Stress and the sick building syndrome

Biopsychosocial Health-Related Variables Affecting Workers Employed in Urban Places where Live or Discotheque Musical Entertainment is provided

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ABSTRACT.

This is the first time that multidisciplinary research has been conducted in South African music venues. The study investigated biopsychosocial health-related variables affecting workers in music venues giving special attention to sick building syndrome. Monitoring methodologies developed for this investigation can be applied in studies of a wide range of workplace environments. This study also resulted in the design of a questionnaire which provided interpretable data within statistical significance limits. The literature review fully describes the multidisciplinary nature of this research.

Long established non-smoking offices were selected as controls. An environmental monitoring system was designed to record conditions whilst questionnaires on staff perceptions were personally administered. Psychosocial variables included job satisfaction, self-esteem, personal confidence and social interaction.

Environmental comfort assessments included lighting, carbon dioxide, temperature, relative humidity levels and air movement.

Pollution impact monitoring involved noise, respirable aerosols, benzene, toluene, xylene, benzo(a)pyrene, total volatile and semi-volatile organic compounds.

Comfort criteria were exceeded in all music venues which caused stress. Only 21,1% of respondents did not experience tiredness. Respiratory infection was higher in music venue staff than in office staff. Average age of staff in music venues was 25 years and 67,37% were smokers. Certain smokers were experiencing discomfort from tobacco smoke pollution. Tobacco smoke impact was demonstrated: mean benzene level for music venues was 12,9 μ/m^3 (maximum 42,44 μ/m^3) and in offices it was 0,606 μ/m^3 (maximum 1,24 μ/m^3).

Multivariate models for sick building syndrome and allergies included tobacco smoke odour concern and the tobacco smoke indicators, xylene and toluene. Aerosol levels were 1,75 mg/m^3 (maximum 45,98 mg/m^3) in music venues compared to an office mean of 0,02 mg/m^3 (maximum 0,58 mg/m^3). Contributors were tobacco smoke and theatrical smoke.

Burning eyes was the symptom causing most concern for 57,89% of respondents. Symptoms that affected 20% and more of the workers were itchy skin, throat irritation, coughing and difficulty in breathing. Tobacco smoke was considered the main stressor.

Noise level mean for music venues was N_{eq} 99,67 dB(A). Only 34,7% of the staff considered music noise a stressor, with 16,9% concerned about people noise.

The percentage that considered their environment to be polluted was 81,06%, however, only 48,42% felt stressed. Virtually all univariate and multivariate associations between psychosocial and psychophysical variables suggest that satisfaction with psychosocial factors may have a positive influence on staff in places of entertainment.

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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 research described in this thesis was carried out in the Department of Medically Applied Psychology under the supervision of Professor L Schlebusch, Professor and Head of the Department of Medically Applied Psychology at the University of Natal Medical School Durban and under the co-supervision of Doctor W C A van Niekerk, Senior Consulting Scientist at the Atomic Energy Corporation of South Africa, Limited, Pretoria.

The project was inspired by the researcher's own personal experiences of stress and ill health when regularly playing live music in smoky venues, in addition to a normal day-time occupation. Furthermore, from enquiries during 1991 it appeared that research into worker stress in places where musical entertainment is provided had not been carried out in South Africa (R Truter, R Griffin and J Saloojee, personal communications). The importance of this type of research is highlighted by the extract from Schlebusch, (1990, p 47), that "destructive lifestyle-induced diseases have been identified as a matter of priority in South Africa". The researcher believes that places of musical entertainment have many stressors. Workers employed therein perhaps are exposed to more stressful events than in many other non-industrial environments. "The biopsychosocial model is the most comprehensive model to date of health and disease" (Schlebusch 1990, p 287). The researcher follows the theory that human functioning is viewed as an interaction of biological, psychological and social factors, as suggested by Schlebusch (1990).

Observation whilst conducting this project suggested that young people employed in these environments were not only exposed to poor indoor air quality but also to immoral and hostile behaviours. At one of the premises a group of male patrons were involved in sexual activities with a female patron at one of the tables near the dance floor. At another venue a striptease competition for female patrons was observed where female contestants were being fondled by males patrons. The owner of a place of entertainment remarked that certain patrons were satanist. Many of the youth in this venue were observed wearing black clothing and females were wearing black lipstick. A regular occurrence was the throwing of beer bottles against walls for no apparent reason.

These psychosocial behaviours would normally not occur in other places of work. It should be acknowledged that such behaviours would contribute to worker stress. In addition, staff also have to cope with psychophysical stress due to excessive smoking and other indoor air pollution effects.

This thesis deals with an investigation into stress factors in places of musical entertainment.

Plate 1 Hazy conditions due to tobacco smoke in a crowded place of musical entertainment.

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GLOSSARY

ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
C	Celsius
Chemicals	Available health affects data on chemical substances found in the indoor air of places of musical entertainment will be provided in section 4.1.5.4
dB(A)	A weighted decibels
DJ	Disk-jockey
EPA	Environmental Protection Agency of the United States of America
ETS	Environmental tobacco smoke
eV	Electron volts
GC	Gas chromatography
GC-FID	Gas chromatography and a flame ionisation detector
GC-MS	Gas chromatography and mass spectrometry
h	Hours
ℓ	Litres
L_{Aeq}	The value of continuous A-weighted sound pressure level, in decibels, that is representative of the instantaneous A-weighted sound pressure levels measured throughout a specific time interval
ℓ/minute	Litre per minute
lx	Lux
mg	Milligram
mg/m^3	Milligram per cubic meter
MIE	Monitoring Instruments for the Environment Inc
mℓ	Millilitre

mm	Millimetre
m/s	Meter per second
MS smoke	Mainstream smoke
NBS	National Bureau of Standards
ng	Nanogram
N_{eq}	The value of the impulse corrected equivalent continuous A-weighted sound pressure level, in decibels, that is representative of the noise environment during the working hours of a typical working week during a period of employment
$n\ell$	Nanolitre
NIOSH	National Institute for Occupational Safety and Health of the United States of America
Personal communications	Details of individuals interviewed are provided at the end of Chapter 6 under the heading of "VARIA"
ppm	Parts per million
p-values	Probability values
RH	Relative humidity
SABS	South African Bureau of Standards
SBS	Sick Building Syndrome
SD	Standard deviation
SS smoke	Sidestream smoke
Statistical tests	The various statistical tests used to analyse data in this research are discussed in section 3.5
μg	Microgram
$\mu\ell$	Microlitre
$\mu g/m^3$	Micrograms per cubic meter

CHAPTER 1
INTRODUCTION

1.1 PURPOSE OF THE RESEARCH

Since the mid-1970's many investigations of building associated complaints and illnesses have been undertaken in North America and Europe in response to occupants' health complaints (London Hazard Centre 1990, Report of the Interministerial Committee on Indoor Air Quality 1988 and Burton 1991a). It has been reported by the London Hazard Centre (1990), that these problems were exacerbated by concerted efforts to minimize building energy use through reducing fresh air ventilation rates and increasing the operational comfort ranges for acceptable temperature and humidity in air-conditioned and mechanically-ventilated buildings.

Many researchers have concluded that health complaints are directly related to prevailing internal environmental conditions such as temperature, relative humidity, air movement, gas and particulates from building materials, tobacco smoke, and infiltration of outside pollutants concentrating in these buildings. Health complaints include chest tightness, breathing difficulty, flu-like symptoms, runny nose, itchy eyes, dry throat, stuffy nose, headache and lethargy (Burge 1991). The term describing these symptoms is *sick building syndrome*.

When poor indoor air quality occurs there may be psychological involvement (Burton 1991a). Concern with the physical environment of humans is a recent development in the social sciences and greater attention should be paid to the complexities of environments created by people (Viljoen 1987). People may become tense and anxious if they cannot control their environment, which can take its toll psychologically (The London Hazard Centre 1990).

Physical and chemical stressors can also increase vulnerability to stress/strain. Carbon monoxide exposure, which is associated with tobacco smoke, has neurotoxic effects (Beard and Grandstaff 1970). Its psychological effects are due to the lack of oxygen in the central nervous system and can result in fatigue, lack of mental energy, irritability and difficulty in concentrating. Research in the United States shows that the major causes of death are heart disease, malignant neoplasms and stroke (Matarazzo 1984). Risk factors include stress, hypertension and cholesterol. For each disease a common associated risk factor is **smoking** and in the case of malignant neoplasms, work-site carcinogens are considered as contributors. Matarazzo (1984) concludes that "these major causes of death are all ones in which behaviourial pathogens, personal habits and lifestyle behaviours of the individual, not external pathogens of earlier epochs in human history, are the single most important etiological factor" (p 7).

Viljoen (1987), advises that environmental psychologists believe that a full comprehension of human functioning demands a holistic approach in terms of which the individual and the total environment are seen as interrelated parts of an indivisible whole.

This research has been designed to screen conditions in environments of musical entertainment and to establish worker perceptions of the various biopsychosocial health-related variables which have the potential to cause stress/strain in workers. The following framework was considered to assess worker stress/strain:

- The lifestyle and personal habits of smoking of workers in crowded places of musical entertainment may not be conducive to psychological health and ultimately, physical health.

- Carcinogenic substances may be present in the indoor air of the majority of these premises which may be at higher levels than in non-smoking environments.

- The majority of staff may be dissatisfied with environmental conditions in their working environment because of the stress/strain they cause.

- Ventilation systems may not cope adequately in reducing indoor air pollution and ensuring comfort during crowded periods.

- Sick building syndrome symptoms may be experienced by the majority of workers.

It has been the object of this research to promote a better understanding and awareness of the psychological and physiological stressors of persons employed in musical entertainment venues. Alerting professionals such as health psychologists, other health specialists, architects, authorities and the public to the harmful lifestyle and health effects for persons working in these environments has been considered important. This project has investigated the need for changes in approach to methods of evaluating ventilation adequacy and the design of appropriate standards in South Africa. It has led to the highlighting of the need for a more pro-active role by local authorities and the medical profession in relation to reduction of cigarette smoking in the workplace.

1.2 SCOPE OF RESEARCH

The research focused on worker smoking habits and assumed that carcinogen levels are useful indicators of potential health risks and stress in places of musical entertainment.

Apart from ear damage, neuroticism and anxiety can be characteristics of those working under noisy conditions (Hassall and Zaveri 1979). Those exposed to impulsive noise can have difficulty in concentrating on their work and can feel that the noises are distractive (London Hazard Centre 1990). The experience of stress/strain may come about because the noise creates continual interruptions which hinder task performance, or it could be that the person feels unable to regulate the noise level and experiences stress because of feelings of helplessness (Viljoen 1987). Workers exposed to loud music may or may not perceive it to be a stressor in South African places of musical entertainment. It is also considered important in the assessment to establish whether workers in places of musical entertainment consider loud music to be a stressor and are taking precautions against loud noise exposure.

Other environmental stressors have been monitored. These include the screening of certain aspects of worker lifestyle, such as: **interpersonal relationships with management, co-workers and the public, job satisfaction and worker perception of their occupational environmental conditions**.

The programme was designed to screen fifteen places of entertainment and five long established non-smoking offices as control areas. A broad outline of the scope of the research and limitations are presented in Table 1 on the following page.

Table 1 Scope of the research

Stressors	Stress/strain indicators
Ventilation performance and comfort	carbon dioxide; temperature; relative humidity; air movement.
Specific indoor pollutants chosen	benzene; xylene; toluene; benzo(a)pyrene; respirable particulates; carbon dioxide.
Screening of various volatile and semi-volatile pollutants	comparison of various chemicals found in a place of entertainment and in an office.
Ergonomic factors	lighting levels; psychedelic lighting.
Noise	time weighted average levels.
Theatrical smoke	establishing its influence on benzene, xylene, toluene and particulate levels
Psychosocial variables	interpersonal relationships with management, co-workers and the public; job satisfaction; tobacco smoke.
Sick building syndrome	physical symptoms; odours and comfort.

1.3 GENERAL LIMITATIONS OF THE RESEARCH

Microbial air sampling was not included in this research as the focus area of this research was chemical analysis of the indoor air. Furthermore, the number of experiments and samples had to be limited for practical and economic reasons. All potential psychosocial variables were not included due to time constraints for questioning respondents in these busy environments.

CHAPTER 2
REVIEW OF LITERATURE

2.1 SEARCH BASIS

The overall objective was to draw together the threads of multidisciplinary research that may have been carried out in places of entertainment. Data bases included Medline, Sabinet and Dialog Information Services, Inc.

