short period would not be feasible.

Questionnaires

Biopsychosocial questionnaire objectives

No specific questionnaire was located that was designed specifically for hospital indoor air and/or biospychosocial stress assessments. McGill (1998), states that stressors and environmental demands can be physical, psychological or sociocultural. McGill (1998) concludes that these events can be divided into three classes, namely cataclysmic events, personal stressors and daily irritations. A questionnaire was required which included these events. A psychological questionnaire, 'Checklist of the General Symptoms of Unhealthy Stress' (The Stress Symptom Checklist), had been designed and previously published by Schlebusch (1997) and Schlebusch (2000) and based on stressors described in American Psychiatric Association (1994). This questionnaire covers physical, psychological and behavioural reactions (see Appendix C). It was considered important to use comparison questionnaires to establish the reliability of The Stress Symptoms Checklist (SSCL). Svebak designed the Tension and Effort Stress Inventory (TESI) in 1987 (see Appendix D). The TESI was designed using the assumptions regarding the structure and dynamics that give rise to the subjective experience of stress (Svebak, 1993). Section C of this scale was used in this research, which relates to moods or emotions in everyday life. This scale was considered to relate well to the psychological section of the SSCL. The Psychosomatic Ailments Questionnaire (PSYSOM) developed by Hinton and Rotheiler and was related to complaints of more than 1000 teachers that stopped work because of burnout (Hinton, 1991) (see Appendix E). The principle components of this scale were used which relate to the physical items of the SSCL. A 10 -point scale was used to rate the respondent's present intensity stress. This scale was used along with the SSCL by Schlebusch et al. (2000) as part of a double-blind, placebo-controlled, double-centre study. Respondents were requested to choose a number between lowest intensity '1' to highest intensity '10'. This scale was used as a comparison to the behavioural items of the SSCL.

The Stress Symptom Checklist (SSCL) and its scoring system

The SSCL was developed in a South African context by Professor L. Schlebusch (Schlebusch, 2004). This questionnaire has been used in previous research to assess stress in the South African situation (Schlebusch, 2004; Schlebusch, 2000; Schlebusch et al., 2000). The SSCL is composed of general signs and symptoms of unhealthy stress (Schlebusch, 2000). It involves the analysis of physical, psychological and behavioural reactions to stress and is based on the biopsychosocial model of stress. The questionnaire has 87 items and is divided into three categories: 18 physical items, 27 psychological reactions and 42 behavioural items (Schlebusch, 2004). This questionnaire was also used in previous preliminary research to assess stress levels of staff in the basement of a Medical Research Council clinic where HIV/AIDS research was conducted (Shadwell et al., 2000).

According to Schlebusch (2000) and Schlebusch (2004) the criteria to assess whether a respondent is considered stressed is based on adding the scores as discussed in the previous paragraph and a total score of 3 or more in any one of the biopsychosocial categories namely, physical, psychological and behavioural (see Appendix C), indicates a stress potential exists for that individual. Schlebusch (2000) specifies that an individual experiencing high stress scores "should take appropriate action" (p. 71). Hospital staff exhibiting stress should be provided with a support system to assist in stress reduction. A score of 3 or more was used for each of the three individual categories and a total score of 9 or more was used when all three categories were combined (Schlebusch, 2000; Schlebusch, 2004).

This checklist is comprised of general signs and symptoms of unhealthy stress based on symptoms contained in American Psychiatric Association (1994) diagnostic and statistical manual of mental disorders, where for example, anxiety and worry are associated with three or more symptoms from a list of only six symptoms.

Observations indicated that respondent stress scores ranged from below the criteria to extremely high proportion of stress reactions. Due to the varied range of scores it was decided to convert the stress scores into categorical data. Dichotomising the data was achieved by indicating scores less than the criterion of 3 or 9 equal to 0 (i.e. proportions stress reactions not considered as being significant) and score 3 or more and 9 or more as equal to 1 (i.e. indicating that the individual has reported significant stress reactions).

It was recognised that a limitation may be that coding the data in this manner may result in overstating or even understating actual stress concerns and may result in a lack of significant results. However, the aim was to separate the significant stress reaction group from the group with little or lower stress reactions.

Environmental questionnaire

The environmental questionnaire was modified mainly from a questionnaire designed by Construction Research Communications Ltd. (1995) entitled "A questionnaire for studies of sick building syndrome *A report to The Royal Society of Health Advisory Group on sick building syndrome*", using some ideas from Burr, Van Gilder, Trout, Wilcox, and Driscoll (1992) and questionnaires developed through the M.L. Sultan Technikon's Bachelor of Technology 1998 microbial research program which the researcher was responsible for. Raw (2000) emphasised the principles of data collection from building occupants. Raw's questionnaire construction concepts were built into the environmental questionnaire, which was adapted for use in the present research. The aim of this questionnaire was to acquire hospital staff comments on physical indoor stressors, to establish tobacco smoking habits, frequency of colds and influenza as an indicator of well-being, occurrence of allergies, feeling of lack of control over the work environment and other physical ailments (see Appendix F). The approach of examining "control" in this questionnaire agrees with recommendations by Folkman (1984) who concludes that perceptions of control must be examined by taking into consideration specific stressors to assist in determining the personal meaning or significance of control. Furthermore, the characteristics of the situation need to be assessed in order to establish the potential influence of stressors.

Allergy questionnaire

An allergy questionnaire was designed after referring to research by Randolph (1998) and research conducted by Gqaleni, Danaviah, Chuturgoon, and Dutton (1998). The purpose of this questionnaire was to establish the potential for allergic reactions. The questionnaire included characteristic itch (Baraniuk, Clauw, & Gaumond, 1998), which include itchy nose, skin, eyes, and roof of the mouth, ears and throat as indicators of allergy (Allergy Society of South Africa, 2002e). This questionnaire is found under Appendix G.

Application of the questionnaires

A letter of introduction explaining the purpose of the research was attached to the questionnaires (see Appendix H).

Respondent selection

Workers employed in the various sections of hospitals were not large in number. The highest populated areas tended to be administration and kitchen sections. In a missionary type hospital only one nurse was employed in the Special Care Section. When conducting indoor air research, low staff numbers for different sections of the hospitals was a limitation. Hence, the aim was to interview all willing staff members.

The interview

Although all staff spoke English certain terms in the psychological questionnaires may be considered difficult to understand. The questionnaire was translated by Zulu speaking staff in the administration section of the M L Sultan Technikon where the researcher was employed at the time. However, it was found that the translated questionnaires were not required as the staff were competent in understanding the questionnaires. During the interview the researcher explained the questionnaires and terms to make sure that a clear understanding was achieved. Additional information volunteered was recorded. Certain staff members were unable to complete their questionnaire at the time of the survey. Appointments were made and the completed questionnaires were scrutinized in the presence of these respondents and issues of concern regarding the questionnaire were dealt with. Respondents were required to complete only the summer sub-section of the 'environmental comfort' section in the HEPSA questionnaire along with all other sections.

Indoor air monitoring equipment and methodologies

The monitoring program was partly developed by the researcher to assess fungi, indoor air quality and psychological factors in the basement of the Medical Research Council clinic in KwaZulu-Natal, Durban, South Africa where HIV/AIDS patient research was conducted (Shadwell et al., 2000). Real-time analysis of carbon dioxide, temperature and relative humidity levels were undertaken both indoors and outdoors. Indoor air quality monitors were placed in the work environments in order to monitor temperature, relative humidity and carbon dioxide levels. A real-time particulate monitor was used to assess respirable particulates as an indicator of cleanliness. The indoor air quality monitors were placed away from the breathing zones of the occupants. Air movement assessments were undertaken indoors using a Kata thermometer, wet bulb thermometer and stop watch. This environmental monitoring system was used in previous research (Shadwell, 1995; Shadwell et al., 2000). Surface fungi and fungal bioaerosols were sampled as previously published (Gqaleni et al., 1998).

Fungal assessment

Purpose and methods

The purpose was to establish the main sources of indoor fungi. Furthermore, the research aimed at establishing the types of fungi present in the surveyed hospital environments and to consider their potential as fungal allergens, pathogens or mycotoxin producing fungi (immune suppressive and toxic). These processes could be used to develop methodology for future research, and hospital maintenance monitoring programs.

Streifel (1998) concluded that building management do not always correctly perceive the risks in health care facilities. When moisture and nutrients are present for more than 72 hours, spores will germinate and reproduce (Streifel, 1998). It was discovered from pre-inspections of the hospitals that there are many potential surface sources with environmental conditions favouring fungi growth. Streifel (1998) advised that when indoor loads exceed cooling plant capacity the relative humidity rises and condensation takes place on cooler surfaces and increases microbial growth.

Burge et al. (1989), Streifel (1998) and Streifel, Mazzarella, and Kline (1999) provided an insight to the potential sources of microbes in occupied spaces. These are summarised in Table 4. The table also includes conditions observed during preliminary surveys of hospitals and relates only to the areas chosen for study; namely, pharmacies, wards, ICU, CSSD, administration, kitchens and theatres.

Table 4

Potential fungal sources in hospital environments

Source	Cause	Potential areas
Water damaged soft carbonaceous material (including cellulose materials) that can absorb moisture e.g. gypsum boards	Occupied spaces where humidity is higher than 70% combined with water leaks and moisture damage.	All soft material, ceilings in pharmacies, wards, ICU, CSSD ventilation inlet and outlets due to increased fibres from clothing and linen cleaning operations, administration, kitchens and theatres. Basement areas are important sources.
Cupboards made of composite boarding	Leaks	All kitchen areas

(table continues)

Table 4 (continued)

Source	Cause	Potential areas
Painted plastered walls and ceilings	Poor air circulation in entire room or corners of room, high humidity, paints as a nutrient. Rising dampness or leaking water piping systems in the walls and ceilings.	Shower, bathroom areas, CSSD due to higher temperatures from linen cleaning and sterilising operations.
Carpeting	Dirt, dust, moisture.	Administration offices
Corrugated asbestos ceilings	Moisture and flaking surfaces	Enclosed veranda sections of extended hospital wards.
Ventilation diffuser linings	Dirt accumulation (usually carbon particles) and moisture.	Accumulation of dirt on diffuser surfaces and adjacent ceilings. The majority of hospital areas had mechanical ventilation.
Dusty surfaces	Poorly cleaned areas.	Ceiling fans and shelving surfaces in wards, kitchens, administration sections.
Pot plants	Damp wood chips	Office areas
Building renovations	Dust, dirt potential moisture sources	All areas
Refrigerator cooling systems	Temperature differences between refrigerator piping systems and wall or ceiling surfaces.	Kitchens
Floors	Chipped broken floor tiles or linoleum surfaces.	Theatres and sluice areas.

The researcher's approach was to carry out observations and sample affected areas to establish the presence of viable fungi in the collected materials and from swabs.

A Single Stage Graseby Andersen microbial sampler was used to establish the various species of fungi present in hospital indoor air and whether they were of a health concern. These findings would also have implications for immune compromised patients (Streifel, 1998). According to Singh (1994) most researchers will refer to the outdoor air as a control in order to reach a decision whether a potential problem may exist in an environment. When a ratio of >1 exists between indoor and outdoor concentrations or when indoor species differs from those outdoors, further investigation would be necessary. The ratio on average is .33. Air samples were taken in all indoor areas under investigation along with outside air samples. Types of mould present in surfaces samples was also considered an indication of health risk.

Two types of media were used in the hospital environment. Media used for growing fungi were malt extract agar (MEA) that is traditionally used as a broad-spectrum medium and Dichloran Glycerol 18 agar (DG18), newly recommended for fungi which is suitable for most fungi including xerophilic fungi (Graseby Andersen, 1995). These media were prepared as described in Samson et al. (1994), namely MEA and DG18. MEA was to enable growth of organisms that require higher water levels and DG18 was used to support organisms requiring lower amounts of water.

Twenty five grams of MEA were weighed and diluted in 500mls of distilled water. In respect to DG18, 15.75 grams were mixed with 44ml of glycerol and diluted in 500mls of distilled water. An antibiotic mixture consisting of .5grams of Chloramphenicol and 10mls of 2.2 Dichoroethanol was mixed in 100mls of distilled water. From this mixture 10mls was added to both the MEA and DG18 solutions. 100 x 15mm plastic disposable petri dishes were used for surface and air samples. The media were then autoclaved for 20 minutes at 121^0C.

The inoculated agar plates were placed in an environmental incubator cabinet for a three day period. After two days the plates were monitored for growth. The temperature was maintained at 37^0C at a relative humidity of 70%. Viable colonies from surface samples were counted and fungi species were identified.

From air samples, the impacted viable particles per unit volume of air were counted and fungal species were identified after incubation based on accepted microbiological theory assuming each colony represents a single particle. The numbers of colonies on each plate were summed to give a grand total. The grand total was then divided by the total air volume sampled in cubic feet. The total volume of air was calculated by multiplying the volume of air sampled (if the constant flow rate of 1 ACFM was maintained) by the number of minutes over which the sampling took place, e.g. 1 x 5 minutes (Graseby Andersen, 1995).

Certain species could not be adequately identified and sub-cultures of these fungi were made. These fungi were inoculated on PDA (potato dextrose agar), MEA and DG18 agars. They were treated to prevent dust mite contamination and forwarded to the USA for further investigation by Dr. Maren Klich of the USDA, New Orleans, United States of America.

Equipment for fungal research

Equipment used for fungal air sampling included a Grasbey Andersen single stage microbial sampler, MEA and DG18 Petri dishes, an aluminium stepladder, stainless steel spatula, masking tape, adhesive tape, sterile swabs, tweezers, sterile gauze pads, container of 70% isopropyl alcohol, freon gas, vacuum cleaner and collection nozzle.

A vacuum cleaner was used to extract fungi from carpets. The vacuum cleaner suction pipe was fitted with a removal nozzle and backing grid to support sterile gauze pads, which were taped to the nozzle. The sterile gauze pads were used to trap "dirt" from the carpet surface. The contaminated gauze pads were then removed from the nozzle. Agar plates were inoculated with the contaminated pads. The inoculated plates were then returned to the laboratory and incubated. Before and after each use, the nozzle was sanitised using 70% isopropyl alcohol soaked on a gauze pad.

The N6 1ACFM (28.3 litres per minute) viable microbial sampler was used to collect and enumerate airborne fungi. The sampling stage has 400 precision-machined orifices. Air is drawn through the sampler by means of a purpose-designed vacuum pump set at a constant flow rate of 1 ACFM. The sampler utilises 100 x 15mm plastic disposable petri dishes and was suitable to be used for indoor air studies in hospital environments. A freon spray was used for cleaning the orifices. Before use, all collection surfaccs of the sampler were sterilised with 70% isopropyl alcohol by wiping the surfaces with a soaked gauze pad.

An environmental incubator, specifically designed to simulate environmental conditions in respect to temperature and relative humidity for the growth of microbes in the laboratory, was used to grow fungal samples.

Sampling procedures

Sufficient MEA and DG18 agar plates were made up prior to each hospital visit. These were stored in cooler boxes. Each section in a room suspected as a source of fungi was sampled using a MEA and DG18 petri dish. These included air conditioning outlets, sections of walls, ceiling sections or sections of the floor. The sampling method depended on the nature of the surface. Water damaged painted plaster surfaces were scraped using a sterile stainless steel spatula, which had been wiped with 70% isopropyl alcohol prior to its use. The scrapings were allowed to fall on to an open agar plate. The petri dish was then sealed using masking tape and coded. Petri dishes were then placed into a cooler box.

Soft surfaces such as gypsum and air conditioning filters and hard metal or plastic surfaces were sampled using sterile swabs. These swabs were prepared in the laboratory and consisted of cotton wool wrapped onto tooth picks. Contaminants on the swabs were inoculated onto the agar plates, which were sealed with masking tape, coded and placed into a cooler box.

Adhesive tape was also used to collect contaminants from surfaces. The contaminated surface of the tape was inoculated on to the agar surface. In certain office areas wood chips were being used to cover the soil in pot plant containers. A wood chip was picked up with tweezers and was used to inoculate the agar.

Carpets were sampled using a vacuum cleaner with a plastic collection nozzle fitted to the flexible hose. The collection nozzle was wiped with 70% isopropyl alcohol before and after each use. Sterile gauze was attached to the nozzle with masking tape. Sections of the carpet exposed to constant use and surface areas that appeared damp or where spillages had occurred were sampled. The gauze was then wiped on to agar plates. The agar plates were sealed with masking tape, coded and placed into a cooler box. All samples were placed in the environmental incubator at the end of the day.

Two MEA and two DG18 agar plates were used in each room surveyed. Outside samples were also collected each day. The calibration of the Graseby Andersen microbial sampler was verified before proceeding with sampling. The sampler surfaces were wiped with 70% isopropyl alcohol. A sampling position was chosen which did not restrict hospital staff in their duties. This sampling position was near the centre of the room to represent general indoor air quality. The sampler was situated at approximately a meter and a half above the floor level. At the beginning of the day the sampling pump was warmed up for approximately 20 minutes before commencing with sampling. An agar plate was placed in the sampler and 5 minute samples were taken. Upon removal of the plate, the agar surface was checked to ensure that adequate surface impactions had occurred. When poor impaction was observed, the instrument was cleaned and samples retaken. An outdoor air sample was also taken each sampling day. The sampler orifices were cleaned using a spray of freon gas and 70% isopropyl alcohol was also undertaken on a regular basis.

Limitation of the fungal assessment program

In certain hospital sections, large surface areas (> $3m^2$) were contaminated by mould (see Table 2). However, due to economic and practical reasons the numbers of samples were limited.

Ventilation performance, temperature, relative humidity, air movement and particulate assessments

Purpose and methods

The purpose was to establish indoor environmental conditions that may support fungal growth and to assess indoor conditions related to human comfort. Relative humidity ≥ 70% can provide conditions favourable to fungal growth (ASHRAE, 1999). Carbon dioxide level provides an indication of poor or effective ventilation performance (ASHRAE, 1999). Poorly ventilated areas may indicate the potential for higher pollutant levels. ASHRAE (1999) suggests that the comfort (odour) criteria may be satisfied if the ventilation rate maintains carbon dioxide levels below 1000ppm. Carbon dioxide criterion is related to environments without known human carcinogens or other harmful contaminants being present. If human carcinogens or other harmful contaminants are present, then the application of other standards or guidelines, for example, the Occupational Safety and Health Administration of the United States of America (OSHA) and Environmental Protection Agency of America (EPA) would be necessary (ASHRAE, 1999). According to Singh (1994) opportunistic pathogens such as *A. fumigatus* and *A. flavus* are not wanted in hospital environments where patients with conditions such as HIV or other such diseases are being treated or where drug or radiation therapy is being administered which reduces immune responses. The findings of this research and the fact that hospitals cater for immunocompromised patients may suggest that further investigations into patient risks would be advisable.

The effects of air movement could act as both a spore distributor and/or where low air movement exists it may, along with temperature and moisture levels, create a local surface environment conducive to microbial growth (Singh, 1994).

Particulates vary in size and may consist of microorganisms, dust, fumes, smoke and other particulate matter (ASHRAE, 1999). The method used to measure particulates was not aimed at characterising specific airborne particles (International Standard, 1999). Although this research was not aimed at linking fungal air concentrations in hospitals to measured particulate levels, it is recognised that cleaner environments may have potentially lower airborne particulate pollutants (International Standard, 1999). This assumption is also based on previous research, which had indicated that mite allergens can be carried by particles having a diameter of $<10\mu$ (De Blay, Colas, Richard, Ott & Vérot, 1997). Pasanen and Offermann (2000) state that ventilation ducts may not be clean and are open to contamination by soil dusts and mud, with an average of $5g/m^2$ of dust being found in air ducts of buildings less than one year old. Furthermore, they concluded that duct systems may be development sites for microbes, including fungi. Particulate measurements were conducted to compare air cleanliness of each hospital and hospital sections.

Comfort measurements were used to assess environmental conditions in each hospital and hospital section and data was compared to acceptable comfort criteria (London Hazard Centre, 1990; ASHRAE, 1992; ASHRAE, 1999). The linkage between these criteria will now be discussed followed by an explanation of the measurement methods. Kearns (1991) confirms that carbon dioxide is an indicator of indoor air quality and low carbon dioxide levels would suggest that ventilation systems are diluting air contaminants. However, as discussed under the previous section, ventilation systems may also contribute to indoor air pollution if not maintained clean. Wyon et al. (2000) confirms that particle and air movement control must be considered important issues. Furthermore, Wyon suggests that air change rates and temperature should be measured when undertaking productivity research.

High and low relative humidity may also cause discomfort. Humidity levels between 40% and 60% are considered acceptable for comfort and odour reduction (ASHRAE, 1992; Burton, 1991). ASHRAE (1992) suggests that during summer months, air temperatures are best between 22.5^0C to 26^0C with a maximum of 60% relative humidity. ASHRAE (1992) indicates that if relative humidity increases, tolerance to temperature would decrease. Relative humidity above 60% reduces the ability of the body to evaporate moisture and air temperatures feel hotter causing people to complain that they feel sticky (London Hazard Centre, 1990). No air movement may be acceptable where temperature and relative humidity are within acceptable limits (ASHRAE, 1992). However, air speeds above .25m/s to .3m/s may result in draught conditions and are not acceptable unless occupants have personal control over air speed (London Hazard Centre, 1990; ASHRAE, 1992). As relative humidity levels and temperatures tend to be high during the summer months in Durban, it was considered important to use a lower air speed limit as a criterion along with an upper limit. Air movements below .1m/s tend to cause stuffiness (London Hazard Centre, 1990). However, as air movement increases above .1m/s in a controlled environment, the London Hazard Centre recommends that temperatures would need to increase. This indicates the complex nature of ensuring comfort within the work place.

In conclusion, the criteria used was air movements between .1m/s to .3m/s. This air movement standard was considered reasonably acceptable after taking relative humidity and temperatures into account. Even in the controlled environments, relative humidity and temperature may be in the regions of 60% and 26^0C respectively. These air movement recommendations were quoted by the London Hazard Centre (1990) and were used in previous research (Shadwell et al., 2000; Shadwell et al., 1996a; Shadwell et al., 1996b; Shadwell, 1995).

Indoor monitoring equipment

Instruments for recording ventilation, temperature, relative humidity and particulate data were real-time data recorders. A Kata thermometer was used to measure air movements. Information from real-time monitors was downloaded onto a laptop computer.

Metrosonic indoor air quality monitors were calibrated each day before monitoring commenced using 1000ppm carbon dioxide span gas and nitrogen dioxide zero gas. These monitors provided real-time data recordings of carbon dioxide, temperature and relative humidity at one-minute averages. Three instruments were used.

A Grimm dust monitor was used to measure respirable particulates. This instrument had been recently calibrated by the factory. The instrument was set to provide real-time one-minute time weighted averages.

A Kata thermometer, wet bulb thermometer, stop watch and distilled water heated to 50^0C were used to measure air velocity. The following formula was used to calculate air velocity based on the methods recommended by the Chamber of Mines South Africa (1982).

$V = (K - .7\,\theta / \theta)^2$

Where:

V = air velocity in metres per second.

K = Wet Kata cooling power.

$\theta = 36.5 - t_{wb}$ (is the reading of an unventilated wet bulb thermometer in ^{0}C).

Indoor sample procedures

Setting up of indoor air monitors was based on procedures suggested by Burton (1991), Shaughnessy and Truter (1995) and Shadwell (1995). Metrosonic indoor air monitors and the Grimm dust monitor were placed to acquire general measurements in the environment.

- Metrosonics indoor air monitors were placed on the floor of each area away from the breathing zones of patients and staff to assess indoor air conditions.
- The Grimm dust monitor was placed at one and a half meters from the floor away from the breathing zone to record particulates. This dust monitor was set to record particles per litre in air at particle sizes of >.3 microns, >.5 microns, >1 microns and >5 microns bases on International Standard (1999).
- All instruments were placed away from ventilation inlets and outlets.
- Indoor air monitors were placed in close proximity to the microbial monitor.

Real-time temperature and relative humidity data were also recorded when using the Metrosonics indoor air monitors. The mean time that indoor air monitors were to set to record data was 1hour. Once recordings were completed data was immediately downloaded to a laptop computer.

Adequate Kata readings were taken in each of the hospital sections to ensure representative air movement data. The wet bulb thermometer was stabilised at chest height prior to taking temperature readings. The Kata thermometer was held at chest level and at arm's length from the body so that airflow was not restricted during data recording. The procedures used conformed to those documented by the Chamber of Mines South Africa (1982). These readings were taken while indoor air monitors were recording data.

Limitations of the indoor monitoring system

Longer measurement periods of indoor air quality may have provided a more detailed description of indoor conditions. However, due to time constraints, this was not feasible.

Carbon dioxide sensors of the indoor air monitors did not respond well linearly. Therefore an upper carbon dioxide limit of the calibration gas had to be chosen that best represented the indoor levels of carbon dioxide. The upper limit chosen was 1000ppm. However, in this study carbon dioxide levels varied within this range.

Allergy testing of hospital staff

Purpose and Methods

As previously discussed, Bryant (2001) suggested that the number of human reactions to mould allergy in South Africa is not clear. The current research provided data on allergy potential in hospital staff and highlighted the importance of reducing fungal sources in these work environments. This South African research was considered necessary to assist in classifying moulds in South African environments and may provide guidance for future South African hospital research needs.

Local allergen testers were not available at the time of this research because of practical and economic reasons. Allergen testers chosen were based on previous allergy research conducted in the Durban area by Gqaleni et al. (1998). Burge et al. (1989) concluded that cockroaches and mites are also sources of airborne antigens. Mite antigen products are their organic faecal particles, which tend to accumulate in dust. Body and faecal parts of cockroaches may also be present in indoor dusts especially if hospital cleaning programs are inadequate. As with fungi, these antigens can cause allergic asthma and allergic rhinitis. The medical school laboratories where fungal research was conducted, requires regular mite control. Durban has a prolific cockroach nuisance and the hot humid climatic conditions may also suggest that ubiquitous dust mite populations may exist. Therefore, in addition to the selected fungal allergens, dust mite and cockroach testers were included. The skin prick test (SPT) was used to assess staff allergies.

Skin reactions greater than the negative control (histamine) were categorised as follows:

0 = not allergic (0 to < 3mm diameter),

1= potential for allergy (3mm to <5mm diameter),

2 = allergic (> 5mm diameter).

The Allergy Society of South Africa (2002d), Immonen, Meklin, Taskinen, Nevalainen, and Korppi (2000), Taskinen et al. (2000) and Nekam et al. (1999) recommended that reactions of 3mm greater than the negative control should be considered as positive. Galant et al. (1998) considered reactions of 2mm or greater than the negative as positive and the methods applied were also supported by research conducted by Gqaleni et al. (1998). Accordingly, the allergy assessment used in the current research was considered sound.

Allergy testers and equipment

The following allergens were used:

- Mould mix II (*Mucor, Neurospora, Pullularia, Rhizopus*) (M2);
- Mould III (*Aspergillus amstelodami, fumigatus, niger* and *terreus*) (M3);
- Mould IV (*Penicillium brevicompactum, expansum, notatum* and *roqueforti*) (MIV);
- Dust mite (Dermatophagoides Pteronyssinus) (DM);
- German cockroach (Blatella germanica) (GC).

A histamine control was used for comparison purposes. Lancets with 1 mm points were used to prick the skin and clean gauze was used for skin cleaning purposes.

Allergy testing procedure

The allergens were administered to 123 of the original 280 respondents who were willing to have the skin prick test (SPT). According to the Allergy Society of South Africa (2002d), the SPT initially requires adequate practice to perform. However, by following guidelines this test provides highly reproducible results. The sample procedure followed was based on the Allergy Society of South Africa (2000d) recommendations, papers by Galant et al. (1998) and Gqaleni et al. (1998):

- The allergy testers used were from a fresh supply so as to avoid loss of potency though prolonged storage.

- An allergy questionnaire (see Appendix G) was administered. One of the questions ascertained if staff had taken anti-histamine medication and they were asked about the nature of their allergies.
- The same competent person administered all tests.
- The SPT test procedure was explained to the patients before proceeding.
- The inner area of the forearm was used.
- Skin was checked for cleanliness and to be free of active eczema.
- A grid was marked on the skin with a pen to identify each allergen and to allow at least 2cm intervals between each test.
- A drop of each allergen was then placed on the skin.
- The skin under each drop was scratched without causing blood to be drawn.
- A new lancet was used for each allergen and patient.
- The solutions were removed using clean gauze.
- A 10-15 minute period was allowed for reactions to occur.
- Reactions were measured using a ruler and comparisons were made to the histamine reaction.
- After completion of the test, hand cream was offered to hospital staff to place on the tested skin areas.

Limitations of allergy testing method

The most effective method of conducting allergy research is to use allergens developed from the fungi that are prevalent in the actual work or home environment. A limitation of this research was that this was not feasible to do. Allergens were acquired that would best match Durban's local situation. Certain staff were taking anti-histamines and could not be tested but details of their allergies were recorded.

Data analysis methodology

SPSS statistical program was used to analyse data sets. The Stress Symptom Checklist questionnaire was tested for reliability and was validated. Reliability analysis studied the properties of the measurement scales used in this research and their items. Reliability analysis determined the extent to which the items in the questionnaires were related to each other; established an overall indication of the repeatability of the scale and identified whether any items could be excluded from the scale. Alpha (Cronbach) test was used. Reliability estimates ranging from .7 to .8 are acceptable for basic research and good correlations are > .8 (Anastasi, 1982; Cronbach, 1951). This estimate was used to establish the reliability of the scales used. The reliability of all scales was assessed to establish whether they were measuring worker stress reactions in the three hospital groups using the Pearson Correlation (2 tailed test).

Descriptive Statistics

Descriptive analysis assisted in summarising the information for establishing an overall impression of description (Huysamen, 1990). Observations were an important part of this research. These observations included documenting the types of surfaces that were contaminated with fungi and dust; surface areas of water-damaged/mouldy conditions; staff comments on factors that caused them concern; staff recognition of conditions in their work environment that required improvement and staff awareness of mouldy conditions in their homes. The latter item was considered important to verify the extent of mould damage in the Durban and Greater Durban area and establish staff awareness of mouldy conditions.

Ventilation systems as a major source of fungal contamination was not confirmed. Observations suggested that air conditioners were used in most work environments. The exposed surfaces of outlets and inlets produced viable fungi. However, there were many environments where the wall and ceiling areas appeared to have greater surface area contamination.

Percentages were used to compare gender, age, hours of work, days at work, job types, and staff occupancy between the three hospital types. Chi-square test was used to establish whether associations between important demographic data and the hospital groups existed. Where groups < 5 were encountered, Fisher's exact test results were reported for two by two tables.

Preliminary screening using the SSCL questionnaire, of biopsychosocial stress reactions in six hospitals were conducted using means, medians, standard deviations and maximum scores. The mean is the middle point that lies between two extremes. Median is the value above and below which half the cases fall and is not sensitive to the outliers as in the case of the mean. Accordingly the median may better represent the central tendency in these data.

Percentages were used to compare staff responses regarding indoor air quality and maintenance issues between hospitals and hospital sections. SBS symptoms occurrences were described using percentages. A ranking system was developed to represent particle levels. This ranking system provided a method of classifying air cleanliness in the hospitals.

Various types of fungi found indoors were listed in order of dominance. This assisted in establishing whether pathogenic (disease causing) or mycotoxin-producing (immune suppressive and toxic) fungi were present in the hospitals through surface and air samples. By using a method of assessment of indoor and outdoor fungal air levels recommended by Singh (1994), ratios between indoor and outdoor fungal levels were assessed. If a ratio of >1 exists between indoor and outdoor concentrations further investigation would be necessary to reduce fungal air levels. This provided a method of establishing sections of hospitals where higher fungal counts may have needed further investigation.

Percentages were used to describe staff allergy reactions to the allergy skin prick test and to assess the occurrence of reported allergy symptoms that were acquired using the allergy questionnaire. Tables were used to summarise these data.

Univariate statistics

The current study was divided into two data sets which were the skin prick test group ($N = 123$) and the total data set ($N = 280$). The response rate for the allergy test and the non-response rate for the allergy test were compared using a z test. To establish whether there was a difference between the skin prick test allergy participants ($N = 123$) and the non-participants ($N = 157$) with regard to potential risk factors for allergy such as age, which could potentially bias the results, the groups were compared in various ways. For age, which was a numeric variable, a t-test of the participants versus the non-participants was used. The other associations were examined using the Chi-square test. Chi-square assessed association between job functions, three hospital groups (provincial, missionary and private) and the skin prick test group and the non-participants and gender. Chi-square tests were conducted using dichotomised data.

A One-way Anova test was used to establish associations between hospitals and each indoor measurement that included carbon dioxide, relative humidity, temperature and air movement. A closer examination for associations between hospitals and the indoor measurements was also conducted using the Bonferroni Post Hoc test. The results showed two-way comparisons between each of the six hospitals for each of the indoor measurements.

Multivariate analysis

Hair, Anderson, and Tatham, (1987) defines multivariate regression analysis as a statistical technique used to analyse the relationship between a single dependent variable and several independent variables.

Multivariate stepwise logistic regression analysis was used to establish the main stress associations and to develop models. This was done through a binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10 respectively to eliminate variables that were not significantly contributing to the model. Models developed were allergy, psychological and SBS.

Results and discussion

Demographic variables

There were 280 respondents from the 6 hospitals in KwaZulu-Natal South Africa. Consideration was given to the time that hospital staff spent in their work environment as this emphasises the importance of providing conditions conducive to comfort and well-being. The majority of staff, 253 of the respondents, had worked in their particular hospital for more than a year. This would suggest that the majority of staff were familiar with their work environments and be able to comment on indoor conditions. Only 27 had worked in their present workplace for less than 12 months. Work shifts ranged from 5 to 13 hours in length.

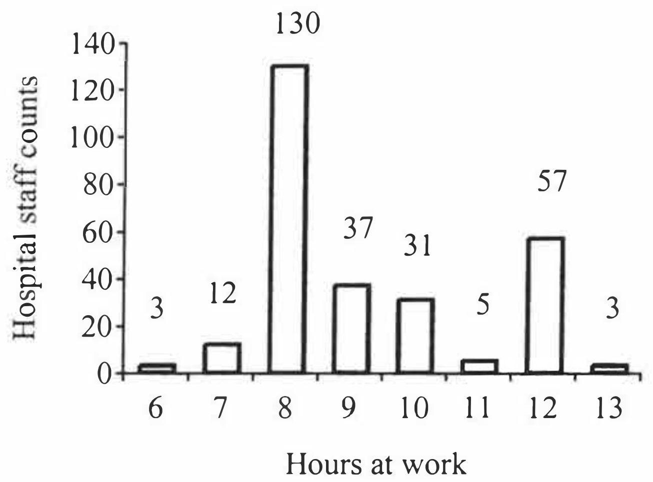

Figure 1. Hours spent at work per day by hospital staff ($N = 280$).

Figure 1 shows that the majority of hospital staff spend 8 hours and more each day in the hospital environments.

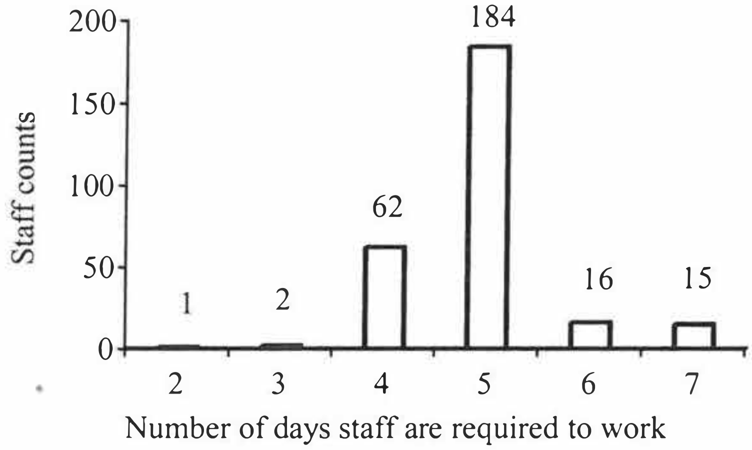

Figure 2. Days worked per week by hospital staff ($N = 280$).

Figures 2 describes that the majority of hospital staff spend 5 days or more each week in the hospital environments. Figures 1 and 2 confirm that the majority of staff spent a large portion of their lives in these workplaces indicating the importance of ensuring a health and safe working environment.

Staff occupancy of work areas were: 34(12%) in basement work spaces; 142(51%) on ground floor levels; the remaining 104 (37%) on the levels 1 to 5. Basements were totally reliant on mechanical ventilation. The ventilation systems were dirty and viable fungi were isolated from the outlet surfaces. The basement walls and ceiling surfaces were also contaminated with mould.

The majority of the respondents were females being 241 (86%) and 39 (14%) were males. Data from the six hospitals were examined by combining hospital types into provincial, missionary and private. The total number of respondents from two provincial hospitals was 119. There were 63 from two missionary hospitals and 98 from two private hospitals.

Demographic data and hospital types

The Chi-square test was used in the following sections. A cutoff of $p < .05$ was used.

Gender

The demographic data of the three hospital types were analysed to establish whether there were associations between the three hospital types. The data in this section was categorical which enabled Chi–square tests to be conducted. Where groups less than 5 were encountered Fisher's exact test results are reported. Association between data sets may suggest variations occurring at the time of the study that required discussion. No association may indicate similar trends existing between the data sets. Apart from data in table 5 data with no associations will not be elaborated on.

Table 5 provides a breakdown of the numbers of male and female respondents from the three different hospital groups.

Table 5

Gender association between the three hospital types

	Males		Females		
Hospitals	*n*	%	*n*	%	*N*
Prov	19	16	100	84	119
Miss	7	11.1	56	88.9	63
Priv	13	13.3	85	86.7	98

Note. No association existed between gender and the three hospital types $p = .649$.

A Chi-square test was conducted on gender numbers and the three hospital types. The results indicated that there was no association between gender and the three hospital types (χ^2 = .865, df = 2, p = .649). There were similar proportions of males to females in each of the hospital types. Females in all three hospital groups were in the majority.

Job functions

Of the total number of respondents (N = 280) nurses were the greatest number of respondents totaling 161 (58%). The pharmacy and kitchen staff totaled 73 (26%) with the administration staff totaling 46 (16%). Table 6 describes the staff job functions and staff complements for the three hospital groups.

Table 6

Associations between job types and hospital types

	Admin		Nursing		Kitchen and Pharmacy		
Hospitals	*n*	%	*n*	%	*n*	%	*N*
Prov	7	5.9	74	62.2	38	31.9	119
Miss	14	22.2	37	58.7	12	19	63
Priv	25	25.5	50	51	23	23.5	98

Note. There was an association between job types and the hospital types p = .001.

Table 6 indicates that in each hospital type, the nurses represented the majority of respondents.

A Chi-square test representing the results in table 6 suggested that there was an association between job types and the hospital types (χ^2 = 18.46, df = 4, p = .001). In each hospital type, nurses represented the majority group. The lower administration staff number in the provincial hospitals was due to staff refusals to participate in the study. However, in the case of private hospitals there were larger numbers of administration staff employed and there was willingness to participate in the study. In private hospitals the administrative staff appeared to be interested in participating in the study.

Age groups

When considering the total data set ($N = 280$), the age of most of the respondents was in the mid thirties. Staff ages ranged from 20 to 61 years. The mean age of the total group was 37.5 years (*Mdn* 36 years and *SD* 10.5). The age distribution of the three hospital groups appeared similar with a tendency towards a slightly younger group in the missionary type hospitals. In the provincial hospital group ($n = 119$): *M* 39 years, *Mdn* 39, *SD* 10, range 38, minimum 23 years, maximum 61 years. In the missionary hospital group ($n = 63$): *M* 36 years, *Mdn* 35; *SD* 9.7, range 38, minimum 21 years, maximum 59 years. In the private hospital group ($n = 98$): *M* was 36 years, *Mdn* 34.5, *SD* 11, range 40, minimum 20 years, maximum 60 years. Age data was placed in categorical groups as represented in Figure 3 as percentages.

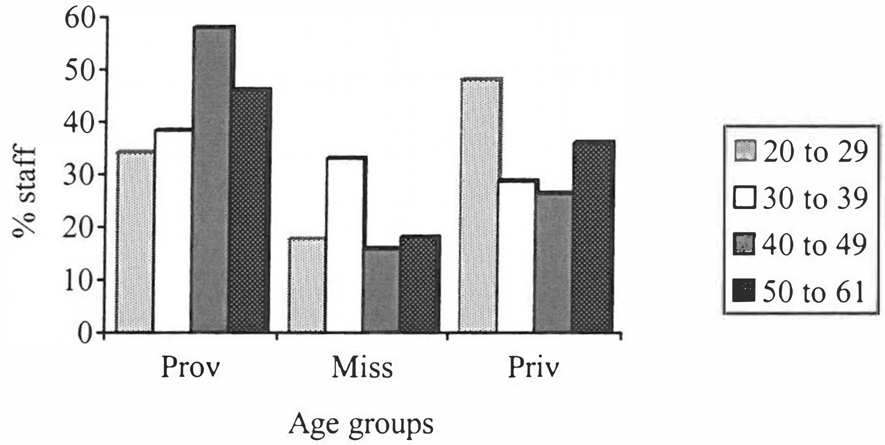

Figure 3. Respondent percentage divided into age groups and hospital types (N = 280).

A Chi-square test on age and the three hospital types was then conducted. The test indicated an association between age and the hospital types (χ^2 = 18.16, df = 6, p = .006). In the provincial hospital group the 30 to 39 year age group represented the largest proportion of the staff (see Figure 3). In private hospitals, the largest proportion of the staff was in the 20 to 29 year age group. In missionary hospitals, there was a higher proportion of staff in the 30 to 38 year age group with fewer participants in the 40 to 61 year age group taking part in the study. These trends may suggest that there were fewer older or more experienced staff working in missionary type hospitals and a predominantly younger respondent group working in the private hospitals.

Stress reactions and demographic variables

Chi-square analyses were conducted to establish whether there was a relationship between demographic data and stress reaction reporting.

Gender

A Chi-square test was used to compare categorical data sets to establish whether an association existed between gender and reported stress reactions. Chi-square was conducted for "each hospital group."

In provincial hospitals (n = 119) no association existed between gender and biopsychosocial stress reactions (χ^2 = .137, df = 1, p = .711). In missionary hospitals (n = 63) where there was < 5 males in a group, the Fisher exact test was conducted. The Fisher's exact test suggested no association between gender and biopsychosocial stress reactions (p = .089). Private hospital results (n = 98) indicated that no association between gender and reported biopsychosocial stress reactions (χ^2 = .946, df = 1, p = .331).

When conducting Chi-square test on the total hospital data scores (N = 280) between gender and reported biopsychosocial stress reactions, the result suggested that no association existed (χ^2 = 3.036, df = 1, p = .081). With the total data set (N = 280) there was an association between gender and physical stress reactions.

Table 7

Associations between gender and physical stress reactions (N = 280)

Females with significant stress reaction		Males with significant stress reaction		Females with insignificant stress reaction		Males with insignificant stress reaction		p
n	%	n	%	n	%	n	%	
161	90.4	17	9.6	80	78.4	22	21.6	.005

Note: Significant association p < .05

Results in table 7 suggest that males may have been less likely to report more physical stress reactions than females at the time of this research.

Table 8

Associations between gender and psychological stress reactions (N = 280)

Females with significant stress reaction		Males with significant stress reaction		Females with insignificant stress reaction		Males with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
114	91.2	11	8.8	127	81.9	28	18.1	.026

Note: Significant association $p < .05$

With the total data set (N = 280) there was an association between gender and psychological stress reactions. In table 8, as in the previous table, a higher proportion of females appear to have reported more psychological stress reactions than males at the time of this research.

Table 9

Associations between gender and behavioural stress reactions (N = 280)

Females with significant stress reaction		Males with significant stress reaction		Females with insignificant stress reaction		Males with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
141	89.8	16	10.2	100	81.3	23	18.7	.041

Note: Significant association $p < .05$

With the total data set (N = 280) there was an association between gender and behavioural stress reactions. As with the previous results, the results table 9 may suggest that males may be less likely to report more behavioural stress reactions than females. Females may be more likely to report more behavioural stress reactions. However, with a low number of male respondents definite conclusions cannot be made.

Chi-square tests between physical, psychological, behavioural stress reactions and gender were studied by examining each of the hospital groups (provincial, missionary and private). The results indicated that there were no associations with psychological and behavioural reactions. In provincial hospitals (n = 119) Chi-square test indicated no association between gender and psychological reactions (χ^2 = .249, df = 1, p = .618).
In provincial hospitals (n = 119) Chi-square test indicated no association between behavioural reactions and gender (χ^2 = 5.617, df = 1, p = .201).

Table 10

Associations between gender and physical stress reactions in provincial hospitals (n = 119)

Females with significant stress reaction		Males with significant stress reaction		Females with insignificant stress reaction		Males with insignificant stress reaction		p
n	%	n	%	n	%	n	%	
61	91	6	9	39	75	13	25	.018

Note: Significant association $p < .05$

As with the previous results, table 9 suggests that males may be less likely to report more physical stress reactions than females. Females may be more likely to report more behavioural stress reactions. However, with a low number of male respondents definite conclusions cannot be made.

In missionary hospitals (n = 63) there was no association between gender and physical stress reactions (χ^2 = 1.575, df = 1, p = .209). In missionary hospitals there was no association between gender and behavioural stress reactions (χ^2 =.008, df = 1, p = .928).

Table 11

Associations between gender and psychological stress reactions in missionary hospitals (n = 63)

Females with significant stress reaction		Males with significant stress reaction		Females with insignificant stress reaction		Males with insignificant stress reaction		p
n	%	n	%	n	%	n	%	
34	97.1	1	2.9	22	78.6	6	21.4	.038

Note: Significant association $p < .05$

In table 11, Fisher's exact test suggested that an association did exist between gender and psychological reactions in missionary hospitals. As in the previous tables, the lower number of males may have influenced these results.

In private hospitals (n = 98) there was no association between gender and physical stress reactions in private hospitals (χ^2 =.711, df = 1, p = .399). There was also no association between gender and psychological stress reactions in private hospitals (χ^2 = 1.953, df = 1, p = .162). Fisher's exact test suggested no association between gender and behavioural stress reactions in private hospitals (p = .075).

In summary, the lower number of male respondents may have influenced the results. However, there may possibly be a tendency for males to report fewer stress reactions compared to the female hospital staff. It is also important to consider that the majority of respondents were female nurses. Accordingly, due to the lower number of males a definite conclusion cannot be draw.

Job functions

Chi-square was conducted for each hospital group (provincial n = 119, missionary n = 63, private n = 98) and no association existed between job and biopsychosocial stress reactions in provincial hospitals (χ^2 = 5.351, df = 2, p = .069). No association between job and biopsychosocial stress reactions existed for missionary hospitals (χ^2 = .084, df = 2, p = .959). Private hospital results indicated that association existed between job and biopsychosocial stress reactions (χ^2 = 2.451, df = 2, p = .294). A Chi-square test on the total hospital data scores (N = 280) between job and biopsychosocial stress reactions, suggested that no association existed (χ^2 = .618, df = 2, p = .734). With the total respondent group no association existed between physical stress reactions and job (χ^2 = .179, df = 2, p = .914). With the total respondent group (N = 280), no association existed between job and psychological stress reactions (χ^2 = 2.7, df = 2, p = .259). With the total respondent group (N = 280), no associations existed between job and behavioural reactions (χ^2 = 1.412, df = 2, p = .494).

Chi-square comparisons between physical, psychological, behavioural stress reactions and job were studied by examining each of the hospital groups provincial (n = 119), missionary (n = 63) and private (n = 98).

Table 12

Associations between job functions and physical stress reactions in provincial hospitals (n = 119)

Nurses with stress reaction		Nurses with low stress reaction		Admin with stress reaction		Admin with low stress reaction		Kitch/pharm with stress reaction		Kitch/pharm with low stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
49	73.1	25	48.1	2	3	5	9.6	16	23.9	22	42.3	.016

Note: Chi-square test indicated that more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution.

Significant association $p < .05$

There was an association between job and physical stress reactions in provincial hospitals. Provincial nursing staff may be more likely to report physical stress reactions than the staff in the other job functions at the time of this research. However, in table 12, Chi-square test indicated that more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution.

No association existed between job and psychological stress reactions in provincial hospitals ($\chi^2 = 5.119$, $df = 2$, $p = .077$). No association existed between job and behavioural stress reactions in provincial hospitals ($\chi^2 = 2.635$, $df = 2$, $p = .268$). No association existed between job and physical stress reactions in missionary hospitals ($\chi^2 = .518$, $df = 2$, $p = .772$). No association existed between job and psychological stress reactions in missionary hospitals ($\chi^2 = .186$, $df = 2$, $p = .991$). No association existed between job and behavioural stress reactions in missionary hospitals ($\chi^2 = .760$, $df = 2$, $p = .684$). No association existed between job and physical stress reactions in private hospitals (χ^2 =1.329, *df* = 2, *p* = .514). No association existed between job and psychological stress reactions in private hospitals (χ^2 =.088, *df* = 2, *p* = .957). No association existed between job and behavioural stress reactions in private hospitals (χ^2 =1.485, *df* = 2, *p* =.476). These results suggest that there was only an association between job and physical stress reactions in provincial hospitals.

Age groups

Chi-square was conducted for "each hospital group" and no association existed between age and biopsychosocial stress in provincial hospitals (χ^2 = 5.912, *df* = 3, *p* = .116). No association between age and biopsychosocial stress existed for missionary hospitals (χ^2 = 4.131, *df* = 3, *p* = .248). Private hospital (*n* = 98) results indicated that no association existed between age and biopsychosocial stress (χ^2 = 1.591, *df* = 3, *p* = .661). A Chi-square test on the total hospital data scores (*N* = 280) between age and biopsychosocial stress, suggested that no association existed (χ^2 = 2.631, *df* = 3, *p* = .452). A Chi-square test on the total hospital data scores (*N* = 280) between age groups and physical stress reactions, suggested that no association existed (χ^2 = 4.836, *df* = 3, *p* = .184). A Chi-square test on the total hospital data scores (*N* = 280) between age groups and psychological stress, suggested that reactions (χ^2 = 4.225, *df* = 3, *p* = .238). A Chi-square test on the total hospital data scores (*N* = 280) between age groups and behavioural reactions suggested that no association existed (χ^2 = 3.337, *df* = 3, *p* = .342). Chi-square comparisons between physical, psychological, behavioural stress reactions and age groups were studied by examining "each of the hospital groups" (provincial *n* = 119, missionary *n* = 63 and private *n* = 98).

Table 13

Associations between age groups and physical stress reactions in provincial hospitals (n = 119)

20 to 29 with stress		20 to 29 with low stress		30 to 39 with stress		30 to 39 with low stress		40 to 49 with stress		40 to 49 with low stress		50 to 61 with stress		50 to 61 with low stress		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
11	16.4	16	30.8	22	32.8	14	26.9	25	37.3	8	15.4	9	13.4	14	26.9	.013

Note: Significant association $p < .05$

Table 13 shows that in provincial hospitals the 30 to 39 and the 40 to 49 year age groups had a larger proportion of staff who reported significant stress reactions compared to those who were not reporting significant physical stress reactions at the time of this research.

In provincial hospitals (n = 119) there was no association between age groups and psychological stress reactions (χ^2 = 6.730, df = 3, p = .081). In provincial hospitals (n = 119) there was no association between age groups and behavioural stress reactions (χ^2 = 5.657, df = 3, p = .13). In missionary hospitals (n = 63) there was no association between age groups and physical stress reactions (χ^2 = 362, df = 3, p = .714). In missionary hospitals (n = 63) no association existed between age and psychological stress reactions (χ^2 = .659, df = 3, p = .883). In missionary hospitals (n = 63) no association existed between age and behavioural stress reactions (χ^2 = 1.176, df = 3, p = .759). In private hospitals (n = 98) there was no association between age groups and physical stress reactions (χ^2 = 1.713, df = 3, p = .634). In private hospitals (n = 98) there was no association between age groups and psychological stress reactions (χ^2 = .805, df = 3, p = .848). In private hospitals (n = 98) there was no association between age groups and behavioural stress reactions (χ^2 = 1.096, *df* = 3, *p* = .778).

In conclusion, there may have been a tendency for males to report less stress reactions than female staff. However, with a low number of male respondents definite conclusions cannot be made. The results suggested that females were experiencing physical stress reactions in missionary type hospitals. Biopsychosocial stress reactions appeared to be a concern in missionary hospitals for females. However, the low number of male respondents was a limitation in this analysis and reporting on male biopsychosocial stress reactions may not be conclusive. In provincial hospitals, a higher proportion of nursing staff reported significant proportions of physical stress reactions. When considering the total respondents (*N* = 280), the results suggested that females may have been more likely to report more behavioural stress reactions than males. However, with a low number of male respondents, conclusive conclusions cannot be made. Psychological stress reactions did not appear to be a concern for the majority of males and females when analysing the total respondent group (*N* = 280). Females may have been more likely to report physical stress reactions when considering the total data set (*N* = 280).

During the investigation comments from the nursing group in provincial hospitals was that absenteeism caused added stress on staff as the healthy staff were asked to work longer hours. Nurses in one of the missionary type hospitals were constantly moved into different wards, which tended to concern certain staff. At the time of this survey, the second missionary type hospital was undergoing an investigation to reduce staff and this was causing concern to the workers. The need to investigate various sources of both psychological and indoor physical stress reactions in the hospital environment was emphasised. The awareness of hospital staff stressors may assist in designing systems facilitating better working environments and staff support. This may help reduce absenteeism and dissatisfaction.

Stress reactions in the six hospitals

Analysis of SSCL biopsychosocial data (N = 280) consisting of physical, psychological and behavioural reactions provided the following results: *M* 15.65; *Mdn* 10; *SD* 15.46; skewness 1.36; maximum 69. Skewness results > 1 indicated that the data was significantly skewed from normal distribution. In such instances, it may be more appropriate to refer to the median as a way of assessing whether criteria had been exceeded. At the time of this study, it appeared that both the mean of 15.65 and median of 10 exceeded the criterion of ≥ 9. It appears that the majority of hospital staff were reporting a high number of biopsychosocial stress reactions.

When comparing biopsychosocial data scores between the three hospitals types, the missionary type hospital (n = 63) had the highest score: *M* 16.43; *Mdn* 12; *SD* 14.41; skewness 1.606; maximum 61. Provincial hospital types had the second highest score: *M* 15.66; *Mdn* (9.5); *SD* 16.75; skewness 1.319; maximum 68.5. Private hospital types results were: *M* 15.14; *Mdn* 9; *SD* 14.59; skewness 1.308; maximum 69. At the time of this study it appeared that both means and medians exceeded or equaled the criterion of ≥ 9. The majority of hospital staff in each of the hospital groups had reported a high number of biopsychosocial stress reactions.

The total respondent group (N = 280) was examined regarding stress reaction reporting of the physical, psychological and behavioural sections of the SSCL. The criterion ≥ 3 was used as an indicator of significant reporting of stress reactions. For physical reactions the results were: *M* 4.6; *Mdn* 4; SD 3.7, skewness .813; maximum 17, indicated that more than 50% were reporting significant numbers of physical stress reactions. The reported behavioural stress reaction were: *M* 6.6; *Mdn* 3.5; SD 8, skewness 1.651, maximum 41.5, indicating that these stress reactions may also have been of significant concern. Psychological stress reactions reported were: *M* 4.4; *Mdn* 2; *SD* 5, skewness 1.354, maximum 21, which indicate that psychological stress reactions may have had a lower significance for hospital staff at the time of this study. Maximum reported scores for all 3 stress reactions (physical, psychological and behavioural) appear high and may suggest the need for further investigation..

Missionary hospital staff (n = 63) reported the highest number of physical stress reactions: *M* 5.2; *Mdn* 4.5; *SD* 3.6; skewness .909; maximum 14.5. Scores for physical stress reactions in private hospitals (n = 98) were: *M* 4.489; *Mdn* 3.75; *SD* 3.42; skewness .647; maximum 13.5. Provincial hospital (n = 119) results were: *M* 4.46, *Mdn* 3, *SD* 3.96; skewness .898, maximum 17.

Provincial hospitals (n = 119) reported the highest number of behavioural stress reactions: *M* 6.8, *Mdn* 3.5, *SD* 8; skewness 1.464, maximum 35. Private hospitals (n = 98): *M* 6.58, *Mdn* 3, *SD* 7.9; skewness 1.947, maximum 41.5. Missionary hospital staff (n = 63) reported: *M* 6.38, *Mdn* 4, *SD* 7.186; skewness 1.593; maximum 28.5.

Psychological stress reactions scores were higher at the missionary hospitals (n = 63): *M* 4.84, *Mdn* 3, *SD* 5; skewness 1.163; maximum 18.5. Provincial stress reaction scores (n = 119): *M* 4.38, *Mdn* 2; *SD* 5.5; skewness 1.408; maximum 2. Private hospital stress reactions scores (n = 98): *M* 4, *Mdn* 2, *SD* 4.96; skewness 1.437; maximum 21.

In conclusion, physical stress reactions appeared to be of greater concern to hospital staff. In most of these data sets, using the median for comparison to the criteria where skewness results were >1, may be the better option. During the investigation, comments from nurses in provincial hospitals suggested that absenteeism caused concerns as staff were asked to work longer hours to compensate. Nurses in one of the missionary type hospitals were constantly moved into different wards, which tended to concern certain staff. The lower number of staff employed in missionary type hospitals were required to cope with extreme work demands. At the time of this survey the second missionary hospital was undergoing investigations aimed at reducing staff numbers and this was causing concern to the workers.

Chi-square comparison of stress reaction reporting between hospital groups

Chi-square analysis using categorical scales of the biopsychosocial stress score revealed a result of χ^2 = 2.994, *df* = 2, *p* = .224) indicating that no associations existed between stress in the three hospital types suggesting that stress reactions were similar by hospital type. There were also no associations between behavioural and psychological stress and the three hospital groups (*p* = .889 and *p* = .139 respectively). However, the Chi-square test between physical stress reactions and the three hospital types indicated an association (χ^2 = 7.069, *df* = 2, *p* = .029). The reason for this association appears to be a proportionally higher reported concern from the missionary type hospital group. Table 14 shows that 76.2% of the missionary hospital group reported a significant number of stress reactions.

Table 14

Hospital group associations between staff and physical stress reactions (N = 280)

Hospitals	Significant reactions		Insignificant reactions		
	n	%	*n*	%	*N*
Prov	67	56.3	52	43.7	119
Miss	48	76.2	15	23.8	63
Priv	63	64.3	35	35.7	98

Note. There was an association between hospital groups and physical stress reactions $p = .029$.

Significant association $p < .05$

This was further examined by comparing physical type stress between the provincial group with the missionary group and between the private with the missionary group. A significant association was found to exist between the provincial group and the missionary group ($\chi^2 = 7.004$, $df = 1$, $p = .008$). Physical stress reactions were not associated with the missionary and private hospital groups.

Table 15

Provincial and Missionary hospital group association between staff and physical stress reactions (N = 280)

Hospital	Significant reactions		Insignificant reactions		
	n	%	*n*	%	*N*
Prov	67	56.3	52	43.7	119
Miss	48	76.2	15	23.8	63

Note. There was an association between provincial and missionary hospital groups and physical stress reactions $p = .008$). Significant association $p < .05$

Table 15 shows that in both hospitals a higher number of physical stress reactions were reported. However, missionary hospitals tended to have a higher proportion of reported physically stress reactions. Physical stress reactions from the SSCL are listed in table 16.

Table 16

Physical stress reactions from in the SSCL

Unusual tiredness	High blood pressure	Unexplained nausea
Apathy/lack of enthusiasm	Sexual problems	Frequent indigestion
Breathlessness for no reason	Unexplained headaches\pain	Erratic bowel function
Feelings that your appearance has altered for the worse	Feeling faint or unusually weak for no reason	Excessive perspiration for no reason
Difficulty in relaxing	Muscle tension	Dizzy spells for no reason
Disturbing dreams/nightmares	Feeling physically unwell	Feeling tight chested for no reason

The missionary type hospitals were smaller operations having less staff employed and lower numbers of older and perhaps more experienced personnel working at these hospitals. The infection control sister at a missionary type hospital also expressed her fear that air in her hospital may not be free of a tuberculosis threat to staff health and that air samples were necessary to indicate conclusively that air quality in the wards was safe from tuberculosis microbes.

In conclusion Schlebusch (2000) suggests that when an individual perceives a situation to be uncontrollable it contributes to stress and poor coping. Schlebusch (2000) suggests that when an individual perceives a situation to be uncontrollable the result is stress and poor coping. Physical stress reactions appear to be the highly reported by hospital staff. This reporting of stress reactions should be seen in the light of conclusions by Schlebusch (2000) and Sutherland and Cooper (1990) that chronic and acute stress can result in health problems. Stress may also have adverse effects: on work performance and increased absenteeism, impact on the immune system, increased accident potential, increased use of tobacco and alcohol, allergy and asthma and even cancer in some people (Sutherland & Cooper 1990). All of these effects could lead to serious consequence due to the nature of work and demands on staff in hospitals.

In summary the major influences of stress reactions in each hospital group are as follows:

- Biopsychosocial stress (physical, psychological and behavioural reactions) of all hospital staff (N = 280) indicated: *M* 15.65; *Mdn* 10; *SD* 15.46; maximum 69. By comparing the mean and median to the "criterion of 9 and more" it appears that the majority of hospital staff were reporting a significant number of stress reactions.
- Biopsychosocial stress reaction reporting was highest in missionary type hospitals (n = 63): *M* 16.43; *Mdn* 12; *SD* 14.41; maximum 61. Provincial hospital types (n = 119) had the second highest stress reaction reporting: *M* 15.66; *Mdn* 9.5; *SD* 16.75; maximum 68.5. Private hospital staff (n = 98) reported: *M* 15.14; *Mdn* 9; *SD* 14.59; maximum 69.
- Missionary hospital staff reported the highest number of physical stress reactions: *M* 5.2; *Mdn* 4.5; *SD* 3.6; maximum 14.5.
- Behavioural stress reactions appeared to be similar between hospitals types: *M* 6.8, *Mdn* 3.5, *SD* 8, maximum 35; private hospitals: *M* 6.58, *Mdn* 3, *SD* 7.9; maximum 41.5; missionary hospital staff reported: *M* 6.38, *Mdn* 4, *SD* 7.18, maximum 28.5.

- Psychological stress reactions were higher at the missionary hospitals: *M* 4.84, *Mdn* 3, *SD* 5, maximum 18.5.
- Extremely high maximum scores reported from hospital staff respondents may suggest that certain staff were not coping with stress.

Analysis of the SSCL

The SSCL proved useful in assessing the general signs and symptoms of unhealthy stress. Analysis of questionnaires was aimed at:

- Establishing the questionnaire reliability.
- Validating The Stress Symptom Checklist
- Establishing the questionnaire as an instrument for hospital stress research.

Initial reliability analysis of the psychological instruments

Comparison questionnaires were used to ascertain the reliability of the SSCL as previously discussed. Reliability analysis was used to study the properties of the measurement scales and their items. The objectives were to determine the extent to which the items in the questionnaires are related to each other; to establish an overall indication of the repeatability of the scale as a whole, and to identify whether any items could be excluded from the scale. Alpha (Cronbach) is a model of internal consistency, based on the average inter-item correlation and was used to analyse the scales (Cronbach, 1951).

The analysis of the SSCL initially involved establishing the reliability of physical, psychological and behavioural sections and also the entire checklist.

Table 17

Reliability Analysis of the SSCL

SSCL	Cronbach's Alpha value
Physical reactions	.87
Psychological reactions	.93
Behavioural reactions	.96
Biopsychosocial (three stress reaction groups)	.97

Note. Acceptable correlations range.7 to .8 and good correlations are > .8.

Table 17 reflects the reliability test results for the SSCL. The reliability analysis was used to determine the extent to which the items in the questionnaire are related to each other. It also assisted in identify problem items that could be excluded from the scale.

Reliability estimates ranging from .7 to .8 are acceptable for basic research with good correlations > .8. These estimates were used to establish the reliability of the scales used (Anastasi, 1982; Cronbach, 1951).

This initial scrutiny of the behavioural items of the SSCL recognised the possible advantage of separating work and non-work items. The results suggested that by removing certain items scale reliability may improve. The purpose of testing this approach was to establish whether the work items of the behavioural section of the SSCL scale were stress reactions of importance to the present hospital respondents. The splitting of this section of the scale may require further research to consider whether to retain work items for future hospital staff stress assessments of this nature.

Twelve stress reactions that were selected for work related items were poor concentration, inability to meet deadlines, poor time management, procrastination, the need to take work home, poor problem solving skills, low interest in work, making unnecessary mistakes, the regular need to work late, poor work quality, difficulty in completing one task before rushing on to the next and the need to cancel leave.

Table 18

Reliability Analysis of the Behavioural Section of the SSCL

Behavioural Stress reactions	Cronbach's Alpha value
Work related items	.88
Non-work related items	.94
Total Behavioural items	.96
Biopsychosocial (three stress reaction groups)	.97

Note. Note. Acceptable correlations range.7 to .8 and good correlations are > .8.

The analysis scored the non-work items as having a higher reliability compared to the work related items (see Table 18). The nursing group had the highest number of respondents and items such as "the need to take work home" and "difficulty in completing one task before rushing on to the next" would not pertain to this type of job. Further analysis of these issues would be required to establish more relevant work items that pertain to nursing. The non-work items would have general relevance to different groups being assessed. A reliability analysis was also conducted on the TESI and Ailments Questionnaires (see Table 19).

Table 19

Reliability Analysis of the TESI and Psychosomatic Ailment Questionnaires

Questionnaires	Cronbach's Alpha value
TESI	.73
Ailments	.86

Note. Note. Acceptable correlations range.7 to .8 and good correlations are > .8.

The Psychosomatic Ailments Questionnaire and TESI reliability scores were acceptable. A concern when administering the TESI was that certain respondents did not clearly understand the terms used in the TESI scale. These terms had to be carefully explained.

The four stress scales were then correlated against each other to establish whether there was consistency in terms of the measurement of stress in the entire hospital population.

Table 20 relates all scales used to establish whether they are measuring worker stress in the three hospital groups.

Table 20

Pearson Correlation (2 tailed test) on four stress scales

N=280	SSCL	TESI	Ailment
10 –point scale	.368*	.289*	.432*
SSCL	1.000	.324*	.468*
TESI		1.000	.454*

Note. * Correlation is significant at the .01 level (2-tailed).

In all cases the table shows a significant correlation between the different scales. Although the TESI's correlation was acceptable the correlation was not as good as those of the other scales. As there was a lower reliability score for TESI the weaker validity was expected. The two main reasons considered for the poor score is that the TESI was originally used to measure teacher stress and not based on South African groups.

Table 21 describes the correlations of the three subscales of the SSCL against the comparison scales that were considered similar and useful contrasts.

Table 21

Pearson Correlation (2 tailed test) of the SSCL components with TESI, Ailment and 10 – point scales

Physical & PSYSOM	Psychological & TESI	Behaviour & 10 –point scale
.591*	.325*	.321*

Note. * Correlation is significant at the .01 level (2 tailed)

There was significant correlation between the physical section of the SSCL and the Psychosomatic Ailments Questionnaire. The physical scale is considered valid. Correlation between the two physical scales enables the conclusion that the physical items in the SSCL are measuring physical stress.

The behavioural section of the SSCL was examined further. Twelve items that were selected as work related issues were separated from the non-work items and correlated against the 10 –point scale.

Table 22

Pearson Correlation of Behaviour work and non-work items and 10 -point scale

Behaviour non-work items with 10 -point scale	Behaviour work items with 10 –point scale
.345*	.235*

Note. * Correlation is significant at the .01 level (2 tailed)

A significant correlation was found between the behavioural non-work items and the 10 -point scale (see Table 22). However, the behaviour work items and the 10 -point scale had a weaker correlation. This was expected considering the reliability analysis, which was .88 for work related items and .94 for non-work items. These items are related but not as well as the former. This may be related to differences in the respondent job types, nursing, administration, and kitchen and pharmacy staff.

In conclusion, the Alpha (Cronbach) model indicated that the SSCL physical, psychological and behavioural sections and the entire checklist were a reliable measure of internal consistency. Pearson Correlation (2 tailed test) conducted on the SSCL components with TESI, Ailment and 10 –point scale revealed a significant correlation between the different scales. Although the TESI's correlation was acceptable, the correlation was not as good as those of the other scales were. The SSCL appeared to be a useful instrument in establishing stress in hospital environments.

Fungi in the hospital environment

The objective under this section was to report surface sampling and air borne fungi monitoring data.

Fungal contamination of surfaces

All hospitals had sources of fungal growth. However, the largest surface areas were observed in a provincial type hospital. Surface sources of fungal contamination are listed in table 4. Damp mouldy organic wood chips were used in flower containers in certain office areas. A missionary hospital ward had rotting wooden window frames. This missionary hospital had pigeons harbouring in an open ceiling above a ward toilet facility. In this ceiling there were large amounts of mouldy pigeon droppings. Many of the ceilings and walls in the provincial type hospitals had surface areas contaminated with fungi greater than $3\,m^2$ (see Figure 4).

Figure 4. Mouldy ceiling in a hospital ward.

These large surface area contaminations were predominant in toilet and bathroom facilities, certain sluice areas, wards, adjoining ward offices and tea kitchens. Leaking roofs, poor air circulation in ceiling corners, dust build up on and in acoustic type ceiling panels, were also fungal surface sources.

Major influences to fungal growth in toilets, bathrooms and sluice areas were the high temperature, high humidity and poor ventilation. All air conditioner outlets and inlets were dirty and in certain situations the adjoining ceiling areas were contaminated with dirt (see Figure 5).

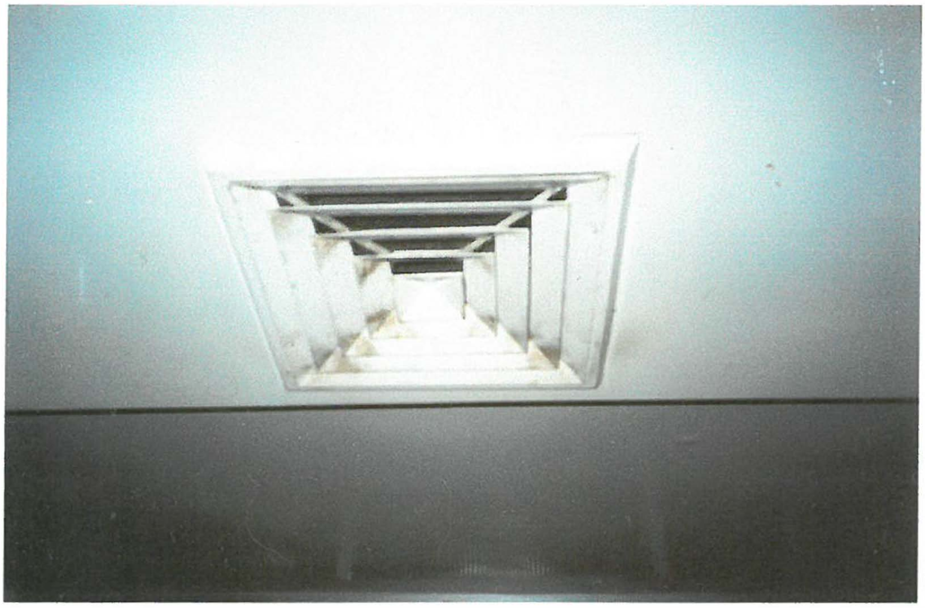

Figure 5. Mouldy ward office air conditioner outlet and ceiling

Swabs taken from these surfaces produced viable fungal growth under laboratory conditions. Other large fungal surface contaminated areas were corrugated asbestos sheeting used in the enclosed veranda ward of a provincial hospital. These deteriorating damp surfaces were supporting mould growth and viable fungi were isolated.