The following searches were conducted though Sabinet and Dialog Information Services, Inc. The first search was conducted for the purpose of acquiring general information on research that has been conducted on sick building syndrome and stress. The following key words were used for the Sabinet and Dialog Information Services searches: *sick/tight building syndrome/ventilation and office, psychological stress, worker/employee attitude*. Limited information was acquired in two additional searches when stressor key words were linked to the types of premises. The key words included: *volatile organic compounds, carbon dioxide, nitrogen dioxide, carbon monoxide, dust, tobacco smoke, noise level, indoor air quality, sick building syndrome, effects on health and comfort, chest tightness, breathing difficulty, flu like symptoms, runny nose, blocked nose, headaches, lethargy, burning eyes, itching skin, health complaints, air conditioning, worker perceptions*. This search was more focused in relation to the research project and the stressors and stress/strain key words were linked with venue titles such as *pubs, bars and public house*. The final search using medline was considered the most useful. The key words for the venue types included : *places of entertainment, discotheque, bars, pubs, music venues, restaurants, rock music, techno-music and pop music*. Limited information was acquired when linking venue types to stressors. It was decided to focus on the stressor key words and screen the literature for relevant information.

The list of appropriate key words were:

- *Biopsychosocial factors: biopsychosocial, psychosocial, lifestyle, stress, job stress, job satisfaction.*
- *Noise: hearing damage, noise levels, ear damage, stress.*
- *Smoking: risk taking behaviour, smoking, passive smoking, tobacco smoking control.*
- *Air pollutants: aerosols, particulates, respirable particulates, carcinogens, benzo(a)pyrene, benzene, xylene, toluene.*
- *Lighting: lighting, flashing lights.*
- *Sick building syndrome: building-related diseases, indoor air quality, ventilation, indoor environment, work-related illness.*

2.2 SCOPE OF INFORMATION

The literature search included books, journals, magazines and newspapers. It included the ongoing debate on health effects in relation to tobacco smoke. Although the research was to focus on tobacco smoke as the major contributor to air pollution in these environments, the research revealed that workers were being exposed to theatrical smoke in certain of the premises which was believed to be more of a nuisance than tobacco smoke. The use of theatrical smoke and its effects is an area that should require further research and is outside the scope of this project.

2.3 RELEVANCE TO THE RESEARCH PROJECT

2.3.1 Introduction

It is evident that although much research has been carried out on noise in places of musical entertainment, limited comprehensive studies of the total potential impact of various stressors in places of musical entertainment have been done. Morrow (1992) reported that limited comprehensively-designed studies of sick building syndrome have been conducted. However, a study of this nature is an arduous task. It includes input from occupational medicine, occupational hygiene, engineering, epidemiology and psychology. Although there are many common psychological, environmental and occupational/organisational factors in various working environments, it is important that models be devised for each type of environment, as has been done for offices by Hedge et al. (1987).

It would appear that mostly young persons work in places of entertainment, who seem to accept the environmental conditions in which they work. The question whether the majority of these workers experience adverse effects from stressors in the South African places of entertainment needs to be answered. This research aims to establish the main stressors of concern in these environments. Scherer et al. (1991) conclude that instead of applying perceptions of stressful stimuli, it is better to allow staff in the workplace to identify the stressors by having the workers write a short narrative of their most stressful encounters. The more comprehensive approach outlined in this thesis is based on a combination of personal experiences, discussions with workers in places of entertainment and a review of literature on stressors in the various environment types.

Hagihara and Morimoto (1991) advise that in Japan the incorporation of the legal right to clean air in public places has progressed concurrently with medical findings regarding the harmful effects of involuntary smoking. Hence it is important to investigate conditions in South African environments for public awareness which could raise the level of demand for clean air in our public places. Lambert et al. (1993) studied respirable particles and nicotine vapours in smoking and non-smoking areas of restaurants. The results indicated higher levels in the smoking sections. However, the research did not establish subjective assessments by the staff or the patrons regarding the acceptability or non-acceptability of conditions.

Sebben et al. (1977) established a carbon monoxide level as an indicator of cigarette smoke accumulation and recognised that symptoms in non-smokers can occur at low level concentrations of pollutants. It is not clear from the report how symptoms experienced by the people were established and clarity on symptoms was not adequately reported. Although the research recognised the effect of particulate matter on non-smokers, it did not include an assessment of particulate levels concurrently with carbon monoxide levels. NIOSH (1991) published a useful document which highlighted the effects of tobacco smoke on smokers and non-smokers in relation to cancer.

The conditions in South African places of entertainment regarding smoking habits, indoor air quality and worker perceptions of the various stressors have yet to be established. The following sections provide more information on the potential stressors or stressor groups.

2.3.2 Loud music: noise

2.3.2.1 Early literature

Literature reviewed were limited to the potential effects of loud music on those persons frequenting noisy venues. South African Bureau of Standards (1983) defines noise as "the undesirable sound to which an individual is exposed" (p 6). However, noise may not always be considered as undesirable.

West and Evans (1990) described amplified music as an exposure to "leisure noise" (p 89). Ostri et al. (1989) stated that "classical music is most frequently wanted sound listened to with pleasure and cannot be compared to industrial noise causing permanent noise-induced hearing loss however it may induce damage to the inner ear" (p 243). Therefore, as the subjective response of the worker/listener to loud leisure noise such as music is that it is acceptable, then there is a potential for hearing loss as little attempt will be made voluntarily to protect the hearing mechanism. Loud music acceptable to the listener could therefore be defined as *a leisure noise having intensity, duration and spectral content that may induce damage to the inner ear resulting in hearing impairment to a minor or major extent depending on the individual susceptibility and the listener's attitude to the noise.* This definition is based on personal ideas and impressions from the research reports by West and Evans (1990) and Ostri et al. (1989).

2.3.2.2 Measuring techniques for assessing noise impact

Methodologies of assessing noise impact have been based on measuring actual noise levels and undertaking audiometric tests on people exposed to the noise. Patrons that regularly attend musical entertainment venues may experience maximum loss of hearing in the speech frequency range (Fearn 1973). Apart from measuring noise levels it is also considered important to establish whether noise in these environments is proving to be a psychological stressors for the staff employed there and whether the workers are concerned enough regarding hearing loss potential to protect their hearing. Shirreffs (1974) concluded that noisy entertainment venues do cause permanent hearing loss. This conclusion was reinforced by Bohne et al. (1976) who demonstrated through animal experiments that loud music alone can result in hearing loss. This was reaffirmed by later research conducted by Drake-Lee (1992), where he stated that there is a "small but definite risk of developing noise damage with sensorineural hearing loss and tinnitus in rock musicians, especially when the music is played loud" (p 618). The awareness of the dangers of noise in places of entertainment lead to codes of practice being designed in the United Kingdom to reduce the impact on workers and the public. However, difficulties were envisaged regarding the practical implementation of the extensive application of these ideas (Anonymous, 1988). A study by West and Evans (1990) suggested that young music listeners, who experience temporary threshold shift or tinnitus following exposure to music, should modify their listening habits. Tan et al. (1990) suggest in their research that discotheques should be included as hazard areas as in the case of noisy industrial environments. They were unable to interview workers regarding the noisy conditions and could not undertake audiometric tests in the environments surveyed.

2.3.2.3 Noise and music: the relationship

From 1989 onwards there appeared to be an interest in establishing and comparing the effects that noise had on orchestral musicians and rock musicians. A study by Roster et al. (1991) also recognised that music cannot always be considered as unwanted sound as in the case of industrial noise, although the intensity, duration and spectral content can prove just as damaging. Lifestyle deterioration in the social life of musicians due to hearing deterioration was reported in research by Ostri et al. (1989). Sataloff (1991) suggested that musicians and singers should take precautions to avoid over exposure and that methods to conserve hearing among performing artists without interfering with performance could be devised. A study by Bergomi et al. (1991) of the biological response to noise and other physical stressors indicated that physical stressors and, particularly noise, may be related to a marked activation of the neuroendocrine system and impairment of some sensory functions in a group of volunteer students.

However, it is not clear how such conditions as crowded environments, smoking or passive smoking effects, discomfort from temperature and humidity were discounted, as these might have had a similar effect on the students.

Soffer (1991) recognised that people less than 35 years old tend to insist on loud music which for the listener trying to communicate, will probably result in laryngitis. Data from the USA indicate that a reading of > 90 "A" weighted decibel level (dB(A)), was the borderline between a safe and a dangerous noise exposure (Clark 1991). However, in South Africa the standard is 85 dB(A) (South African Bureau of Standards, 1983).

Henderson et al. (1993) considered that exposure to noise levels of 85 dB(A) or higher over a period of time poses a risk of developing noise-induced hearing loss, which agrees with the level stated in the South African Bureau of Standards 083-1983.

Clark (1991) reviewed literature and reported that the geometric mean of a number of studies from 1968 to 1986 indicated a level of 103,4 dB(A) for places of musical entertainment. He also reported that workers exposed to these levels on a daily basis may be presented with a real risk of hearing loss. Clark (1991) also summarised the findings of previous reports which explained why young people tolerate noisy environments. However, the document does not establish whether the youth and workers in these environments actually cope with adverse environmental conditions and whether an improvement in the environmental conditions would be desired.

2.3.2.4 Non-auditory agents

None of the former documented research papers discussed the possible influence of non-auditory agents on hearing loss. According to Rybak (1992) recent clinical and experimental studies have identified a number of chemical agents that are commercial products, chemical intermediates, waste products or contaminates that can effect hearing. Rybak (1992) reports that almost half of the workers exposed to synthetic varnishes containing benzene, toluene, styrene, xylene and butyl acetate in the presence of noise experienced additive or synergistic hearing loss. Places of entertainment are normally contaminated with noise and tobacco smoke. Tobacco smoke contains benzene and toluene (Burns 1991). However the synergistic effect with noise may be insignificant as the levels may be too low to have any effect on the hearing of non-smokers. Henderson et al. (1993) reported that rats exposed to toluene (1000 ppm, 16 hours per day, 5 days per week for 2 weeks) and then to noise (100dB(A) L_{eq}, 10 hours per day, 7 days per week for 4 weeks) demonstrated greater hearing loss than those exposed to noise alone. Reversal of levels in order of exposure resulted in no interaction between the two agents. Long-term studies are required to conclusively establish whether lower levels of carbon monoxide, toluene and benzene in sidestream smoke in combination with high noise levels will have no effect on hearing loss of non-smokers in places of entertainment.

Henderson et al. (1993) reported that ship painters exposed to both toluene and high-frequency noise incurred greater hearing loss than from noise alone. Although the relationship between smoking and hearing loss is difficult to establish, it has been shown that smoking produces a higher increase in permanent threshold shift in populations of workers. Literature on noise-induced hearing loss suggests that future studies on noise should include data on uncontrolled chemical agents. Considerations may also have to be given by authorities to include non-auditory factors when assessing potential percentage risk due to the effects of noise as outlined in South African Bureau of Standards 083-1983.

As these stressors are present in places of entertainment it is considered necessary to include information on smoking habits to provide a more comprehensive assessment of the potential of noise as a stressor.

2.3.2.5 Concerns amongst workers in places of musical entertainment

Workers in these places are exposed to high noise levels due to amplified music and people noise. This threat may not be limited to the musicians and disk-jockeys. Bar attendants and waiters who are constantly in the work environment are also exposed. Data collection by observation provided a useful method of assessing worker concern regarding the effects of high noise levels. The assessment was based on whether workers, disk-jockeys and musicians wear hearing protection as is being done by some of their overseas counterparts, as reported by Sataloff (1991). Also it was considered important to include ways of reducing exposure in places of entertainment, that would facilitate reduction of risks in these environments.

2.3.2.6 Education

Shirreffs (1974) raised the important issue of education of students regarding exposure to recreational noise. Shirreffs (1974) also recognised the individual differences in response to noise, both psychologically and personal susceptibility to hearing loss. It was therefore considered vital to establish the general attitude and coping ability of workers to noise as an indication of how a programme for noise conservation should be designed for South African places of entertainment.

Establishing noise levels and worker perceptions of noise were considered as important indicators of worker stress/strain.

2.3.3 Lighting: lighting levels and psychedelic lights

Only one study relating to noise and other physical stressors, which included flashing lights, in places of entertainment was acquired (Bergomi et al. 1991). Knowledge of the non-auditory effects of noise, and the biological effects of vibration and psychedelic lights on people attending places of entertainment is limited. Increased blood pressure, heart rates and increased urinary hormone levels of norepinephrine and cortisol were observed in a group of volunteers after exposures to discotheque stressors which resulted in impairment in visual performance (Bergomi et al. 1991). Although the volunteers were told not to drink, it is not stated whether any of the group were smokers and told not to smoke at the discotheque. This is important as smoking causes a rise in blood pressure (Burns 1991). Conversely, apart from noise and lighting effects, if the volunteers were non-smokers, the effect of ETS may have had significant physical and mental impact through sick building syndrome symptoms. Furthermore, eye irritation through tobacco smoke, and tiredness should have also been considered in relation to safety and accidents, before assuming that the major stressors in places of entertainment are noise and lighting.

This research emphasises the importance of establishing worker perceptions of holistic environmental conditions, as job requirements restrict their movements in and out of an environment which is potentially stressful. Psychedelic lighting in a crowded environment can make certain activities more difficult. It would be important to consider the job design of waiters as moving through an area carrying drinks could be a potential hazard and eventually may prove stressful.

Lighting levels at strategic work stations and the subjective assessment by workers of psychedelic lights were considered as stress/strain indicators.

2.3.4 Air pollutants in public places

Today concern centres on domestic air pollution, especially passive smoking and radon (Higginson 1993). Sterling et al. (1982) provided a review of literature on research carried out on indoor air where the byproducts of tobacco smoke were investigated. From this it is evident that one of the main stressors in places of entertainment would be tobacco smoke. Researchers have used various markers of environmental tobacco smoke (ETS), for example, carbon monoxide, nitrogen dioxide, nicotine, respirable particles, saliva cotinine, benzene, formaldehyde, acetaldehyde, toluene, ethylbenzene, *m.p*-Xylene, *p*-Xylene, benzo(a)pyrene, acrolein and *N*-nitrosamine. However, no single compound has been found to represent ETS exposure reliably or to estimate accurately the disease-causing potential of ETS (Gold et al. 1993).

2.3.5 Smoking habits in places of entertainment

As mentioned in the introduction, specific research documents on places of musical entertainment covering all the stressors relevant to this research could not be located. However, literature on studies specifically on smoking in restaurants, bars, and offices were reviewed.

2.3.5.1 Health risks from tobacco smoke

In 1964 the Surgeon General of America concluded that "cigarette smoke causes lung cancer in smokers" (NIOSH 1991, p 11). Furthermore, additional research on the toxicity and carcinogenicity of tobacco smoke has demonstrated that the risks from inhaling tobacco smoke are not limited to smokers, but also include those who inhale environmental tobacco smoke (NIOSH 1991). Environmental tobacco smoke (ETS) is the term that describes air contaminants generated from the smoking of tobacco (Burton 1991a). Gold et al. (1993) describe ETS as a combination of diluted sidestream smoke (SS) released into the air from the cigarette's burning end, and mainstream smoke (MS), smoke exhaled by the active smoker. Mainstream smoke includes some volatile components that diffuse through cigarette paper. More than 4500 compounds have been identified in the vapour and particulate phases of tobacco aerosols, of which sixty are known or suspected human carcinogens (Gold et al. 1993). A study by the U S Environmental Protection Agency

(EPA) has concluded that environmental tobacco smoke is a Class A human carcinogen (Kogan 1993). Strict limiting of exposure to a Class A human carcinogen should be observed (American Conference of Governmental Industrial Hygienists 1989).

Farrow and Samet (1991) reported on the identification of the high-risk smoker in relation to factors that increase the smoker's susceptibility to cardiovascular, cancer and nonmalignant respiratory diseases. It is known that susceptibility to colds can be increased by smoking (Cohen et al. 1993). A difficulty with the study was not being able to avoid totally a person to person transmission of viruses. It may be expected that a higher incidence of colds and flu would occur in workers in places of entertainment than in non-smoking offices. It has also been established that people with a history of atopy or respiratory illness are more sensitive to irritating effects of environmental tobacco smoke than people without such medical history (Cummings et al. 1991). There is wide variability in the reporting on symptoms associated with ETS, for example, active smokers have been shown to be less susceptible to the eye and upper respiratory effects of ETS than non-smokers and ex-smokers (Cummings et al. 1991).

2.3.5.2 Regulatory concerns

Tobacco products have been exempted from all the health and safety laws in the United States and there are no regulatory constraints to adding chemicals to tobacco (Broder and Hensley 1990). The USA has developed some of the most rigorous anti-smoking policies. During 1993 it was expected that the Environmental Protection Agency (EPA) would prompt the Clinton administration and the Federal Occupational Safety and Health Administration to consider a total ban on workplace smoking (Kogan 1993). The most sweeping anti-smoking legislation was then proposed in the USA which related to bans on smoking in buildings entered by 10 or more persons each day. It may be expected that bars, restaurants and almost every public structure will eventually become smoke-free zones (Farley 1994). The situation in the USA during September 1995 regarding the tobacco smoking can be summarised as follows (J Saloojee, personal communication):

- cigarette products are considered as being not entirely legal

- sales to children are illegal

- tobacco product use in most public places is illegal

- cigarette product advertising on television and radio is illegal

In the Australian situation, arguments against smoke-free areas in restaurants have been based on emotional appeals and not on accurate data about customer preferences (Schofield et al. 1993). Self-regulation by the restaurant industry has largely failed and legislation may be the most viable option (Schofield et al. 1993). In other countries similar action has been taken. Sapa-Reuter (1995) reported that in Melbourne an Australian nursing aide was awarded R10 000 for eye damage he suffered due to passive smoking in a Victorian public hospital after working with smoking patients and hospital staff for six years.

France has laws that severely restrict the number of public places where the French can smoke. However, the public ignore the restrictions and continue to smoke at will (Smolowe 1994). Similar difficulties are experienced throughout Canada, Asia and Europe (Smolowe 1994).

In South Africa clean air policies have already been implemented by many companies and state departments (Van Niekerk 1993). Yach and Saloojee (1993) reported that epidemiological and economic evidence with regard to the impact of tobacco has accumulated at a rapid rate in South Africa.

However, the tobacco industry in South Africa may be seen to financially support international sports events such as cricket, thus strengthening their image and influence potential at government level.

It is documented that nicotine is a drug which causes dependence and withdrawal symptoms in users (American Psychiatric Association 1994). Hopefully legislation known as the Tobacco Products Control Act No. 83 of 1993 may assist in reducing tobacco use.

2.3.5.3 Research needs in South Africa

Several workplace studies have been carried out in South Africa with the emphasis on men who work in the mining sector (Yach and Martin 1993). Future research in various types of environments, especially those where young people frequent, will be needed in the future to establish the extent of tobacco usage. This is substantiated by Abratt (1993) who concludes that "the risk for those who start to smoke at around 15 years of age compared to those who start smoking 10 years later is 3 times greater at the age of 60 years" (p 902). Yach and Saloojee (1993) also consider reducing tobacco sales to younger persons as an important priority in South Africa. Yach and Saloojee (1993) consider it important that organisations such as ratepayers associations and worker groups actively lobby local authorities to restrict smoking in public places. In support of this, it is important that workplace environmental research on environmental conditions and smoking habits within public places be conducted in this country to provide officials involved with the Tobacco Products Control Act (1993), as well the public media, with evidence of the prevailing problems and to create public awareness.

Research is also required for an evaluation of the policy of establishing non-smoking and smoking areas in public buildings (Lambert et al. 1993). The voluntary creation of non-smoking areas has taken place in certain restaurants in South Africa as has been done in other countries. Non-smoking areas may reduce but not eliminate the exposure of non-smokers to environmental tobacco smoke (Lambert et al. 1993). It may also be established that as in the case of discotheques, smoking controls will be more difficult or even impossible without a total ban on smoking.

2.3.5.4 The challenge for smoke-free environments

- The need for smoky environments

It can be expected that anti-smoking lobbies will receive some resistance from club owners as they will probably fear loss of patrons. Furthermore, the trend in places of musical entertainment visited is to create a smoky environment to enhance the effect of discotheque lighting. Apart from tobacco smoke pollution many of these environments surveyed are also filled with what has been named "theatrical smoke" by means of specially designed equipment which heats an oily liquid and pumps the aerosol into the environment. A comment from one of the owners of a club that refused entry to the researcher was that the ventilation system is turned off during the evening to ensure that a smoky environment exists. This would enhance the effects of pollution on smoking and non-smoking workers. High levels of particulate matter and chemical pollutants from ETS may have the potential to affect the majority of people in such an environment, whether they smoke or not.

- The image of smoking: attitudes

It is an area of concern that popular youth magazines provide a positive image of smoking through advertising (Amos 1993 and Sussman et al. 1993). Ernster (1993), states that "the tobacco industry persists in deliberately targeting women in its smoking campaigns" (p 1202). It appears that a concerted effort to reduce smoking in different environments will meet with differing levels of resistance, therefore, preliminary surveys to establish conditions in various types of venues are necessary, and are to be followed by attitude surveys.

Research by Hagihari and Morimoto (1991) studied the relationship between opinions concerning the right to clean air and the personal lifestyle of the respondents. In the case of Japanese women, knowledge of the right to clean air and opinions concerning the right to clean air can be effectively promoted by health education. Hagihari and Morimoto (1991) found that health education has limited impact on attitudes towards the right to clean air. Unfortunately, no recommendations were made on how to achieve attitude changes.

- Health education

Once areas of concern are established, long-term anti-smoking campaigns can be designed using the data from research to reach the public. Coordinated community campaigns to reduce smoking prevalence could achieve a decline in smoking (Pierce 1991). This again emphasises the need for public awareness of problem environments as a vital factor in achieving change. Seftel (1993) suggests that smoking should be forbidden in public places in South Africa, especially where young people congregate. There are difficulties envisaged. The major obstacles to prolonged non-smoking are social contexts and stages of self-change which relate to a stressful environment, the presence of other smokers and unpleasant mood states related to nicotine craving through withdrawal (Ewart 1991).

It would appear that there is the need for health education programmes in addition to legislation, to reduce smoking in public places. Education regarding risk-taking behaviours must begin very early (Hamburgen 1991). However, Townsend et al. (1991) state that the success of education of children on smoking through school programmes have been disappointing in the United States and in the United Kingdom. General practice is an appropriate setting for adolescents to receive advice on lifestyle. According to Ewart (1991) the influence of the person's home or work environment may complicate this. There is a positive association between social support from work, family and community and maintenance of behaviour (Rabinowitz et al. 1992). Community educational programs will be necessary to encourage smoking cessation in South Africa and should focus on environments where the smoking public congregate. Non-smoking regulations are vital to facilitate a change. Contributions from clinical health psychology and behaviourial medicine will be needed for health education and stress management programs in different work situations.

Establishing the average age of workers and percentage of staff that smoke in places of entertainment were considered important considerations for this research.

2.3.6 Methods for evaluating tobacco smoke levels

2.3.6.1 Introduction

Sterling et al. (1982) provided a critical review of literature on indoor byproduct levels of tobacco smoke measured under realistic conditions and concluded that serious methodological problems persist with this type of research. They discussed key factors that were included in various research projects and suggested areas for improvement. This document provided useful information for the design of a research framework.

2.3.6.2 Indicators of tobacco smoke levels

Various symptoms such as eye irritation and respiratory distress have been reported when non-smokers, and even smokers, are exposed to high levels of tobacco smoke in unventilated offices or laboratory chambers (Sterling and Sterling 1984). It may be expected that similar worker stress/strain could exist in all crowded places of entertainment. Establishing useful tobacco smoke indicators was hence important.

- Carbon monoxide

High levels of carbon monoxide occur in night clubs, mostly as a result of cigarette smoke (Sebben et al. 1977). Monitoring of levels of carbon monoxide provides a means of maintaining stable levels of cigarette smoke in laboratory research to establish the physiological effects of acute passive exposure to cigarette smoke on humans (Pimm et al. 1978).

- Suspended particles

The monitoring of particulate levels is an important part of estimating the level of pollution by tobacco smoke, as tobacco smoke has gaseous and particulate phases. Few researchers distinguish between the phases (Sterling et al. 1982). Although the physiological changes are often small, subjective complaints of eye irritation and coughing are common (Pimm et al. 1978). Up to 1978 researchers reported that despite indications that passive smoking might be harmful to health, there had been few experimental studies of short-term human responses to ETS (Pimm et al. 1978). This is in fact still the case for South Africa and the workplace studies should be the emphasis. Sterling and Sterling (1984) reported that literature shows that "elevated levels of particulate and gases related to smoking have been measured indoors almost exclusively in experimental situations using special chambers, in the absence of ventilation or while excessive amounts of cigarettes were smoked" (p 35).

Respirable particulates was considered as an indicator of tobacco smoke pollution.

☻ Saliva cotinine

Jarvis et al. (1992), conducted a study on non-smoking bar staff using saliva cotinine levels to establish their exposure to environmental tobacco smoke. This method does not provide information on toxic pollutants in the bar air which could have been correlated against the saliva cotinine levels. Information on carbon dioxide levels would also have been useful to establish the effectiveness of ventilation in the bars during the research as pollution by ETS will depend on the number of cigarettes being smoked and dilution of the pollutants.

☻ Nicotine

Nicotine absorption in non-smoking females established under laboratory conditions has been used as an indicator of passive smoking (Iwase et al. 1991). Siegel (1993) reviewed published studies on indoor air quality which reported on mean concentrations of carbon monoxide, nicotine and particulate matter from measurements taken in one or more bars, restaurants, offices or residence with at least one smoker. The review concludes that ETS levels are higher in bars and restaurants than in offices and homes. Siegel (1993) reports that ETS is an important contributor to mutagenicity of air in dining areas and levels correlate with smoker density. Lambert et al. (1993) measured nicotine and respirable particulate levels in smoking and non-smoking sections of restaurants and found levels to be higher in smoking areas. The results were limited to patron exposure. Health efforts to regulate smoking in bars and restaurants must no longer focus only on protecting patrons, but should undoubtedly include the workers (Siegel 1993). It would be of benefit in future surveys of this nature to include the areas where workers are present as they are regularly exposed to ETS.