Carpeting in hospital administration areas was another large surface area that harboured fungi. In a private hospital, carpeting was used in a basement ICU office. This carpet had been steam cleaned the day before fungal sampling was conducted and no viable fungal counts were isolated which suggested that cleaning procedures were important in reducing allergens in these environments. In this private hospital's ICU ward, the ceiling was water damaged and was supporting fungal growth. Fungal contaminated air conditioning inlets and outlet surfaces were also observed. A damp wall surface area of approximately $2m^2$ and contaminated air conditioning filters were observed in the ICU ward of the second private hospital.

Sources of mould were also observed on operating theatre wall surfaces and on theatre air conditioning systems in a provincial hospital. These water damaged wall surfaces covered an area $>1m^2$ from which viable fungi were isolated. In the second provincial hospital viable fungi were isolated from a broken section of the floor surface. These fungi were grown even though the flooring had been disinfected approximately 30 minutes before fungi were sampled. CSSD areas were found to have higher air temperatures and humidity. Linen washing processes were found to release particles of fibre and dust. Ventilation vents in these areas had a buildup of clothing fibres and dust adhering to them. Fungi were isolated from many of these surfaces.

A pharmacy basement area in a provincial hospital had extensive dampness damage to walls and ceiling surfaces. This area also proved to be poorly ventilated. Four staff members were working in this environment sorting tablets and placing medication into containers. Other mould contaminated surfaces observed included kitchen ceiling fans, pharmacies and wards with dusty and greasy surfaces from where fungi were isolated; water damaged composite wooden tea kitchen cupboards and leaking ceiling pipes. A refrigerator coolant pipe in a provincial hospital kitchen was creating suitable conditions for mould.

The data in table 23 suggests that both provincial hospitals had more sections where fungal contaminated surfaces were greater than $3m^2$. Provincial 1 and 2 had greater surface areas with fungal growth. This trend was followed by a missionary hospital. The second missionary hospital and private hospital 1 had only one area with fungal surface area $> 3m^2$. In provincial hospitals it was evident from observations and comments from staff that maintenance programs may have been inadequate. Flanningan and Morey (1996) suggested that fungal contaminated surface areas >3m^2 must be fully contained and negatively pressurized prior to removal of the damaged area and it is important that personnel trained in the handling of hazardous materials be used for the cleanup. Even with the .2m^2 to 3m^2 contaminated areas local containment is required using HEPA vacuum cleaners to contain the dust and spores.

Table 23

Sections in hospitals and fungal contaminated surface areas

	Prov 1			Prov 2			Miss 1			Miss 2			Priv 1			Priv 2		
Surface area in m^2	<.2	.2 to 3	>3	<.2	.2 to 3	>3	<.2	.2 to 3	>3	<.2	.2 to 3	>3	<.2	.2 to 3	>3	<.2	.2 to 3	>3
Pharm	_	_	X	_	X	_	_	_	X	X	_	_	X	_	_	X	_	_
ICU	_	_	_	_	X	_	_	X	_	X	_	_	X	_	_	_	_	X
Ward 1	_	_	X	_	_	X	_	X	_	X	_	_	X	_	_	X	_	_
Ward 2	_	_	X	_	_	X	_	X	_	X	_	_	X	_	_	X	_	_
Ward 3	_	_	X	_	_	X	_	X	_	X	_	_	X	_	_	X	_	_
Admin	_	_	X	_	X	_	_	_	X	_	_	X	_	X	_	X	_	_
Kitch	X	_	_	_	X	_	_	_	X	X	_	_	X	_	_	X	_	_
CSSD	_	X	_	_	X	_	X	_	_	X	_	_	X	_	_	X	_	_
Theatre	_	X	_	X	_	_	X	_	_	X	_	_	X	_	_	X	_	_
Total	1	3	5	1	5	3	2	4	3	8	0	1	8	1	0	8	0	1

Note. X = indicates sections in the individual hospitals with fungal contaminated surfaces in m^2; _ = not applicable.

Surface fungi identified in all six hospitals

Surface swabs and wall scrapings were taken from different surfaces where mould was observed and the following fungi were most predominant:

- *Aspergillus flavus, A.ustus, A. niger, A. syndowii, A. trichoderma, A. ochraceus, A. versicolor, A. japonicus.*
- *Penicillium* species with the specific identification of *P. citrinum, P. chrysogenum.*
- *Fusarium* species.
- *Cladosporum herbarium; Rhizopus, Moneliella; Geotrichum candidum* and *Mucor.*

Table 24 and 25 provides a summary of the various fungal surface sources and the isolated fungi species.

Table 24

Fungi species of dominance in descending order of occurrence on surfaces in six hospitals

Ceiling	Fan	A/C	Wall
Cladosporium Herbarum	*Rhizopus*	*Cladosporium herbarum*	*Aspergillus*
Penicillium	*Penicillium*	*Aspergillus*	*Penicillium*
Aspergillus	*Fusarium*	*Penicillium*	*Cladosporium herbarum*
Moneliella	*Aspergillus*	*Rhizopus*	*Rhizopus*
Fusarium	*Cladosporium herbarum*	*Moneliella*	*Fusarium*
Rhizopus	*Geotrichum candidum*	*Fusarium*	*Moneliella*
Geotrichum candidum		*Geotrichum candidum*	*Geotrichum candidum*
		Mucor	

Note. A/C = air conditioned.

Table 25

Dominant fungal species in descending order of occurrence on surfaces in six hospitals

Shelves	Floors	Carpets	Wooden windows	Wood chips
Penicillium	*Fusarium*	*Moneliella*	*Aspergillus*	*Penicillium*
Aspergillus	*Cladosporium Herbarum*	*Fusarium*	*Penicillium*	*Aspergillus*
Cladosporium herbarum	*Penicillium*	*Aspergillus*	*Moneliella*	*Fusarium*
Rhizopus	*Mucor*	*Penicillium*	*Rhizopus*	*Cladosporium herbarum*
	Aspergillus	*Cladosporium herbarum* *Geotrichum candidum*	*Fusarium*	

Table 26

Predominant fungal species on surfaces

Surfaces	Predominant fungal species
A/C system inlets and outlets	*Cladosporium*
Ceilings	*Cladosporium*
Walls	*Aspergillus*
Fans	*Rhizopus*
Shelves	*Penicillium*
Floors	*Fusarium*
Wooden windows	*Aspergillus*
Wood chips in plant containers	*Penicillium*
Carpets	*Moneliella*

Table 26 summarises indoor surfaces and predominant fungi are listed in descending order of importance. In the majority of cases *Aspergillus spp* and *Penicillium spp* were regularly found growing on the same contaminated surfaces or in the same room on various contaminated surfaces. These two fungi were also present in the majority of air samples. These findings agree with previous research in the Durban area which stated that the predominant fungi were *Aspergillus* and *Penicillium* (Gqaleni et al., 1998).

Fungi in hospital air

Predominant fungi in the indoor air

Identified fungi in the indoor air were *Cladosporium herbarum; Moneliella*; various *Penicillium spp* with the specific identification of *P. citrunum*; various *Fusarium* *spp*, *Rhizopus; Aspergillus ochraceus, A. flavus, A. trichoderma, A.ustus, A.versicolor, A. syndowii, A. niger; Geotrichum candidum.* According to Frisvad and Gravesen (1994) the presence of *Aspergillus and Penicillium spp* in an indoor environment poses a serious health risk to the occupants as both of these fungi species produce pathogenic mycotoxins. Previous findings by Danaviah et al. (2000) suggested that *Aspergillus* and *Penicillium* genera are predominant in the Durban area. According to Bryant (2001), *Cladosporium, Aspergillus* and *Penicillium* are common allergy provoking mould in South Africa.

Comparison of indoor and outdoor fungal spore levels

Table 20 summarises ratios that were calculated for each area in each of the hospitals to establish hospitals and hospital areas where the ratio between indoor and outdoor air fungal levels was >1. This assessment of indoor and outdoor fungal levels was based on the recommendations by Singh (1994) that when a ratio of >1 exists between indoor and outdoor concentrations, further investigation would be necessary to reduce fungal air levels. Table 27 shows hospital areas in each of the six hospitals where indoor air fungal levels were higher than outdoor fungal levels. Missionary 1 had the highest number of areas where indoor levels of viable fungi were greater than outdoor levels (i.e. 5 areas out of 9 areas sampled). Provincial 2 then followed with 4 out of the 9 areas sampled. Provincial 1, missionary 2 and private 2 had two areas with higher indoor levels. Only private 1 had no higher indoor levels.

Table 27

Ratios between indoor and outdoor air

	Prov 1	Prov 2	Miss 1	Miss 2	Priv 1	Priv 2
Pharm	<1	>1*	<1	<1	<1	>1*
ICU	<1	<1	<1	<1	<1	<1
Ward 1	>1*	<1	<1	<1	<1	<1
Ward 2	<1	<1	<1	<1	<1	<1
Ward 3	<1	<1	>1*	<1	<1	>1*
Admin	=1	>1*	>1*	>1*	<1	<1
Kitch	>1*	>1*	>1*	>1*	<1	<1
CSSD	<1	>1*	>1*	<1	<1	<1
Theatre	<1	<1	>1*	<1	<1	<1

Note. Areas with indoor and outdoor concentration ratios of >1* require further fungal investigation.

Hospital staff allergy

Fungi were ubiquitously present in hospital indoor air and it was considered important to assess whether there was a potential health implication for the staff. In this regard the following objectives were considered to assess allergy as a potential health issue for hospital staff.

Allergy and asthma

During the screening of the 280 respondents the following results were acquired in respect of allergies and asthma.

Allergy

Ninety one (32.5%) of the respondents reported that they experience allergies. One hundred and eighty nine (67.5%) reported that they did not have allergies. Forty-three of the 91 staff members with allergies took medication. Forty-six of the 91 staff members with allergy felt that their allergy conditions were worse when at work. The occurrences of allergy complaints ranged from 1 day a year up to 365 days per year. Eighteen of the 91 respondents reported that they experienced allergies every day of the year. The main health symptoms reported by 26 respondents were rhinitis and sinus, 19 with hay fever, 12 with runny nose and itchy eyes, 6 with nasal congestion/headaches and watery eyes.

The number of respondents reporting various other health symptoms in an open ended question were tight chest 2, rhinitis/sinus 26, hay fever 19, eczema/rash 12, runny nose/itchy eyes 3, nasal congestion/headaches/watery eyes 6, burning nose 1, itchy skin/runny nose 3, sore throat/sneezing 2, sneezing/itchy eyes/itchy throat 1, runny nose/watery eyes 2, *penicillium* allergy 4, allergy to UV rays 1, cat dust allergy 2, itching hands from gloves 1, post nasal drip 2, skin allergy to condoms 1, allergy to dust mite 1, urticaria rash 1, hay fever including blocked nose and eczema 1. Of these 280 respondents 189 reported no allergy. It was interesting to note that in the entire sample group only one staff member reported itchy hands from rubber gloves in hospitals.

Asthma

Thirty four (12%) of the respondents reported that they were asthmatics. Twenty four of these respondents took medication for asthma. The asthma symptom that was most prevalent was tight chest with 31 of the respondents experiencing this condition. Other related conditions included 1 with irritated throat and dry cough; 1 with allergic reactions; 1 with mild asthma. Occurrence of asthma ranged from 1 day to 365 days with 4 respondents experiencing asthma every day. Twelve respondents stated their asthma was worse at work. Health conditions of greatest concern were upper respiratory allergy type reactions, asthma and concerns about skin rash.

Allergy testing results

Of the 280 respondents, 123 were willing to undertake an allergy test and answer the allergy questionnaire. A one-way frequency table 28 provides the results of the skin prick allergy tests conducted on 123 hospital staff.

Table 28

Respondents from all hospitals experiencing allergic reactions to allergens (N = 123)

	Non - allergic staff		Allergy potential		Allergic staff	
Allergy testers	*n*	%	*n*	%	*n*	%
M2	111	90	12	10	0	0
M3	111	90	12	10	0	0
M4	108	88	12	10	3	2
DM	74	60	27	22	22	18
GC	92	74.8	29	23.6	2	1.6

Note. Allergy tester coding:

- Mould II (M2): *Mucor, Neurospora, Pullularia,*; *Rhizopus;*
- Mould III (M3): *Aspergillus amstelodami, fumigatus, niger & terreus*;
- Mould IV (M4): *Penicillium brevicompactum, expansum, notatum & roqueforti*;
- Dust mite: (DM): *Dermatophagoides Pteronyssinus*;
- German cockroach (GC): *Blatella germanica.*

The allergy assessments in table 28 were based on skin reactions greater than the negative control (histamine) and were categorised as follows:

0 = not allergic (0 to < 3mm diameter),

1= potential for allergy (3mm to <5mm diameter),

2 = allergic (> 5mm diameter).

The last column of table 28 indicated that the confirmed allergic responses are related to dust mite, cockroach and mould mix IV (*Penicillium* group). By combining allergic response and potential for allergy, dust mite allergy had the highest proportion at 40%. The proportion of respondents with cockroach allergy was 25%. Allergy reactions to the three mould mixes ranged from 10% to 12%. These results appear not to compare well with information from the UCT Lung Institute South Africa in that up to 30% of the people referred to the unit were allergic to moulds (Bryant, 2001). However, it is understood that allergenic patients were being referred to the lung unit. This suggests that more research may be necessary to clarify this. Fungal, dust mite and cockroach allergy reactions were occurring in certain of the hospital respondents. However, many other allergens may have been present at the time of this research that may have had a synergistic effect on sensitive people. An allergy questionnaire would be a useful measurement tool to establish allergy sensitive staff.

Allergy questionnaire survey results

Environments that are not well maintained may have a greater potential to cause upper respiratory tract irritation and lower respiratory tract reactions. The allergy questionnaire responses (see Appendix G) were divided into lower respiratory tract and upper respiratory tract concerns.

Table 29

Lower respiratory tract symptom report by staff undertaking the allergy test (N = 123)

	Yes		No	
Symptoms	*n*	%	*n*	%
Asthma	21	17	102	83
Exercise-induced Asthma	15	12	108	88
Tight chest	39	32	84	68
Cough	56	46	67	54
Wheeze	28	23	95	77
Short breath	20	16	103	84
React to pollution	82	67	41	33
Head cold goes to chest	36	29	87	71
Missed work due to tight chest	32	26	91	74

In the one-way frequency table 29, 17% of respondents reported that they experienced asthma symptoms. The highest concern was pollutants at 67%. The question relating to this item was "Do cold air, smoke, fumes (perfumes, paints), dust or mould ever cause chest tightness or cough or wheezing?" Twenty six percent of respondents reported that they had missed work because of chest tightness or cough or wheezing or prolonged shortness of breath.

Table 30

Upper respiratory tract symptoms reported by staff undertaking the allergy test (N = 123)

	Yes		No	
Symptoms	*n*	%	*n*	%
Hay fever or allergic rhinitis	46	37	77	63
Diagnosed sinus	46	37	77	63
Itchy eyes	67	55	56	45
Itchy ears	44	36	79	64
Itchy roof of mouth	41	33	82	67
Itchy throat	50	41	73	59

A one-way frequency table 30 describes respondent incidences of upper respiratory tract allergy reactions. These were based on hay fever or rhinitis and sinus diagnoses along with important symptomatic questions such as itchy eyes, ears, roof of mouth and throat. The highest reported symptomatic response was itchy eyes.

To conclude, the allergy questionnaire indicates that 37% of the 123 respondents experience hay fever or allergic rhinitis with up to 17% reporting asthma symptoms. The skin prick test indicated that lower staff proportions were prone to fungal, dust mite and cockroach allergies. The presence of asthmatics and allergy sensitive individuals in an environment along with the presence of surface fungal contamination emphasises the need for awareness to remove the allergen sources. The allergy questionnaire was able to detect a higher number of potentially allergenic staff than the allergy test that is specific in nature.

Staff indoor air quality perceptions and indoor air monitoring

The objectives of air quality assessments were to:

- Establish hospital staff perceptions and symptoms of stress from indoor environmental factors, personal factors, building characteristics and the effectiveness of building maintenance programs.
- Establish a methodology for assessing air quality and the potential for discomfort by recording levels of carbon dioxide, temperature, relative humidity and air movement, which could be used for future hospital research and hospital maintenance monitoring programs.
- Assess particulate levels by real-time analysis as a method of classifying cleanliness.

As described in figure 1, hospital staff spent many hours in their work environment therefore was important to assess environmental conditions to establish whether conditions are conducive to comfort and health.

Occurrence of colds and influenza as indicators of general health

Colds and influenza occurrences were considered as a health indicator. Of the 280 respondents, 31 did not experience a cold in the preceding 12 months. Occurrence of colds: 86 experienced 1 cold, 63 two colds, 52 three colds, 20 four colds, 28 five or more colds.

Eighty seven had reported having influenza in the last 12 months (82 experienced 1 influenza occurrence, 52 had two influenza occurrences, 37 experienced three influenza occurrences, 9 had four influenza occurrences, 3 had five or more influenza occurrences). The occurrences of colds and influenza may have impacted on the overall absenteeism rate in hospitals. Doctor Rajen Naidoo, the Deputy Director of the Centre for Occupational and Environmental Health and a specialist in Occupational Medicine at the Nelson Mandela

Medical School KwaZulu-Natal, Durban, South Africa, advised that colds occur when a person is predisposed to the causal organisms whereas influenza is dependant on occurrences of viruses and he suggested that colds or influenza occurring more than twice a year would be considered undesirable (R. Naidoo, personal communication, July 9, 2002).

Tobacco smoking habits of hospital staff

Smoking tobacco is considered high risk behaviour (Stokols, 1992; Schlebusch, 1990). Accordingly, there was a need to report on the habits of tobacco smoking in hospitals. The proportion of respondents that smoked was 49 (17.5%) of the 280 respondents. The number of cigarettes smoked ranged from 1 to 40 per day. Fifteen of the 49 smokers reported ill health effects from smoking tobacco. It was interesting that 137 (49%) of the respondents reported that they observed other staff smoking tobacco while in the hospital buildings. Twenty eight tobacco smokers stated that they smoked while in the building. In any workplace tobacco smoking can impact on personal health. The potential health effects from passive smoking and the long term effects on the workforce need to be acknowledged and controlled. According to Yach, McIntyre, and Saloojee (1992) comprehensive tobacco prevention programs are needed in South Africa.

SBS symptoms

Respondent numbers in each of the areas surveyed in the hospital were too low to confirm SBS. However, certain areas showed high carbon dioxide levels that suggested ventilation systems were not supplying adequate air changes and that indoor air quality may have an impact on certain staff. Furthermore, the presence of mould, high relative humidity and temperature may have also been contributing factors to health and discomfort effects. ASHRAE (1999) and ASHRAE (1992) suggest that when 20% or more of the respondents have similar symptoms that improve when away from the work environment, there may be conditions in the environment that have caused health effects. This standard was applied in table 31 as a method of suggesting whether SBS symptoms were a concern for certain of the 280 respondents.

Table 31

SBS symptom occurrence in descending order of concern (N = 280)

	Yes		No	
Symptoms	*n*	%	*n*	%
Lethargy	117	41.8	163	58.2
Blocked nose	71	25.4	209	74.6
Headaches	69	24.6	211	75.4
Dry Throat	51	18.2	229	81.8
Dry eyes	42	15	238	85

Note. Percentages more than 20% indicate environmental conditions of concern.

In the one-way frequency table 31, the SBS symptom that appeared to be of most concern was lethargy. Allergy symptoms were also given consideration. Allergy concerns were related to upper respiratory tract effects and are indicated in the one-way frequency table 32.

Table 32

Allergy Symptoms reported by hospital staff (N = 280)

	Yes		No	
Symptoms	*n*	%	*n*	%
Itchy or watery Eyes	115	41.1	165	58.9
Runny Nose	105	37.5	175	62.5
Dry itchy skin	76	27.1	204	72.9

Note. Percentages more than 20% indicate environmental conditions of concern.

Other reported health symptoms

The respondents were asked whether they experienced other health symptoms at work. Twenty five respondents reported various symptoms that occurred during working hours. However, there were no common symptoms. These symptoms were neck pain aching cheeks when mixing chemotherapy/parental nutrition, back pain, chest pain, feeling tired from theatre gases, feeling faint when wearing mask, nausea, thyroid problems, facial rashes, dizzy spells and weakness, sinusitis, constant nasal sensitivity sneezing and blocked nose, irregular bowel, sore throat and coughing, weakness, tired eyes, sneezing due to dusty air conditioning and paint, yawning and slight disorientation, sinus due to smokers' room and pleurisy.

Some conditions such as neck pain, aching cheeks when mixing chemotherapy/parental nutrition, sinusitis, constant nasal sensitivity sneezing and blocked nose, sore throat and coughing and sinus due to a smokers' room occurred twice.

Physical work related symptoms caused by feeling tired from theatre gases, feeling faint when wearing mask, sneezing due to dusty air conditioning and paint and sinus due to smokers' room require further investigation. Common symptoms were not reported and certain symptoms were specific to hospital environments, for example, effects from theatre gas and wearing masks.

Indoor environmental comfort

Indoor environmental comfort assessments were based on respondent perceptions of indoor temperature, air movement, humidity, stuffy air, odours and control of their indoor environment. Reports from the 280 respondents were considered. In the tables, percentages > 20% suggested that environmental conditions may have been a concern. Indoor environment discomfort concern was assessed as percentages > 50%.

Table 33

Proportion of respondents reporting indoor environmental comfort concerns (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Concerns	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Hot air	24	41	25	41	8	25	11	36	4	8	13	26	.002
Temp var	18	31	37	61	20	63	21	68	34	71	39	78	.000
Air still	21	36	15	25	11	34	13	42	10	21	15	30	.29
Humid	20	35	28	46	12	38	14	45	11	23	23	46	.130
Stuffy	45	78	48	79	26	81	24	77	36	75	47	94	.191
Odour	33	57	48	79	23	72	22	71	32	67	46	92	.002
N	58		61		32		31		48		50		

Note. Percentages > 20% suggest environmental conditions of concern. Temp var = temperature variation. Significant Chi-square association: $p < .05$. Chi-square was acceptable: 0 cells had counts less than 5.

Table 33 suggests that at the time of this research there were similar proportions of respondents reporting low air movement, high relative humidity and stuffy air concerns. In provincial hospitals, discomfort due to hot temperature appeared to be more of a concern than for the other hospital groups. However, temperature variation appeared to be more of a concern for the private hospital 2. Private hospital 2 respondents also reported higher proportions of concern regarding odours than the other hospital groups.

Tables 33 to 39 summarise indoor environmental discomfort responses in each hospital and in each work areas. Chi-square test indicated that more than 20% of the cells had expected counts < 5, thus Chi-square assumptions were not met and *p* values should be interpreted with caution. Descriptive results were discussed for these data.

Of the total respondent group of 280, 85 (30%) reported concerns that room temperatures were too high. Concern regarding temperature being too cold may not be as relevant to respondents as hot temperatures. At the time of this research 28 (10%) of the total respondent group reported concern in certain work areas regarding cold temperatures.

Table 27

Proportion of respondents reporting hot air discomfort (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Sections	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Pharm	2	14	0	0	0	0	0	0	0	0	0	0	.762
ICU	1	33	2	22	1	50	0	0	1	10	1	25	.721
Ward 1	4	66	2	67	0	0	4	100	0	0	3	43	.033
Ward 2	1	25	2	50	0	0	1	50	3	43	2	40	.672
Ward 3	3	100	2	40	5	63	1	33	0	0	3	75	.051
Admin	4	80	2	50	2	33	1	11	0	0	1	7	.006
Kitch	7	88	4	67	0	0	1	50	0	0	1	10	.006
CSSD	0	0	4	24	0	0	2	100	0	0	0	0	.054
Theatre	2	18	7	78	0	0	1	25	0	0	2	40	.074
N	58		61		32		31		48		50		

Note. For many of the cross-tabulations, more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution. The descriptive results were used in discussion of these data. Percentages > 20% suggest environmental conditions of concern.

Results in table 33 suggests that provincial 1 and missionary 2 hospitals may have had proportionally more staff concerned about hot air temperatures in their work areas compared to the respondents from the other hospitals.

Of the 280 respondents, 85 (30%) reported concerns that air movement was too low. A similar proportion of concern was reported regarding hot temperatures. Concern regarding draughty air movement may have been less relevant to respondents. Low air movement concern at the time of this research was reported by 26 (9%) of the total respondent group.

Table 34

Proportion of respondents reporting low air movement discomfort (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Sections	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Pharm	4	29	1	25	4	80	0	0	0	0	0	0	.087
ICU	1	33	1	11	0	0	0	0	3	30	3	100	.058
Ward 1	3	50	2	67	1	50	3	75	1	20	2	29	.530
Ward 2	0	0	2	50	0	0	2	100	2	29	3	60	.076
Ward 3	2	67	1	20	4	50	1	33	0	0	3	75	.143
Admin	2	40	3	75	2	33	1	11	3	43	0	0	.022
Kitch	4	50	1	17	0	0	2	100	0	0	2	20	.091
CSSD	2	50	0	0	0	0	2	100	0	0	0	0	.001
Theatre	3	27	4	44	0	0	2	50	1	100	2	40	.575
N	58		61		32		31		48		50		

Note. For many of the cross-tabulations, more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution. The descriptive results were used in discussion of these data. Percentages > 20% suggest environmental conditions of concern.

Results in table 34 may suggest that air movement in the wards in most of the hospitals may need further investigation. Missionary 2 hospital respondents appeared to have proportionally more concerns than the other hospitals.

Of the total respondent group of 280, 108 (39%) reported concerns regarding high humidity. Concern regarding dry air appeared to be of less relevance. Dry air concern was reported by 27 (10%) of the total respondent group.

Table 35

Proportion of respondents reporting high relative humidity discomfort (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Sections	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Pharm	4	29	1	25	3	60	1	33	0	0	0	0	.489
ICU	2	67	2	22	0	0	1	50	2	20	2	67	.337
Ward 1	2	33	2	67	1	50	2	50	2	40	4	57	.934
Ward 2	4	100	4	100	0	0	2	100	3	43	2	40	.015
Ward 3	2	67	3	60	5	63	1	33	0	0	2	50	.211
Admin	1	20	2	50	2	33	2	22	2	29	1	7	.516
Kitch	4	50	4	67	1	50	1	50	1	33	10	100	.15
CSSD	0	0	5	29	0	0	2	100	1	20	0	0	.164
Theatre	1	9	5	56	0	0	2	50	0	0	2	40	.207
N	58		61		32		31		48		50		

Note. For many of the cross-tabulations, more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution. The descriptive results were used in discussion of these data. Percentages > 20% suggest environmental conditions of concern.

Results in table 35 may suggest that humidity in the wards in most of the hospitals may need further investigation.

Of the total respondent group of 280, 226 (81%) reported concerns regarding stuffy air.

Table 36

Proportion of respondents reporting stuffy air discomfort (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Sections	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Pharm	11	79	3	75	5	100	2	67	2	50	1	100	.594
ICU	2	67	8	89	1	50	2	100	6	60	3	100	.458
Ward 1	5	83	3	100	1	50	4	100	3	60	7	100	.226
Ward 2	4	100	4	100	4	100	2	100	6	86	5	100	.727
Ward 3	3	100	4	80	7	88	3	100	6	100	4	100	.713
Admin	4	80	4	100	6	100	6	67	6	86	12	86	.534
Kitch	6	75	6	100	2	100	2	100	1	33	10	100	.039
CSSD	3	75	11	65	0	0	0	0	5	100	1	100	.277
Theatre	7	64	5	56	0	0	1	25	1	100	4	80	.276
N	58		61		32		31		48		50		

Note. For many of the cross-tabulations, more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution. The descriptive results were used in discussion of these data. Percentages > 20% suggest environmental conditions of concern.

Results in table 36 may suggest that in general stuffy air was a concern in all hospitals. Of the total respondent group of 280, 204 (72.8%) reported concerns regarding odour.

Table 37

Proportion of respondents reporting odour discomfort (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Sections	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Pharm	9	64	3	75	2	40	2	67	0	0	1	100	.189
ICU	2	67	8	89	0	0	2	100	6	60	3	100	.101
Ward 1	1	17	3	100	2	100	4	100	3	60	7	100	.006
Ward 2	4	100	4	100	4	100	2	100	6	86	4	80	.752
Ward 3	2	67	4	80	6	75	3	100	5	83	4	100	.796
Admin	5	100	4	100	5	83	6	67	6	86	14	100	.178
Kitch	2	25	4	67	2	100	2	100	1	33	10	100	.010
CSSD	3	75	13	76	0	0	0	0	5	100	1	100	.062
Theatre	5	46	5	56	2	100	1	25	0	0	2	40	.508
N	58		61		32		31		48		50		

Note. For many of the cross-tabulations, more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution. The descriptive results were used in discussion of these data. Percentages > 20% suggest environmental conditions of concern.

Results in table 37 may suggest that odours concern was proportionally greater for respondents in private hospital 2. Poor lighting appeared to be a concern to 121 (43%) of the 280 respondents from all of the hospitals.

In the next section respondent concern regarding their personal control over the work environment will be discussed.

Indoor environment control and maintenance issues

Data regarding "lack of control" of temperature, ventilation and lighting by the 280 respondents suggested that the lack of ability to control ventilation was a concern for 214 (77%) of the total group. The lack of ability to control temperature was a concern for 211 (75%) respondents. Lack of ability to control lighting was a concern for 169 (60%) respondents.

Concern regarding hospital cleanliness by the 280 respondents suggested that 179 (64%) of all the respondents had concerns about poor hospital cleanliness. Cleanliness and the lack of ability to control comfort in the workplace appeared to be a concern for the majority of hospital staff.

Table 38

Respondents reporting lack of control over indoor environmental concerns (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Concerns	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Temp	33	57	50	82	22	69	22	71	41	85	43	86	.002
Vent	36	62	50	82	23	72	22	71	41	85	42	84	.031
Lighting	29	50	33	54	14	44	21	68	39	81	33	66	.004
Cleaning	49	85	49	80	13	41	23	74	21	44	24	48	.000
N	58		61		32		31		48		50		

Note. Chi-square $p < .05$ are significant. Percentages more than 50% indicate environmental conditions of concern.

Results in table 38 suggests that private hospitals had a higher proportion of concern regarding temperature and ventilation control. Respondents in provincial hospitals appeared to have a higher proportion of concern regarding poor hospital cleanliness.

Consideration in this next section was given to respondent perceptions as to how effective hospital maintenance programs were. A summary of all respondent reports from the total groups suggested that the majority of hospital staff were concerned that maintenance programs were not effective.

With regards to ventilation system maintenance 169 (60%) of the 280 respondents had made requests for improvements to air conditioning systems. The requests were repair needs 17(6.1%), renew/replace 13 (4.6%), clean 10(3.6%), temperature control 52 (18.6%), upgrade ventilation/provide air conditioning 17 (6.1%), service 20 (7.1%), inadequate ventilation 35 (12.5%), too much air movement 1 (.4%), improve air circulation 1 (.4%), installation of fans 1 (.4%) and repair and cleaning 2 (.7%). The speed of response for maintenance was a concern for 70 (25%) of the respondents with 44 (15.7%) staff suggesting investigation into the response speed.

The effectiveness of maintenance was a concern for 118 (42%) of respondents. Table 39 summarises ventilation maintenance reporting. Percentages above 50% were considered as a relevant level for concern.

Table 39

Respondents reporting ventilation maintenance concern (N = 280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Concerns	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Request	29	50	11	82	22	31	6	81	23	52	20	40	.000
Response	21	36	28	46	8	25	18	58	12	25	27	54	.005
Effective	20	34	30	49	7	22	20	65	14	29	27	54	.001
N	58		61		32		31		48		50		

Note. Chi-square $p < .05$ are significant. Percentages more than 50% indicate environmental conditions of concern. Request = requests made for maintenance; response = reported dissatisfaction with response time; effective = reported dissatisfaction with work.

Missionary 2 hospital appeared to have a higher proportion of dissatisfied staff compared to the other hospitals with regards to ventilation maintenance issues.

Air conditioning maintenance issues reported by the total respondent group were: repair needs, renew/replace the system, cleaning, temperature control improvements, upgrade or provide air conditioning, service, inadequate ventilation, too much air movement, improve air circulation, installation of fans and repair and cleaning of fans. These results may suggest the need for the effectiveness of air conditioning maintenance issues to be assessed regularly. A missionary hospital and a private hospital reported the greater concern respectively regarding ventilation maintenance issues.

In addition to ventilation issues an assessment of staff concerns in all hospitals regarding other improvements requirements were established though an open-ended question. One hundred and two (36%) of the staff suggested structural improvement needs in hospitals. These improvement concerns were dampness 1(.4%), painting 4 (1.4%), painting and dampness 1(.4%), toilet required 3 (1.1%), repair roof 2 (.7%), leaks from geyser 1(.4%), restroom needed 5 (1.8%), personal hygiene improvements needed 3 (1.1%), cleaning and maintenance needs 10 (3.6%), renovations 28 (10%), ultraviolet lights 1 (.4%), stretchers 2 (.7%), need computers 1(.4%), fix equipment 3(.1.1%), covered corridors to transport patient to and from the theatre 4 (1.4%), new chairs 2 (.7%), medical equipment 3 (1.1%), lift repair 1 (.4%), improve lighting 3 (1.1%), need air conditioning 1 (.4%), overcrowding 8 (2.9%), to improve ventilation 4 (1.4%), freezer space 1 (.4%), place sharps container at each bed 1 (.4%)26; upgrade kitchen equipment 1 (.4%), need more staff 1 (.4%), dampness and odour 1 (.4%), safety rails for toilets 1(.4%), remove smokers room 1(.4%), broken windows 1 (.4%), renovate air conditioning 1 (.4%), need blinds for glare 1 (.4%), phone call box for operating theatre 1 (.4%). The issues of most concern were the need for hospital renovations, cleaning and maintenance and overcrowding of wards. The 280 respondents data summary suggested that the speed of response to rectify these problems was a concern for 74 (26%) of the respondents. Two hundred and six (74%) of the staff were not concerned. Effectiveness of the maintenance work was reported and 77 (28%) considered effectiveness of the work to inadequate with 203 (72%) of the staff not reporting concern. Table 40 summaries these concerns by examining responses from each of the hospitals.

Table 40

Respondents reporting hospital improvement needs (N =280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2		
Concerns	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*p*
Request	29	50	24	39	6	19	19	61	10	21	14	28	.000
Response	19	33	18	30	5	16	15	48	5	10	12	24	.004
Effective	20	34	19	31	6	19	15	48	5	10	12	24	.004
N	58		61		32		31		48		50		

Note. Chi-square $p < .05$ are significant. Percentages more than 50% indicate environmental conditions of concern. Request = requests made for maintenance; response = reported dissatisfaction with response time; effective = reported dissatisfaction with work.

It appears that a high proportion of the staff in missionary 2 were concerned about additional hospital needs compared to the other hospital respondents.

In addition to the previous questions, a further open ended question elicited more responses from the staff. The question requested respondents to comment generally about their work environment. Although certain of the responses listed previously were repeated, new concerns were also reported. These responses are summarized as follows: renovate hospital 12(4.3%); need restroom 1 (.4%), need chlorine based sanitizers and cockroach poison 1 (.4%), hospital congested 3 (1.1%), ventilation improvement needed 4 (1.4%), dampness 1 (.4%), no smoking in hospitals 1 (.4%), fine white dust 1 (.4%), need windows for ventilation 2 (.7%), peeling paint – needs painting 2 (.7%), need more natural light 1 (.4%), neck ache under air conditioners 1 (.4%), too hot 1 (.4%).

In summary, although the findings are non-specific there are some common indoor environmental issues that can be highlighted. These are ventilation issues, lighting, dampness, overcrowding, smoking in hospitals, hygiene and cleanliness issues, general renovation and upgrading of equipment needs. A pro-active documented "needs analysis" by the various hospitals is recommended to prioritise the more important concerns for maintenance action.

It is also important to acknowledge that maintenance did occur in private hospitals and to a lesser extent, in missionary type hospitals. Some improvements had also taken place in provincial hospitals. During follow-up interviews with staff in a private hospital, renovations of the theatre section were observed. Increases in particulate levels were visually noticeable.

Eighty nine (31.8%) of the 280 respondents reported the following internal alterations that had occurred in hospital work areas during the past year. These alterations included: new windows 5 (1.8%), new air conditioner 2 (.7%), autoclave 2 (.7%), lamina flow extractor 3 (1.1%), major structural changes 17 (6.1%), new office 5 (1.8%), piping for freezer in kitchen 1 (.4%), toilet added 15 (5.4%), ceiling repair 3 (1.1%), borer maintenance 1(.4%), sinks installed 3 (1.1%), ceiling and lighting repair 3 (1.1%), new refrigerator shelves and repaired leakages in ceiling 1 (.4%), painting 5(1.8%), carpeting 1(.4%), renovating the ward 6(2.1%), new dental chair 1(.4%), new equipment 2(.7%), leaking roof and odour concerns dealt with 2(.7%), re-occurring wall dampness dealt with 1(.4%), reconditioned air conditioners 1(.4%), electrical alterations 1(.4%), fans installed 1(.4%), camera installation to monitor patients 7 (2.5%).

These results indicate that certain maintenance issues were being dealt with. However observations during the study confirmed that provincial hospitals had many conditions that required maintenance.

Respondents with mould in their homes

Hospital respondent reports on mould in their homes were included in this study merely to suggest confirmation of staff recognition and awareness of mouldly conditions and, perhaps of lesser importance to the present research, family allergy incidence.

The 280 respondents in the hospital study were found to be residing in Durban and greater Durban residential areas. This information is summarised in a one-way frequency table 41.

Table 41

Hospital respondent and their residential areas (N =280).

Residential area	Respondents living in the residential area	
	n	%
Phoenix	26	9.3
Reservoir Hills	6	2.1
Isipingo Beach	3	1.1
Westville	2	.7
Overport	11	3.9
Berea/Musgrave	11	3.9
Redhill	2	.7
Sydenham	7	2.5
Newlands	21	7.5
Inanda	4	1.4
Cato Manor	3	1.1
Springfield	2	.7
Kwa Mashu	16	5.7
Umlazi	21	7.5
Woodlands	3	1.1
Asherville	2	.7
Lamontville	2	.7

(table continues)

Table 41 (continued)

Residential area	Respondents living in the residential area	
	n	%
Central Durban	8	2.9
Morningside	15	5.4
Pinetown/New Germany	5	1.8
Durban North	7	2.5
Amatilwe	1	.4
Malvern/Hillary	4	1.4
Mount Edgecome	1	.4
Mobeni Heights	1	.4
Glenwood	10	3.6
Durban beach front	14	5
Montclair	2	.7
Nkandla	1	.4
Wentworth	1	.4
Seaview	2	.7
Tongaat/Verulam	3	1.1
Chatsworth	16	5.7
Greenwood Park	1	.4
Queensburgh	5	1.8
Umhlanga	2	.7

(table continues)

Table 41 (continued)

Residential area	Respondents living in the residential area	
	n	%
Claremont	1	.4
Marianhill	2	.7
Merebank	1	.4
Ntuzuma	2	.7
Rossburgh	1	.4
Port Shepstone	2	.7
Clare Estate	3	1.1
Mayville	2	.7
Kwaduguza	1	.4
Umbilo	3	1.1
Sherwood	2	.7
Bakerville	1	.4
Avoca Hill	1	.4
Umhlatuzana	1	.4
Shellcross	2	.7
Northdene	1	.4
Hillcrest	1	.4
Camperdown	1	.4
Bluff	3	1.1

(table continues)

Table 41 (continued)

Residential area	Respondents living in the residential area	
	n	%
Amanzimtoti/Winkelspruit	4	1.4
Ballito	1	.4
Greyville	1	.4
Lindelana	1	.4
Sarnia	1	.4

Ninety (32%) of the 280 respondents listed in table 41 reported that they had observed mouldy conditions in their homes.

Data on the number of people residing with each respondent were acquired. Numbers of occupants in all respondent homes were 1277. This information is provided in a one-way frequency table 42.

Table 42

Number of people residing in hospital respondent homes (N=1277)

Home categories	Number of homes	Total number of occupants
Single occupant home	8	8
Two occupant home	31	62
Three occupant home	52	156
Four occupant home	54	216
Five occupant home	58	290
Six occupant home	35	210
Seven occupant home	17	119
Eight occupant home	15	120
Nine occupant home	5	45
Ten occupant home	4	40
Eleven occupant home	1	11
N		1277

Of the total group of hospital respondents (N = 280), 126 (45%) reported that they had members residing in their homes that experienced allergies (see Table 43).

Table 43

Allergy incidence in the homes of the hospital respondents

Allergic family members	Hospital respondents	Total allergic family members
1	73	73
2	48	95
4	2	8
6	3	18
n	126	194

Family members of the respondents with reported allergies were 194. Excluding the possibility of an allergic hospital respondent as part of the 1277 group, the 194 family members with allergies represented 15% of the 1277 respondent family member group.

In conclusions, many of the hospital staff appeared to be aware of how to recognise mould in their homes. Further research would be necessary to confirm allergy incidences in the Durban region.

Environmental monitoring and measurements

Environmental measurements were used to assess the potential for indoor discomfort. The mean monitoring time for carbon dioxide, temperature and relative humidity was 1 hour 30 minutes *SD* 45. London Hazard Centre (1990), ASHRAE (1999) and ASHRAE (1992) standards were applied in this research and are summarised in table 44.

Table 44

Indoor measurement standards

Standards	Acceptable range
Temperature	22.5 to 26^{0}C
Air movement	.1 to .3m/s
Humidity	40 to 60%
Carbon dioxide	Below 1000ppm

Table 45 summarises air quality and comfort data measured in the hospital indoor environment.

Table 45

Air quality and comfort data comparison between hospitals (N=280)

Measurements	Prov 1	Prov 2	Miss 1	Miss 2	Priv 1	Priv 2
Mean CO^2	688	562	713	607	694	576
Mean CO^2 SD	265	86	351	113	185	104
Mean CO^2 max	818	644	903	718	918	721
Mean CO^2 max SD	361	140	423	133	156	145
CO^2 max	1390	1012	2547	962	1203	1188
CO^2 min	411	432	446	412	346	435

(table continues)

Table 45 (continued)

Measurements	Prov 1	Prov 2	Miss 1	Miss 2	Priv 1	Priv 2
Mean temp ^{0}C	24	24	26	25	23	24
Temp *SD*	2.76	1.3	1.5	1.6	1.5	1.4
Mean temp max	25	25	27	26	23	25
Mean temp max *SD*	2.9	1	2	1	1.6	1.3
Temp max ^{0}C	30	28	30	29	26	27
Temp min ^{0}C	20	22	23	22	20	22
Mean RH %	66	65	69	72	61	62
RH SD	6.7	9.3	7.5	7.2	2.68	6.7
Mean RH % max	70	67	71	75	64	67
Mean RH % max *SD*	6.4	9.3	7.4	8.1	4.5	6.98
RH max %	79	82	88	84	73	73
RH min %	53	50	56	50	58	45
Mean air flow	.092	.46	.14	.18	.07	.097
Mean air flow *SD*	.032	1.01	.096	.14	.038	.06
Air flow max	.15	3.5	.3	.5	.14	.2
Air flow min	.3	.06	.06	.01	.03	.3
N	58	61	32	31	48	50

Note. CO^2 = carbon dioxide level in ppm; Mean temp ^{0}C = mean temperature in degree centigrade; Mean air flow measured in m/s. Mean airflow maximums were not calculated.

A One-way Anova test suggests statistically significant associations between hospitals and each indoor measurement (see Table 46).

Table 46

Analysis of variance for indoor environmental measurement means

Measurements	*df*	*F*	*p*
	Between each measurements		
Mean CO^2	5	4.805	.000
Mean CO^2 max	5	9.414	.000
Mean temp	5	11.621	.000
Mean temp max	5	18.784	.000
Mean RH %	5	12.371	.000
Mean RH % max	5	11.186	.000
Mean air flow	5	5.512	.000

Note. CO^2 = carbon dioxide levels: temp = temperature levels; RH = relative humidity levels; Air flow = air movement levels.

*p < .05 is significant

A closer examination for associations between hospitals and the indoor measurements was then conducted using the Bonferroni Post Hoc test. Results show the two-way comparisons between each of the six hospitals for each of the indoor measurements (see Table 47). Only significant comparisons are shown.

Table 47

Air quality and comfort data associations between hospitals

Measurements	Hospital associations		p
	Prov 2	Miss 1	.009
Mean CO^2	Prov 2	Priv 1	.01
	Miss 1	Priv 2	.038
	Prov 1	Prov 2	.003
	prov 2	miss1	.000
	prov 2	priv 1	.000
Mean CO^2 max	miss 1	miss 2	.049
	miss 1	priv 2	.020
	miss 2	priv 1	.008
	priv 1	priv 2	.002

(table continues)

Table 47 (continued)

Measurements	Hospital associations		p
	Prov 1	Miss 1	.001
	Prov 1	Priv 1	.001
	Prov 2	Miss 1	.000
	Prov 2	Priv 1	.007
Mean temp	Miss 1	Priv 1	.000
	Miss 1	Priv 2	.001
	Miss 2	Priv 1	.000
	Priv 1	Priv 2	.007
	Prov 1	Miss 1	.000
	Prov 1	Priv 1	.000
	Prov 2	Miss 1	.000
	Prov 2	Priv 1	.000
	Miss 1	Priv 1	.000
Mean temp max	Miss 1	Priv 2	.000
	Miss 2	Prov 2	.044
	Miss 2	Priv 1	.000
	Miss 2	Priv 2	.027
	Priv 1	Priv 2	.003

(table continues)

Table 47 (continued)

Measurements	Hospital associations		*p*
	Prov 1	Miss 2	.008
	Prov 1	Priv 1	.009
	Prov1	Priv 2	.013
	Prov 2	Miss 2	.000
Mean RH %	Miss 1	Priv 1	.000
	Miss 1	Priv 2	.000
	Miss 2	Priv 1	.000
	Miss 2	Priv 2	.000
	Prov 1	Miss 2	.044
	Prov 1	Priv 1	.000
Mean RH % max	Prov2	Miss 2	.000
	Miss 1	Priv 1	.000
	Miss 2	Priv 1	.000
	Miss 2	Priv 2	.000
	Prov 1	Prov 2	.000
Mean air flow	Prov 2	Miss 1	.03
	Prov 2	Priv 1	.000
	Prov 2	Priv 2	.001

Note. *p < .05 is significant

The results in table 47 suggest that indoor conditions varied in hospital environments. Table 45 shows that certain indoor air quality criteria, as listed in table 44, were being exceeded in hospitals. In each of the hospitals, except missionary hospital 2, carbon dioxide levels had exceeded 1000ppm. This suggested that ventilation systems may not have been performing adequately to ensure sufficient air changes. Maximum temperatures indicated that at times during the measurement period, levels exceeded the standard. However, in most cases, temperatures were acceptable. Relative humidity in all hospitals exceeded the standard. Maximums exceeded 70% which may cause discomfort and support fungal growth. Air movement in most cases was within acceptable comfort limits. However, fungal spores tend to be released between .5m/s to 1 m/s (Pasanen et al., 1991).

Table 48 describes various ventilation systems used in each hospital section.

Table 48

Ventilation system types in hospitals and hospital sections (N=280)

	Prov 1		Prov 2		Miss 1		Miss 2		Priv 1		Priv 2	
Sections	A/C	NV	A/C	NV	A/C	NV	A/C	NV	A/C	NV	A/C	NV
Pharm	X	_	X	_	X	_	X	_	X	_	X	_
ICU	X	_	X	_	X	_	X	_	X	_	X	_
Ward 1	X	X	X	X	X	X	X	X	X	_	X	X
Ward 2	X	X	X	X	X	X	X	X	X	_	X	X
Ward 3	X	X	X	X	X	X	X	X	X	_	X	X
Admin	X	X	X	_	X	_	X	_	X	_	X	_
Kitch	_	X	X	X	X	X	X	X	X	_	X	X
CSSD	X	_	X	_	X	_	X	_	X	_	X	_
Theatre	X	_	X	_	X	_	X	_	X	_	X	_

Note. A/C = air conditioning; NV= natural ventilation, natural meaning windows that could be opened; _ = not applicable.

Table 48 indicates that, in the majority of hospital areas, air conditioning was provided. Although air conditioning was provided it was not always used. Observations revealed that air conditioning maintenance and cleaning programs may have varied greatly between the hospitals. In certain situations these systems were not operational and required repair or replacement.

Table 49 describes the various hospital situations where comfort indices of carbon dioxide, temperature, relative humidity and air movement were exceeded.

Table 49

Hospital sections where environmental comfort indices were exceeded (N = 280)

Sections	Prov 1	Prov 2	Miss 1	Miss 2	Priv 1	Priv 2
Pharm	C R A	R	C R A	R	R	R
ICU	R A	R A	R	A	A	C A
Ward 1	T R	R A	R	R A	R	R
Ward 2	R A	R	T R	R A	C A	R
Ward 3	T R	T R	T R A	R A	R	T R
Admin	C R	R	C R A	R	R A	A
Kitch	T R	C T R A	T R	T R	R	C R
CSSD	C T	G	G	T R	R	G
Theatre	R	R	T R	R A	R A	R

Note. Codes: C = carbon dioxide maximum; T =temperature mean; R = relative humidity mean; A = air movement mean; G = acceptable comfort indices.

Table 49 indicates that relative humidity levels exceeded the standard in most hospital areas. High relative humidity levels and high temperature levels could exacerbate the potential for staff discomfort and had the potential to support fungal proliferation

(ASHRAE, 1999). Carbon dioxide levels exceeding 1000ppm were limited to basement, administration offices and in the office of an ICU unit, two kitchen offices, an air conditioned CSSD unit and a mechanically ventilated pharmacy.

Mean particle/litre can be used as indicators of air cleanliness (International Standard, 1999). Mean particles/litre of dust were used as particle level indicators in each section in each hospital. Particle counts of four different particles sizes in each of the hospital sections were summed. The total particle levels of each of the sections were then ranked. Lowest particle levels are represented by "1" and highest particle levels represented by "6". Ranked particulate level means were used as indices of poor air quality (see Tables 49 to 58)

Table 49

Ranking of particle levels: pharmacies

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Priv 2	1908	3057	666	38	22850	1
Priv 1	23026	2840	260	22	26147	2
Prov 2	26367	3204	395	29	29995	3
Prov 1	23564	6593	2248	179	32584	4
Miss 1	32007	4439	1030	32	37508	5
Miss 2	58605	6720	608	20	65953	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column M = 35840 with *SD* 15602.
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 50

Ranking of particle levels: ICU

			Particles			
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Priv 1	7811.2	1667	311.1	39.7	982.9	1
Prov 2	12062	1894.7	321.9	29.9	14308.5	2
Priv 2	20916.3	4756.1	839.1	24.5	26536	3
Miss 1	23841.5	2865.4	485.8	20.2	27212.9	4
Miss 2	30532.1	2880.8	311	18.2	33742.1	5
Prov 1	42800.3	14186.1	3769.3	77.8	60833.5	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column $M = 27269$ with SD 20139
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 51

Ranking of particle levels: Ward 1

			Particles			
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Priv 2	22323	5291	1371.9	62.3	29048.2	1
Prov 2	40895.3	4508.9	651.6	125.8	46181.6	2
Miss 2	43326.7	4355.1	599.1	18	48298.9	3
Priv 1	42375.8	7989.5	1738.9	65.4	52169.6	4
Miss 1	53235.2	7572.5	2556.7	87.2	63451.6	5
Prov 1	107375.7	16760.8	3512.2	74.7	127723.4	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column $M = 61145.5$ with SD 34460.67
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 52

Ranking of particle levels: Ward 2

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Prov 2	18681.5	4723.6	1602.8	73.9	25081.8	1
Priv 2	21057.7	4570.6	1285.2	40.1	26953.6	2
Priv 1	27357.1	4918.8	550.5	43.4	32869.8	3
Miss 1	61501.4	7337.1	2261.5	71.7	71171.7	4
Prov 1	61374.4	12350.8	3209.5	75.5	77010.2	5
Miss 2	73721.5	8317.6	1623.6	76	83738.7	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column M = 52820.96 with SD 27241
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 53

Ranking of particle levels: Ward 3

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Miss 1	19023.75	3777.85	1021.8	53.65	23877	1
Prov 2	19179.7	5541.2	1931.9	171.2	26824	2
Priv 2	26612.2	6611.4	1797.4	93.7	35114.7	3
Priv 1	42505.5	7666.5	590.4	25.6	50788	4
Prov 1	68161.4	12594.2	2457.3	60.6	83273.5	5
Miss 2	72614	9904.6	2198.5	55	84772.1	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column M = 50774.88 with SD 27402
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 54

Ranking of particle levels: Administration

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Priv 2	17128.2	3354.1	727.4	35.6	21245.3	1
Prov 2	37223.9	5694.2	839.4	47.5	43805	2
Priv 1	39969.2	9061.8	1308.2	20.4	50359.6	3
Miss 2	50168.4	9996	2071.8	59.9	62296.1	4
Miss 1	57458.36	5426.6	774.96	43.03	63703	5
Prov 1	114114	12481	3103.4	115.7	129814.1	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column $M = 61871$ with *SD* 36685.5
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 55

Ranking of particle levels: Kitchen

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Miss 1	32225.6	7070.9	1819.9	49.4	41165.8	1
Prov 2	33510.75	7219.55	1971.15	159.9	42861.35	2
Priv 1	37640.6	7731.9	1324.9	27.1	46724.5	3
Priv 2	53946.2	11130.95	1996	44.75	67117.9	4
Miss 2	60453.8	13191.4	3431.2	73.7	77150.1	5
Prov 1	69452.3	12235.2	3048.2	77.2	84812.9	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column $M = 59972$ with *SD*18895
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 56

Ranking of particle levels: CSSD

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Prov 2	3865.8	535.9	113.4	11.7	4526.8	1
Priv 2	14215.5	1942.7	228.3	27	16413.5	2
Priv 1	14082.5	2393.8	210	20.8	16707.1	3
Miss 1	13324.4	2985.5	662.2	30.2	17002.3	4
Miss 2	22697.3	4886.8	638.6	9.9	28232.6	5
Prov 1	28171.1	4617.1	816.5	42.2	33646.9	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column *M* = 19421.5 with *SD* 10238
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Table 57

Ranking of particle levels: Theatre

	Particles					
Hospital	>.3 microns	>.5 microns	>1 microns	>5 microns	*Sum	Rank
Priv 1	553.2	197.8	67	5.4	823.4	1
Priv 2	18827.5	2083.7	177.4	15.4	21104	2
Prov 1	2114.5	461.5	123.8	4.3	2704.1	3
Miss 2	3318.2	374.3	37.2	1.9	3731.6	4
Miss 1	7060	798.6	177.2	18	8053.8	5
Prov 2	7494.9	1009.6	44.3	2.9	8551.7	6

Note. Particles were measured as mean particles/litre. Particle data were acquired from a real-time data logger and represented mean particle levels recorded. *SD* was not provided.
*Sum column *M* = 7495 with *SD* 7324.7
Ranking: Highest particle count represented by 6 with lowest particle count represented by 1.

Summary of ranked mean particle levels are presented in table 59.

Table 59

Ranking of hospitals and hospital sections in terms of particle counts (N = 280)

Sections	Prov 1	Miss 2	Miss 1	Priv 1	Prov 2	Priv 2
Pharmacy	4	6	5	2	3	1
ICU	6	5	4	1	2	3
Ward 1	6	3	5	4	2	1
Ward 2	5	6	4	3	1	2
Ward 3	5	6	1	4	2	3
Admin	6	4	5	3	2	1
Kitch	6	5	1	3	2	4
CSSD	6	5	4	3	1	2
Theatre	3	4	5	1	6	2
Total score	47	44	34	24	21	19
Ranking	6	5	4	3	2	1

Private hospital 2 had the lowest overall particle score followed by provincial hospital 2, private hospital 1, missionary hospital 1, missionary 2, and lastly provincial hospital 1 had the highest score.

These results may be useful in reinforcing the need for effective cleaning/maintenance programs. Sections of the hospital were identified which would require further investigation as to the cause of higher particle levels. Particulates may consist of microorganisms, dust, fumes, smoke and other particulate matter (ASHRAE, 1999). This may have health consequences in sections of the hospital such as theatres, CSSDs, ICUs and wards. Regular cleaning of air conditioning systems would assist in ensuring particle level reduction. In the case of theatres, regular particle counts and cleaning of the systems is considered important along with the elimination of water damaged surfaces. Descriptive data was then considered for inclusion in univariate analysis.

Univariate analysis of data

There were many univariate associations reported for information. It is acknowledged that some of these associations may be due to confounding. However; they may also have not reached statistical significance in multivariate analysis due to sample size.

Univariate analysis of the skin prick allergy test group (N=123)

An allergy assessment was carried out on the 123 respondents that were prepared to undertake the allergy skin prick test. Stressors in a non-industrial indoor environment may tend to have subtle synergistic effects on building occupants. ASHRAE (1999) and ASHRAE (1992) suggest that when 20% or more staff expressed concern in a particular environment this may be indicative of some indoor environment effect. These effects may be comfort concerns such as odour, poor ventilation and pollutants. However, where potentially lung damaging respirable particles ranging from .2 to 5 micrometers in size and/or certain species of fungi and/or associated mycotoxins exist, there may be a health impact.

Comparison between the skin prick participants and the non-participants

One of the aims of this research was to assess allergy responses of all participants using the skin prick allergy test. However, this was not achieved as the majority of respondents would not submit to the test. The maximum number of participants that was acquired was 123. It is therefore considered important to report associations between the two participant groups. The response rate for the allergy test was 43.9%, contrasted with the non-response rate of 56.1%. These proportions were compared using a *z* test. The *z* value of 2.79 and one-sided *p* value of .0026 revealed that a significantly lower proportion had chosen to participate in the skin prick test, than those who had chosen not to participate. Establishing associations between the skin prick test allergy participants (n = 123) and the non-participants (n = 157) with regard to potential risk factors for allergy such as age was undertaken. This was important because association may indicate potentially bias in the results. The groups were compared in various ways. One variable was age which was a numeric variable. A *t*-test of the participants versus the non-participants yielded a *p* value .057, indicating a borderline significant difference in ages. Other associations were examined using Chi – square tests. Lack of association with the Chi-square test indicated similar trends between the participants and non-participants with regard to potential risk factors for asthma. Chi-square tests conducted on job functions show a significant association between job and the two participant groups (p = .006). In both groups, the nurses had the highest proportion of participants. However, more clerical staff and kitchen/pharmacy staff participated in the n = 123 group. Nurses tended to be more resistant in taking part in the skin prick test than the other hospital staff groups. In one case a nurse jokingly advised her colleague that the test was painful. Her colleague then refused the test.

No significant Chi-square association was found between the 3 hospital groups, the skin prick test group and the non-participants. A higher number of participants from missionary hospitals took part in the skin prick allergy test compared to provincial and private hospitals.

Chi-square test of hospital sections (pharmacy, ICU, ward 1, ward 2, ward 3, administration, kitchen, CSSD, theatre) indicated a significant association (p = .009) between the skin test group and the non-participants. Much lower proportions of participants occurred in ward 3 and theatres in the skin prick test groups. There was a higher proportion of administration respondents that took part in the skin prick test. Assessment of gender revealed a borderline Chi-square association between the two groups (p = .09). In both groups the majority of participants were female. A higher proportion of males participated in the skin test than those that did not. Males appeared to be less resistant to the allergy test than females. Table 60 summarises Chi-square tests of associations between the groups experiencing various health symptoms.

Table 60

Comparison between staff taking the skin prick test, non-participant group and health symptoms reported by non-participant and skin test groups (N = 280)

	Non-participant group		Skin prick test group		
Symptoms	*n*	%	*n*	%	*p*
Allergy	42	46.1	49	53.8	.02
Allergy at work	19	12.1	27	22	.043
SBS dry eyes	18	11.5	24	19.5	.061
Itchy/watery eyes	54	34.4	61	49.6	.010
Itchy/watery eyes at work	31	19.7	36	29.3	.037
Dry itchy/irritated skin	35	22.3	41	33.3	.039
N	157	157	123	123	

Note. Significant association $p < .05$.

In table 60 it appears that a higher proportion of staff in the skin test group were also reporting a higher proportion of health affects. Chi-square tests did not indicate significant associations between the two groups in respect to the following: physical reactions, psychological reactions, behavioural reactions, biopsychosocial reactions; SBS symptoms of blocked nose, dry throat, lethargy, headaches; allergy symptoms of runny nose; smoking habits; asthma, asthma worse at work; occurrence of colds and occurrence of influenza at work.

Skin prick test and allergy questionnaire: hospital staff allergy potential

The sensitivity and specificity of using a questionnaire to obtain information about allergy symptoms was compared to participant results from the skin prick tests. The Chi-square test, when comparing the allergy questionnaire score with the allergy skin prick test results for allergens, revealed no association between allergy skin test used in this research and the allergy questionnaire. The *p* values for each of the allergens, mould 2, mould 3, mould 4, dust mite and cockroach were all greater than .05. The results show low false negatives and high false positives, for example mould 2 allergen with the allergy questionnaire showed 3 false negatives and 92 false positives for the staff. These results are useful in that they indicate that the use of the allergy questionnaire as an allergy screening tool may ensure that a high proportion of the staff with potential allergies could be recognised, whereas the skin prick tests were sensitive to specific allergens that may or may not be found in a particular work environment. The questionnaire is sensitive but not very specific. When associating the mould 3 allergen and the allergy questionnaire, the sensitivity of the questionnaire reported that 91 staff were potentially allergenic whereas only 2 had a specific allergy potential through the skin prick test. When associating the mould 4 allergen and the allergy questionnaire, the sensitivity of the questionnaire reported that 89 staff were potentially allergenic whereas only 3 had a specific allergy potential through the skin prick test. When associating the dust mite allergen and the allergy questionnaire, the sensitivity of the questionnaire reported that 59 staff were potentially allergenic whereas only 7 had a specific allergy potential through the skin prick test. When associating the cockroach allergen and the allergy questionnaire, the sensitivity of the questionnaire reported that 74 staff were potentially allergenic whereas only 4 had a specific allergy potential through the skin prick test.

Associations between the allergy questionnaire and the hospital environmental and personal stress assessment (HEPSA) questionnaire's allergy question

The allergy questionnaire and skin prick test were conducted approximately 3 weeks to 1 month after the administering of the HEPSA questionnaire. This approach assisted in establishing a questionnaire comparison between the two questionnaires. However, the approach also had limitations. Chi -square tests of the two data sets revealed that although significant associations were found there were differences in responses. Examples included the smoking of tobacco (p = .000). Some staff members differed in their reporting of this habit in the second questionnaire. This could mean that they were either not reporting truthfully, not wishing to commit to paper that they smoked tobacco or their smoking habit had changed. Reporting of job functions also had some discrepancies. However, some nursing positions could be considered as having a clerical emphasis which may account for the difference in recording staff duties between the two questionnaires (p = .000). The results of the question on "whether the staff member had allergies or not" in the HEPSA questionnaire, was associated with the question from the allergy questionnaire "do cold air, smoke, fumes (perfumes, paints), dust or mould ever cause chest tightness or cough or wheezing?" (p = .013). There were a greater proportion of people in the allergy questionnaire who reported that they were experiencing allergic reactions due to "cold air, smoke, fumes (perfumes, paints), dust or mould which cause chest tightness or cough or wheezing." The reason could be that the latter question probes deeper into the allergy issue. In addition, these reactions include upper respiratory conditions, lung reactions and responses to cold air. This emphasised the need to refine questions as carefully as possible to reduce response differences.

Data reported in table 61 related to staff that experienced allergies. The table compares the allergy questionnaire and the allergy question from the HEPSA questionnaire.

Table 61

Allergy response associations between and the allergy questionnaire and the HEPSA questionnaire (N = 123).

	Allergy questionnaire	HEPSA	
Symptoms	*n*	*n*	*p*
Hay fever	32	17	.000
Asthma	14	35	.006
Sinus	27	22	.001
Itchy eyes	37	12	.000
Itchy ears	21	28	.182
Itchy mouth	21	28	.068
Itchy throat	26	23	.023

Note. Significant association $p < .05$.

Table 61 suggests associations between hay fever, asthma, sinus, itchy eyes and itchy throat from the allergy questionnaire and the allergy question from the HEPSA. The allergy indicator, itchy ears, had no association with the HEPSA. Chi-square test between "itchy mouth" and allergy indicated a borderline association. An overall assessment of these results indicates significant associations between most of the allergy indicators and the allergy question from the HEPSA questionnaire.

Allergy questionnaire assessment

The main dependant variables used in the allergy questionnaire to assess allergy were hay fever, asthma, sinus and itchy eyes, ears, mouth and throat. Associations between these variables were examined.

Tables 62 to 68 summarise Chi-square tests conducted using the dichotomised data to study associations between reported allergy reactions. In these tables the first column indicates the number of respondents and proportion of those respondents that reported two allergy reactions. The second, third and fourth columns provide data of respondents with just one allergy reaction or no symptoms. Significant associations are reported. In each of the tables significant proportions of respondents had reported allergy symptoms.

Table 62

Association between itchy eyes and hay fever (N =123)

Itchy eyes with hay fever		Hay fever		Itchy eye		No symptoms		*p*
n	%	*n*	%	*n*	%	*n*	%	
36	78.3	10	21.7	31	40.3	46	59.7	.000

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

Table 63

Association between itchy eyes and sinus (N =123)

Itchy eyes and sinus		Sinus		Itchy eye		No symptoms		*p* value
n	%	*n*	%	*n*	%	*n*	%	
35	76.1	11	23.9	32	41.6	45	58.4	.000

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

Table 64

Association between itchy ears and sinus (N =123)

Itchy ears and sinus		Sinus		Itchy ears		No symptoms		*p* value
N	%	*n*	%	*n*	%	*n*	%	
23	50	23	50	21	27.3	56	72.7	.011

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

Table 65

Association between itchy roof of mouth and hay fever (N =123)

Itchy roof of mouth/hay fever		Hay fever		Itchy roof of mouth		No symptoms		*p* value
n	%	*n*	%	*n*	%	*n*	%	
21	45.7	25	54.3	20	26	57	74	.025

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

Table 66

Association between itchy roof of mouth and sinus (N =123)

Itchy roof of mouth and sinus		Sinus		Itchy roof of mouth		No symptoms		*p* value
N	%	*n*	%	*n*	%	*n*	%	
22	47.8	24	52.2	19	24.7	58	75.3	.008

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

Table 67

Association between hay fever and itchy throat (N =123)

Hay fever and itchy throat		Hay fever		Itchy throat		No symptoms		*p* value
n	%	*n*	%	*n*	%	*n*	%	
28	60.9	18	39.1	22	28.6	55	71.4	.000

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

Table 68

Association between itchy throat and sinus (N =123)

Itchy throat and sinus		Sinus		Itchy throat		No symptoms		*p* value
n	%	*n*	%	*n*	%	*n*	%	
27	58.7	19	41.3	23	29.9	54	70.1	.002

Note. The first two columns indicate the number and percentage of respondents reporting the associated symptoms. Significant association $p < .05$.

There was no association between itchy ear and hay fever ($\chi^2 = .979$, $df = 1$, $p = .323$). An allergy scoring method was developed and was graduated from none, mild, moderate and severe. A score of 1 was used where respondents reported any one of the symptoms of either: hay fever, asthma, sinus or any one of the allergy indicators itchy eyes, itchy ears, itchy roof of mouth or itchy throat. A score of 2 was used if they reported 2 symptoms and 3 for 3 symptoms and 4 for >3 symptoms. This scale was then dichotomised by combining the mild, moderate and severe scores as an experience of allergy and compared to staff with no allergy (see Table 69).

Table 69

Occurrence of allergy related indicators (N = 123).

Scale	Frequency	%
No allergy	22	17.9
Mild	43	35
Moderate	22 + 26	17.9 and 21.1
Severe	10	8.1

Dichotomised score indicated that 22 (17.9%) staff experienced no allergy symptoms with 101 (82.1%) reporting an allergic reaction. Developing the "allergy score" assisted in univariate and multivariate analysis of the data.

The allergy questionnaire is an allergy screening tool that will ensure that a high percentage of the staff with potential allergies or those at risk of developing an allergy will be recognised. This allergy scoring system was used as part of an allergy model in figure 6 to conduct univariate and multivariate analysis on the data.

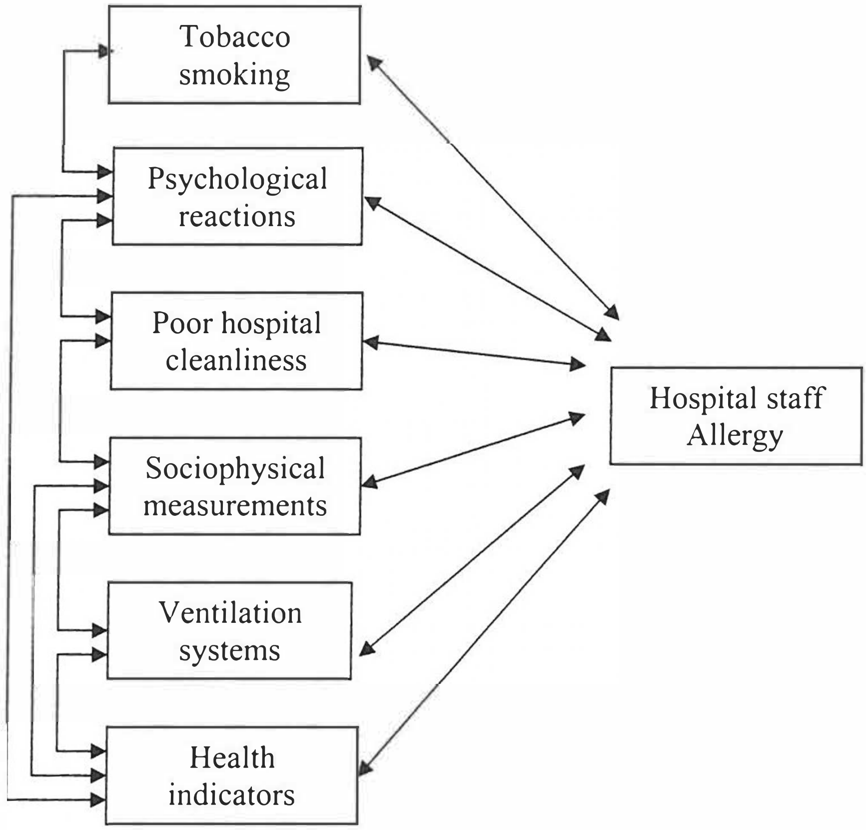

Figure 6. Initial proposed variable associations with allergy ($N = 123$)

Items in figure 6 were considered as possible associations with staff allergy. Consideration was also given to possible association between variables other than just with allergy. They were examined using Chi-square (see Tables 70 to 93). Where groups less than 5 were encountered Fisher's exact test results are reported. Certain sections of the chart contained sets of variables and are listed below.