☻ Environmental questionnaires

Sterling and Sterling (1984) administered a health and work environmental questionnaire to establish the effects of tobacco smoke. The questionnaire contained information on environmental conditions, health-related symptoms, lifestyle factors and stress factors.

Various approaches to questionnaire design were scrutinised during the literature review (Report of the Interministerial Committee on Indoor Air Quality 1988, Burton 1991a, Griffith 1991, Environmental Protection Agency 1991). Designs were too general to be directly applicable in the proposed research.

It was considered important that a questionnaire be designed to evaluate worker perceptions of stressors in places of musical entertainment.

2.3.6.3 Carcinogenic and toxic chemicals as indicators of potential harmful effects

☻ Introduction

A striking method of indicating the potential harmful effect of ETS in various environments is to represent levels in terms of the presence of carcinogenic and potentially toxic chemicals. Cells are believed to be most susceptible to carcinogenic transformation during replication, and "the irritant and inflammatory effects of tobacco smoke lead to increased cell turnover, as well as to interference with the normal barrier and clearance mechanisms of the lung "(Burns 1991 p 635). USA government agencies concern has been about the synergism between active smoking and exposures to ETS combined with other airborne exposures in public places (Lebowitz 1990). Therefore, it should be considered of benefit to indicate the impact that ETS has on levels of carcinogenic chemicals in various environments in relation to ventilation. Even though these levels appear low, the synergistic effects of the constituents of cigarette smoke should be considered.

Hajimiragha et al. (1989) reported on research which has established that a smoker inhales 20 to 80 μg of benzene, 80 to 160 μg of toluene, about 10 μg of ethylbenzene and about 10 to 30 μg of the xylene per cigarette. Their research focused on examining blood levels of these pollutants in smokers and non-smokers. Hajimiragha et al. (1989) concluded that the levels of these pollutants were highest in smokers and that non-smoker blood levels reflected the common concentration patterns found in outdoor urban air as well as indoor air sources. It would therefore be of interest to establish the potential levels of benzene, toluene and xylene pollution in places of entertainment and compare these levels to levels that are inhaled by a smoker with each cigarette.

- Benzene

Benzene is a human carcinogen that is ubiquitously found in the environment (Adlkofer et al. 1990 and Yardley-Jones et al. 1991). It is a component of petrol and has been used as a solvent, in inks, rubber, lacquers and as a paint remover (Mehlman 1991, Wallace 1989). A study by Wiglusz and Slebioda (1991) showed that finishing and building materials based on chemical compounds might release trace amounts of benzene.

Benzene in mainstream cigarette smoke accounts for 50% of the total population exposure in the United States (Wallace 1989 and Wallace 1993). Wallace (1993) estimates that even passive smoking contributes about 5% of the total exposure to benzene in the United States. Accordingly, non-smokers who live with or come into contact with a smoker also have elevated levels of benzene in their breath which indicates an increased lifetime cancer risk for a non-smoker (Hattemer-Frey et al. 1990). Smoking is by far the largest anthropogenic source of ambient levels of benzene in the environment (Hattemer-Frey et al.

1990). For example, average smokers (20 cigarettes a day) take in about three times more benzene daily from smoking than from exposure to ambient benzene contamination. It was even suggested by Mehlman (1991) that it may be advisable to avoid any exposure to benzene and benzene-containing products. The significance of exposure to benzene and other aromatic hydrocarbons through environmental tobacco smoke was studied by exposing non-smokers in a laboratory to ETS levels that were considered higher than levels experienced in a real-life situation (Adlkofer et al. 1990). The research referred to benzene levels in blood from ETS as not being of significance. A comprehensive number of gaseous phase components and particulate matter were measured in an experimental room. The type of ventilation system was not stated, although the ventilation was considered poor. No objective measurements apart from temperature and humidity were provided to substantiate this. Reported benzene data were limited to offices and traffic situations.

The conclusion from these data was that it is highly unlikely that benzene from ETS under real-life conditions poses a carcinogenic risk to the general population. There are other research papers which support the opposite view. It has been established that benzene is retained in the bone marrow as much as 20 times higher than reflected in the blood. Even low levels of benzene may hence be of toxicological significance (Hajimiragha et al. 1989).

Benzene was considered as an indicator of the impact of tobacco smoke in places of entertainment.

- Toluene

Toluene is also present in tobacco smoke (NIOSH 1991). Samet and Spengler (1991) estimated that the amount of toluene per non-filter cigarette in mainstream smoke is 100-200 ng. The toluene ratio between diluted sidestream smoke and mainstream smoke emissions is 5.6-8.3 measured in nanograms (Samet and Spengler 1991). Brugnone et al. (1989), monitored the breath of chemical plant workers and hospital workers and found that alveolar benzene concentrations were significantly higher in smokers than in non-smokers in both hospital staff and factory staff. However, alveolar toluene concentrations were found to be significantly higher in smokers than in non-smokers only in the hospital staff. This indicated the potential impact that smoking could have on an environment where there are no smoking restrictions.

Similar to benzene, toluene was considered as an indicator of tobacco smoke impact in establishing the difference between non-smoking environments and places of entertainment.

- Xylene

Xylene monitoring in relation to tobacco smoke has been conducted, but xylenes have not been used as the only indicator (Hajimiragha et al. 1989). However, xylenes were not contained in the list of toxic and carcinogenic agents in undiluted cigarette smoke (NIOSH 1991). Xylenes have not been listed in terms of distribution of constituents in fresh, undiluted mainstream smoke and diluted sidestream smoke from non-filtered cigarettes (Samet and Spengler 1991).

Xylenes were considered as indicators of tobacco smoke impact in establishing the difference between non-smoking environments and places of entertainment.

- Benzo(a)pyrene

Benzo(a)pyrene is a carcinogenic agent present in sidestream and mainstream tobacco smoke (NIOSH 1991). According to NIOSH (1991), the major source of ETS is sidestream smoke which contains higher amounts of some toxic and carcinogenic agents than mainstream smoke. Samet and Spengler (1991) state that the amount of benzo(a)pyrene per non-filter cigarette in mainstream smoke is 20-40 ng. The benzo(a)pyrene ratio between diluted sidestream smoke and mainstream smoke emissions is 2.5-3.5 measured in nanograms (Samet and Spengler 1991). Although indoor air and ambient air levels of benzo(a)pyrene are closely correlated, higher indoor air values are often indicative of prominent indoor combustion sources such as smoking and cooking (Waldman et al. 1991). Although a fireplace could have considerable impact on benzo(a)pyrene levels, it is still less than tobacco smoke (Samet and Spengler 1991).

Previous studies reviewed by Sterling et al. (1982) indicated questionable results for research projects. In one of the studies benzo(a)pyrene levels appeared exaggerated when related to carbon monoxide levels. The other study had not provided for controls for comparison purposes. Other findings did not reveal much difference between indoor levels in coffee bars to outdoor air controls.

It was considered important to investigate whether cigarette smoking has an impact on benzo(a)pyrene levels in places of musical entertainment.

- Aerosol pollution

Aerosols are solid particles or liquid droplets and are small enough to remain airborne for long periods of time. Tobacco produces a wet smoke composed of minute tarry droplets (Plog 1993). The irritation from ETS will be used as a stress/strain indicator. Furthermore, it is possible that the smoke concentrations from theatrical smoke machines could be sufficiently high during the short periods of time so that it could also contribute to health symptoms (Driscoll et al. 1992).

It was considered important to investigate the impact that aerosol levels have in places of musical entertainment.

2.3.7 Biopsychosocial factors

2.3.7.1 Biopsychosocial factors in perspective

In most episodes of poor indoor air quality there are psychological involvements (Burton 1991a) and greater attention should be paid to a holistic approach to the complexities of environments and their stressors (Viljoen 1987). The London Hazard Centre (1990) reports that people may become tense and anxious when they cannot control the environment around them, which can ultimately take its toll psychologically.

2.3.7.2 Limitations of early studies

Two early studies on stress in the workplace were not approached holistically. Schmitt et al. (1980) reported symptoms in eight organisations, but failed to include the potential effect of poor indoor air quality on worker health. Research by Payne et al. (1982) reported on the potential usefulness of a "Job Reaction Questionnaire" as a contextually based measure of stress at work. However, the questionnaire did not include the potential for psychophysics, for example the sensory response to cigarette smoke as a potential stressor.

Hedge et al. (1987) developed a useful model in which work-related illness is shown to be affected by architectural/ environmental factors, individual/psychological factors, and occupational/organisational factors. This model was related to office conditions and may not be suitable to be applied directly to places of entertainment.

Skov et al. (1989) studied the influence of personal characteristics, job-related factors and psychosocial factors on the sick building syndrome on office workers. However, environmental pollutants were not monitored and no control premises were used. The inclusion of environmental monitoring is considered essential for this type of research.

2.3.7.3 Worker stressors

- Hours of work

Research by Arcuri and Lester (1990) on moonlighting and stress in police officers indicated that the number of hours worked at other jobs is positively associated with subjective feelings of stress. **The inclusion of hours of work as a potential stressor in workers in places of entertainment was considered important.**

- Smoking as an indicator of regressive coping

Although a study by Parkes (1990) was related to university graduates taking a teachers training course, there were aspects that could be used in this present study. Parkes (1990) suggests that the work environment exerts a causal influence on mental and physical health. The researcher referred to withdrawal, smoking, drinking and the use of medication as being maladaptive outcomes of regressive coping. **Smoking will be one of the aspects looked at in the present study. The consumption of alcohol by workers in places of entertainment is not permitted and therefore could not be used as an indicator of poor coping.**

- Ergonomics, epidemiology and organisational science

From research on worker stress experienced by postal workers caused by their working conditions a model was developed attempting to combine the areas of ergonomics, epidemiology, and organisational science (Amick III and Celentano 1991). More psychosomatic symptoms were observed in those workers using machine paced technological systems. Furthermore, noisy equipment was recognised as a disrupter of communication. Accordingly, it may be questionable to refer to all health symptoms as being psychosomatic without examining the indoor environmental effects. An important consideration is that each type of work environment will differ in some way in terms of potential effects on human health.

The majority of health promotion programmes implemented in corporate and community settings have been designed to modify individuals' health habits and lifestyles, for example, exercise and dietary regimes. These are implemented in preference to the provision of environmental resources and interventions that enhance well-being amongst occupants of the area, such as installation of improved ventilation systems to improve indoor air quality (Stokols 1992). There are many aspects that can impact on human well-being. Table 2 provides examples on dimensions and criteria of health-promotive environments (Stokols 1992).

Table 2 Examples of dimensions and criteria of a health-promotive environment

Facets of health	Environmental	Behaviourial, psychological and physiological outcomes
physical health	safe, comfortable environment	physiological health and perceived comfort
mental and emotional well-being	controllable environment	sense of personal competence and challenge
social cohesion	economic stability, low intergroup conflict	social contact and cooperation health-promotive environment

Research by Jex et al. (1992) concluded that the use of the word "stress" in survey items should be avoided. This factor was taken into account when designing the questionnaire for the current investigation.

It is necessary to investigate biopsychobehavioural factors and psychophysical environmental factors that occur specifically in a particular type of environment, to establish a better understanding of the potential stressors that a group of workers are exposed to, and the stress/strain that these cause on the workers.

2.3.7.4 Personal determinants

Personal determinants of health promoting behaviour were reviewed in a study by Rabinowitz et al. (1992). These included:

- Personality, health beliefs, and health attitudes

- Environmental factors which include the concept of modelling and social support. Modelling was clarified as follows: the persons own perceptions of their abilities to personify a certain behaviour and on how the person sees others coping with the situation (Farquhar 1993). **For example: "If others can stop smoking so can I".**

- Barriers which limit change in the risk taking behaviour of smoking. It is evident that there can be many barriers which may differ from one environment to another. It is important to establish the most important barriers and to deal with those as a first priority.

- Although no specific work type was targeted in the proposed study in places of musical entertainment, musicians have been singled out by research as being a group of workers warranting special attention. Studies of popular musicians are lacking and there is a likelihood that they may run an even higher risk of stress/strain because of uncertain economics and frequent touring (Sternbach 1993). Accordingly this research will also serve to heighten awareness of stressors for performing artists.

"Serious physical and mental health problems can be predisposed, initiated, sustained or exacerbated by the behaviour of people" (Schlebusch 1990 p 46). These behaviour pathogens/health-risk behaviours are related to lifestyle and could be stress-related (Schlebusch 1990). Destructive lifestyle-induced diseases have been identified as a matter of serious concern (Schlebusch 1990). An example would be that some people smoke in areas with poor air quality (caused by excessive cigarette smoke), to cope with the poor conditions. Furthermore, many potential stressors may exist in places of public entertainment over which the worker may have little control and a knowledge of these stressors is necessary as a first priority in reducing the impact of stress.

2.3.8 Sick building syndrome (SBS)

Indoor air complaints experienced in the 1990's are not a new phenomenon. Two hundred years ago Benjamin Franklin wrote of the effects of smoke emitted from a fire place into a small room (Burton 1991a). Large numbers of complaints from non-industrial workers were received by public health departments in America in the late 1970's (Samet and Spengler 1991 and Kreiss 1993).

Five groups of SBS symptoms may be listed (Morrow 1992):

- Irritation of eye, nose, and throat.
- Neurasthenic symptoms (headaches, dizziness, fatigue, confusion, nausea).
- Skin irritation.
- Hypersensitivity reactions for example, non-asthmatics with asthmatic-type symptoms.
- Unpleasant odour and taste sensations.

Apart from physical complaints, psychological complaints can also be a result of indoor air quality in that fear, frustration regarding noise, lights, stressful work loads, and other factors may be contributing stressors (Burton 1991b).

Although environmental factors may explain some symptoms, the study should also include psychological and social factors (Small 1993).

SBS is defined as follows: "Building sickness comprises of a group of symptoms which are common in the general population, but which are more common in workers in some buildings than in others and which deteriorate while working in a building and improve after leaving it" (Burge 1991 p 1). The most common recommendation of air-quality consultants has been to increase ventilation with outdoor air replacement (Kreiss 1993). However, according to Kreiss (1993) improving outside air intake in some cases does not lead to reduced symptoms. For example, strong body odours may occur in a well ventilated room and other factors such as the presence of recurring dampness on a carpet could cause occupants to complain constantly about the musty odour. This highlights the need to approach SBS problems by considering all possible contributors. In places of entertainment ventilation should be an important factor to consider. Excessive concentrations of indoor pollutants should be reduced or sources eliminated, rather than just increasing air removal rates (Fisk and Grimsrud 1993).

Various contributors to poor indoor air quality and comfort are listed (Gold 1992):

- Tobacco smoke.
- Combustion products such as carbon monoxide and nitrogen dioxide.
- Biological agents.
- Infectious agents.
- Volatile organic compounds.

- Temperature and humidity.

- Psychological factors that tend to aggravate complaints.

There has been much debate about the various stressors involved in indoor work environments. Stressors may have the tendency to have a synergistic effect on the occupants. There may be common factors associated with sick building syndrome in indoor environments in general. However, it should be recognised that classifying environments and establish models highlighting stressors specifically pertaining to a particular environment requires consideration. Few comprehensively designed studies of SBS have been conducted (Morrow 1992), nor have holistic studies of SBS been undertaken in places of musical entertainment, both overseas and in South Africa. Studies have tended to concentrate on individual stressors, for example noise, smoking or chemical pollutants.

Studies were conducted in an environmental chamber to establish the relationship between psychological measurement of odour in the context of non-smoking and smoking occupancy, to examine ventilation requirements (Cain et al. 1983). For both smoking and non-smoking conditions a combined high temperature of 25,5 C and a humidity of greater than 70% exacerbate odour problems. The high summer humidity and temperatures in Durban may increase the potential for odour as a stressor in places of entertainment. Furthermore, particulate levels were unacceptable in relation to what would be acceptable outdoors due to the tobacco smoke.

These results were considered useful as the environmental conditions in the majority of crowded South African musical entertainment places may be found to be similar, thereby permitting recommended ventilation standards established by Cain et al. (1983) to be included as part of recommendations.

2.3.9 Key literature inputs to the survey design

From the reviewed literature the main objective for the survey design and methodology have been listed. These are followed by a model summarising the potential stressors.

- Establishing noise levels and worker perceptions of noise were considered as important indicators of worker stress/strain.

- Lighting levels at strategic work stations and the subjective assessment by workers of psychedelic lights were considered as stress/strain indicators.

- Establishing the incidence of colds and flu in workers in places of entertainment and in non-smoking offices was considered.

- Establishing the effects of environmental tobacco smoke on people with a history of atopy or respiratory illness was considered.

- Establishing the average age of workers and percentage of staff that smoke in places of entertainment was considered.

- Respirable particulates were considered as an indicator of tobacco smoke pollution.

- It was considered important that a questionnaire be designed to evaluate worker perceptions of stressors in places of musical entertainment.

- It was considered important that apart from the health effects, existing smoking habits be established in places of entertainment as an indicator of lifestyle.

- Benzene was considered as an indicator of the impact of tobacco smoke in places of entertainment.

- Toluene was considered as an indicator of tobacco smoke impact to establish the difference between non-smoking environments and places of entertainment.

- Xylene was considered as an indicator of tobacco smoke impact to establish the difference between non-smoking environments and places of entertainment.

- It was considered important to investigate whether cigarette smoking has an impact on benzo(a)pyrene levels in places of musical entertainment.

- It was considered important to investigate the impact that aerosol levels have in places of musical entertainment.

- The importance of including hours of work as a potential stressor in workers in places of entertainment was considered.

- It was necessary to investigate biopsychobehavioural factors.

- The use of the word stress in survey items would be avoided.

- Certain personality, health beliefs, and health attitudes would be included in this study.

- Environmental factors preventing smoking cessation would be established.

- Barriers that exist which limit change in smoking behaviour would be established.

- **SBS prevalence would be assessed.**

- **Ventilation performance would be monitored.**

It is expected that on the conclusion of this research additional stressors might be listed that would require further research. The stressors are summarised in Table 3 as a biopsychosocial model of stress. The stressors in each column are not intended to be linked in any way.

Table 3 Biopsychosocial Model of Stress in Places of Musical Entertainment

Biological	Psychological	Social
cancer potential	odours	job satisfaction
hearing loss potential	air pollution	social interaction
physical discomfort	loud music	substance abuse:smoking
regular colds and flu	flashing lights	interaction with fellow workers
SBS Symptoms: upper respiratory irritation, decreased respiratory function,neurological symptoms and immunological reaction	crowds people noise self-efficacy	interaction with management
tiredness from work	self-esteem	
body pains	personal confidence	
exacerbated physical ailments	no personal control over environment	

CHAPTER 3
SURVEY DESIGN AND METHODOLOGIES

3.1 GENERAL APPROACH

Many potential stressors exist for workers in places of musical entertainment. This research was intended to screen for the more prominent stressors that occur whilst present in these environments. Data acquisition was based on questionnaire surveys, environmental monitoring and researcher observations whilst present in the work environment.

- Questionnaires were designed to establish the worker's perceptions on environmental, psychophysical and psychosocial stressors experienced whilst working in crowded musical entertainment venues.

- An environmental monitoring system was designed to record stressors occurring on evenings when the questionnaire surveys were being conducted.

- The researcher and an assistant were to be present in the work environment at all times during measurement periods to record worker and patron behaviours.

3.2 SELECTION OF PREMISES

3.2.1 Places of entertainment

A list of places of entertainment was acquired from the Greater Durban Marketing Authority. Entertainment sections of the local news papers were also screened. The beach front area was surveyed on foot and young people who frequent places of entertainment were questioned to ensure that all possible care was taken in preparing a complete list of existing entertainment venues. This approach is statistically justifiable (E Gouws, personal communication). A list of 41 venues was compiled. A random sample of 15 premises was taken using the "lottery method" (Leedy 1985). An additional 5 premises were drawn to compensate for the possibility of entry refusal by certain owners. In fact, 4 owners did eventually refuse access.

3.2.2 Control venues

Initially consideration was given to use crowded places of entertainment with adequate ventilation as control venues. However, from preliminary surveys it became evident that there were no smoking controls in any of the venues. Ventilation systems did in general not appear to be adequate.

Parking garages and non-smoking offices were also considered as controls. The former would have proven useful for comparisons of potentially higher levels of pollutants from motor vehicle exhaust emissions, for example, comparing garage benzene levels to levels in places of entertainment. However, an insufficient number of workers to acquire adequate questionnaire returns was a decisive limitation.

Long established non-smoking offices were selected as control venues. The benefits of these were sufficient number of respondents and lower levels of pollution for comparison to the crowded environments. Limitations were that the age groups would more than likely differ and the types of work would be different to that of workers in musical entertainment venues. However, the advantages of this choice far outweighed the limitations.

3.2.3 Method of gaining access to premises

A letter of introduction was designed to explain the purpose of the research, emphasising the confidentiality of the data collected (see Annexure 1). The management of each of the premises was contacted telephonically and appointments were made to discuss the proposed research. Those people who could not be contacted during the day by phone were visited at their premises during the evening. In the majority of cases a favourable response was received.

3.3 QUESTIONNAIRES

3.3.1 Objectives for questionnaire design

The questionnaire was designed specifically for places of musical entertainment. The questions were established from a combination of personal experiences, discussions with workers in places of entertainment and a review of literature. The term "stress" was omitted in the final questionnaire. A limitation was that comparisons with office controls had to be restricted to certain common stressors. This emphasises the need for questionnaires to be evolved according to the nature of the environment and its potential stressors. The questionnaire was designed to be personally administered by the researcher and the trained assistant. This approach was considered important for the following reasons.

- The type of work of the respondents provided them with little or no spare time at all during the evening. By the end of the evening they are too tired and most leave immediately for home.

- It had to be ensured that the highest number of questionnaires were uniformly completed.

- It was important that all questions were fully understood and answered by the respondents.

- By personally administering the questionnaire, time was not wasted, which resulted in a more favourable attitude from the staff who were under pressure to serve customers.

- By personally administering the questionnaire, ad-hoc additional information not included in the questionnaire could be acquired.

3.3.2 Letter of introduction to the questionnaire

A letter of introduction was attached to each questionnaire. (see Annexure 2).

3.3.3 Practical application of the questionnaire

3.3.3.1 Selection of respondents

Access to the various premises was permitted on the condition that there was minimum interference with staff duties. The survey design outlined that a minimum number of 5 persons be interviewed at each of these premises. This was to be undertaken on the basis of random choice. In certain of the premises the staff numbers were less than 5 workers. It was hence decided to interview all willing members of staff at the places of musical entertainment and in the non-smoking offices.

3.3.3.2 The interview

The letter of introduction was first read to the staff member. The respondents then completed the questionnaire in the presence of the researcher. Any additional information volunteered by the respondent was recorded on the questionnaire.

3.4 MONITORING EQUIPMENT AND METHODOLOGIES

3.4.1 Noise measurement

3.4.1.1 Purpose and methodology

It was the purpose of this part of the investigation to establish an equivalent continuous A-weighted sound pressure level (L_{Aeq}) which would be reasonably representative of the exposure of workers to the noise levels in their working environment. The South African Bureau of Standards (SABS) Code of Practice 083-1983 has been designed as a guide for the measurement and assessment of occupational noise for hearing conservation purposes. The noise evaluations in this research were based on the procedure contained in this SABS code.

L_{Aeq} is "the value of the continuous A-weighted sound pressure level, in decibels, that is representative of the instantaneous A-weighted sound pressure levels measured throughout a specific time interval" (South African Bureau of Standards 083-1983 p 5). As impulse noise is present in places of musical entertainment, the equivalent continuous A-weighted sound pressure level included an impulse correction. Impulse correction was not included in the control premises samples as impulsive noise was not present. Principles adopted to calculate worker exposure to continuous noise during the evening on which the monitoring was conducted were as follows: **Equivalent noise level of worker exposure per night** (Schoeman and Schröder 1994).

$$L_{Aeq} = \text{continuous noise recorded} + 10 \log_{10} \frac{\text{hours worked}}{8 \text{ hours}}$$

The period that the worker may remain in the environment without being exposed to an equivalent noise level of more than 85 dB(A), can be calculated :

$$85 = L_{Aeq} + 10 \log_{10} \frac{t}{8 \text{ hours}}$$

t = permissible hours per night.

It should be recognised that a knowledge of exposure to noise over a full working week would provide a more accurate hazard assessment.

3.4.1.2 Equipment for noise measurement

Ideally noise dose meters attached to the workers to monitor exposure during the entire evening should have been used. However, the management of most of the places of entertainment were not receptive to this. A Rion NL-14 noise meter which has a type 1 level of accuracy, as required by SABS 083-1983, capable of integrating the impulse time weighted characteristic directly was used. This instrument has been designed to operate in areas of elevated temperature and humidity. The instrument and its calibrator were calibrated by SABS laboratories prior to use in the field.

3.4.1.3 Sampling procedure

SABS 083-1983 recommends that the microphone is placed about 1,5 m above the floor and at least 1,2 m away from the walls and other large flat surfaces. Scanning of the area with the microphone while the instrument is integrating is also suggested and was achieved in this research by swivelling the instrument on its tripod at regular intervals. The impulse setting was used in places of entertainment whilst the fast response setting was used in the office environments. A position was, on each occasion, selected to be reasonably representative of musicians, disk-jockeys and bar attendant exposures. Representative time weighted averages were achieved by monitoring over a period which reflected the nature of worker exposure. However, in certain premises the bar area was separate from the band/discotheque area, thus requiring two separate measurements. The instrument was calibrated and checked before and after each series of sound level measurements to ensure that results were acceptable.

3.4.1.4 Limitation of the noise measurement survey

- Most of the workplaces were restricted in size with high levels of activity. Placing of the instrument at specific working positions could have resulted in an accident and damage to the equipment.