- Psychological stress reactions: biopsychosocial (physical, psychological, behavioural).
- Sociophysical measurements: indoor air quality measures of carbon dioxide levels, relative humidity, air movement, temperature, particles and fungi measurements of *Rhizopus* and/or *Mucor* in air, *Rhizopus* and/or *Mucor* on surfaces, area of surface

fungal contamination, surface *Aspergillus, Aspergillus* in indoor air, surface *Penicillium* and *Penicillium* in indoor air.

- Health indicators: sick building syndrome and colds, and influenza.
- Hospital staff allergy: hay fever, asthma, sinus, allergy reactions of itchy eyes, itchy ears, itchy mouth and itchy throat, and allergy skin tests.

For analysis of allergy associations the cut off for significance was p = .05. However, borderline significance will be taken as = or < .09. Certain of the data group tables that follow, are lengthy and have had to be continued on additional pages. Data findings are discussed under the "discussion of association's" column. Dichotomised scores used in this data analyses. Consideration was given to screening various potential associations to examine possible associations between indoor environmental factors and personal factors in hospitals.

Table 70

Associations between allergy scores and high and low particle mean scores (N = 123)

Allergy/high particles		Allergy/low particles		No allergy high particle		No allergy low particle		*p*
n	%	*n*	%	*n*	%	*n*	%	
34	33.7	67	63.3	12	54.5	10	45.5	.067

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 71

Associations between allergy and behavioural stress reaction scores (N = 123)

Allergy and significant stress reaction		No allergy and significant stress reaction		Allergy and insignificant stress reaction		No allergy and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
58	90.6	6	11.4	43	72.9	16	27.1	.010

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 72

Associations between allergy and SBS (N = 123)

Allergy and SBS		No allergy and SBS		Allergy and no SBS		No allergy and no SBS		*p*
n	%	*n*	%	*n*	%	*n*	%	
73	90.1	8	9.9	28	66.7	14	33.3	.001

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 73

Associations between allergy and behavioural stress reactions (N = 123)

Severe allergy with stress reaction		Severe allergy with low stress reaction		Moderate allergy with stress reaction		Moderate allergy with low stress reaction		Mild allergy with stress reaction		Mild allergy with low stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
7	70	3	30	31	64.6	17	23.4	20	46.5	23	53.5	

Note. An additional group: 16 (72.7%) had no allergy with low behavioural stress reactions with 6 (27.3%) having no allergy with significant behavioural stress reactions.

Significant association $p < .05$.

Borderline significance will be taken as ≤ .09.

Chi-square test indicated that more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and *p* values should be interpreted with caution.

Table 74

Associations between low mean air movement and biopsychosocial stress reactions (N =123)

Low air movement and significant stress reaction		Low air movement with insignificant stress reaction		Acceptable air movement with significant stress reaction		Acceptable air movement with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
20	38.5	32	61.5	43	60.6	28	39.4	.015

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09. Criteria applied: low air movement < .1m/s.

Table 75

Associations between low mean air movement and physical stress reactions (N = 123).

Low air movement and significant stress reaction		Low air movement and insignificant stress reaction		Acceptable air movement and significant stress reaction		Acceptable air movement and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
27	51.9	25	48.1	51	71.8	20	26	.024

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s.

Table 76

Associations between low mean air movement and behavioural stress reactions (N = 123).

Low air movement and significant stress reaction		Low air movement with insignificant stress reaction		Acceptable air movement with significant stress reaction		Acceptable air movement with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
22	42.3	30	57.7	42	59.2	29	40.8	.065

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s.

Table 77

Associations between air movement and particle level means (N = 123).

Low air movement and high particle		Low air movement and low particle		Acceptable air movement and high particle		Acceptable air movement and low particle		*p*
n	%	*n*	%	*n*	%	*n*	%	
14	19.4	38	73.1	32	45.1	39	54.9	.04

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s.

Table 78

Associations between mean air movement and hospital ventilation systems (N = 123)

Low air movement association and NV		Low air movement association and A/C		Acceptable air movement association and NV		Acceptable air movement association and A/C		*p*
n	%	*n*	%	*n*	%	*n*	%	
1	11	51	98.1	25	35.2	46	64.8	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s. A/C represents air conditioning; NV represents natural ventilation.

Fisher's Exact Test result was reported.

Table 79

Associations between low mean air movement and relative humidity (N = 123)

Low air movement and high RH		Low air movement and acceptable RH		Acceptable air movement and high RH		Acceptable air movement and acceptable RH		*p*
n	%	*n*	%	*n*	%	*n*	%	
28	53.8	24	46.2	59	83.1	12	16.9	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Relative humidity = RH. Criteria applied: low air movement < .1m/s; acceptable relative humidity = or < 60%.

Table 80

Associations between air movement and temperature means *(N = 123)*

Low air movement and high temperature		Low air movement and acceptable temperature		Acceptable air movement and high temperature		Acceptable air movement and acceptable temperature		*p*
n	%	*n*	%	*n*	%	*n*	%	
1	1.9	51	98.1	17	23.9	54	76.1	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s; acceptable temperature < 26^{0}C. Fisher's exact test result was reported.

Table 81

Associations between mean air movement and maximum carbon dioxide levels (N = 123)

Low air movement and $CO^2 \geq$ 1000ppm		Low air movement and $CO^2 <$ 1000ppm		Acceptable air movement and $CO^2 \geq$ 1000ppm		Acceptable air movement and acceptable CO^2		*p*
n	%	*n*	%	*n*	%	*n*	%	
22	42.3	30	57.7	3	4.2	68	95.8	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s; acceptable carbon dioxide levels < 1000ppm. Fisher's Exact Test result was reported.

Table 82

Associations between low mean air movement and fungal ratio >1 (N = 123)

Low air movement and fungal ratio >1		Low air movement and low fungi		Acceptable air movement and fungal ratio >1		Acceptable air movement and low fungi		*p*
n	%	*n*	%	*n*	%	*n*	%	
10	19.2	42	80.8	36	50.7	35	49.3	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: low air movement < .1m/s; indoor and outdoor air fungal ratio level >1 is unacceptable.

Table 83

Associations between relative humidity and temperature (N = 123)

High RH and high temperature		High RH and acceptable temperature		Acceptable RH with high temperature		Acceptable RH with acceptable temperature		*p*
n	%	*n*	%	*n*	%	*n*	%	
17	94.4	70	66.7	1	5.6	35	33.3	.022

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: acceptable temperature < 26^0C; acceptable relative humidity = or < 60%. Fisher's Exact Test result was reported.

Table 84

Associations between relative humidity and maximum carbon dioxide levels (N = 123)

High RH and $CO^2 \geq 1000$ppm		High RH and acceptable CO^2		Acceptable RH and $CO^2 \geq 1000$ppm		Acceptable RH with acceptable CO^2		*p*
n	%	*n*	%	*n*	%	*n*	%	
11	12.6	76	87.4	14	38.8	22	61.1	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: acceptable relative humidity = or < 60%; acceptable carbon dioxide levels $CO^2 < 1000$ppm.

Table 85

Associations between SBS symptoms and physical stress reaction (N = 123)

SBS and significant stress reaction		SBS and insignificant stress reaction		No SBS and significant stress reaction		No SBS and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
56	69.1	25	30.9	22	52.4	20	47.6	.067

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 86

Associations between lack of hospital cleanliness and fungal surface area contamination (N = 123)

Poor cleanliness and fungi $>3m^2$		No concern and fungi $>3m^2$		Poor cleanliness and fungi $.2m^2$ to $3m^2$		No concern and fungi $.2m^2$ to $3m^2$		Poor cleanliness and fungi $<.2m^2$		No concern and fungi $<.2m^2$		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
22	71	9	29	25	69.4	11	30.6	27	48.2	29	51.8	.009

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: Fungal surface contamination $>3m^2$ and $.2m^2$ to $3m^2$.

Table 87

Associations between temperature and fungal ratio (N = 123)

High temperature and fungal ratio >1		High temperature with low fungi		Acceptable temperature and fungal ratio >1		Acceptable temperature and low fungi		*p*
n	%	*n*	%	*n*	%	*n*	%	
14	77.8	4	22.2	32	30.5	73	69.5	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.Criteria applied: acceptable temperature < 26^0C; indoor and outdoor air fungal ratio level >1 is unacceptable. Fisher's Exact Test result was reported.

Table 88

Associations between fungal levels and particle levels (N = 123)

Fungal ratio >1 and high particle		Fungal ratio >1 and low particle		Low fungi and high particle counts		Low fungi and low particle counts		*p*
n	%	*n*	%	*n*	%	*n*	%	
22	47.8	24	52.2	24	31.2	53	68.8	.065

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: indoor and outdoor air fungal ratio level >1 is unacceptable.

Table 89

Associations between particle (lower, medium and higher levels) and ventilation systems (N = 123)

High particle and fungal ratio >1		High particle and fungal ratio < 1		Medium particle and fungal ratio >1		Medium particle and fungal ratio < 1		Low particle and fungal ratio > 1		Low particle and fungal ratio < 1		p
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
16	57.1	12	42.9	15	28.8	37	71.2	15	34.9	28	65.1	.041

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 90

Associations between particle (lower, medium and higher levels) and ventilation systems (N = 123)

A/C with high particle		NV with high particle		A/C with medium particle		NV with medium particle		A/C with low particle		NV with low particle		p
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
17	60.7	11	39.3	46	88.5	6	11.5	34	79.1	9	20.9	.015

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. A/C = air conditioning; NV = natural ventilation.

Table 91

Associations between particles and ventilation systems (N = 123)

A/C and high particle		A/C and low particle		NV and high particle		NV and low particle		p
n	%	n	%	n	%	n	%	
32	33	65	67	14	53.6	12	46.2	.051

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. A/C = air conditioning; NV = natural ventilation.

Table 92

Associations between particles and mean carbon dioxide levels (N = 123)

High range particle levels and $CO^2 \geq$ 1000ppm		Lower particle levels (in the high range) and $CO^2 \geq$ 1000ppm		Medium range particle levels and $CO^2 <$ 1000ppm		Lower range particle levels and $CO^2 <$ 1000ppm		p
n	%	n	%	n	%	n	%	
9	100	0	0	71	62.3	43	37.7	.055

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria applied: acceptable carbon dioxide levels (CO^2) < 1000ppm. Particles were graduated into a high, medium and low range. Chi-square test indicated that more than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution.

Table 93

Associations between particle (lower, medium and higher levels) and relative humidity (N = 123)

High particle with RH > 60%		High particle with RH < 60%		Medium particle with RH > 60%		Medium particle with RH < 60%		Low particle with RH > 60%		Low particle with RH < 60%		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
25	89.3	3	10.7	43	82.7	9	17.3	19	44.2	24	55.8	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Chi-square test indicated that 0 cells (.0%) had expected counts < 5.

The univariate associations in tables 70 to 93 suggest many possible associations that may have existed in the hospitals at the time of this research. The intent is not to summarise all findings from the univariate analysis at this point in the research but merely to highlight a few. There appeared to be extremely significant associations between allergy and SBS and allergy and behavioural stress reactions. These findings may be of some significance as stress may reduce an individual's immune response (O'Leary, 1990; Schlebusch, 1998; Quine, 1998).

In conclusion, these associations will be examined using multivariate stepwise logistic regression analysis whilst controlling for confounding variables.

Univariate analysis of the hospital staff ill health and stress intervention model (N=280)

Ensuring that hospital-working environments are conducive to staff and patient health and safety is important. From the univariate results, multivariate models were developed. These models may assist in prioritising concerns in hospitals to enable the planning of remedial measures. Furthermore, the methodologies developed in the current research may be used for hospital investigations in other parts of South Africa and overseas. The initial approach was to consider possible variable associations as shown in figure 7.

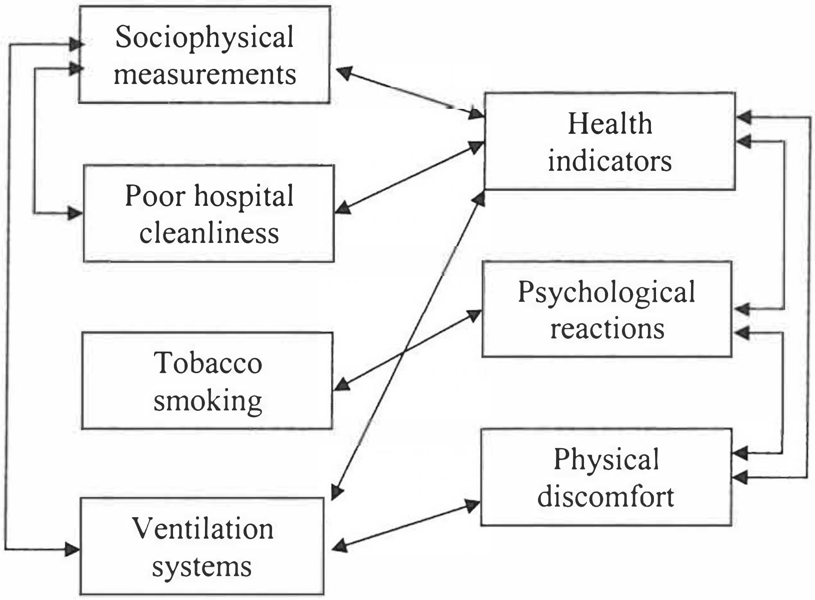

Figure 7. Proposed hospital staff ill health and stress reaction intervention models (*N* = 280)

Chi-square was used to establish associations between variables (see Tables 94 to 211). Where groups less than 5 were encountered Fisher's exact test results were reported. Certain sections in figure 7 contained groups of variables. These are expanded on. Psychological stress reactions included biopsychosocial (physical, psychological and behavioural), control over work environment which includes temperature, ventilation and lighting control and hospital maintenance issues. Health indicators included allergy and asthma, allergy symptoms, colds, influenza and SBS. Indoor environmental discomfort issues included air quality concerns including temperature, relative humidity, air movement, air quality, stuffy air, odours air. Physical concerns included lighting, noise and vibration. Sociophysical measurements: indoor air quality measure of carbon dioxide levels, relative humidity, air movement, temperature, particles and fungi measurements of *Rhizopus* and/or *Mucor* in air, *Rhizopus* and/or *Mucor* on surfaces, area of surface fungal contamination, surface *Aspergillus, Aspergillus* in indoor air, surface *Penicillium* and *Penicillium* in indoor air.

The following univariate analyses were assessed.

Table 94

Associations *between allergy and SBS (N = 280)*

Allergy and SBS		No allergy with SBS		Allergy with no SBS		No allergy or SBS		*p*
n	%	*n*	%	*n*	%	*n*	%	
69	38.5	110	61.5	22	21.8	79	78.2	.004

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 95

Associations between allergy worse at work and SBS (N = 280)

Allergy worse with SBS		Allergy worse with no SBS		Allergy not worse with SBS		Allergy not worse with no SBS		Non allergic group with SBS		Non allergic group with no SBS		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
38	82.6	8	17.4	31	68.9	14	31.1	110	58.2	79	41.8	.006

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 96

Associations between SBS and physical stress reaction (N = 280)

SBS with significant stress reaction		No SBS with significant stress reaction		SBS with insignificant stress reaction		No SBS with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
128	71.9	50	28.1	51	50	51	50	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 97

Associations between SBS and psychological stress reaction (N = 280)

SBS with significant stress reaction		No SBS with significant stress reaction		SBS with insignificant stress reaction		No SBS with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
89	71.2	49	31.2	71	57.7	52	42.3	.023

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 98

Associations between SBS and behavioural stress reaction (N = 280)

SBS with significant stress reaction		No SBS with significant stress reaction		SBS with insignificant stress reaction		No SBS with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
108	68.8	49	31.2	71	57.7	52	42.3	.056

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 99

Associations between SBS and biopsychosocial stress reaction (N = 280)

SBS with significant stress reaction		No SBS with significant stress reaction		SBS with insignificant stress reaction		No SBS with insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
106	70.2	45	29.8	73	56.6	56	43.4	.018

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 100

Associations between SBS and maximum carbon dioxide levels (N = 280)

SBS with CO^2 > 1000ppm		No SBS with CO^2 > 1000ppm		SBS with CO^2 < 1000ppm		No SBS with CO^2 < 1000ppm		*p*
n	%	*n*	%	*n*	%	*n*	%	
38	77.6	11	22.4	141	61	90	39	.029

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$. Criteria CO^2 levels >1000ppm were significant.

Table 101

Associations between SBS and ventilation systems (N = 280)

SBS with A/C		No SBS with A/C		SBS with NV		No SBS with NV		*p*
n	%	*n*	%	*n*	%	*n*	%	
138	68.3	64	31.7	41	52.6	37	47.4	.014

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09. A/C represents air conditioning; NV represents natural ventilation.

Table 102

Associations between SBS and fungal ratio (N = 280)

SBS with fungal ratio >1		No SBS with fungal ratio >1		SBS with low fungal counts		No SBS with low fungal counts		SBS with fungal ratio = 1		No SBS with fungal ratio = 1		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
44	53.7	38	46.3	131	67.9	62	32.1	4	80	1	20	.06

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

More than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and *p* values should be interpreted with caution.

Table 103

Associations between colds > twice a year and allergy (N = 280)

Colds > twice a year and allergy		Colds > twice a year and no allergy		Cold < twice a year and allergy		Colds < twice a year and no allergy		p
n	%	n	%	n	%	n	%	
46	46	54	54	45	25	135	75	.000

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09. Significant occurrence of colds during the year: > 2 colds per year.

Table 104

Associations between colds > twice a year and asthma (N = 280)

Colds > twice a year and asthma		Cold > twice a year and no asthma		Colds < twice a year and asthma		Colds < twice a year and no asthma		p
n	%	n	%	n	%	n	%	
23	23	77	77	11	6.1	169	93.9	.000

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Significant occurrence of colds during the year: > 2 colds per year.

Table 105

Associations between colds > twice a year and physical stress reaction (N = 280)

Colds > twice a year and significant stress reaction		Cold > twice a year and insignificant stress reaction		Colds < twice a year and significant stress reaction		Colds < twice a year and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
75	75	25	25	103	57.2	77	42.8	.003

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Significant occurrence of colds during the year: > 2 colds per year.

Table 106

Associations between colds > twice a year and Rhizopus spp (N = 280)

colds > twice a year and *Rhizopus spp*		cold > twice a year and No *Rhizopus spp*		Colds < twice a year and *Rhizopus spp*		No *Rhizopus spp* and colds < twice a year		*p*
n	%	*n*	%	*n*	%	*n*	%	
26	26	74	74	24	13.3	156	86.7	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Significant occurrence of colds during the year: > 2 colds per year.

Table 107

Associations between Aspergillus spp and allergy (N = 280)

Aspergillus spp and allergy		*Aspergillus spp* and no allergy		No *Aspergillus spp* and allergy		No *Aspergillus spp* and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
90	34.5	171	65.5	1	5.3	18	94.7	.009

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Fisher's Exact Test result was reported.

Table 108

Associations between Aspergillus spp and allergy worse at work (N = 280)

Aspergillus spp and allergy worse at work		*Aspergillus spp* and allergy not worse at work		*Aspergillus spp* and not allergenic		No *Aspergillus spp* and allergy worse at work		No *Aspergillus spp* and allergy not worse at work		No *Aspergillus spp* and not allergenic		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
45	17.2	45	17.2	171	85.5	1	5.3	0	0	18	94.7	.029

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

More than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and *p* values should be interpreted with caution.

Table 109

Associations between Penicillium and Aspergillus spp with allergy (N = 280)

Penicillium and *Aspergillus spp* with allergy		*Penicillium* and *Aspergillus spp* with no allergy		*No Penicillium* and *Aspergillus spp* with allergic group		*No Penicillium* and *Aspergillus spp* with no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
88	34	171	66	3	14.3	18	85.7	.088

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Fisher's Exact Test result was reported.

Table 110

Associations between requests for improvements to the ventilation system with allergy (N = 280)

Improve ventilation system with allergy		Improve ventilation system with no allergy		No request to improve ventilation system with allergy		No request to improve ventilation system with no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
66	39.1	103	60.9	25	22.5	86	77.5	.004

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 111

Associations between requests for improvements to the ventilation system allergy worse at work (N = 280)

Improve ventilation with allergy worse at work		Improve ventilation but allergy not worse at work		Improve ventilation but not allergenic		No request to improve ventilation with allergy worse at work		No request to improve ventilation with allergy not worse at work		No request to improve ventilation and not allergenic		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
35	20.7	31	18.3	103	60.9	11	9.9	14	12.6	86	77.5	.012

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 112

Associations between effectiveness of response to requests to repair to ventilation system and allergy (N = 280)

Ineffective repair response and allergy		Ineffective repair response and no allergy		No concern with repair responses and allergy		No concern with repair responses and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
48	40.7	70	59.3	43	26.5	119	73.5	.013

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 113

Associations between speed of response to repair the ventilation system and allergy (N = 280)

Major response speed concern and allergy		Major response speed concern and no allergy		Investigate response speed and allergy		Investigate response speed and no allergy		Satisfied with response speed and allergy		Satisfied with response speed and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
32	45.7	38	54.3	12	27.3	32	72.7	23	41.1	33	58.9	.003

Note. A group which did not comment on the ventilation system but reported having allergies were 24 (21.8%) compared to 86 (78.2%) of the staff who had no allergies and did not comment on the ventilation system.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 114

Associations between speed of response to repair the ventilation system and allergy worse at work (N = 280)

Major response speed concern and allergy worse at work		Major response speed concern and allergenic but not worse at work		Major response speed concern and no allergy		Further investigate response speed and allergy worse at work		Further investigate response speed and allergy not worse at work		Further investigate response speed and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
19	27.1	13	18.6	38	54.3	5	11.4	7	15.9	32	72.7	.014

Note. In addition to the above concern responses, 12 (21.4%) of the respondents reported that speed of repairing the ventilation system was of little concern but these respondents' allergies were worse at work compared to 11 (19.6%) of the staff who considered that speed of repairing the ventilation system was of little concern but their allergies were not worse at work compared to 33 (58.9%) of the respondents who considered that speed of repairing the ventilation system was of little concern but had no allergies A fourth group of 10 (9.1%) had no air conditioning system but reported that their allergies were worse at work compared to 14 (12.7%) with no air conditioning system but who had allergies that did not improve when they left work. A further 86 (78.2%) had no air conditioning system and did not experience allergies. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 115

Associations between effectiveness of response to requests for other improvements to the hospital and allergy (N = 280)

Request for hospital improvements and allergy		Request for hospital improvements and no allergy		No request for hospital improvements and allergy		No request for hospital improvements and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
40	39.2	62	60.8	51	28.7	127	71.3	.069

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 116

Associations between dry itchy or irritated skin and allergy (N = 280)

Dry itchy or irritated skin and allergies		Dry itchy or irritated skin and no allergy		No dry itchy or irritated skin and allergies		No dry itchy or irritated skin and no allergies		*p*
n	%	*n*	%	*n*	%	*n*	%	
40	52.6	36	47.4	51	25	153	75	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 117

Associations between dry itchy or irritated skin that improved when away from work and allergy (N = 280)

Dry itchy skin improved and allergies		Dry itchy skin improved and no allergy		Dry itchy skin does not improve and allergy		Dry itchy skin does not improve and no allergy		No dry itchy and allergies		No dry itchy and no allergies		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
18	50	18	50	22	55	18	45	51	25	153	75	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 118

Associations between dry itchy or irritated skin and allergy worse at work (N = 280)

Dry itchy skin and allergy worse at work		Dry itchy skin and allergy not worse at work		Dry itchy skin and not allergenic		No dry itchy skin and allergy		No dry itchy and allergy not worse at work		No dry itchy and not allergenic		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
24	31.6	16	21.1	36	47.4	22	10.8	29	14.2	153	75	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 119

Associations between dry itchy or irritated skin that improved when away from work and allergy worse at work (N = 280)

Dry itchy skin improved and allergy worse at work		Dry itchy skin improved and allergy not worse at work		Dry itchy skin improved and not allergenic		No dry itchy skin and allergy worse at work		No dry itchy and allergy not worse at work		No dry itchy and not allergenic		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
15	41.7	3	8.3	18	50	9	22.5	13	32.5	18	45	.000

Note. A fourth respondent group 22 (10.8%), reported that they did not experience dry itchy or irritated skin but were experiencing allergies that were worse at work compared to 29 (14.2%) of the staff that did not experience dry itchy or irritated skin and were experiencing allergies that were not worse at work and a further 153 (75%) staff who did not experience dry itchy or irritated skin nor allergies.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

0 cell (.0%) had expected count less than 5.

Table 120

Associations between runny nose and allergy worse at work (N = 280)

Runny nose and allergy worse at work		Runny nose and allergy not worse at work		Runny nose and not allergenic		No runny nose and allergy worse at work		No runny nose and allergy not worse at work		No runny nose and not allergenic		p
n	%	n	%	n	%	n	%	n	%	n	%	
30	28.6	31	29.5	44	41.9	16	9.1	14	8	145	82.9	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 121

Associations between runny nose that improved when away from work and allergy (N = 280)

Runny nose improved and allergy		Runny nose improved and no allergy		Runny nose improved and allergy		Runny nose does not improve and no allergy		No runny nose and allergy		No runny nose and no allergy		p
n	%	n	%	n	%	n	%	n	%	n	%	
33	56.9	25	43.1	28	59.6	19	40.4	30	17.1	145	82.9	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 122

Associations between runny nose that improved when away from work and allergy worse at work (N = 280)

Runny nose improved and allergy worse at work		Runny nose improved and allergy not worse at work		Runny nose improved and no allergy		Runny nose does not improve and allergy worse at work		Runny nose does not improve and allergy not worse at work		No runny nose and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
21	36.2	12	20.7	25	43.1	9	19.1	19	40.4	19	40.4	.000

Note. In a fourth group 16 (9.1%) respondents were not experiencing runny nose but reported allergies which were made worse at work compared to 14 (8%) of the staff who were not experiencing runny nose and whose allergies did not get worse at work and a further 145 (82.9%) staff who did not experience runny nose nor allergies.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 123

Associations between runny nose and allergy (N = 280)

Runny nose and allergy		Runny nose and no allergy		No runny nose and allergy		No runny nose and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
61	58.1	44	41.9	30	17.1	145	82.9	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 124

Associations between itchy or watery eyes that improved when away from work and allergy (N = 280)

Itchy or watery eyes improved and allergy		Itchy or watery eyes improved and no allergy		Itchy or watery eyes not improved and allergy		Itchy or watery eyes not improved and no allergy		No itchy or watery eyes and allergy		No itchy or watery eyes and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
35	52.2	32	47.8	26	54.2	22	45.8	30	17.1	135	81.8	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 125

Associations between itchy or watery eyes and allergy worse at work (N = 280)

Itchy or watery eyes and allergy worse at work		Itchy or watery eyes and allergy not worse at work		Itchy or watery eyes and no allergy		No itchy or watery eyes and allergy worse at work		No itchy or watery eyes and allergy not worse at work		No itchy or watery eyes and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
35	30.4	26	22.6	54	47	11	6.7	19	11.5	135	81.8	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 126

Associations between itchy or watery eyes improved when away from work and allergy worse at work (N = 280)

Itchy or watery eyes improved and allergy worse at work		Itchy or watery eyes improved and allergy not worse at work		Itchy or watery eyes improved and no allergy		Itchy or watery eyes not improved and allergy worse at work		Itchy or watery eyes not improved and allergy not worse at work		No itchy or watery eyes and not allergenic		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
22	32.8	13	19.4	32	47.8	13	27.1	13	27.1	22	45.8	.000

Note. In a fourth group 11 (6.7%) of the staff were not experiencing itchy or watery eyes but reported that their allergies are worse at work compared to 19 (11.5%) of the staff who were not experiencing itchy or watery eyes but had allergies which are not worse at work and a further 135 (81.8%) staff who did not experience itchy or watery eyes and did not have allergies.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 127

Associations between headaches that improved when away from work and allergy (N = 280)

Headache and allergy		Headache and no allergy		No headache and allergy		No headache and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
34	49.3	35	50.7	57	27	154	73	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 128

Associations between headaches (SBS symptom) that improved when away from work and allergy worse at work (N = 280)

Headache and allergy worse at work		Headache and allergy not worse at work		Headache and no allergy		No headache and allergy worse at work		No headache and allergy not worse at work		No headache and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
22	31.9	12	17.4	35	50.7	24	11.4	33	15.6	154	73	.000

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 129

Associations between dry throat (SBS symptom) that improved when away from work and allergy (N = 280)

Dry throat and allergy		Dry throat and no allergy		No dry throat and allergy		No dry throat and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
24	47.1	27	52.9	67	29.3	162	70.7	.014

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 130

Associations between dry throat (SBS symptom) that improved when away from work and allergy worse at work (N = 280)

Dry throat and allergy worse at work		Dry throat and allergy not worse at work		Dry throat and no allergy		No dry throat and allergy worse at work		No dry throat and allergy not worse at work		No dry throat and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
17	33.3	7	13.7	27	52.9	29	12.7	38	16.6	162	70.7	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 131

Associations between blocked nose (SBS symptom) that improved when away from work and allergy (N = 280)

Blocked nose and allergy		Blocked nose and no allergy		No blocked nose and allergy		No blocked nose and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
41	57.7	30	42.3	50	23.9	159	76.1	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 132

Associations between blocked nose (SBS symptom) that improved when away from work and allergy worse at work (N = 280)

Blocked nose and allergy worse at work		Blocked nose and allergy not worse at work		Blocked nose and no allergy		No blocked nose and allergy worse at work		No blocked nose and allergy not worse at work		No blocked nose and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
26	36.6	15	21.1	30	42.3	20	9.6	30	14.4	159	76.1	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 133

Associations between dry eyes (SBS symptom) that improved when away from work and allergy (N = 280)

Dry eyes and allergy		Dry eyes and no allergy		No dry eyes and allergy		No dry eyes and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
22	52.4	30	47.6	69	29	169	71	.003

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 134

Associations between dry eyes that improved when away from work and allergy worse at work (N = 280)

Dry eyes and allergy worse at work		Dry eyes and allergy not worse at work		Dry eyes and no allergy		No dry eyes and allergy worse at work		No dry eyes and allergy not worse at work		No dry eyes and no allergy		p
n	%	n	%	n	%	n	%	n	%	n	%	
14	33.3	8	19	20	47.6	32	13.4	37	15.5	169	71	.003

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 135

Associations between cold/influenza occurrence (based on whether a cold and influenza occurred more than twice a year) and allergy (N = 280)

Cold/influenza and allergy		Cold/influenza and no allergy		Cold/influenza < 2 and allergy		No cold/influenza < 2 and no allergy		p
n	%	n	%	n	%	n	%	
49	44.1	62	55.9	42	24.9	127	75.1	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 136

Associations between cold/influenza occurrence (based on whether a cold and influenza occurred more than twice a year) and allergy worse at work (N = 280)

Cold/ influenza and allergy worse at work		Cold/ influenza and allergy not worse at work		Cold/ influenza and no allergy		cold/ influenza < 2 and allergy worse at work		Cold/ influenza < 2 and allergy not worse at work		No cold/ influenza and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
27	24.3	22	19.8	62	55.9	19	11.2	23	13.6	127	75.1	.002

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 137

Associations between influenza occurrence (based on whether influenza occurred more than twice a year) and allergy (N = 280)

Influenza and allergy		Influenza and no allergy		influenza < 2 and allergy		Influenza < 2 and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
26	44.1	33	55.9	65	29.4	156	70.6	.033

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 138

Associations between cold occurrence (based on whether cold occurred more than twice a year) and allergy (N = 280)

Cold and allergy		Cold and no allergy		Cold < 2 and allergy		Cold < 2 and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
46	46	54	54	45	25	135	75	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 139

Associations between cold occurrence (based on whether a cold occurred more than twice a year) and allergy worse at work (N = 280)

Cold and allergy worse at work		Cold and allergy not worse at work		Cold and no allergy		Cold < 2 and allergy worse at work		Cold < 2 and allergy not worse at work		No cold and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
25	25	21	21	54	54	21	11.7	24	13.3	135	75	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 140

Associations between stuffy air and allergy (N = 280)

Stuffy air and allergy		Stuffy air and no allergy		No stuffy air and allergy		No stuffy air and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	
80	35.4	146	64.6	11	20.4	43	79.6	.034

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 141

Associations between asthma and allergy worse at work (N = 280)

Asthma and allergy worse at work		Asthma and allergy not worse at work		Asthma and no allergy		No asthma and allergy worse at work		No asthma and allergy not worse at work		No asthma and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
10	29.4	10	29.4	14	41.2	36	14.6	35	14.2	175	71.1	.002

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 142

Associations between asthma worse at work and allergy worse at work (N = 280)

Asthma worse at work and allergy worse at work		Asthma worse at work and allergy not worse at work		Asthma worse at work and no allergy		Asthma not worse at work and allergy worse at work		Asthma not worse at work and allergy not worse at work		Asthma not worse at work and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
7	58.3	0	0	5	41.7	3	13.6	10	45.5	9	40.9	.000

Note. With a fourth group 36 (14.6%) of respondents who did not have asthma but were experiencing allergies that were worse at work compared to 35 (14.2%) of the staff who were not experiencing asthma and their allergies were not worse at work and a further 175 (71.1%) of the staff who had no asthma and did not have allergies.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Cross-tabulation had more than 20% of the cells with expected counts < 5, thus the Chi-square assumptions were not met and p values should be interpreted with caution.

Table 143

Associations between odour and allergy worse at work (N = 280)

Odour major concern and allergy worse at work		Odour major concern and allergy not worse at work		Odour major concern and no allergy		Odour needs investigation and allergy worse at work		Odour needs investigation and allergy not worse at work		Odour needs investigation and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
16	23.9	12	17.9	39	58.2	14	10.2	23	16.8	100	73	.073

Note. With a third group 16 (21.1%) of respondents had little no odour concern but reported allergy worse at work compared to 10 (13.2%) of the staff who had no odour concern and their allergies were not worse at work and a further 50 (65.8%) of the staff who had no odour concern and did not have allergies. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 144

Associations between physical stress reaction and allergy worse at work (N = 280)

Significant stress reaction and allergy worse at work		Significant stress reactions and allergy not worse at work		Significant stress reaction and no allergy		Insignificant stress reaction and allergy worse at work		Insignificant stress reaction and allergy not worse at work		Insignificant stress reaction and no allergy		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
37	20.8	24	13.5	117	65.7	9	8.8	21	20.6	72	70.6	.019

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 145

Associations between cold/influenza occurrence (based on whether a cold and influenza occurred more than twice a year) and physical stress reaction (N = 280)

Cold/influenza and significant stress reaction		Cold/influenza and insignificant stress reaction		Cold/influenza < 2 and significant stress reaction		Cold/influenza < 2 and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
81	73	30	27	97	57.4	72	42.6	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 146

Associations between itchy watery eyes and physical stress reaction (N = 280)

Itchy watery eyes and significant stress reaction		Itchy watery eyes and insignificant stress reaction		No itchy watery eyes and significant stress reaction		No itchy watery eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
85	73.9	30	26.1	93	56.4	72	43.6	.003

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 147

Associations between itchy watery eyes, which improved when away from the hospital and reported significant physical stress reaction (N = 280)

Itchy watery eyes improved and significant stress reaction		Itchy watery eyes improved and insignificant stress reaction		Itchy watery eyes did not improve and significant stress reaction		Itchy watery eyes did not improve and insignificant stress reaction		No itchy watery eyes and significant stress reaction		No itchy watery eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
49	73.1	18	26.9	36	75	12	25	93	56	72	43.6	.011

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 148

Associations between dry itchy or irritated skin and physical stress reaction (N = 280)

Dry itchy or irritated skin and significant stress reaction		Dry itchy or irritated skin and insignificant stress reaction		No dry itchy or irritated skin and significant stress reaction		No Dry itchy or irritated skin and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
60	78.9	16	21.1	118	57.8	86	42.2	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 149

Associations between dry itchy or irritated skin that improved when away from the hospital and physical stress reaction (N = 280)

Dry itchy or irritated skin improved and significant stress reaction		Dry itchy or irritated skin improved and insignificant stress reaction		Dry itchy or irritated skin did not improve and significant stress reaction		Dry itchy or irritated skin did not improve and insignificant stress reaction		No dry itchy or irritated skin and significant stress reaction		No dry itchy or irritated skin and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
31	86.1	5	13.9	29	72.5	11	27.5	118	57.8	86	42.1	.002

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 150

Associations between stuffy air and physical stress reaction (N = 280)

Stuffy air a major concern and significant stress reaction		Stuffy air a major concern and insignificant stress reactions		Stuffy air needs further investigation and significant stress reaction		Stuffy air needs further investigation and insignificant stress reaction		No stuffy air and significant stress reaction		No stuffy air and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
74	72.5	28	27.5	70	56.5	54	43.5	34	63	20	37	.043

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 151

Associations between lethargy that improved when away from the hospital and physical stress reaction (N = 280)

Lethargy and significant stress reaction		Lethargy and insignificant stress reaction		No lethargy and significant stress reaction		No lethargy and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
88	75.2	29	24.8	90	55.2	73	44.8	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 152

Associations between headaches that improve when away from the hospital and physical stress reaction (N = 280)

Headaches and significant stress reaction		Headaches and insignificant stress reaction		No headaches and significant stress reaction		No headaches and insignificant stress reaction		p
n	%	n	%	n	%	n	%	
52	75.4	17	24.6	126	59.7	85	40.3	.019

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 153

Associations between dry throat that improve when away from the hospital and physical stress reaction (N = 280)

Dry throat and significant stress reaction		Dry throat and insignificant stress reaction		No dry throat and significant stress reaction		No dry throat and insignificant stress reaction		p
n	%	n	%	n	%	n	%	
43	84.3	8	15.7	135	59	94	41	.001

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 154

Associations between blocked nose that improve when away from the hospital and physical stress reaction (N = 280)

Blocked nose and significant stress reaction		Blocked nose and insignificant stress reaction		No blocked nose and significant stress reaction		No blocked and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
53	74.6	18	25.4	125	59.8	84	40.2	.025

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 155

Associations between temperature (temp) too hot and psychological stress reaction (N = 280)

Temp a major concern and significant stress reaction		Temp a major concern and insignificant stress reactions		Temp needs further investigation and significant stress reaction		Temp needs further investigation and insignificant stress reaction		Temp ideal and significant stress reaction		Temp ideal and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
28	50.9	27	49.1	12	40	18	60	54	38	88	62	.051

Note. A fourth group of respondents 31 (58.5%), were not concerned about temperature but reported significant psychological stress compared to 22 (41.5%) of the respondents who were not concerned about temperature and had no significant psychological stress.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 156

Associations between itchy or watery eyes and psychological stress reaction (N = 280)

Itchy or watery eyes and significant stress reaction		Itchy or watery eyes and insignificant stress reaction		No itchy or watery eyes and significant stress reaction		No itchy or watery eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
61	53	54	47	64	38.8	101	61.2	.018

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 157

Associations between itchy or watery eyes that improved when away from the hospital and psychological stress reaction (N = 280)

Itchy eyes improved and significant stress reaction		Itchy eyes improved and insignificant stress reaction		Itchy eyes not improved and significant stress reaction		Itchy eyes not improved and insignificant stress reaction		No itchy eyes and significant stress reaction		No itchy eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
37	55.2	30	44.8	24	50	24	50	64	38.8	101	61.2	.053

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 158

Associations between temperatures vary in summer and psychological stress reaction (N = 280)

Varying temperature concern and significant stress reaction		Varying temperature concern and insignificant stress reaction		No varying temperature concern and significant stress reaction		No varying temperature concern and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
86	50.9	83	49.1	39	35.1	72	64.9	.009

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 159

Associations between dry itchy or irritated skin and psychological stress reaction (N = 280)

Dry itchy or irritated skin and significant stress reaction		Dry itchy or irritated skin and insignificant stress reaction		No dry itchy or irritated skin and significant stress reaction		No dry itchy or irritated skin concern and insignificant stress reaction		p
n	%	n	%	n	%	n	%	
43	56.6	33	43.4	82	40.2	122	59.8	.041

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 160

Associations between dry itchy or irritated skin that improved when away from the hospital and psychological stress reaction (N = 280)

Dry itchy or irritated skin improved and significant stress reaction		Dry itchy or irritated skin improved and insignificant stress reaction		Dry itchy or irritated skin not improved and significant stress reaction		Dry itchy or irritated skin not improved and insignificant stress reaction		No dry itchy or irritated skin and significant stress reaction		No dry itchy or irritated skin and insignificant stress reaction		p
n	%	n	%	n	%	n	%	n	%	n	%	
21	58.3	15	41.7	22	55	15	41.7	82	40.2	122	59.8	.047

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 161

Associations between dry throat that improved when away from work and psychological stress reaction (N = 280)

Dry throat and significant stress reaction		Dry throat skin and insignificant stress reaction		No dry throat and significant stress reaction		No dry throat and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
30	58.8	21	41.2	95	58.8	134	58.5	.024

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 162

Associations between lethargy that improved when away from work and psychological stress reaction (N = 280)

Lethargy and significant stress reaction		Lethargy and insignificant stress reaction		No lethargy and significant stress reaction		No lethargy and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
61	52.1	56	47.9	64	39.3	99	60.6	.033

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 163

Associations between inadequate lighting concern and psychological stress reaction (N = 280)

Inadequate lighting a major concern and significant stress reaction		Inadequate lighting a major concern and insignificant stress reaction		Inadequate lighting needs further investigation and significant stress reaction		Inadequate lighting needs further investigation and insignificant stress reaction		Adequate lighting and significant stress reaction		Adequate lighting and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
23	69.7	10	30.3	38	43.2	50	56.8	64	40.3	95	59.7	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 164

Associations between higher particle levels and psychological stress reaction (N = 280)

Higher particle levels and significant stress reaction		Higher particle levels and insignificant stress reaction		Lower particle levels and significant stress reaction		Lower particle levels and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
56	51.9	52	48.1	69	40.1	103	59.9	.055

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 165

Associations between low air movement and psychological stress reaction (N = 280)

Low air movement and significant stress reaction		Low air movement and insignificant stress reaction		Adequate air movement and significant stress reaction		Adequate air movement and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
41	38	67	62	84	48.8	88	51.2	.075

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 166

Associations between air too draughty and psychological stress reaction (N = 280)

Draughty air and significant stress reaction		Draughty air and insignificant stress reaction		Adequate air movement and significant stress reaction		Adequate air movement and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
18	69.2	8	30.7	107	42.1	147	57.9	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 167

Associations between fungal surface contamination and psychological stress reaction (N = 280)

Surface fungi >3m² and significant stress reaction		Surface fungi >3m² and insignificant stress reaction		Surface fungi .2m² to 3m² and significant stress reaction		Surface fungi .2m² to 3m² and insignificant stress reaction		Surface fungi <.2m² and significant stress reaction		Surface fungi <.2m² and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
36	56.3	28	43.8	32	38.1	75	56.8	57	43.2	75	56.8	.08

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 167

Associations between dry eyes that improve when away from the hospital and behavioural stress reaction (N = 280)

Dry eyes and significant stress reaction		Dry eyes and insignificant stress reaction		No dry eyes and significant stress reaction		No dry eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
30	71.4	12	28.6	127	53.4	111	46.6	.030

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 168

Associations between itchy or watery eyes and behavioural stress reaction (N = 280)

Itchy or watery eyes and significant stress reaction		Itchy or watery eyes and insignificant stress reaction		No itchy or watery eyes and significant stress reaction		No itchy or watery eyes and insignificant stress reaction		p
n	%	n	%	n	%	n	%	
79	68.7	36	31.3	78	47.3	87	52.7	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 169

Associations between itchy or watery eyes that improves when away from the hospital and behavioural stress reaction (N = 280)

Itchy or watery eyes improved and significant stress reaction		Itchy or watery eyes improved and insignificant stress reaction		Itchy or watery eyes not improved and significant stress reaction		Itchy or watery eyes not improved and insignificant stress reaction		No itchy or watery eyes and significant stress reaction		No itchy or watery eyes and insignificant stress reaction		p
n	%	n	%	n	%	n	%	n	%	n	%	
45	67.2	22	32.8	34	70.8	14	29.2	78	47.3	87	52.7	.002

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 170

Associations between lethargy that improved when away from the hospital and behavioural stress reaction (N = 280)

Lethargy and significant stress reaction		Lethargy and insignificant stress reaction		No lethargy and significant stress reaction		No lethargy and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
74	63.2	43	36.8	83	50.9	80	49.1	.04

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 171

Associations between dry itchy or irritated skin and behavioural stress reaction (N = 280)

Dry itchy or irritated skin and significant stress reaction		Dry itchy or irritated skin and insignificant stress reaction		No dry or irritated skin and significant stress reaction		No dry or irritated skin and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
52	68.4	24	31.6	105	51.5	99	48.5	.011

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 172

Associations between dry itchy or irritated skin that improves when away from the hospital and behavioural stress reaction (N = 280)

Dry itchy skin improved and significant stress reaction		Dry itchy skin improved and insignificant stress reaction		Dry itchy skin not improved and significant stress reaction		Dry itchy skin not improved and insignificant stress reaction		No dry itchy skin and significant stress reaction		No dry itchy skin and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
25	69.4	11	30.6	27	67.5	13	32.5	105	51.5	99	48.5	.039

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 173

Associations between inadequate lighting levels and behavioural stress reaction (N = 280)

Inadequate lighting levels and significant stress reaction		Inadequate lighting levels and insignificant stress reaction		Adequate lighting levels and significant stress reaction		Adequate lighting levels and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
77	63.6	44	36.4	80	50.3	79	49.7	.026

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 174

Associations between stuffy air and behavioural stress reaction (N = 280)

Stuffy air a major concern and significant stress reaction		Stuffy air a major concern and insignificant stress reaction		Stuffy air needs further investigation and significant stress reaction		Stuffy air needs further investigation and insignificant stress reaction		No stuffy air and significant stress reaction		No stuffy air and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
67	57.2	35	34.3	62	50	62	50	28	51.9	26	48.1	.048

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 175

Associations between concern regarding temperature variation in summer and behavioural stress reaction (N = 280)

Temperature variation and significant stress reaction		Temperature variation and insignificant stress reaction		No temperature concern and significant stress reaction		No temperature concern and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
103	60.9	66	39.1	54	48.6	57	51.4	.043

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 176

Associations between fungal surface contamination and behavioural stress reaction (N = 280)

Surface fungi >3m^2 and significant stress reaction		Surface fungi >3m^2 and insignificant stress reaction		Surface fungi .2m^2 to 3m^2 and significant stress reaction		Surface fungi .2m^2 to 3m^2 and insignificant stress reaction		Surface fungi <.2m^2 and significant stress reaction		Surface fungi <.2m^2 and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
44	68.8	20	31.3	41	48.8	43	51.2	60	45.5	60	45.5	.047

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 177

Associations between concern regarding poor cleanliness in hospitals and behavioural stress reaction (N = 280)

Poor hospital cleanliness and significant stress reaction		Poor hospital cleanliness and insignificant stress reaction		No cleanliness concern and significant stress reaction		No cleanliness concern and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
111	62	68	38	46	45.5	55	54.5	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 178

Associations between request for improvements in the hospital and behavioural stress reaction (N = 280)

Improvement requested and significant stress reaction		Improvement requested and insignificant stress reaction		No improvement requested and significant stress reaction		No improvement requested and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
64	62.7	38	37.3	93	52.2	85	47.8	.089

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 179

Associations between speed of response to improvements in hospital and biopsychosocial stress reaction (N = 280)

Major response speed concern and stress reaction		Major response speed concern and insignificant stress reaction		Further investigate response speed and stress reaction		Further investigate response speed and insignificant stress reaction		No concern regarding response speed and stress reaction		No concern regarding response speed and stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
39	69.6	17	30.4	7	38.9	11	61.1	12	46.2	14	53.8	.042

Note. In addition to the above concern responses: 93 (51.7%) of the respondents reported significant biopsychosocial stress but had no requests for hospital improvements compared to 87 (48.3%) of the staff who did not report significant biopsychologically stress reaction and requests for hospital improvements. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 180

Associations between allergy and biopsychosocial stress reaction (N = 280)

Allergy and significant stress reaction		Allergy and insignificant stress reaction		No allergy and significant stress reaction		No allergy and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
56	61.5	35	38.5	95	50.3	94	49.7	.076

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 181

Associations between effectiveness of response to improvements in hospital and biopsychosocial stress reaction (N = 280)

Major improvement concern and stress reaction		Major improvement concern and insignificant stress reaction		Further investigate response and stress reaction		Further investigate response and insignificant stress reaction		No concern regarding response and stress reaction		No concern regarding response and stress reaction		p
n	%	n	%	n	%	n	%	n	%	n	%	
41	69.5	18	30.5	7	38.9	11	61.1	10	41.7	14	58.3	.028

Note. In addition to the above concern responses: 93 (52%) of the staff reported significant biopsychosocial stress reactions but had no requests for improvements in hospital compared to 86 (48%) of the staff who did not have significant biopsychosocial stress reactions and had no requests for improvements in hospital. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 182

Associations between itchy or watery eyes and biopsychosocial stress reaction (N = 280)

Itchy or watery eyes and significant stress reaction		Itchy or watery eyes and insignificant stress reaction		No itchy or watery eyes and significant stress reaction		No itchy or watery eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
76	66.1	39	33.9	75	45.5	90	54.5	.001

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 183

Associations between itchy or watery eyes that improves when away from the hospital and biopsychosocial stress reaction (N = 280)

Itchy or watery eyes improved and significant stress reaction		Itchy or watery eyes improved and insignificant stress reaction		Itchy or watery eyes not improved and significant stress reaction		Itchy or watery eyes not improved and insignificant stress reaction		No itchy or watery eyes and significant stress reaction		No itchy or watery eyes and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
46	68.7	21	31.3	30	62.5	18	37.5	75	45.5	90	54.5	.002

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 184

Associations between temperature (temp) too hot and biopsychosocial stress reaction (N = 280)

Temp a major concern and significant stress reaction		Temp a major concern and insignificant stress reaction		Temp needs further investigation and significant stress reaction		Temp needs further investigation and insignificant stress reaction		Temp ideal and significant stress reaction		Temp ideal and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
33	60	22	40	14	46.7	16	53.3	68	47.9	74	52.1	.052

Note. A fourth group of respondents, 17 (32.1%) were not concerned about temperature but reported significant biopsychosocial stress reaction compared to 36 (67.9%) of the respondents who were not concerned about temperature and had no significant psychological stress reaction.

Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 185

Associations between concern regarding temperature variation in summer and biopsychosocial stress reaction (N = 280)

Temperature variation and significant stress reaction		Temperature variation and insignificant stress reaction		No temperature concern and significant stress reaction		No temperature concern and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
100	59.2	69	40.8	51	45.9	60	54.1	.03

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 186

Associations between dry itchy or irritated skin and biopsychosocial stress reaction (N = 280)

Dry itchy or irritated skin and significant stress reaction		Dry itchy or irritated skin and insignificant stress reaction		No dry or irritated skin and significant stress reaction		No dry or irritated skin and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
54	71.1	22	28.9	97	47.5	107	52.5	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 187

Associations between dry itchy or irritated skin that improves when away from the hospital and biopsychosocial stress reaction (N = 280)

Dry itchy skin improved and significant stress reaction		Dry itchy skin improved and insignificant stress reaction		Dry itchy skin not improved and significant stress reaction		Dry itchy skin not improved and insignificant stress reaction		No dry itchy skin and significant stress reaction		No dry itchy skin and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
26	72.2	10	27.8	12	30	28	70	97	47.5	107	52.5	.002

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 188

Associations between dry throat that improved when away from work and biopsychosocial stress reaction (N = 280)

Dry throat and significant stress reaction		Dry throat skin and insignificant stress reaction		No dry throat and significant stress reaction		No dry throat and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
35	68.6	16	31.4	116	50.7	113	49.3	.02

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 189

Associations between lethargy that improved when away from the hospital and biopsychosocial stress reaction (N = 280)

Lethargy and significant stress reaction		Lethargy and insignificant stress reaction		No lethargy and significant stress reaction		No lethargy and insignificant stress reaction		p
n	%	n	%	n	%	n	%	
72	61.5	45	38.5	79	48.5	84	51.5	.03

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 190

Associations between inadequate lighting levels and biopsychosocial stress reaction (N = 280)

Inadequate lighting a major concern and significant stress reaction		Inadequate lighting a major concern and insignificant stress reaction		Inadequate lighting needs further investigation and significant stress reaction		Inadequate lighting needs further investigation and insignificant stress reaction		Adequate lighting and significant stress reaction		Adequate lighting and insignificant stress reaction		p
n	%	n	%	n	%	n	%	n	%	n	%	
24	72.7	9	27.3	45	51.1	43	48.9	82	51.6	77	48.4	.07

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 191

Associations between particle levels and biopsychosocial stress reaction (N = 280)

High particle levels and significant stress reaction		High particles level and insignificant stress reaction		Medium particle levels and significant stress reaction		Medium particle levels and insignificant stress reaction		Low particle levels and significant stress reaction		Low particle levels and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
46	64.8	25	35.2	56	54.4	47	45.6	49	46.2	57	53.8	.052

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 192

Associations between higher particle levels and biopsychosocial stress reaction (N = 280)

Higher particle levels and significant stress reaction		Higher particle levels and insignificant stress reaction		Lower particle levels and significant stress reaction		Lower particle levels and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
66	61.1	42	38.9	85	49.4	87	50.6	.056

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 193

Associations between low air movement and biopsychosocial stress reaction (N = 280)

Low air movement and significant stress reaction		Low air movement and insignificant stress reaction		Adequate air movement and significant stress reaction		Adequate air movement and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
51	47.2	57	52.8	100	58.1	72	41.9	.074

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 193

Associations between Penicillium species in indoor air and biopsychosocial stress reaction (N = 280)

Penicillium and significant stress reaction		*Penicillium* and insignificant stress reaction		No *Penicillium* and significant stress reaction		No *Penicillium* and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
145	53.1	128	46.9	6	85.7	1	14.3	.088

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

More than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and *p* values should be interpreted with caution.

Table 194

Associations between Rhizopus and Mucor species on surfaces and biopsychosocial stress reaction (N = 280)

Rhizopus and *Mucor* and significant stress reaction		*Rhizopus* and *Mucor* and insignificant stress reaction		No *Rhizopus* and *Mucor* significant stress reaction		No *Rhizopus* and *Mucor* insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	
46	46	54	54	105	58.3	75	41.7	.047

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 195 *Associations between fungal ratio and biopsychosocial stress reaction (N = 280)*

Fungal ratio >1 and significant stress reaction		Fungal ratio >1 and insignificant stress reaction		Lower fungal counts and significant stress reaction		Lower fungal counts and insignificant stress reaction		Fungal ratio = 1 and significant stress reaction		Fungal ratio = 1 and insignificant stress reaction		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
39	47.6	43	52.4	107	55.4	86	44.6	5	100	0	0	.055

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

More than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and *p* values should be interpreted with caution.

Table 196

Associations between relative humidity (RH) respondent concern and RH levels (N = 280)

RH of major concern and RH ≥ 60%		RH of major concern and RH < 60%.		RH needs further investigation and RH ≥ 60%		RH needs further investigation and RH < 60%.		RH ideal and RH ≥ 60%		RH ideal and RH < 60%.		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
44	83	9	17	44	80	11	20	84	66.1	43	33.9	.019

Note. A fourth group of respondents, 38 (84.4%) considered relative humidity as being of no concern and were exposed to relative humidity ≥ 60%, compared to 7 (15.6%) of respondents who considered relative humidity as being of no concern and were exposed to relative humidity <60%.

Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 197

Associations between relative humidity (RH) respondent concern and temperature (temp) levels (N = 280)

RH of major concern and temp ≥ 26°C		RH of major concern and temp < 26°C		RH needs further investigation and temp ≥ 26°C		RH needs further investigation and temp < 26°C		RH ideal and temp ≥ 26°C		RH ideal and temp < 26°C		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
15	28.3	38	71.7	8	14.5	47	85.5	16	12.6	111	87.4	.018

Note. A fourth group of respondents, 13 (28.9%) of respondents reported relative humidity as being of no concern and were exposed to mean temperature levels ≥ 26°C compared to 32 (71.1%) of respondents who reported relative humidity as being of no concern and were exposed to temperatures < 26°C.
Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 198

Associations between respondent hot temperature (temp) concern and temperature levels (N = 280)

Temp concern and temp ≥ 26°C		Temp concern and temp < 26°C		No temp concern and temp ≥ 26°C		No temp concern and temp < 26°C		*p*
n	%	*n*	%	*n*	%	*n*	%	
29	34.1	56	65.9	23	11.8	172	88.2	.000

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 199

Associations between fungal ratio and maximum carbon dioxide levels (CO^2) (N = 280)

Fungal ratio >1 and CO^2 ≥1000ppm		Fungal ratio >1 and CO^2 <1000ppm		Lower fungal counts and CO^2 ≥1000ppm		Lower fungal counts and CO^2 <1000ppm		Fungal ratio = 1 and CO^2 ≥1000ppm		Fungal ratio = 1 and CO^2 <1000ppm		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
9	11	73	89	35	18.1	158	81.9	5	100	0	0	.000

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

More than 20% of the cells had expected counts < 5, thus the Chi-square assumptions were not met and *p* values should be interpreted with caution.

Table 200

Associations between relative humidity (RH) respondent concern and maximum carbon dioxide levels (CO^2) (N = 280)

RH of major concern and CO^2 ≥1000ppm		RH of major concern and CO^2 <1000ppm		RH needs further investigation and CO^2 ≥1000ppm		RH needs further investigation and CO^2 <1000ppm		RH ideal and CO^2 ≥1000ppm		RH ideal and CO^2 <1000ppm		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
6	11.3	47	88.7	13	23.6	42	76.4	27	21.3	100	78.7	.052

Note. A fourth group of respondents, 3 (6.7%) of reported that relative humidity was of no concern were exposed to carbon dioxide maximum levels of ≥ 1000ppm and more, compared to 42 (93.3%) of respondents who reported that relative humidity was of no concern and were exposed to carbon dioxide levels <1000ppm. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 201

Associations between allergy and low air movement level (< .1m/s) *(N = 280)*

Allergy and air movement < .1m/s		Allergy and air movement > .1m/s		No allergy and air movement < .1m/s		No allergy and air movement > .1m/s		*p*
n	%	*n*	%	*n*	%	*n*	%	
25	27.5	66	72.5	83	43.9	106	56.1	.008

Note. Low air movement level = levels < .1m/s.

Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 202

Associations between allergy worse at work and low air movement level (< .1m/s) *(N = 280)*

Allergy worse at work and air movement < .1m/s		Allergy worse at work and air movement > .1m/s		Allergy not worse at work and air movement < .1m/s		Allergy not worse at work and work and air movement > .1m/s		No allergy and air movement < .1m/s		No allergy and air movement > .1m/s		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
11	23.9	35	76.1	14	31.1	31	68.9	83	43.9	106	56.1	.023

Note. Low air movement level = levels < .1m/s.

Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 203

Associations between allergy and maximum carbon dioxide levels (CO^2) (N = 280)

Allergy and CO^2 ≥1000ppm		Allergy and CO^2 <1000ppm		No allergy and CO^2 ≥1000ppm		No allergy and CO^2 <1000ppm		*p*
n	%	*n*	%	*n*	%	*n*	%	
21	23.1	70	76.9	28	14.8	161	85.2	.088

Note. Significant association $p < .05$. Borderline significance will be taken as ≤ .09.

Table 205

Associations between requests for hospital improvements and poor cleanliness in hospitals (N = 280)

Improvement request and hospital cleanliness concern		Improvement request and no cleanliness concern		No improvement request but had hospital cleanliness concern		No improvement request and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	
119	70.4	50	29.6	60	54.1	51	45.9	.005

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 206

Associations between concerns regarding speed of response to repair the ventilation system and poor cleanliness in hospitals (N = 280)

Response problem and hospital cleanliness concern		Response problem and no cleanliness concern		No response problem but had hospital cleanliness concern		No response problem and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	
83	72.8	31	27.2	96	57.8	70	42.2	.01

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 207

Associations between concerns regarding effectiveness of response to repair the ventilation system and poor cleanliness in hospitals (N = 280)

Effectiveness problem and hospital cleanliness concern		Effectiveness problem and no cleanliness concern		No effectiveness problem but had hospital cleanliness concern		No effectiveness problem and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	
86	72.9	32	27.9	93	57.4	69	42.6	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 208

Associations between particle levels and hospital cleanliness concern (N = 280)

High particle levels and hospital cleanliness concern		High particles level and no cleanliness concern		Medium particle levels and with hospital cleanliness concern		Medium particle levels and no cleanliness concern		Low particle levels with hospital cleanliness concern		Low particle levels and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
56	78.9	15	21.1	58	56.3	45	43.7	65	61.8	41	38.2	.008

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 209

Associations between fungal surface contamination and hospital cleanliness concern (N = 280)

Surface fungi >3m² and hospital cleanliness concern		Surface fungi >3m² and no cleanliness concern		Surface fungi .2m² to 3m² and hospital cleanliness concern		Surface fungi .2m² to 3m² and no cleanliness concern		Surface fungi <.2m² and hospital cleanliness concern		Surface fungi <.2m² and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
49	76.6	15	23.4	59	70.2	25	29.8	71	53.8	61	46.2	.003

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 210

Associations between odours in hospital and poor hospital cleanliness (N = 280)

Odour and hospital cleanliness concern		Odour and no cleanliness concern		No odour concern but had hospital cleanliness concern		No odour concern and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	
144	70.6	60	29.4	35	46.1	41	53.9	.000

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

Table 211

Associations between stuffy air and hospital cleanliness concern (N = 280)

Stuffy air of major concern and hospital cleanliness concern		Stuffy air of major concern and no cleanliness concern		Stuffy air needs further investigation and hospital cleanliness concern		Stuffy air needs further investigation and no cleanliness concern		No stuffy air concern but hospital cleanliness concern		No stuffy air concern and no cleanliness concern		*p*
n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
77	75.5	25	24.5	74	59.7	50	40.3	28	51.9	26	48.1	.006

Note. Significant association $p < .05$. Borderline significance will be taken as $\leq .09$.

In summary, the univariate associations in tables 94 to 211 suggested many possible associations that may have existed in the hospitals at the time of this research. As with the 123 respondent group, the intent is not to discuss all of the findings from these univariate tables. Only some of the more significant associations are reported here. There appeared to be extremely significant associations between SBS and SBS symptoms and allergy in tables 95 and 131. Other significant associations were between SBS and biopsychosocial stress reactions including psychological stress reactions, behavioural stress reactions and physical stress reaction in tables 99, 97, 98 and 96 respectively. It was also interesting to note in table 105 that a greater proportion of respondents that reported colds more than twice a year also reported significant physical stress reaction concerns compared to respondents that only reported cold > twice a year and experienced with fewer physical stress reactions.

In conclusion, the univariate analysis highlighted the many variable associations in hospital environments. Significantly associated variables were included in multivariate analysis.

Multivariate stepwise logistic regression analysis of hospital staff concerns

Gaynor (1993) suggested that evaluation of indoor air quality can include physical, chemical, biological, and social effects, with physical factors consisting of temperature, humidity, air movement, noise, light and dust. The developing hospital multivariate models may provide guidance in reducing discomfort in hospital environments.

The main considerations in the current research were biopsychosocial stress reactions, indoor environmental concerns and SBS that may negatively influence hospital staff health and comfort. The allergy, psychological and SBS models may assist in clarifying the current research hypotheses.

Two allergy models were proposed. One model was based on the 123 respondent group and the other was based on the 280 respondents. The two allergy models had different approaches to obtaining allergy symptom data. The allergy outcome of the HEPSA questionnaire for 280 respondents was established though self-reporting of one allergy question whereas the 123 allergy respondent model was developed from an allergy symptoms score. A clearer case definition was acquired using the allergy symptom score method.

In all of the models, variables from significant univariate associations were included in multivariate stepwise logistic regression analysis whilst controlling for confounding variables.

Multivariate analysis of the allergy skin test group (N=123)

For the binary outcome of allergy associations "any allergy symptoms" as opposed to "no allergy" were used. The missionary type hospitals were utilised as a baseline for comparison of the various hospital types. The missionary type hospitals were selected as the baseline as this group demonstrated the lowest allergy risk in univariate analysis for the 123 group of respondents.

Allergy influencing variables established from the univariate analysis were selected for the multivariate model. These were hospitals, physical stress, psychological stress, behavioural stress, sick building syndrome, various mould reactions including dust mite and cockroach, gender, age, job, smoking, particles, family history of allergy and ventilation systems. The binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10 respectively was completed in 16 steps. Table 212 summarises the final step in this model.

Table 212

Binary logistic regression of allergy (N=123)

	Wald	*df*	*Sig*	*OR*	95% confidence interval Lower	Upper
Overall hospital effect	4.630	2	.099			
Priv hospital	4.630	1	.031	4.896	1.152	20.808
Prov hospital	1.062	1	.303	1.892	.563	6.361
Behavioural	6.813	1	.009	4.479	1.453	13.807
SBS	8.987	1	.003	5.282	1.779	15.679
Constant	1.147	1	.284	.508		

Note. Associations were established with binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10. Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

In table 212 the baseline hospital was missionary. The overall effect of 'hospital' is shown in the first row of the table. The other hospitals in the table form part of the individual "effect" of these hospitals compared to the baseline. The effect for hospital is the individual effect of private hospital compared to the baseline of missionary hospital. This also applies to the private hospitals. However, the association between provincial hospitals and allergy was not significant. Table 212 compares respondents with allergy versus those respondents with no allergy. The data suggests that respondents in private hospitals appear approximately 4.896 times more likely to report that they are suffering from allergies than respondents not in private hospitals. Furthermore, respondents with SBS symptoms were 5.282 times more likely to report allergies than those people without SBS. The confidence intervals were wide indicating an imprecise estimate of the true odds ratio in the underlying population. An important finding is that respondents in private type hospitals were more likely to have reported allergies than respondents from the other two hospital types. Variables included in this model predicted the outcome of allergy 82.8% correctly which suggests that there may have been other factors that contributed to allergy responses at the time of this study.

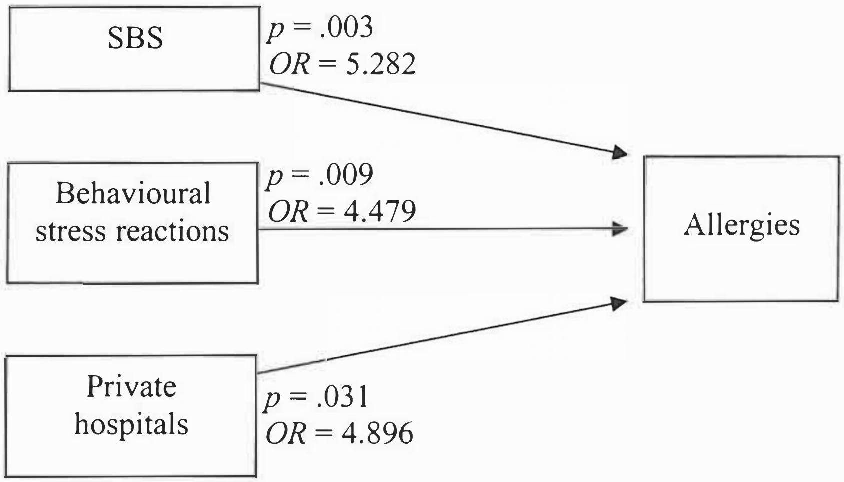

Figure 8. Proposed allergy model and associated variables ($N = 123$)

Multivariate analysis of the total data set (N=280)

Proposed allergy model (N=280)

From the univariate analysis, likely allergy influencing variables were selected. These were gender (female v. male), colds more than twice a year, influenza more than twice a year, effective response to repair requests for ventilation system, speed of response to repair requests for ventilation system, requests for improvements to the ventilation system, particulate level (particles below the mean score v. particles above the mean score), carbon dioxide maximum (carbon dioxide levels below 1000ppm v. carbon dioxide levels 1000ppm and above), A*spergillus* in indoor air, gender, biopsychosocial stress reaction, smoking habit, asthma, dry eyes (SBS), blocked nose (SBS), dry throat (SBS), headache (SBS), stuffy air, hospital cleanliness and *Mucor* and *Rhizopus* in indoor air.

The binary logistic regression model was completed in 11 steps. Table 71 summarises the final step.

Table 213

Binary logistic regression of allergy (N = 280)

					95% confidence interval	
	Wald	*df*	*Sig*	*OR*	Lower	Upper
Gender (female vs. male)	6.949	1	.008	5.633	1.558	20.366
Asthma	5.469	1	.019	2.836	1.184	6.795
Colds	3.131	1	.077	1.749	.942	3.250
Dry eyes	2.941	1	.086	1.992	.906	4.380
Blocked nose	13.426	1	.000	3.418	1.771	6.596
Stuffy air	2.794	1	.095	2.001	.887	4.514
Improve ventilation	5.707	1	.017	2.174	1.150	4.111
Particles	4.450	1	.035	1.972	1.049	3.706
Aspergillus indoors	5.242	1	.022	14.041	1.463	134.784
Constant	25.420	1	.000	.001		

Note. Associations were established using binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10.

Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

Table 213 describes the variables that were associated with staff reporting allergies in the total hospital respondent group ($N = 280$). There were wide confidence intervals for the variables gender and *Aspergillus*. These confidence intervals were wide indicating imprecise estimates of the true odds ratio in the underlying population. The corresponding low proportions of males to females may have resulted in the wide confidence interval for gender. *Aspergillus* were found in most indoor air environments at the time of this study and may have influenced the confidence interval. This model did not predict that a specific hospital type was more likely to experience allergies. The model therefore may predict that the variables associated with allergy would be applicable for all hospital types in this study.