- Flat surfaces such as tables are undesirable for accurate noise measurements, but could not be avoided.

3.4.2 Lighting levels

3.4.2.1 Purpose and methodology

It was the purpose of this research to establish whether lighting at work stations were reasonably adequate to avoid worker stress and whether psychedelic lights were a stressor.

3.4.2.2 Equipment for assessment of lighting levels

Two portable light meters were used namely a Yew type 3281 and a Delta OHM luxmeter HD 8366.

3.4.2.3 Method of measurement

Light meters were used to assess the lighting levels at tills and at positions where disk-jockeys needed light to read compact disk covers.

3.4.2.4 Limitations

The effects of flashing lights which were present in some premises could only be assessed subjectively as the instrument response time was too slow.

3.4.3 Ventilation and comfort assessment

3.4.3.1 Purpose and methodology

It was the purpose of this part of the investigation to establish whether under crowded conditions the ventilation systems in places of entertainment are able to keep the carbon dioxide levels below 1000 ppm. This reference value is proposed by the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE 1989). Furthermore, it was necessary to establish whether the ventilation systems could maintain temperature, relative humidity and air movement within acceptable limits.

Carbon dioxide is a surrogate indicator of indoor air quality (Kearns 1991), providing a good indication of air distribution/circulation and how effectively the ventilation system is diluting and removing contaminants from the air.

Air temperature, relative humidity and air movement were measured to assess worker comfort. Air temperature was measured in real-time (continuous minute averages).

Relative humidity, apart from the potential to affect the release rate of many indoor contaminants, their air concentration and microbial growth, can affect worker comfort (Kearns, 1991). Recordings of relative humidity were also measured in real-time.

Air velocity was measured with a Kata thermometer plus a wet bulb thermometer using the following formula for calculation (Chamber of Mines South Africa, 1982):

$$V = (K-0,7\ \theta\ /\ \theta)^2$$

where: V = air velocity in metres per second.

K = wet Kata cooling power.

θ = $36,5-t_{wb}$ (t_{wb} is the reading of an unventilated wet bulb thermometer in C).

3.4.3.2 Equipment for ventilation and comfort assessment

It was convenient to utilise equipment that could provide real-time analysis of conditions in the environment. Metrosonics indoor air quality monitoring systems, AQ 501 and AQ 502, were utilised for this purpose. These systems can, apart from other stressors, continuously log and store carbon dioxide, temperature and relative humidity changes in the environment. Information can then be down-loaded onto a computer. The temperature and relative humidity sensors compared favourably with readings acquired from wet and dry thermometers.

For low air movements the Kata thermometer is the preferred instrument to use (Chamber of Mines South Africa, 1982). An Ebro EB4003 Thermo-anemometer was used where air movements were in the range of 0,5 to 1 m/s.

3.4.3.3 Sampling procedures

The indoor air quality monitors were switched on for a minimum of 1 hour before calibration. Calibrations were carried out prior to each survey. The monitoring for carbon dioxide must not be done in the vicinity of the breathing zone of workers (Burton 1991a). The siting of indoor air quality monitors were as follows:

- On the floor of the survey premises away from the breathing zone of workers and patrons.

- Away from the air supply and outlet points.

- Out of reach from the patrons and where it could not restrict the movement of the workers.

In the case of smaller premises one indoor air quality monitor was used. However, in larger venues or where the bar area was separated from the discotheque/band area, two monitors were used. The instruments were switched on for an hour in the environment before patrons were allowed in. They were set to start recording as the premises opened for business and monitored for periods representative of the environmental conditions.

Temperature and relative humidity levels were also recorded by the real-time analysis facility of the indoor air quality monitors. The procedures for measurement of air velocity using a Kata thermometer were as follows:

- An adequate number of Kata readings were taken in the bar and band/discotheque areas in positions to ensure representativeness of environmental data.

- These readings were taken at the beginning of the evening. The wet bulb temperatures were taken simultaneously with the Kata readings by using a wet bulb thermometer. The wet bulb thermometer was stabilised at chest height in the environment prior to recording of the readings.

- The Kata thermometer was held stationary at arm's length at chest level without obstructing the flow of air past the instrument.

- Readings were taken at different work station points to ensure a good overall picture of the conditions.

The thermo-anemometer was used where higher velocity air movements were experienced.

3.4.3.4 Limitations of measurements to assess ventilation and worker comfort

- Indoor air monitors cannot be easily placed or moved in crowded environments due to their size and the need for an external power supply.

- It is vital to acquire accurate calibration gases. The instruments are not linear in response and it is therefore important to use a gas standard that is in the range of the expected environmental carbon dioxide levels.

- The carbon dioxide sensor used by Metrosonics has an upper limit of approximately 5000 ppm. Maximum carbon dioxide levels could not be determined in some of the premises.

- Kata readings could only be taken in the early part of the evening, because the environment became too crowded and the levels of activity too high to take further readings.

3.4.4 Respirable particulate matter

3.4.4.1 Purpose and methodology

It was the purpose of this part of the investigation to establish the respirable particulate impact in crowded smoky environments compared to non-smoking office environments. The method adopted was a continuous real-time monitor. The Metrosonics air monitor was placed in the vicinity of the work stations in order to establish an indication of aerosol exposure.

3.4.4.2 Equipment for determination of respirable particulate matter

The Metrosonics AQ502 indoor air monitor is fitted with a MIE real-time respirable aerosol analyser. The operational principle is based on the detection of scattered electromagnetic radiation in the near infrared and has been designed to respond to the particle size range of 0,1 to 10 micrometers (MIE, 1990). Results are given in mg/m^3. Due to the difficulty in moving the AQ502 indoor air quality monitor easily in these environments only one sampling position could be used. Furthermore, the design of the instrument and the requirements for carbon dioxide readings necessitated the equipment to be situated at ground level. From the observations in certain of the environments, it would appear that the position may underestimate the particulate levels, especially in the case of theatrical smoke.

3.4.4.3 Sampling procedure

Calibration of the on-line monitoring instrument was conducted prior to each survey. The aerosol sampler was first zeroed using a filter attachment provided by Metrosonics and then spanned using a 22,88 mg calibrator supplied with the instrument. The instrument was programmed to monitor on the basis of one minute averages throughout the measurement period, which provided an in-depth picture of the variations in particulate levels.

3.4.4.4 Limitations of particulate matter determinations

Only one sampling position could be used. The design of the instrument and the requirements for carbon dioxide readings necessitated the equipment to be situated at ground level which may underestimate the particulate levels, especially in the case of theatrical smoke.

3.4.5 Sampling and analysis of volatile and semi-volatile organic compounds

3.4.5.1 Equipment used for volatile and semi-volatile sample collection

Four Gil-Air constant flow air sampling pumps were used in the test environments. Calibrations were carried out using a Gilibrator primary flow calibrator.

Low flow adaptors were fitted on the two pumps with charcoal sampling tubes. The charcoal tube holders were attached to the pumps with sufficient plastic tubing to allow the sampling heads to be situated at breathing height in the test environment.

Attachments were 37 mm closed face sampling head, 20 mm length of plastic tubing, a metal connector, XAD-2 sampling tube and adequate plastic tubing were pump attachments required for benzo(a)pyrene monitoring.

3.4.5.2 Purpose and methodology used for volatile and semi-volatile sample collection

The main purpose of this part of the investigation was to screen places of musical entertainment for the presence of volatile and semi-volatile organic compounds and compare the results to levels in non-smoking offices.

Benzene, benzo(a)pyrene, toluene and xylene were selected as target compounds for analysis. As these compounds are present in tobacco smoke it was believed that these pollutants may be found at higher levels in places of musical entertainment than in non-smoking environments.

Sampling methodology for benzene, toluene and xylene using charcoal tubes was derived from the NIOSH Method 1501. The sampling methodology for benzo(a)pyrene was derived from NIOSH Method 5515. Benzo(a)pyrene was absorbed on XAD-2 resin, while the volatile organic compounds were absorbed on charcoal.

Prior to the commencement of monitoring at each venue the four sampling pumps were calibrated. The two pumps fitted with charcoal absorbents were calibrated to a maximum of 200 mℓ/minute for the collection of benzene, toluene and xylene.

The 37 mm closed face sampling head for benzo(a)pyrene was attached to a 20 mm length of plastic tubing by means of a metal connector. The XAD-2 sampling tube was opened by breaking off the glass seals at each end. The XAD-2 tube was then inserted into the plastic tubing making sure that the flow direction as indicated on the tube was correct. The other end of the XAD-2 was inserted into the plastic tubing attached to the pump. The 20 mm plastic tubing and metal connector which preceded the XAD-2 tubing was cleaned with ethanol before each use. Masking tape was used to seal off all joins.

The two pumps fitted with the 37 mm PTFE filters followed by the XAD-2 tubes were calibrated at 2 ℓ/minute for the collection of particulate and gas-phase benzo(a)pyrene. The calibration was carried out at each venue to ensure the least possible variations in flow rates.

The pumps were placed at heights equivalent to the breathing zones of workers. Four pumps were use at each venue. Two pumps, one fitted with the charcoal tube and other for the sampling for benzo(a)pyrene were placed next to each other in the bar areas and the other two in the music areas, out of the reach of the general public. Care was taken to ensure that the sampling heads were in the vertical position. It was not permitted to place pumps on the workers.

The pumps operated for a minimum of 4 hours during the work period to acquire a representative sample. Longer averaging time is important to ensure a sufficiently large amount of air for the collection substances (Van der Wiel and Molhave, 1993).

At the end of the sampling period the pumps were retrieved and carefully dismantled. The sampling heads were sealed with plastic stoppers, wrapped in foil, labelled and placed in plastic bags to keep dry. Thereafter they were placed in a cooler bag which contained freezer bags/blocks. Each group of samples was vacuum-packed, correctly labelled and placed under refrigeration. Samples were shipped to the Atomic Energy Corporation in cooler bags with freezer blocks.

3.4.5.3 Limitations of volatile and semi-volatile organic compound collection

- Only 2 area samples for benzo(a)pyrene and benzene, xylene and toluene were taken at each of the premises due to analysis cost and equipment limitation.

- Screening for presence of additional pollutants were limited to one place of entertainment and one office due to financial restraints. Unfortunately, a benzene based solvent was used at the time of the sampling of the office control, which resulted in high air pollutant concentrations.

3.4.5.4 Sample preparation and analysis, largely taken from Atomic Energy Corporation Report BAW/0843 (Meyer 1994)

Forty-six activated charcoal tubes and forty-six XAD-2 tubes with corresponding PTFE filters were submitted to the Atomic Energy Corporation for analysis. Field blanks were submitted with each batch of samples. All samples were stored at 4 C before and after sample preparation. In addition, two smoke machine mixtures were submitted for analysis of volatile organic compounds.

- Activated charcoal tubes

Preparation and analysis methods for the activated charcoal tubes were derived from the NIOSH Method 1501. Dichloromethane (DCM) was used as the extraction solvent and the samples were extracted in an ultrasonic bath for 30 minutes. The samples were analysed with a gas chromatography and a flame ionisation detector (GC-FID). A glass capillary column, 30 m x 0,33 mm inside diameter with stationary phase PS 089, was used. The GC conditions were as follows: GC carrier gas Helium, injection 2 $\mu\ell$ split (110:1). The temperature program was 50 C isothermal for 5 minutes, heating rate 10 C/minute up to 150 C.

Field blanks were prepared and analysed for background comparison with sample tubes. The desorption efficiency was determined for each batch of charcoal tubes received for analysis.

Quantitative analyses of activated charcoal tubes were achieved using the external standard technique. The GC-FID was calibrated for benzene, toluene and xylene.

Calculation was as follows :

$$C_i = \frac{(V_i - V_B) \times D_i}{V_s \times R_i}$$

where:

C_i = Concentration of compound i ($\mu g/m^3$)
V_i = Volume measured of compound i in sample ($n\ell$)
V_B = Volume measured of compound i in field blank ($n\ell$)
D_i = Density of compound i ($\mu g/m^3$)
V_s = Air volume sampled (m^3)
R_i = % recovery determined for compound i.

- XAD-2 adsorbent tubes and PTFE filters

The sample preparation and analysis method was derived from the NIOSH method 5515. PTFE and cellulose filters were soxhlet-extracted with dichloromethane (DCM) and dried at 100 C for 2 hours before the filters were weighed and sent for sampling.

The front sorbent sections of the XAD-2 tubes and the corresponding filters were combined in glass vials and extracted with 3 $m\ell$ toluene in an ultrasonic bath. All the samples were spiked with an internal standard, chosen as deuterated phenanthrene. The amount of internal standard in the extract of each sample was 15 μg. A gas chromatography-mass spectrometer (GC-MS) was used for the qualitative and quantitative analyses. A glass capillary column 30 m x 0,33 mm inside diameter with stationary phase SE 52, was used. The GC conditions were as follows : GC carrier gas Helium, injection 2 $\mu \ell$ splitless, injection temperature 250 C. The temperature program was 35 C isothermal for 5 minutes, heating rate 20 C/minute up to 200 C and a heating rate 2 C/minute up to 250 C as final temperature. The MS conditions were as follows: temperature of the ion source 230 C, ionisation 70 eV electron impact. The full scan made was used for the qualitative analysis and the quantitative determination of benzo(a)pyrene was conducted in the selective ion mode.