In summary the model suggests that females may be 5.6 times more likely to report that they are suffering from allergies than males. Staff in indoor environments where *Aspergillus* spp were prevalent may be 14 times more likely to report allergies than staff in areas where no *Aspergillus* spp were measured. Respondents reporting the SBS symptom blocked nose were 3.4 times more likely to report allergies than those people without the SBS symptom of blocked nose. Respondents reporting asthma appear approximately 2.8 times more likely to report that they suffer from allergies than people without asthma. It is interesting that respondents reporting stuffy air concerns and those concerned that ventilation required improvement were both approximately 2 times more likely to report that they were suffering from allergies than people with no concern regarding stuffy air or needs for ventilation improvement. Respondents who reported another SBS symptom, dry eyes, were 1.99 times more likely to report allergies than respondents not experiencing dry eyes. Hospital staff that experienced higher particle levels were 1.97 times more likely to report allergy symptoms than those people not exposed to higher particle levels. Respondents reporting colds were 1.75 times more likely to report allergy that those with no cold. Variables included in this model predicted the outcome of allergy 75.7% correctly which suggests that there may have been other factors that contributed to allergy responses at the time of this study. The model in figure 9 may suggest the importance of improving indoor hospital environments as a possible approach to reduce discomfort in the hospital investigated.

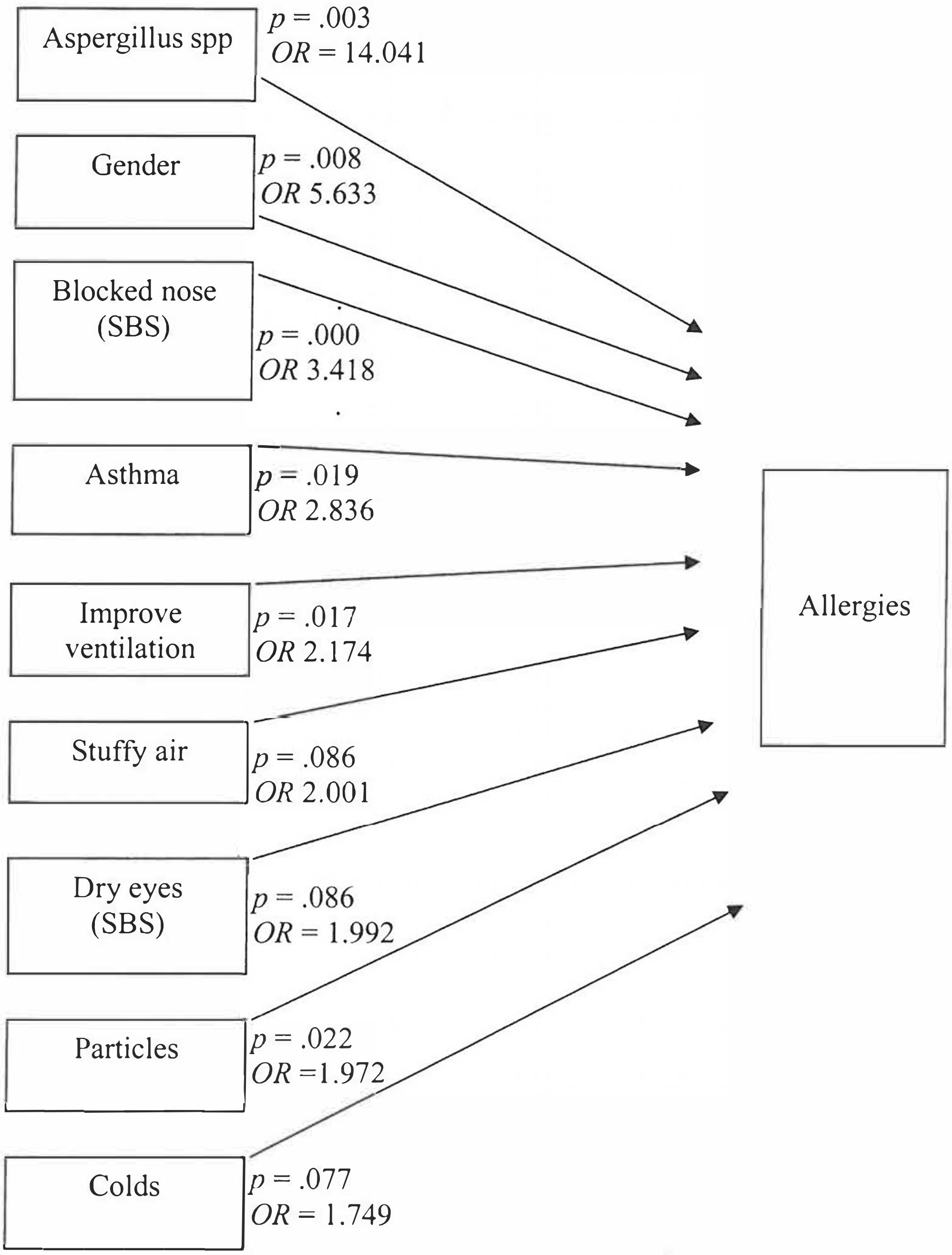

Figure 9. Proposed allergy model and associated variables with odds ratios (N=280).

Biopsychosocial stress reaction model and associated variables

In this model the provincial type hospital group was used as a baseline for comparison between the various hospital types. The provincial hospital group was chosen as it demonstrated the lowest proportions of reported stress reaction. Other likely variables were gender (females v. males), age, job, hours of work, itchy skin, fungal surface area contamination, lighting adequacy, temperatures varies in summer, itchy or watery eyes, allergy, hot temperatures in summer, dry throat, lethargy, particle levels, *Penicillium spp* in indoor air, *Aspergillus spp* in indoor air and stuffy air. The binary logistic regression model was completed in 13 steps. Table 214 summarises the final step.

Table 214

Binary logistic regression of biopsychosocial stress (N = 280)

					95% confidence interval	
	Wald	*df*	*Sig*	*OR*	Lower	Upper
Itchy skin	6.332	1	.012	2.178	1.188	3.994
Temperature varies	4.573	1	.032	1.760	1.048	2.954
Itchy or watery eyes	7.632	1	.006	2.116	1.243	3.600
Lethargy	5.186	1	.023	1.824	1.087	3.61
Particle levels	5.240	1	.022	2.159	1.117	4.173
Penicillium in air*	2.517	1	.113	.174	.020	1.510
Constant	.218	1	.641	1.696		

Note. Associations were established using binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10.

* *Penicillium spp* was protective against biopsychosocial stress reactions but not significantly so ($p = .113$). Protective due to only 7 staff that were not exposed to it

Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

Table 214 suggests variables that were associated with staff reporting biopsychosocial stress reactions in the total hospital respondent group ($N = 280$). This model did not predict that a specific hospital type was more likely to experience significant biopsychosocial stress reactions. The model therefore may predict that the variables associated with biopsychosocial stress reactions would be applicable for all hospital types in this study.

In summary the model suggests that respondents reporting itchy skin were 2.178 more likely to report significant proportions of biopsychosocial stress reactions than those people not reporting itchy skin. Staff reporting concerns regarding temperature variation may be 1.760 times more likely to report biopsychosocial stress reactions than staff not reporting variations in temperature. Respondents reporting itchy or watery eyes appeared to be 2.115 times more likely to report biopsychosocial stress reactions than those people not reporting itchy or watery eyes. Respondents reporting lethargy were 1.824 times more likely to report biopsychosocial stress reactions than people without itchy or watery eyes. It is interesting that respondents in areas with high particle levels were 2.159 times more likely to report biopsychosocial stress reactions than respondents with lower particle levels. Variables included in this model were predicted the outcome of biopsychosocial stress reactions 68.2% correctly which suggests that there may have been other factors that contributed to biopsychosocial stress reactions at the time of this study. The biopsychosocial stress reaction model is represented in figure 10.

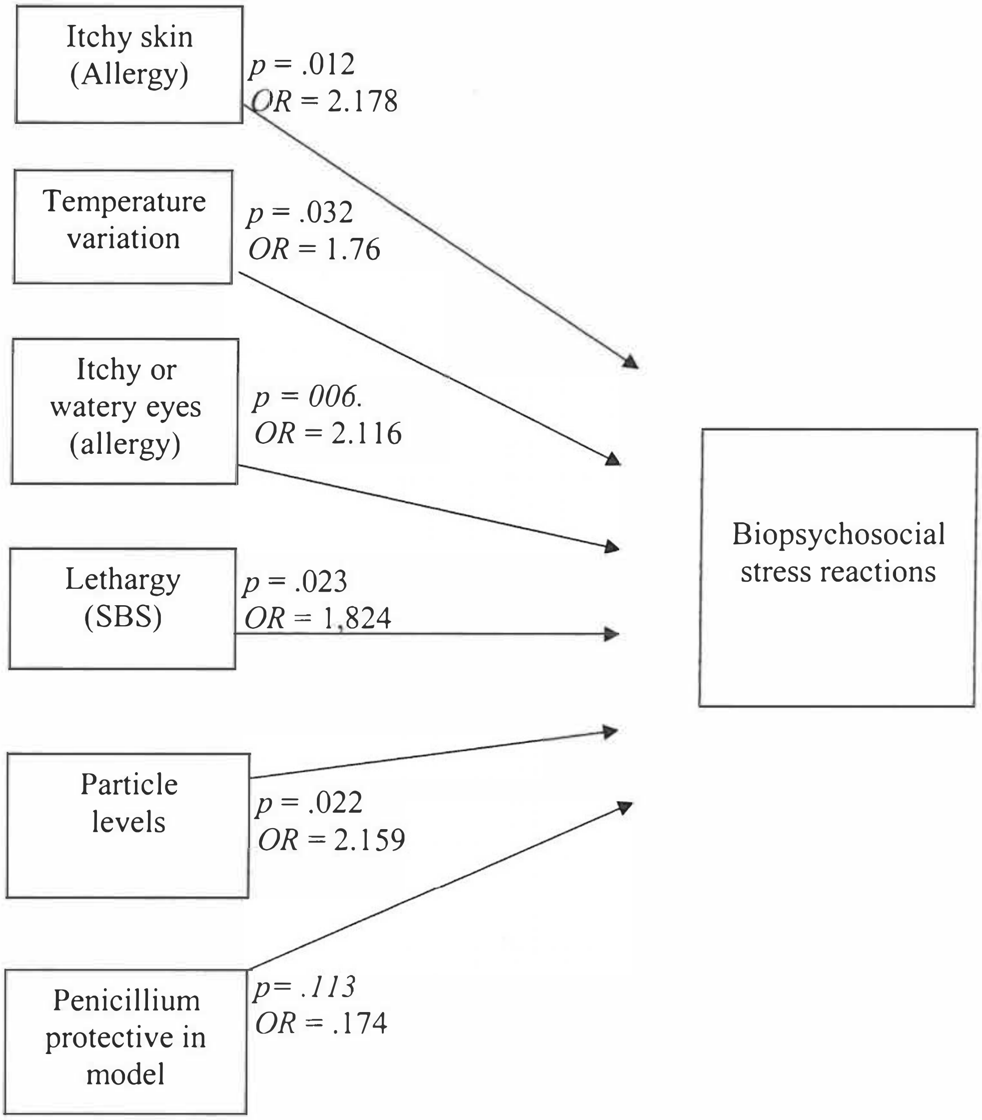

Figure 10. Biopsychosocial stress model and associated variables (N=280).

Psychological stress reactions and associated hospital variables.

Psychological reactions from the biopsychosocial stress reaction model were analysed to establish the independent variable associations. For the binary outcome of psychological stress symptoms as opposed to none, the provincial type hospital group was used as a baseline for comparison of the various hospital types as this hospital type was associated with the lowest proportions of stress reactions.

From the univariate analysis, likely variables were: gender (females v. males), age, job, hours of work, behavioural stress, itchy skin, physical stress reactions, sick building syndrome, particles, air movement measurements, fungal surface area contamination, draughty air movement, lighting adequacy, temperatures varies in summer, hot temperatures in summer and overall comfort in summer. The binary logistic regression model was completed in 14 steps. Table 215 summarises the final step.

Table 215

Binary logistic regression of psychological stress reactions (N = 280)

					95% confidence interval	
	Wald	*df*	*Sig*	*OR*	Lower	Upper
Behavioural stress	52.691	1	.000	17.206	7.981	37.096
Physical stress	35.193	1	.000	13.276	5.650	31.196
Particles	4.183	1	.041	2.098	1.031	4.267
Draughty air	5.000	1	.025	4.147	1.192	14.430
Constant	62.56	1	.000	.013		

Note. Associations were established using binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10.

Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

Table 215 suggests variables that were associated with staff reporting psychological stress reactions in the total hospital respondent group ($N = 280$). This model did not predict that a specific hospital type was more likely to experience significant proportions of biopsychosocial stress reactions. The model therefore may predict that the variables associated with biopsychosocial stress reactions would be applicable for all hospital types in this study.

In summary the model suggests that respondents reporting significant proportions of behavioural stress reactions were 17.206 times more likely to report psychological stress reactions than those people not reporting significant proportions of behavioural stress reactions. Staff reporting significant proportions of physical stress reactions may be 13.276 times more likely to report psychological stress reactions than staff not reporting significant proportions of physical stress reactions. Respondents in areas with high particle levels were 2.098 times more likely to report psychological stress reactions than respondents with lower particle levels. Respondents reporting draughty air appeared to be 4.147 times more likely to report psychological stress reactions than those people not reporting that the air is draughty. Variables included in this model predicted the outcome of psychological stress reactions 85.7% correctly which suggests that there may have been other factors that contributed to psychological stress reactions at the time of this study. Figure 11 describes the psychological model.

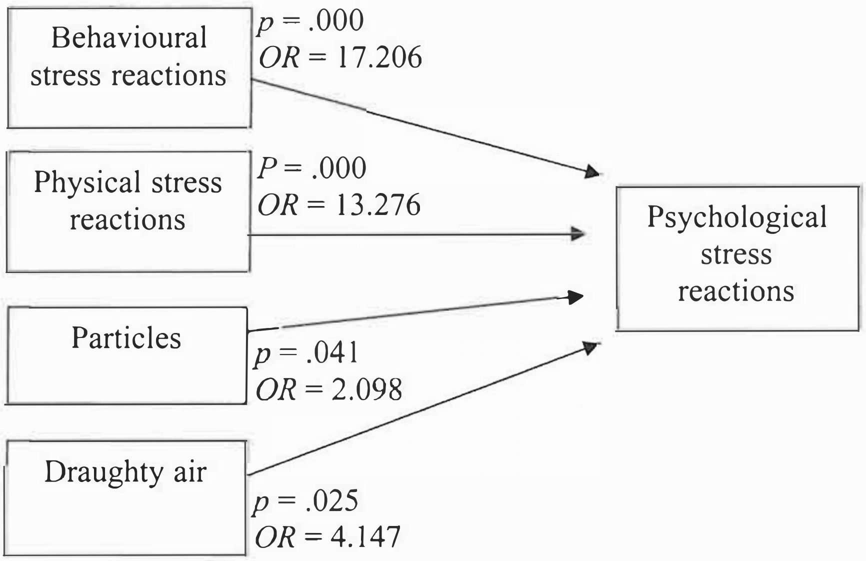

Figure 11. Psychological stress model and associated variables (N=280).

Physical stress reactions and associated hospital variables

For the binary outcome of physical symptoms as opposed to none, the provincial type hospital group was used as a baseline for comparisons with the various hospital types.

Provincial type hospital group was chosen as a baseline because this hospital demonstrated the lowest proportions of stress reactions. From the univariate analysis, likely variables to be included in this model were: private and missionary hospitals, gender (females vs. males), age, job, hours of work, behavioural stress, psychological stress, dry eyes, blocked nose, dry throat, headache, itchy or watery eyes, runny nose, colds, colds and influenza, asthma and stuffy air. The binary logistical regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10 respectively was completed in 14 steps. Table 216 summarises the final step.

Table 216

Binary logistic regression of physical stress reactions (N = 280)

					95% confidence interval	
	Wald	*df*	*Sig*	*OR*	Lower	Upper
Overall hospital effect	8.341	2	.015			
Colds and influenza	9.414	1	.002	2.854	1.461	5.578
Missionary hospitals	7.285	1	.007	3.332	1.390	7.986
Private hospitals	4.320	1	.038	2.128	1.044	4.338
Behavioural stress	4.881	1	.027	2.214	1.094	4.482
Psychological stress	33.072	1	.000	12.586	5.309	29.838
Dry throat	6.620	1	.010	3.386	1.337	8.575
Constant	23.586	1	.000	.174		

Note. Associations were established using binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10.

Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

Table 216 suggests variables that were associated with staff reporting psychological stress reactions in the total hospital respondent group (*N* = 280). This model did predict that respondents in missionary hospital types might have been more prone to experience physical stress reactions than the other two hospital groups. The model suggests that the variables associated with physical stress reactions may have been of lesser concern to the provincial hospital group at the time of this study.

In summary the model suggests that respondents experiencing colds and influenza more than twice a year may be 2.854 times more likely to report physical stress reactions than those people not reporting significant occurrences of colds and influenza. Staff in missionary type hospitals may have been 3.332 times more likely to report physical stress reactions than staff in provincial or private hospitals. Respondents in private hospitals may have been 2.128 times more likely to report physical stress reactions than respondents not in private hospitals. Respondents reporting significant proportions of physical stress reactions appeared have been 2.214 times more likely to report physical stress reactions than those people not reporting behavioural stress reactions. Respondents reporting significant proportions of psychological stress reactions appeared have been 12.586 times more likely to report physical stress reactions than those people not reporting proportions of psychological stress reactions. Staff reporting dry throat appear to have been 3.386 times more likely to have reported physical stress reactions than people who did not report dry throat. Variables included in this model predicted the outcome of physical stress reactions 76.8% correctly which suggests there may have been other factors that contributed to physical stress reactions at the time of this study. Figure 12 describe the physical stress reaction model.

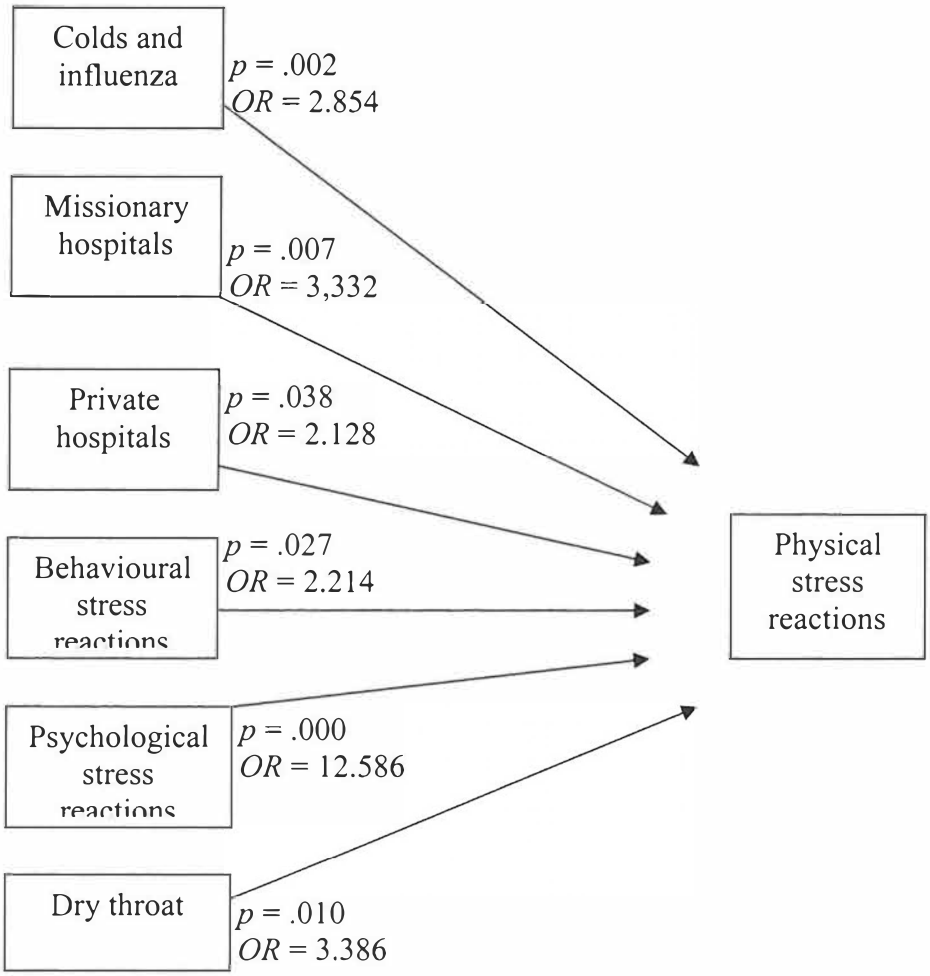

Figure 12. Physical stress reaction model and associated variables (N=280).

Behavioural stress reactions and associated hospital variables

For the binary outcome of any allergy symptoms as opposed to none, the provincial type hospital group was used as a baseline for comparison of the various hospital types. Provincial type hospital group was chosen as a baseline because this hospital showed the lowest stress. From the univariate analysis, likely variables chosen to be included in this model were gender (females v. males), age, job, hours of work, itchy skin, physical stress, sick building syndrome, fungal air indoor and outdoor ratio, lighting adequacy, temperature variations, psychological stress, itchy or watery eyes, stuffy air, hospital cleanliness, request for hospital improvements and allergy. The binary logistical regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10 respectively was completed in 14 steps. Table 75 summarizes the final step.

Table 217

Binary logistic regression of behavioural stress (N = 280)

					95% confidence interval	
	Wald	*df*	*Sig*	*OR*	Lower	Upper
Physical reactions	4.125	1	.042	2.045	1.025	4.079
Psychological reactions	49.923	1	.000	14.886	7.038	31.484
Itchy or watery eyes	5.028	1	.025	2.063	1.095	3.884
Cleanliness of hospital	5.147	1	.023	2.126	1.108	4.081
Constant	28.956	1	.000	.140		

Note. Associations were established using binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10.

Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

Table 217 suggests variables that were associated with staff reporting behavioural stress reactions in the total hospital respondent group ($N = 280$). This model did not predict that a specific hospital type was more likely to experience significant behavioural stress reactions. The model therefore may predict that the variables associated with behavioural stress reactions would be applicable for all hospital types in this study.

In summary the model suggests that respondents reporting significant proportions of physical stress reactions may have been 2.045 times more likely to report behavioural stress reactions than those people not reporting significant proportions of physical stress reactions. Respondents reporting significant proportions of psychological stress reactions appeared have been 14.886 times more likely to report behavioural stress reactions than those people not reporting significant proportions of psychological stress reactions. Respondents reporting itchy or watery eyes appeared have been 2.063 times more likely to report behavioural stress reactions than those people not reporting itchy or watery eyes. Staff reporting concern regarding poor cleanliness in hospitals may have been 2.126 times more likely to have reported behavioural stress reactions than people who did not report poor hospital cleanliness. Variables included in this model predicted the outcome of behavioural stress reactions 79.3% correctly which suggests that there may have been other factors that contributed to behavioural stress reactions at the time of this study. Figure 13 describes the behavioural stress reaction model.

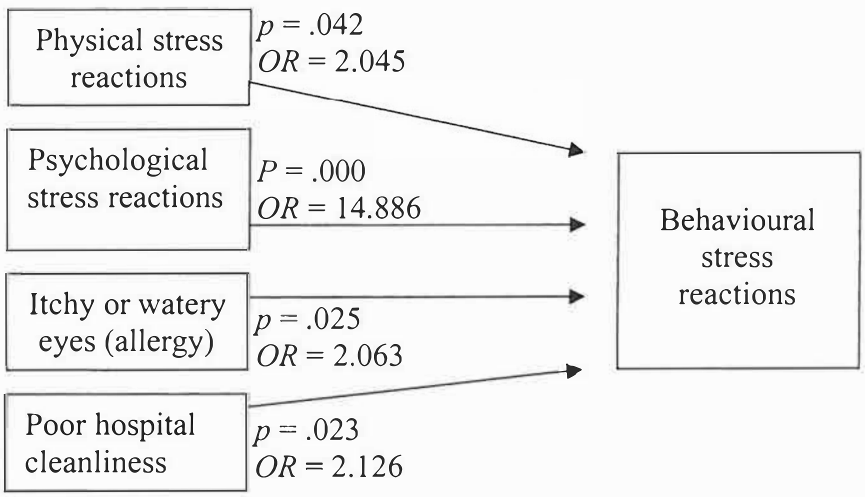

Figure 13. Behavioural stress model and associated variables ($N = 280$).

Proposed SBS model (N = 280)

For the binary outcome of SBS symptoms as opposed to none, the age group 50 to 61 years was used as a baseline for comparisons with the various respondent age groups. The "50 to 61 age group" was chosen as a baseline because this age group demonstrated the lowest proportions of reported stress reactions. From the univariate analysis, likely SBS influencing variables were selected. These were gender (female v. male), age groups (20 to

29 years, 30 to 39 years, 40 to 49 years and 50 to 61 years), job functions, hospitals divided into the three types, ventilation systems (air conditioning v. natural ventilation), carbon dioxide maximum (carbon dioxide levels 1000ppm and above v. carbon dioxide levels below 1000ppm), biopsychosocial stress reactions, behavioural stress reactions, physical stress reactions, psychological stress reactions, allergy, allergy worse at work, and fungal ratio between in and outdoor air.

The binary logistic regression model was completed in 9 steps. Table 218 summarises the final step.

Table 218

Binary logistic regression of SBS (N = 280)

					95% confidence interval	
	Wald	*df*	*Sig*	*OR*	Lower	Upper
Overall age effect	9.540	3	.023			
Age (20 to 29 yrs)	3.311	1	.069	2.093	.945	4.640
Age (30 to 39 yrs)	2.820	1	.093	1.924	.896	4.131
Age (40 to 49 yrs)	.403	1	.525	.763	.331	1.758
Physical reactions	14.491	1	.000	2.883	1.671	4.973
Allergy	7.216	1	.007	2.276	1.249	4.148
Carbon dioxide Max	3.366	1	.067	2.063	.952	4.473
Ventilation systems	3.589	1	.058	1.756	.981	3.145
Constant	8.401	1	.004	.306		

Note. Associations were established using binary logistic regression model using backward elimination based on the likelihood ratio tests with entry and removal probabilities of .05 and .10.

Significant associations $p < 0.05$; borderline association ≤ 0.07; not significant > 0.07.

Table 218 suggests variables associated with staff reporting SBS in the total hospital respondent group (*N* = 280). This model did not predict that respondents in a specific hospital type were more likely to experience SBS. It may be concluded that the data may be applicable to staff in all hospital types at the time of this current study.

In summary there was a borderline association between the 20 to 29 year age group and SBS. These results suggested that respondents in this age group were 2 times more likely to report SBS than the respondents in the other age groups. Staff reporting significant physical stress reactions were 2.88 times more likely to report SBS than staff not reporting significant physical stress reactions. Respondents reporting allergies were 2.276 times more likely to report SBS than those people without allergies. Carbon dioxide maximums and air conditioning ventilation systems both had borderline associations with SBS. These findings may suggest that respondents working in environments where carbon dioxide levels > 1000ppm were 2.06 times more likely to report SBS than people working in areas with lower carbon dioxide levels. Respondents working in air conditioned work areas may have been 3.589 times more likely to report SBS than people working in naturally ventilated work areas. Variables in this model predicted the outcome of SBS 70.7% correctly which suggests that there may have been other factors that contributed to SBS responses in the hospital environments at the time of this study. The model in figure 14 suggests variables associated with SBS in the hospital environments investigated at the time of this study.

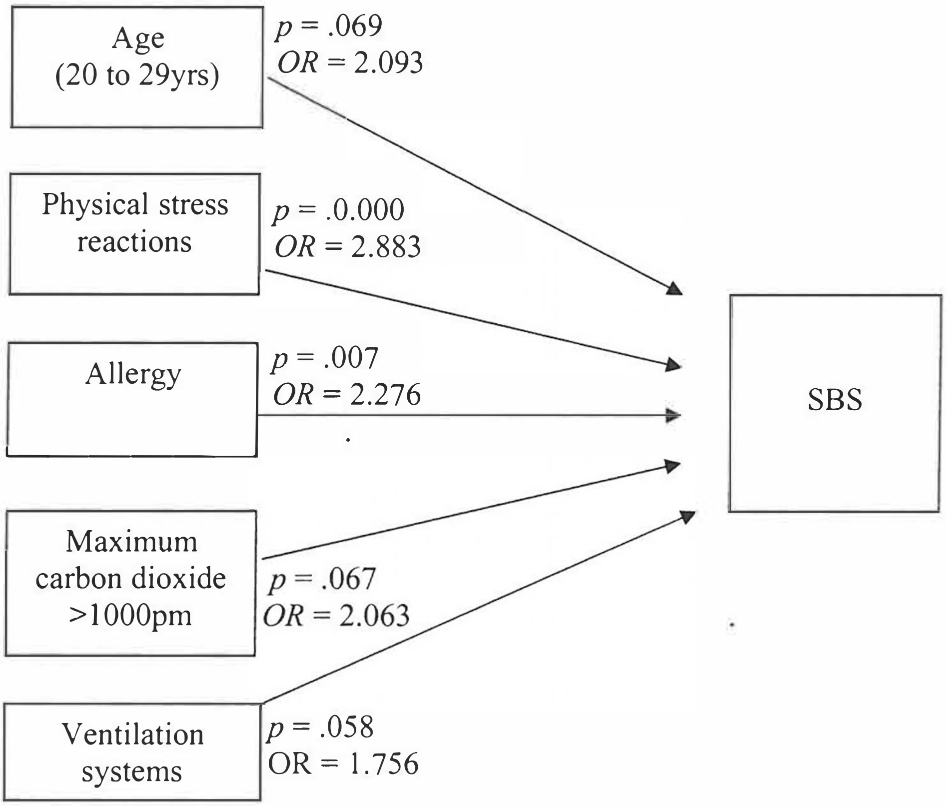

Figure 14. Proposed SBS model and associated variables (N = 280)

Conclusions and recommendations

Hypothesis testing

Hospital work environments may present many varying factors that adversely affect the staff. Berglund and Gunnarsson (1999) concluded that psychologically stressed people may be more sensitive to environmental issues. The current study highlighted indoor environmental conditions and person factors in hospitals that can cause staff discomfort and concern. The study proposes new multivariate allergy, stress reaction and SBS models. A multidisciplinary method of investigating potentially stressful issues in hospitals was developed and used. These processes may assist in promoting a better understanding of subtle effects of indoor environmental conditions and biopsychosocial stress reactions affecting certain hospital staff.

The following hypotheses were studied and will be reported on:

(a) It was hypothesised that hospital staff in provincial type hospitals would experience more biopsychosocial stress than hospital staff in missionary and private hospitals. More than 50% of all hospital staff would report that they were experiencing more biopsychosocial stress reactions.

(b) It was hypothesised that a greater proportion of Provincial hospital staff would express concerns about indoor environmental factors than hospital staff in the missionary and private hospitals. More than 50% of all hospital staff would be concerned about indoor environmental factors with more than 20% reporting SBS symptoms.

(c) It was hypothesised that air conditioning ventilation inlet and extraction outlets would be the main source of indoor fungi when compared to other surface fungal sources.

(d) It was hypothesised that certain viable fungi isolated from indoor hospital environment surfaces and hospital indoor air would be potential allergens, pathogenic (disease causing) or mycotoxin producing (immune suppressive and toxic) and would be a potential health concern to allergenic hospital staff.

Psychological stress reactions

Nursing staff in a missionary hospital commented that they were regularly moved around to different sections and many found this a concern. The second missionary hospital was undergoing investigations to reduce staff and this was causing concern to the workers. These observations may support the suggestion by the London Hazard Centre (1990) that people become tense when they are unable to control their work environment. A comment from provincial nursing staff was that staff absenteeism created additional demands on nurses. A CSSD nurse in a provincial hospital reported a noticeable decline in hospital cleaning and maintenance programs.

From the descriptive analysis of the biopsychosocial stress reactions of all hospital staff, it appears that the majority of hospital staff were reporting significant proportions of stress reactions. When comparing the individual hospital types (provincial, missionary and private), biopsychosocial stress reaction reporting was highest in missionary type hospitals. Furthermore, missionary hospital staff reported the highest proportion of physical stress reactions. Behavioural stress reaction scores appear to be reasonably similar between the three hospital groups. Psychological stress reactions were higher at the missionary hospitals. In all hospitals, extremely high maximum scores reported by hospital staff respondents may suggest that certain staff were not coping with stress. These findings appear to concur with reports by NIOSH (1988) and Schwam (1998) that hospital staff have to cope with stressful work situations. The findings may also concur with Schlebusch

(2000) who suggested that when an individual perceives a situation to be uncontrollable it contributes to stress and poor coping.

The multivariate models suggest priority intervention needs based on specific groups of respondents namely those predisposed to allergy and those reporting significant biopsychosocial stress reactions. The important items highlighted in these models were biopsychosocial stress, certain SBS symptoms, certain allergy reactions, hospital cleanliness issue, ventilation improvement needs, particle levels, stuffy air, presence of *Aspergillus* mould, females being more stressed, colds and asthma as health concerns, temperature variations and draughty air. This analysis may provide a means of focusing hospital maintenance resources and highlighting a need for management to consider making available stress reduction programs for their staff. The models attempt to explain interactions between environmental issues, individual reactions and psychological factors and suggest further insight into the complex interactions that take place in hospital indoor environments. This approach considers the recommendations by Berglund and Gunnarsson (1999) suggesting the need for broader based models to examine SBS. The findings of the current research tends to support the conclusions of the International Society of Indoor Air Quality and Climate (2000) that hospitals are complex environments, which necessitate ventilation for comfort and control of hazardous emissions for all occupants and visitors.

In conclusion, the SSCL was validated and found to be reliable and appeared to be a useful instrument to measure staff stress reactions in hospitals. Results suggested that >50%, of hospital staff were reporting significant proportions of stress reactions. However, the hypothesis that hospital staff in provincial type hospitals would experience more biopsychosocial stress than hospital staff in missionary and private hospitals did not hold true. The multivariate models did not predict that provincial hospital respondents were expressing more concern than the other two hospital respondent groups. However, the physical stress reaction multivariate model did predict that respondents in missionary hospital types might have been more prone to experience physical stress reactions than the other two hospital groups. The model suggests that the variables associated with physical stress reactions may have been of lesser concern to the provincial hospital group at the time of this study. Staff in missionary type hospitals may have been 3.332 times more likely to report physical stress reactions than staff in provincial or private hospitals. Respondents in private hospitals may have been 2.128 times more likely to report physical stress reactions than respondents not in private hospitals.

Indoor environmental factors

Concerns and lack of control by staff over their work environment needs consideration as people are becoming progressively more sensitised to the quality of their indoor air environment (Patterson, 1991). Hospital comfort appeared to be important to hospital staff. This is also considered in the light that work shifts ranged from 5 to 13 hours per day with the majority of hospital staff working a 5-day week. SBS symptoms that appeared to be of concern were lethargy, blocked nose and headaches. More than 20% of the total respondents reported these symptoms. It was interesting to note that the SBS multivariate data suggested that the 20 to 29 year age group were 2 times more likely to report SBS than respondents in other age groups. In the majority of hospitals under investigation, > 50% of staff reported concern about stuffy air, smelly air and temperature variation. Ninomura and Cohen (1999) suggested that odour is not something that a person can get used to. Considering that the majority of hospital staff that took part in the current study had worked for more than a year in their work places, the finding may concur with Ninonmura and Cohen findings. In a private hospital, these items appeared to be of a greater concern to the staff. When considering staff comfort concern in each of the nine sections studied in each hospital, it was revealed that provincial type hospitals had an overall higher percentage of staff that reported concern about temperatures being too hot. High humidity level appeared to be a concern for more than 50% of staff in all hospitals with a provincial and a missionary hospital reporting high concerns in all nine of the hospital sections. Stuffy air concern appeared to be of greater concern in both provincial hospitals and in a private hospital. Smelly air also appeared to be a concern in all sections in a provincial hospital and a private hospital. The researcher experienced odour conditions that were prevalent in the wards of a provincial hospital. These wards appeared extremely contaminated with mould. Inability to control comfort in a work environment was reported by many of the staff as being a concern. For example, feeling discomfort from temperature and having little or no control to change the situation or move out of the environment can, to a greater or lesser degree, impact on sensitive people. Aspects considered in this research were temperature, ventilation and lighting. Concern for poor lighting levels in private hospitals may be explained by the reliance on artificial lighting in many of the work areas as opposed to natural lighting in certain of the other hospitals. The two private hospitals reported concern regarding the lack of temperature and ventilation control, which tends to suggest a greater staff expectation on the part of private hospital staff to have better environmental control. This tendency would require further investigation as observation and indoor air measurements concluded that private hospital conditions in relation to these potential stressors appear better than the other hospital types. Staff reporting lack of cleanliness in hospitals was supported by the researcher's own observations in the two provincial hospitals which had the highest percentage of staff dissatisfaction followed by one of the missionary type hospitals.

Consideration was also given to ventilation maintenance and general maintenance issues in the hospitals. Staff reports highlighted ventilation maintenance as a concern. A missionary hospital and a private hospital reported higher general dissatisfaction regarding ventilation maintenance.

The comfort level measurement of relative humidity may be of the greatest concern as the standard of 60% relative humidity was exceeded in most sections of the hospitals investigated.

Particle counts were used to reinforce the need for effective cleaning/maintenance programs. Sections such as theatres, CSSDs, ICUs and wards may be important areas of concern for patients and allergenic staff. Regular particle counts should be undertaken in operating theatres to assist in assessing the need to improve these environments for health and safety purposes. Cleaning of the ventilation systems is considered important along with the elimination of water-damaged surfaces in hospitals. Kalliokoski et al. (2000) concluded that "Indoor air quality is more critical in hospitals and other health care facilities than in most other indoor environments. Nevertheless, its importance is not yet unanimously recognized" (p. 107). Staff concerns regarding indoor comfort and health issues in their work places seems to support Kalliokoski et al. (2000) statement, emphasising the need for focused interventions to be implemented.

In conclusion, according to Schlebusch (2000), the work environment may have an influence on stress at all levels of all job descriptions. Lazarus (1999) suggests that psychological stress is not only related to the environment itself and not just the result of personality characteristics, but may depend on a particular kind of person-environment relationship. This raises concern that more than 50% of hospital staff appeared to express dissatisfaction regarding their indoor environmental discomfort levels and SBS symptoms. Multivariate models relating to staff who were allergenic and/or reported a significant proportions of biopsychosocial stress reactions were associated with comfort and building related variables such as sick building syndrome symptoms, particle levels, temperature variation, ventilation improvement requests, allergy reactions and draughty air which may emphasise the importance of affective building maintenance programs. It was hypothesised that a greater proportion of provincial hospital staff would express concerns about indoor environmental factors than hospital staff in the missionary and private hospitals. However, this did not always hold true. The SBS multivariate model did not predict that respondents in a specific hospital type were more likely to experience SBS. It may be concluded that the findings in the SBS model may have been applicable to staff in all hospital types at the time of this current study. Results did indicate that > 50% of all hospital staff would be concerned about indoor environmental factors with more than 20% reporting SBS symptoms.

Ventilation systems as a source of indoor fungi

Fungal surface sampling produced viable fungal growth from ventilation inlets and outlets. In many cases the surface areas adjacent to the inlets and outlets were soiled and viable fungi were isolated from samples. Observations and sampling of mould confirmed that water-damaged surfaces, especially in the provincial type hospitals, were assessed as being > $3m^2$ in many sections. Surfaces apart from ventilation system surfaces where mould was isolated were ceilings, shelving, walls, carpets, wooden windows, damaged flooring, wood chips in plant pots and ceiling fans. Maintenance programs to remove mould were not evident in provincial and missionary type hospitals and even in certain sections of the private hospitals. The importance of maintaining buildings free of mould is reported in several studies (Garrett et al., 1998; Whillans, 1996; Must et al., 1996; Morey, 1996). They concluded that the impact of micro-organisms in buildings can be increased due to design problems, leakages, water damage and poor ventilation system maintenance.

In conclusion, ventilation systems were not considered the major source of surface fungi. However, mechanical ventilation systems contaminated with mould would assist in spreading fungal spores throughout these work environments.

Fungi in hospital environments as potential allergens, pathogens (disease causing) or mycotoxin producers (immune suppressive and toxic)

All hospitals had sources of mould as a result of various maintenance and hygiene issues. Fungal contaminated surface areas appeared to be more predominant in the provincial type hospitals. It was reported by staff at one of the provincial hospitals that a reason for lack of maintenance was that the hospital was to be replaced by a new facility. Even in the second provincial hospital it appeared that the maintenance and hygiene programs were not reducing dust build up and removing mouldy conditions. Staff at that provincial hospital confirmed that cleaning programs "were not what they should be." The main surface areas where mould was isolated included air conditioning inlets and outlets, ceilings, walls, fans shelving, sections of flooring, wooden windows, wood chips in plants and carpeting. The most predominant surface fungi isolated were: *Aspergillus flavus, A. ustus, A. niger, A. syndowii, A. trichoderma, A. ochraceus, A. versicolor, A. japonicus; Penicillium* species with the specific identification of *P. citrinum, P. chrysogenum; Fusarium* species; *Cladosporum herbarium; Rhizopus, Moneliella; Geotrichum candidum* and *Mucor.* Potential health symptoms related to these fungi are listed in Table 1 which describes their effects. Identified fungi in the indoor air were: *Cladosporium herbarum; Moneliella*; various *Penicillium spp* with the specific identification of *P. citrunum*; various *Fusarium spp*, *Rhizopus; Aspergillus ochraceus, A. flavus, A. trichoderma, A.ustus, A.versicolor, A. syndowii, A. niger; Geotrichum candidum.* These results may be seen as important as Bryant (2001) suggested that the common allergy provoking moulds in South

Africa include *Cladosporium, Aspergillus and Penicillium spp.* The current research findings agree with previous research in the Durban area which stated that the predominant fungi were *Aspergillus* and *Penicillium* (Gqaleni et al., 1998). Table 1 provides examples of fungal species and other allergens and their potential health effects. This information was acquired from a number of sources, namely Gill and Wozniak (1993), Nevalainen et al. (2000), Husman (2000), Smedbold et al. (2002), Smedbold et al. (2001), and Harrison (1999). This information suggested that many of the fungi isolated from indoor hospital environment surfaces and hospital indoor air were potential allergens, pathogenic (disease causing) or mycotoxin producing (immune suppressive and toxic).

A missionary hospital had the highest proportion of areas where indoor levels of viable fungi were greater than outdoor levels (i.e. 5 areas out of 9 areas sampled). A provincial hospital followed with 4 out of the 9 areas sampled being affected. The second provincial hospital, the second missionary hospital and a private hospital had two areas with higher indoor levels. The second private hospital had no higher indoor levels. These results also disproved the hypothesis that provincial hospitals may have the greater concerns.

The confirmed allergic responses were related to dust mite, cockroach and mould mix IV (*Penicillium* group). When combining allergic response and potential for allergy, dust mite allergy was the highest occurrence at 40%. According to Bryant (2001), house dust mites cause the most allergies in South Africa. Therefore the concern that hospital hygiene may have deteriorated in certain hospitals may result in an increase in allergy amongst staff and patients. This concern is further enphasised because dust mites are normally found in buildings and along with fungal contaminated surfaces. Cockroach was the second most important allergen with a 25% allergy potential. Allergy reactions to the three mould mixes ranged from 9% to 12%. These findings suggest that there may be a health issue in relation to allergenic hospital staff working in environments where an allergy potential exists.

The allergy issue in hospitals may have been broader based than only those allergens tested for. Results from the allergy questionnaire suggested that of the 123 staff surveyed 37% reported hay fever/allergic rhinitis, 37% with diagnosed sinus, 55% with itchy eyes, 36% with itchy ears, 33% with itchy roof of mouth and 41% with itchy throat. An allergy questionnaire was found to be a useful and inexpensive tool to screen for allergy sensitive staff. However, once the potential allergens are discovered through environmental surveys, allergy skin prick tests can better indicate the potential for specific staff allergic responses.

In conclusion, the current research followed the recommendation of Skoloks (1992) by attempting to analyse issues that may have concerned hospital respondents at the time of the study, both personally and collectively. The multivariate models developed from the current research did include factors such as ventilation system and SBS concerns that were listed in table 3 (see Table 2 of Stokols, 1992, for complete data). The hospital study suggests methodologies that established respondent concerns that may have required priority attention at the time of this study. Viable fungi were isolated from indoor hospital environment surfaces and hospital indoor air. Many of these were potential allergens, pathogenic (disease causing) or mycotoxin producing (immune suppressive and toxic). Allergenic hospital staff were located who may have been affected by the mouldy conditions that prevailed in certain areas of the hospitals in this investigation. In the 123-respondent allergy model, association between provincial hospitals and allergy was not significant. The data suggested that respondents in private hospitals appear approximately 4.896 times more likely to report that they are suffering from allergies than respondents not in private hospitals.

Recommendations to reduce hospital staff concerns

Hospital awareness of present findings

A summary of the findings of this research will be developed and forwarded to the participating hospitals to create awareness of the reported indoor environmental and psychological issues of concern that hospital staff reported. Scientific papers will be produced detailing the methodologies used.

Tobacco smoking

It appeared that that 49 (17.5%) of staff taking part in the current study were tobacco smokers. It is recommended that priority be given to assist hospital staff that smoke tobacco to stop smoking.

Indoor environment comfort and mouldy conditions

Hospital maintenance departments may use the summary of research findings from this research as a guide for improving environmental comfort and the removal of mouldy conditions from the work areas.

Staff psychological stress reactions

Consideration should be given by hospital management to investigate staff concerns with the view to introducing wellness programs for stressed employees. An emphasis should also be placed on the need to ensure that maintenance programs are effectively targeting priority indoor environmental staff concerns.

Recommendations for further research

Indoor environmental conditions and their impact on work performance in hospitals

The present research has shown that staff concerns do exist regarding the various indoor environmental conditions. However, an aspect that was not clarified in the current research was whether poor indoor environmental conditions had actually influenced hospital staff work performance. This may need further investigation.

Developing a data base of local prominent fungi

Establishing a database of local fungi is considered important as this would be a prerequisite for developing local allergens for skin prick tests.

Developing local allergens for skin prick tests

Developing fungal allergens based on local fungi would benefit mould research and possibly allergy intervention in the South African community.

Other hospital allergens and health issues

It was evident that other allergens may have been a concern in hospital environments. For example, the impact of rubber protective gloves may also require further investigation. It was interesting to note that the open-ended question reported only one health effect from protective gloves. However, certain nurses advised that in other provinces it was considered a concern. A staff member at a missionary hospital requested research to be conducted regarding the air quality safety in wards with tuberculosis patients. The present research suggests that staff in South African hospitals were reporting psychological stress reactions, asthma, SBS, sinusitis and rhinitis. This research has also confirmed the presence of mycotoxins producing fungi such as *Penicillium* and

Aspergillus. The SSCL screened staff for stress reactions such as memory loss, poor concentration, making unnecessary mistakes along with many other stress indicators which were found to be issues of concern. With these results in mind, it is important to consider recent research reported at the 5th International Conference on Bioaerosols, Fungi, Bacteria, Mycotoxins and Human Health. These findings are now summarised. Associations between toxic mould and cognitive impairments where findings were most pronounced in the area of memory (Gordon, Cantor, Charatz, Breeze, & Johanning, 2003). Remedial maintenance measures that reduced symptoms of respiratory infection, bronchitis, conjunctivitis, symptoms of allergic rhinitis helped to alleviate sick leave in teachers working in a moisture and mould damaged school (Patovirta et al., 2003). The results from a study of chronically ill patients exposed to toxigenic mould growth experiencing sick building syndrome concluded that "there is a systematic pro-inflammatory cytokine response to biologically produced neurotoxins made by indoor resident fungi that caused multiple symptoms and impairment in the central hypothalamic hormone pathways" (Shoemaker, Hundell, & House, 2003, p. 42). A potential association was found between toxigenic organisms discovered in water-damaged buildings and visual contrast sensitivity (Hudnell, House, & Shoemaker, 2003). A study by Singer (2003) concluded that a female worker who had worked in a mould-contaminated building for 10 years had elevated antibodies to the mould types present in her work environment. Singer, (2003) concluded that "neurobehavioural testing confirmed deficits consistent with neurotoxicity, such as in working memory, processing speed, executive function, and sensory-perceptual processes, supporting the concluding diagnoses of mould neurotoxicity" (p. 43). Furthermore, Kilburn (2003) demonstrated that mould problems were associated with reduced balance, reaction time, visual function and grip, increased blink latency and combined reduced cognition, recall memory, attention/concentration and long-term memory.

The current research and these findings provide important issues for further hospital research. Confirming these findings would have far reaching significance to South African hospital patient care and staff health in mould contaminated hospital environments.

Hospital staff smoking habit

Health impacts of tobacco smoking are well-documented (Stokols, 1992; Schlebusch, 1990; Behera, 2004; Gold, Naugle & Berry, 1993; Sextro, Reijula, Hyvärinen, 2000; Keepmedia, 2004, Chest X-ray, 2004; eMedicine Consumer Health, 2004; American Lung Association, 2004; Farrow & Samet, 1991; Yach, McIntyre, & Saloojee, 1992). This current research indicates that certain hospital staff were tobacco smokers. It may be worthwhile to investigate staff attitudes to the provision of a tobacco smoking intervention assistance program in hospitals.

Univariate results

Univariate table summaries provide a proportion of aspects that may require further clarification which supports the statement by the International Society of Indoor Air Quality and Climate (2000) that the hospital environment is complex.

In summary, this research focused on the importance of the hospital worker in the community. With completed and proposed future publications of research findings it is hoped that more attention will be given to the many environmental and psychological issues that may prevail in hospital work environments. This multidiscipline research will contribute towards improving hospital working conditions. The literature review and methodologies may be useful for future studies in South African and overseas hospitals.

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Appendixes

Appendix A

FROM: PROFESSOR L SCHLEBUSCH

TO: Hospital contact details

Dear ....,

Re: Stress and Mouldy Building Research Project by Anthony Shadwell under the supervision of Professor L Schlebusch, Department of Medically Applied Psychology, University of Natal.

Further to the telephonic communication between my student Anthony Shadwell and "contact person" on "day and date", I wish to confirm that we are conducting a multi-factorial study on stress and ill health associated with fungi, indoor environmental factors and personal factors in hospitals. The study requirements are as follows:

Psychological Questionnaire Survey

Willing staff would be requested to answer a stress questionnaire.

Building Maintenance Questionnaire

A questionnaire will also be administered to those persons/companies responsible for the maintenance of the air conditioning system and building maintenance.

Physical Sampling Program Procedures

A preliminary survey of premises to establish suitable sampling points which would take at least 2 hours.

The sampling time periods during the year would be during the warmer periods at the end of September, October, November and the beginning of December. One to two days per hospital would be necessary to complete surface and air samples. The sampling will not interfere with normal daily hospital procedures. It is hoped that sampling could be undertaken both during summer and the cooler period of the year.

Nature of the sampling:

- Fungal Air sampling using an Anderson Air Sampler - involves setting up an instrument in the various work areas for approximately 15 minutes and requires a plug point.
- Indoor Air Quality sampling - involves setting up instruments in the various work areas for approximately for at least 6 hours. The equipment will not hinder or disrupt any work operations. The instrument will require a plug point.
- Fungal surface swabbing of air conditioner ducting and water damaged surfaces. These are quick procedures and should not cause disruption to work and can be quickly accomplished.

All information obtained will be treated with the utmost confidentiality.

It would be greatly appreciated if you could assist by allowing Mr. Shadwell access to your hospital.

Yours faithfully,

L Schlebusch
PROFESSOR AND HEAD
DEPARTMENT OF MEDICALLY APPLIED PSYCHOLOGY
FACULTY OF MEDICINE
UNIVERSITY OF NATAL
DURBAN
SOUTH AFRICA

Appendix B

T Shadwell
C/O Faculty of Medicine
Department of Medically
Applied Psychology
Private Bag 7
Congella
4013
Phone: 0824951868 (wife's cell)
2666832 (h)

Office of the Medical Superintendent
Hospital Address details

Date

Dear Dr ....

Re: Research Project Tony Shadwell, File References

Further to my telephonic communication with your department on "Date" regarding the possibility of conducting a preliminary walk through survey of certain areas in "Name of Hospital".

This inspection would include areas such as the administration section, ICU, three general wards including the laundry and other related sections, pharmacy, CSSD area, kitchen and a theatre. The main focus is to look for areas of dampness, types of ventilation and their general condition and to gain a general impression of the ventilation performance and air quality.

Recently I have undertaken preliminary inspections at other hospitals with the infections control sisters; however, any staff member assisting me with the initial walk through would be greatly appreciated as I realize your staff are busy.

Should you require any further information please contact me at the above contact numbers.

Yours faithfully,

T Shadwell

Appendix C

THE STRESS SYMPTOM CHECKLIST

Make a ✓ if you experience the symptoms *often* (at least once a week or more), and an × if you experience it *sometimes* (less than weekly, but at least monthly). Do you experience:

PHYSICAL REACTION					
UNUSUAL TIREDNESS		HIGH BLOOD PRESSURE		UNEXPLAINED NAUSEA	
APATHY/LACK OF ENTHUSIASM		SEXUAL PROBLEMS		FREQUENT INDIGESTION	
BREATHLESSNESS FOR NO REASON		UNEXPLAINED HEADACHES\PAIN		ERRATIC BOWL FUNCTION	
FEELINGS THAT YOUR APPEARANCE HAS ALTERED FOR THE WORSE		FEELING FAINT OR UNUSUALLY WEAL FOR NO REASON		EXCESSIVE PERSIRATION FOR NO REASON	
DIFFICULTY IN RELAXING		MUSCLE TENSION		DIZZY SPELLS FOR NO REASON	
DISTURBING DREAMS/NIGHTMARES		FEELING PHYSICALLY UNWELL		FEELING TIGHT – CHESTED FOR NO REASON	
PSYCHOLOGICAL REACTIONS					
FEELINGS OF HELPLESSNESS		FEELINGS OF DISLIKING YOURSELF		FEELINGS THAT YOU ARE A FAILURE	
FEELINGS OF DEPRESSION		BEING AFRAID OF DISEASE		FEELING YOU CAN'T COPE	
FEELINGS THAT NO ONE UNDERSTANDS YOU		AN INCREASE IN COMPLAINTS ABOUT WHAT HAPPENS TO YOU		FEELINGS THAT OTHER PEOPLE DISLIKE YOU	
FEELINGS OF GENERAL ANXIOUSNESS		LOW SELF-ESTEEM/LOW OPINION OF YOURSELF		FEELINGS OF CONFUSION	
PHOBIAS(IRRATIONAL FEARS)		FEELINGS OF BEING GOSSIPED ABOUT		FEELINGS OF CONCERN MAINLY FOR YOURSELF	
AWKWARD FEELINGS WHEN CLOSE TO OTHERS		BEING OVER SELF-CRITICAL		FEELINGS OF FREQUENT CRITICISM	
FEELINGS THAT YOU HAVE FAILED IN YOUR ROLE AS A PARENT, SPOUSE, CHILD, EMPLOYEE, EMPLOYER		FEELINGS THAT NO ONE WANTS TO WORK WITH YOU		FEELINGS THAT YOU HAVE BEEN NEGLECTED OR LET DOWN	
PANICKY FEELINGS		FEELING TENSE AND KEYED-UP		FEELINGS OF LONELINESS AND NO ONE TO TALK TO	

BEING UPSET BY DISEASE IN OTHERS		PERSISTENT GUILT		A LACK OF SELF- CONFIDENCE	
BEHAVIOURAL REACTIONS					
MEMORY LOSS/ FORGETFULNESS		DIFFICULTY IN MAKINHG UP YOUR MIND		DISINTERST IN OTHER PEOPLE	
POOR LONG TERM PLANNING		DIFFICULTY IN SHOWING/EXPRESSING YOUR TRUE FEELINGS		SUPPRESSED OR UNEXPRESSED ANGER	
POOR CONCENTRATION		WORRYING		FEARFULNESS	
INCONSISTENCY		SOCIAL WITHDRAWAL		POOR DECISION MAKING	
INABILITY TO MEET DEADLINES		MAKING UNNECESSARY MISTAKES		UNCO-OPERATIVE RELATIONSHIPS	
POOR TIME MANAGEMENT		THE NEED TO REGULARLY WORK LATE		FEELING DISGRUNTLED/MOODY/ IRRITABLE	
PROCRASTINATION		POOR WORK QUALITY		EMOTIONAL OUTBURSTS	
THE NEED TO CONSTANTLY TAKE WORK HOME		DIFFICULTY IN COMPLETING ONE TASK BEFORE RUSHING ON TO THE NEXT		GREATER USE OF ALCOHOL, CAFFEINE, NICOTINE. MEDICINES TO COPE	
POOR PROBLEM SOLVING SKILLS		THE NEED TO CANCEL LEAVE		FIDGETING/RESTLESSNESS	
ACCIDENT – PRONENESS		NAILBITING		UNPREDICTABILITY	
LOW INTEREST IN WORK		AN EXCESSIVE APPETITE		A LOSS OF APPETITE	
A DROP IN PERSONAL STANDARDS		ENGAGING IN FREQUENT CRITICISM OF OTHERS		THE NEED TO CRY FOR NO REASON	
INCREASED AGGRESSIVENESS		FRANTIC BURSTS OF ENERGY		TICS/NERVOUS HABITS	
LACK OF INTEREST IN LIFE		LITTLE SENSE OF HUMOUR		SLEEP DISTURBANCES	

Rate the PRESENT INTENSITY of your stress somewhere along the scale below. Choose any number between lowest intensity (1) to highest intensity (10). Circle only one number along the scale below:

No stress ☺ — The most intense stress imaginable ☹

1 2 3 4 5 6 7 8 9 10

Appendix D

The Tension and Effort Stress Inventory (TESI): moods and emotions section.

Subject code: Sex______________ Age______________

Please give your answers by ***circling*** the appropriate figure.

Estimate here the degree to which you have experienced the following moods or emotions in everyday life over the ***last seven days.***

	Not at all Very much
Relaxation:	1-2-3-4-5-6-7-8-9-10
Anxiety:	1-2-3-4-5-6-7-8-9-10
Excitement:	1-2-3-4-5-6-7-8-9-10
Boredom:	1-2-3-4-5-6-7-8-9-10
Placidity:	1-2-3-4-5-6-7-8-9-10
Anger:	1-2-3-4-5-6-7-8-9-10
Provocativeness:	1-2-3-4-5-6-7-8-9-10
Sullenness:	1-2-3-4-5-6-7-8-9-10
Pride:	1-2-3-4-5-6-7-8-9-10
Humiliation:	1-2-3-4-5-6-7-8-9-10
Modesty:	1-2-3-4-5-6-7-8-9-10
Shame:	1-2-3-4-5-6-7-8-9-10
Gratitude:	1-2-3-4-5-6-7-8-9-10
Resentment:	1-2-3-4-5-6-7-8-9-10
Virtue:	1-2-3-4-5-6-7-8-9-10
Guilt:	1-2-3-4-5-6-7-8-9-10

Thank you

Designed 1987 by Sven Svebak, Department of Somatic Psychology, Arstadveien 21, N-5009 Bergen, Norway.

Appendix E

Ailments Questionnaire

Please give your answers by ***circling*** the appropriate figure.

Please estimate the degree to which you have experienced the following health conditions ***IN THE PAST TWO WEEKS.***

		Not at all very often
1	Difficulty in falling asleep	1-2-3-4-5-6-7-8-9-10
2	Difficulty in falling back to sleep after waking up late at night	1-2-3-4-5-6-7-8-9-10
3	Exhaustion	1-2-3-4-5-6-7-8-9-10
4	Getting tired quickly	1-2-3-4-5-6-7-8-9-10
5	Stomach upset	1-2-3-4-5-6-7-8-9-10
6	Itching without skin rash	1-2-3-4-5-6-7-8-9-10
7	Headaches	1-2-3-4-5-6-7-8-9-10
8	Heart pounding of palpitations	1-2-3-4-5-6-7-8-9-10
9	Feeling giddy	1-2-3-4-5-6-7-8-9-10
10	Breathlessness	1-2-3-4-5-6-7-8-9-10
11	Perspiring (e.g. from palms, not from physical exertion)	1-2-3-4-5-6-7-8-9-10
12	Voice disturbances (hoarse, clearing throat)	1-2-3-4-5-6-7-8-9-10
13	Muscle tension, especially neck and shoulders	1-2-3-4-5-6-7-8-9-10
14	Hands trembling	1-2-3-4-5-6-7-8-9-10
15	Lower back pains	1-2-3-4-5-6-7-8-9-10

Thank you

Developed by Hinton and Rotheiler (1987)

Appendix F

HOSPITAL ENVIRONMENTAL AND PERSONAL STRESS ASSESSMENT

This questionnaire relates to the environment in your hospital. It is being used as part of an evaluation of your working environment.

PLEASE ATTEMPT TO ANSWER ALL THE QUESTIONS. DO NOT TAKE TOO MUCH TIME OVER YOUR RESPONSES; JUST PROVIDE YOUR INITIAL RESPONSE.

Please note that neither this questionnaire nor any information from it will be given to your employer, except as averaged anonymous data.

IT IS IMPORTANT THAT YOU PROVIDE ONLY YOUR OWN OPINIONS, WITHOUT TALKING TO YOUR CO-WORKERS.

BIOGRAPHICAL DATA

Hospital ____________________ Address ______________________
Please write in Please write in

Please indicate your response with a tick in the non-shaded box.

Gender

Female	Male
1	2

Age

	Years

JOB DETAILS

Job ________________________________
Please write in

On which floor do you work? ___________________________
Please write in

In which room do you work for the majority of the time?

____
Please write in

Have you worked in this hospital for more than one year?

Yes	No
1	2

If less than a year, please indicate how may months. _______________
Please write in

Please describe your job function.

Clerical/Secretarial	1
Nursing	2
Doctor	3
Other	4

If you have indicated other please state your job function ___________
Please write in

One average, how many days do you spend at work? ____________
Please write in

On average, how many hours per day do you spend at work? _________
Please write in

On average, how many hours per week do you operate a VDU(computer) at work?

____
Please write in

How many people, including yourself, occupy the room where you spend most of your working day? _________
Please write in

Do you smoke while in the building?

Yes	No
1	2

Do others smoke while in the building?

Yes	No
1	2

LIFESTYLE ISSUE

Please note this question is relating only to whether you smoke tobacco and is not necessarily inquiring whether you smoke tobacco at work.

Do you smoke tobacco?

Yes	No
1	2

If yes, how many cigarettes do you smoke per day? ____________________
Please write in

Do you notice any ill effects from smoking?

Yes	No
1	2

If yes, please state the effect/s ____
Please write in

HEALTH ISSUES

Please indicate with a tick in the appropriate box which of the following medical conditions you may suffer from. Also indicate if you are presently taking medication for these conditions briefly describe your condition.

CONDITION	YES	NO	Medication: Are you taking any medication for allergies at present	Briefly describe your condition	Tick the relevant row if these conditions appear worse at work	How often did these ailments occur in the last 12 months?
Allergies (5)						
Asthma (6)						
Other Comments: **Please indicate in the appropriate columns**						
	1	2	3	4 a b c d e	(5) (6)	

How often do you experience colds and flu during the year? Please tick the relevant block.

	Never	**Once**	**Twice**	**Three times**	**Four times**	**Five or more**
Cold						
Influenza						
	0	1	2	3	4	5

PERSONAL WELL-BEING

The following questions ask about your general well-being **over the last 12 months.**

Please tick the box representing the answer to each question. If you are undecided about your answer to any question, then please tick "No" for that question.

In the past 12 months have you experienced the following symptoms **on more than two** occasions:

Dryness of the eyes

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Itchy or watery eyes

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Blocked or stuffy nose

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Runny nose

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Dry throat

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Lethargy and/or tiredness

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Headache

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

Dry, itchy or irritated skin

Yes	No
1	2

If "Yes" did the condition improve when away/out of the hospital?

Yes	No
1	2

If "Yes" how frequent was the symptom?

Every day spent at work	3-4 days each week	1-2 days each week	Every 2-3 weeks	Less often
1	2	3	4	5

OTHER SYMPTOMS

In the past 12 months have you had any other symptoms that you feel might be related to the indoor environment?

Yes	No
1	2

If "Yes" please indicate the symptom/s and describe the situation:

ENVIRONMENTAL COMFORT

Please could you assess your indoor working environmental conditions in both **SUMMER** and **WINTER**.

Describe typical conditions in the hospital in **SUMMER**. If you have not worked in the hospital in **SUMMER** then leave this question blank and go to the question about working conditions in winter.

Tick one box on scale from 1 to 7.

Temperature in summer

Comfortable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Uncomfortable**
Too hot	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Too cold**
Does not vary during the day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Varies during the day**

Air movement in summer

Too still	1	2	3	4	5	6	7	**Too draughty**

Air quality in summer

Dry	1	2	3	4	5	6	7	**Humid**
Fresh	1	2	3	4	5	6	7	**Stuffy**
Odourless	1	2	3	4	5	6	7	**Smelly**

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Lighting levels in summer

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Noise in summer

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Vibration in building in summer

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Comfort overall in summer

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Now please describe typical conditions in the hospital in WINTER. If you have not worked in the hospital in **WINTER** then leave this question blank and go on to the next question.

Tick one box **on scale from 1 to 7.**

Temperature in winter

Comfortable	1	2	3	4	5	6	7	**Uncomfortable**
Too hot	1	2	3	4	5	6	7	**Too cold**
Does not vary during the day	1	2	3	4	5	6	7	**Varies during the day**

Air movement in winter

Too still	1	2	3	4	5	6	7	**Too draughty**

Air quality in winter

Dry	1	2	3	4	5	6	7	**Humid**
Fresh	1	2	3	4	5	6	7	**Stuffy**
Odourless	1	2	3	4	5	6	7	**Smelly**
Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Lighting levels in winter

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Noise in winter

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Vibration in building in winter

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

Comfort overall in winter

Satisfactory overall	1	2	3	4	5	6	7	**Unsatisfactory overall**

OTHER ASPECTS OF YOUR WORK ENVIRONMENT

How much control do you have over the following aspects of your working environment?

Please tick one box on each of the following scales.

Temperature	None at all	1	2	3	4	5	6	7	Full control
Ventilation	None at all	1	2	3	4	5	6	7	Full control
Lighting	None at all	1	2	3	4	5	6	7	Full control

How would you describe the cleanliness of your hospital?

Satisfactory	1	2	3	4	5	6	7	Unsatisfactory

Have you or your colleagues ever made requests for improvements to heating, ventilation or air-conditioning in your hospital?

Please tick a box and give details.

Yes	No
1	2

Brief details

Please write in

If Yes, how satisfied were you?

Please tick one box on each scale.

Speed of response	Satisfactory	1	2	3	4	5	6	7	Unsatisfactory
Effectiveness of response	Satisfactory	1	2	3	4	5	6	7	Unsatisfactory

Have you or your colleagues ever made requests for improvements to other aspects of your hospital?
Please tick a box and give details.

Yes	No
1	2

Brief details ______________________________
Please write in

If Yes, how satisfied were you?
Please tick one box on each scale.

Speed of response	Satisfactory	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Unsatisfactory
Effectiveness of response	Satisfactory	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Unsatisfactory

---

Have internal alterations to your work area been undertaken during the past year?

Yes	No
1	2

If Yes, please describe______________________________

ANY OTHER COMMENTS ABOUT THE ENVIRONMENT

____

____

CONTACT DETAILS

Please print Name ________________Contact phone number ________________

Your name and all information will be kept confidential. The above details will assist should there be any queries regarding the completion of the questionnaire.

This questionnaire was developed using extracts from Raw GJ A questionnaire for studies of sick building syndrome. A Report of the Royal Society of Health Advisory Group on sick building syndrome. 1995. Modification included health issues other than sick building symptoms and the questionnaire was re-oriented specifically for hospitals.

VOLUNTARY ADDITIONAL INFORMATION

Are you aware of mouldy conditions in your home?

Yes	No
1	2

Which area are you residing in? (e.g. Morningside, Kloof)

____

How many members of your family live together with you? __________

How many of this immediate family experience allergies? __________

Appendix G

Allergy Questionnaire

Start Time ________ **Finish Time** ____________

Last Name **First Name** **Initial**

I General Information: Birth (month/day/year)

Date Sex *(circle one):* Male Female Hospital

II History:

1.Have you ever been told you have (had):

a.Hay fever or allergic rhinitis (stuffy nose when you do not have a cold) Y N
b.Asthma Y N
c.Exercise-induced asthma Y N

2.Do you **EVER** have the following symptoms:

a.Chest tightness Y N
b.Cough Y N
c.Wheezing Y N
d.Prolonged shortness of breath Y N
e.Skin rash Y N

3 Do cold air, smoke, fumes (perfumes. paints), dust or mould ever cause chest tightness or cough or wheezing? Y N

4.Do you frequently have "head colds" that end up with symptoms in your chest? Y N

5.Has your doctor ever diagnosed you with sinusitis? Y N

6.Does anyone in your family have asthma, hay fever or allergies? Y N
If yes, list who and describe briefly: ______________________________

7.Do you get itchy eyes? Ears? Roof of mouth? Throat?

If so, what months?
____________*____________*________________*____________*

8.Do you have a cold now or have you one in the last month? Y N

9.Have you ever missed work because of chest tightness or cough or wheezing or prolonged shortness of breath? Y N

10. Have you ever taken medication for asthma or allergy? Y N

11. Have you ever smoked? Y N
If yes are you a current smoker? Y N

12. Results of Allergy tests

+		**A**		**C**	
--		**P**			
M		**D**			

Appendix H

INDOOR ENVIRONMENTAL FACTORS AND PERSONAL FACTORS RESEARCH IN HOSPITALS.

Dear Staff Member,

I would firstly like to introduce myself. My name is Anthony Shadwell and I am undertaking a study of stress and ill health associated with fungi, indoor environmental factors and personal factors in hospitals.

The fact that your management has permitted me to conduct this research indicates their interest and concern for staff matters. I therefore hope that you will assist me with this questionnaire.

Please note that any information given by you will be treated as confidential and will only be used as part of a holistic statistical assessment. The data will be used towards my Doctorate Degree in Medical Science.

The questionnaire is designed to establish the psychological stress and evaluate perceptions of your working environment.

Should you be experiencing allergic reaction in your work environment you may wish to have a free allergy test to establish your potential allergic reactions on spores. Obviously, this is totally voluntary. The result of such a test would be made available to you and will be treated as confidential.

Please assist by answering all questions. However, should you not wish to participate or wish to withdraw at any time you will in no way suffer any disadvantage.

Thank you for your help in completing this questionnaire.

Anthony Shadwell