Field blanks of the XAD-2 tubes were prepared and analysed with each batch of samples. The blanks were also spiked with internal standard and carried through all the stages of sample preparation. The GC-MS system was tuned daily with a calibration compound. The mass spectra obtained had to meet standard EPA specifications. The chromatograms were carefully examined for any deviations.

PTFE filters were weighed before and after the sampling was conducted. For the quantitative analysis of XAD-2 adsorbent tubes and PTFE filters the GC-MS system was calibrated for benzo(a)pyrene and quantification was achieved using the internal standard technique.

The XAD-2 with PTFE filter extracts and the corresponding activated charcoal extracts taken at a place of entertainment and an office control were qualitatively analysed with the GC-MS, to identify the organic compounds that were adsorbed from the test environment. An analyte was identified by comparison of the sample mass spectrum with standard reference mass spectra. The NBS library with standard reference mass spectra was used and a library search was conducted for the purpose of positive identification.

3.4.5.5 Equipment used for volatile and semi-volatile organic compound analysis

Gas chromatography is an effective method for the separation of complex mixtures in the gas phase (Toon and Ellis 1973). With typical gas chromatography separation and analysis, the sample which contains a mixture of compounds is injected into a stream of carrier gas at the inlet of the chromatographic column. This column is packed with an inactive pulverised solid material coated with a layer of nonvolatile liquid known as the partitioner (Toon and Ellis, 1973). Capillary columns do not have any packing material but the inner surfaces are coated with the mobile partitioner phase.

The carrier gas transports the sample through the column and components of the mixture arrive at the outlet at different times. This separation is caused by the interaction of the mixture components with the partitioner liquid which selectively interferes with the progress of each component of the mixture . The less soluble, more volatile compounds are swept ahead and are separated from the less volatile compounds. At the outlet these gases pass into a detector. (Toon and Ellis, 1973).

Mass spectrometry is a powerful compound-specific detector. In a mass spectrometer ion source positive ions are produced from the substance of interest, with a spectrum of mass-to-charge peaks with characteristic abundance (peak-heights). These positive ions are accelerated by an electrical field and pass through a magnetic field which is perpendicular to their path. Ions are deflected from their straight path in accordance with their mass-to-charge characteristics. The lighter ions are deflected the most, resulting in the recording of a spectrum that is a fingerprint of the compound (Moeller et al. 1989).

The Finnigan Library Search Program was used for the identification of organic compounds. At the heart of the search is the algorithm which computes a numerical measure of the similarity of two spectra, namely the unknown spectrum and the library spectrum. The system considers three numbers. These are termed PURITY, FIT and RFIT. PURITY considers the degree to which the spectra are similar. FIT measures the degree to which the library spectrum is included in the unknown spectrum. RFIT measures the degree to which the unknown spectrum is included in the library spectrum. The closest match is when the three numbers produced by the algorithm, each of which could fall between 0 and 1000, are all over 900 (Sokolow et al. 1978). Hence when comparing the unknown spectrum to the library spectrum, all three numbers, namely the PURITY, FIT and RFIT should be approaching 900 or be more than 900 to ensure high probability match values. Figure 1 provides an example of a library research output.

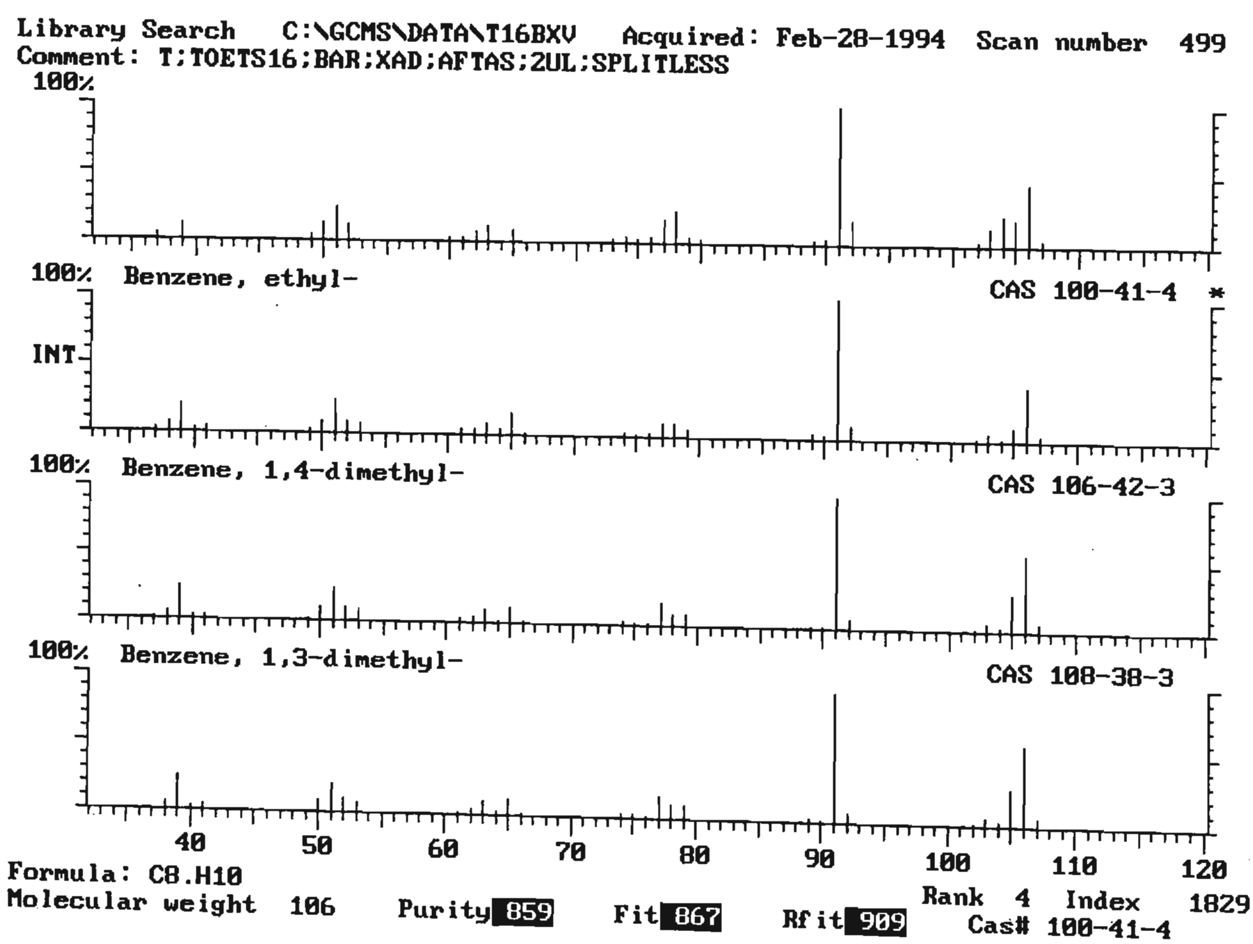

Figure 1 A typical example of a library search

3.4.5.6 Limitations of volatile and semi-volatile organic compound analysis

The limit of quantification was determined as 4,5 $\mu g/m^3$ benzene, 2,9 $\mu g/m^3$ toluene and 1,5 $\mu g/m^3$ xylene per sample. The limit of detection was calculated as 1,3 $\mu g/m^3$ benzene, 0,9 $\mu g/m^3$ toluene and 0,4 $\mu g/m^3$ xylene per sample.

The limit of detection of benzo(a)pyrene was estimated as 2,5 $\mu g/m^3$ for a 600 ℓ air sample.

3.5 DATA ANALYSIS METHODOLOGY

3.5.1 Descriptive statistics

The purpose of descriptive analysis is to summarise data so that an overall impression of distribution can be established (Huysamen 1990).

Descriptive statistical analysis included the calculation of percentages for comparing stress in staff in places of musical entertainment to office worker stress. This method was also use to compare demographic data and staff satisfaction with psychosocial factors.

The chi-square test was used for categorical data and the τ-test was used for continual data in this research. These tests compared the difference between music venues and office controls with respect to pollution indicator monitoring periods, chemical substance levels, health symptom concern, demographic data and psychosocial satisfaction.

Graphs of typical indoor air quality changes in musical entertainment venues were compared to the conditions in a typical office control situation and discussed.

3.5.2 Univariate statistics

Univariate analysis of variance is defined as "a statistical technique used to determine, on the basis of one dependent measure, whether samples are from populations with equal means" (Hair Jr et al. 1987).

The τ-test was used to compare the psychosocial responses of staff in the two venue types and to establish mean satisfaction levels. This test was also used to highlight significant correlations between staff in music venues that were experiencing allergic symptoms associated with various stressors compared to results from the staff group that had no symptoms.

The Cronbach alpha coefficient was used to validate the continual data responses contained in the psychosocial questionnaire. Although this test is not a univariate statistical analysis, the results will be included under section 4.2.1 which discusses the psychosocial questionnaire.

The Pearson correlation coefficient (r) was used to establish all possible associations between the many continual data variables in places of entertainment.

The chi-square test was use to analyse the influence that confounding variables, collected as categorical type data, had on the reporting of allergic type symptoms measured as continual data.

Significant univariate association were used in the multivariate analysis.

3.5.3 Multivariate analysis

Multiple regression analysis is a statistical technique used to analyse the relationship between a single dependent variable and several independent variables (Hair Jr et al. 1987). Models of health symptoms and their possible causes were established using two multivariate statistical methods.

Stepwise logistic regression analysis was used to correlate allergic type stress responses, based on nominal data, with environmental influences, based on ordinal data.

Stepwise multiple regression was used to correlate certain ordinal data psychophysical stress responses with various environmental influences.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 DESCRIPTIVE STATISTICAL RESULTS AND DISCUSSION

Descriptive data results of worker physical and psychosocial lifestyle stressors in places of musical entertainment are summarised and compared to office control data. The number of respondents interviewed in the two venue types are described in these tables as "N". The p-values demonstrate significant differences between the two types of environments. Staff that experience stress for the majority of time in the work place will be reported as percentages to two decimal places so that the reader can accurately establish staff numbers.

4.1.1 Demographic data: hours and days of work

4.1.1.1 Results and discussion on demographic data

Table 4 reflects the male and female staff percentages.

Table 4 The chi-square test of male and female staff variation

Venue	Male	Female	N
Music	62,11%	37,89%	95
Offices	32,00%	68,00%	25

p-value 0,007 (p-value < 0,05 is significant)

A larger number of males were working in places of musical entertainment. This table also shows that a significant difference exists between the ratio of males and female in the two venue types.

During completion of questionnaires it was discovered that the majority of workers in music venues were students. Certain of the respondents advised that they also worked during the day and most of the bouncers were off-duty police officers.

Table 5, demonstrates that the majority of staff work for 8 hours and more per shift in entertainment venues. Long work hours and demanding patrons may prove stressful for many of these workers.

Table 5 Staff percentages (%) related to hours of work per shift

Venue	< 8 hours	8 hours	> 8 hours
Music	34,74%	26,32%	38,95%
Offices	8,00%	92,00%	0,00%

Table 6 *T*-test showing mean hours worked per night and mean days worked per week

Venues	Mean hours	SD	Mean days	SD	N
Music	7 hours 59 minutes	2,58	3,88	1,54	95
Offices	7 hours 31 minutes	1,66	4,92	0,4	25

p-value for hours of work 0,2684 (p-value < 0,05 is significant)
p-value for days of work 0,0001

Although Table 6 shows little mean variation between hours worked per night by the music venue staff and hours worked per day by the office staff, the larger standard deviation for the music venue mean illustrates that more variation in hours worked by the music venue staff does occur. This variation is clearly illustrated in Table 5.

Table 6 shows a significant difference in the number of days worked during the week by the two groups. It was established through Table 7 that 37,90% of the staff in places of entertainment were employed for 5 nights and more a week. This may contribute to a stressful lifestyle, especially for those staff working in day jobs as well.

Table 7 Staff percentages (%) related to days of work

Shifts per week	1	2	3	4	5	6	7
Music venue	5.26%	17,89%	17,89%	21,50%	18,95%	17,9%	1,05%
Office staff	0%	0%	4,00%	0%	96,00%	0%	0%

The character of the work demands bar attendants and waiters to work continuously during their shifts. Most workers in places of entertainment remarked that by the end of the evening they felt exhausted. The potential for stress due to long work hours was assessed though the workers' feelings of tiredness. The concept of using tiredness as an indicator of stress was based on previous research which concluded that moonlighting was positively associated with stress (Arcuri and Lester 1990).

Table 8 demonstrates the difference in the occurrence of tiredness between the two groups. The p-values emphasis significant differences between staff in places of musical entertainment and offices.

Table 8 The chi-square test of symptoms of tiredness which is represented as worker percentages (%)

Occurrence of tiredness	Music venue	Office	p-value
No effect	21,10%	72,00%	0,001
Continuously tired	18,90%	4,00%	0,001
Goes on leaving work	10,50%	24,00%	0,001
Goes after sleep	48,50%	0%	0,001
Medical and made worse	1,05%	0%	0,606
Occurs on other shifts	73,68%	20,00%	0,001

(p-value < 0,05 is significant)

Table 8 shows that 18,90% of the staff experience continuous tiredness, 48,50% feeling tired after a work shift and need a good night's sleep to recover. **It is interesting to note that only 10,50% of staff in places of musical entertainment may have experienced possible "sick building syndrome (SBS) type tiredness," but these respondents emphasised that long hours were the greater influence. This observation is hence questionable.** Indoor air-quality related tiredness improves on leaving the workplace and the percentage of office workers with SBS type tiredness was 24,00%. Tiredness is also experienced by 73,68% of the staff in music venues on other nights during the week emphasising the stress that this lifestyle is causing. In offices, 72,00% did not experience symptoms of tiredness compared to only 21,10% of the entertainment venue workers demonstrating that tiredness is an important stressor for music venue staff.

4.1.1.2 Conclusion: hours and days of work

The physical job demands and hours of work are important lifestyle stressors in places of entertainment.

4.1.2 Noise as a potential stressor

4.1.2.1 Results and discussion on noise stress

Noise is defined as "unwanted sound" and measurements are expressed in the logarithmic ratio, decibel (dB), which is one tenth of a Bel (Hassall and Zaveri 1979). The sound level meter was set on the A-weighted network which simulates the response of the human ear to noise frequencies.

Lifestyle in places of musical entertainment includes exposure to loud noise levels for the duration of the work shift. Noise exposures, especially in the case of discotheques, proved to be continuous throughout the shift.

Table 9 *t*-test of the monitoring period of noise

Venues	N	Mean	SD
Music	95	3 hours 31 minutes	1,7
Offices	25	2 hours	1,28

p-value 0,0001 indicates the significant difference between monitoring periods
(p-value < 0,05 is significant)

There were significant differences between the mean monitoring periods of noise in offices and places of entertainment shown in Table 9. However, sufficient data was acquired to ensure adequate impact assessments in both environments.

Table 10 *T*-test of noise levels

Noise in dB(A)	Music venues N_{eq}	Offices L_{Aeq}
N	95	25
Mean	99,67	55,84
SD	5,5	4,37
Max dB(A)	109,00	64,00
Min dB(A)	90,00	49,00

p-value 0,0001 indicates the significant difference between noise levels in the two venue types
(p-value < 0,05 is significant)

N_{eq} and N_{eq} have been defined in the glossary. Sound levels in Table 10 show the mean N_{eq} recorded as 99,67 dB(A). The lowest N_{eq} was 90 dB(A) which are in excess of SABS 083-1983 standard 85 dB(A) for an eight hour exposure. Sound levels in musical entertainment environments were revealed to be an important potential stressor.

However, Table 11 shows that only 3,16% of the workers were concerned enough to use hearing protection in the workplace.

Table 11 Workers observed wearing ear protection in entertainment venues

n	Percentage (%)
3	3,16%

N = 95

Table 12 *T*-test of worker age distribution

Age	Music venues	Offices
N	95	25
Mean	25,01	35,36
SD	5,7	10,375
Youngest	18	21
Oldest	44	56

p-value 0,0001 showing a significant difference between the age of workers in the two venue types
(p-value < 0,05 is significant)

Table 12 displays that most of the workers are young in music venues and accordingly loud modern music may not be a psychological stressor. This is substantiated by data in Table 13 where only 34,7% of the workers considered loud music to be a stressor for the majority of the work shift emphasising the need for education and the provision of ear protection by management.

Table 13 Worker percentage (%) who consider noise to be a stressor for >50% of the time in the work environment

Venues	Type of Noise	Staff
Music	Loud music	34,7%
Music	People noise	16,9%
Offices	General noise	12%

N = 95

People noise as a result of a crowded environment was also commented on. Only 16,9% of the staff considered "people noise" to be a stressor for the majority of the work shift.

Table 14 Lowest recommended exposure time to noise compared to the highest in places of musical entertainment

Music venues	Lowest	Highest
Per night	2 minutes	2 hour 48 minutes
Per week	11 minutes	72 hour 54 minutes

N = 95

The mean exposure limits were calculated to underscore the need for noise protection in these environments. Table 14 provides an example of exposure time limit variations where during a work shift, a single exposure of only 2 minutes would represent the worst exposure scenario in music venues monitored. Other workers could receive up to 2 hours 48 minutes of noise before reaching their exposure limit. Presuming that noise exposure is similar on other shifts, certain workers should only spend 11 minutes during a week in these environments when not using hearing protection, whilst others could spend up to 72 hours 54 minutes in the environment without ear protection.

Table 15 Acceptable noise exposure limits per night and per week to avoid the potential for hearing loss compared to actual mean noise exposure for workers in places of musical entertainment

Work period	Acceptable mean exposure limit	SD	Actual mean exposure time	SD	Maximum exposure time recorded	Minimum exposure time recorded
Per night	29 minutes	40	6 hour 22 minutes	2	10 hours	3 hours
Per week	6 hour 54 minutes	12,9	24 hour 12 minutes	12,3	56 hours	7 hours

* Offices noise never exceeded 85 db(A). N = 95

Table 15 compares an acceptable mean exposure limit as a contrast to the actual mean exposure in places of entertainment for workers not provided with ear protection. The aim has been to highlight the need for awareness of the potential health-risk related to noise exposure with this type of lifestyle. Table 15 shows that the actual mean exposure period was 6 hours 22 minutes per night. A mean acceptable exposure time of only 29 minutes was calculated for these exposure levels. Projecting the data for a working week, the mean exposure to noise was 24 hours 12 minutes. A mean exposure time of only 6 hours 54 minutes would be a weekly limit for the majority of workers with no hearing protection at the measured noise levels. However, large standard deviations for these suggested mean exposure limits demonstrates that noise levels vary between premises. Authorities should individually evaluate noise impacts at each venue and should preferably conduct personal worker exposure assessments. The enforcing of wearing hearing protection is considered a priority for staff in places of musical entertainment.

Table 16 Staff in places of musical entertainment who experience strain for 50% or more of the time from a sore throat because of having to communicate over loud noise

Percentage (%) concern over sore throat
32,63%

N = 95

Table 16 shows that staff having to raise their voices above the noise level to communicate caused 32,63% of these workers to experience a sore throat for the majority of the time in music venues. However, other environmental stressors may also have caused the staff to experience a sore throat. This will be discussed further in terms of univariate statistical analysis later in this thesis.

4.1.2.2 Conclusion: noise as a stressor

It is evident that noise levels in places of musical entertainment are a potential threat which may lead to hearing loss. For some of the staff it also proves to be a psychological stressor. Communicating over loud noise may cause certain staff to experience a sore throat.

4.1.3 Lighting as a potential stressor

4.1.3.1 Results and discussion on lighting

Lighting levels was assessed using lux as the unit of measurement. Lux (lx) is defined as the metric unit of illuminance (SABS 0114 1973). The two potential lighting stressor types assessed in places of musical entertainment were psychedelic lighting and local lighting. Local lighting is defined as "lighting designed to increase the illuminance at certain specific positions (for instance on the task)" (SABS 0114 1973, p 10).

Table 17 *t*-test of lighting levels measured in lx at strategic points in the workplace

Venues	N	Mean	SD	Max	Min
Music	95	154,88	319,6	1327	3
Offices	25	495,88	160,9	761	200

p-value 0,0001 showing that a difference exists between lighting levels at the two venue types
(p-value < 0,05 is significant)

Not all places of entertainment used psychedelic lighting effects. Local lighting was recorded at work stations, such as bar tills, disk-jockey stands and band stands. Levels were extremely varied in places of entertainment. This is demonstrated in Table 17 where a mean of 154,88 lx with a standard deviation of 319,6 for places of entertainment is stated. A maximum level of 1327 lx and a minimum level of 3 lx were recorded.

Local lighting in the office controls were less diverse, the mean being 495,88 lx with a standard deviation of 160,9. A maximum of 761 lx and minimum of 200 lx were measured. However, a significant contrast existed between the mean levels of lighting in the two types of venues because of the differing jobs.

As no specified lx level is recommended in SABS 0114 for places of musical entertainment a minimum level of 100 lx was used as a musical venue guide for the purpose of this research. This level was decided on as it represented the lowest indoor lighting requirement in the SABS lighting code and may be acceptable for places of entertainment which require low lighting levels to create an acceptable ambience. For offices the level recommended is 500 lx. The mean of 495,88 lux for offices compares reasonably well with the 500 lx standard and the mean of 154,88 lx for places of musical entertainment exceeds the chosen 100 lx level.

Table 18 Workers exposed to lighting levels below suggested standards

Venues	N	Worker percentage (%)
Music (<100 lx)	95	75,80%
Offices (<500 lx)	25	60,00%

Although the mean lx level for music venues was higher than the suggested standard, Table 18 shows that 75,8% of the musical venue staff work with lighting levels at strategic work points of less than 100 lx. Similar results occurred for offices where 60% of the staff work with lighting levels less than 500 lx.

Table 19 Workers that consider lighting levels at strategic work points to be a stressor for 50% of time and more

Music venues	N	Offices	N
11,60%	95	8,00%	25

Although lighting levels appeared to be a potential stressor, Table 19 confirms that only 11,60% of music venue staff and 8% of office staff expressed concern regarding lighting levels. The young age of respondents may have had a positive influence on these results because of good eye sight.

Table 20 Workers that are exposed to psychedelic lights and consider them a stressor for 50% of the time and more

Exposed worker percentage (%)	Stressed worker percentage (%)
77,89%	24,32%

* Staff exposed to flashing lights N = 74

Not all workers in places of musical entertainment were exposed to psychedelic lighting. The subjective reaction of the 74 exposed workers, described in Table 20, showed that 24,32% of these workers felt that flashing lights are a stressor for 50% of the time and more.

4.1.3.2 Conclusion: lighting as a stressor

Subjective and objective assessments tend to indicate that local lighting is not an important stressor. However, flashing lights may prove a stressor and this will be discussed further in terms of univariate correlations in section 4.2.

4.1.4 Ventilation and comfort as potential stressors: results and discussion

4.1.4.1 Ventilation systems utilised in places of musical entertainment and office controls

Table 21 Types of ventilation sources in relation to staff percentages (%) and their working positions

Ventilation sources	Music venue staff	Office staff
1	43,20%	0%
2	21,10%	0%
3	26,30%	28,00%
4	4,20%	0%
5	5,30%	0%
6	0%	72,00%

Music venue N = 95 Offices N = 25

Ventilation sources described:

1 Air conditioning duct outlet near work position.
2 No nearby source of conditioned air supply.
3 Workers that move around a ducted air-conditioned work environment.
4 Near natural ventilation and with a nearby air conditioning duct outlet.
5 Natural ventilation only.
6 Air conditioning wall unit and natural ventilation sources that were closed at the time of the survey.

Of the total staff interviewed in places of musical entertainment, 90,60% worked in environments served by ducted air conditioning systems only. Of the office staff interviewed, 72% work in rooms with air conditioning wall units and natural ventilation sources that were closed at the time of the survey. Twenty eight percent of office staff worked in ducted air conditioned environments. **The majority of staff in places of musical entertainment have no personal control over ventilation and deterioration of air quality during work shifts. This has the potential to increase worker stress and will be discussed in section 4.2.2.11 which deals with univariate confounding variables.**

4.1.4.2 Carbon dioxide levels: an indicator of ventilation performance

Table 22 *t*-test of monitoring period for relative humidity, temperature, carbon dioxide and respirable aerosols

Venues	N	Mean monitoring period	SD
Music	95	6 hours	1,687
Office	25	6 hours 47 minutes	0,43

p-value 0,0002 showing the significant difference in the monitoring periods between the two venue types (p-value < 0,05 is significant)

The carbon dioxide level in indoor environments is an accepted indicator of ventilation performance. Table 22 shows a significant difference between monitoring periods conducted in the two venue types. This was due mainly to the varied hours of work in entertainment venues and was demonstrated by the larger standard deviation for the music venues. However, the real-time monitoring periods of carbon dioxide for both environments were adequate and provided an evaluation of ventilation performance over the majority of the work shift.

Table 23 Comparisons of maximum and minimum carbon dioxide levels, worker percentages and exposure time in relation to the carbon dioxide standard of 1000 ppm

Venues	Worker percentage (%) where CO_2 levels were >1000ppm for the majority of monitoring period	Worker percentage (%) where CO_2 levels were <1000ppm for the majority of monitoring period	Max CO_2	Min CO_2
Music	83,20%	16,80%	>5000ppm	312ppm
Offices	0%	100%	810ppm	351ppm

N = 95 Music venues N = 25 Offices

Results showed that in all places of entertainment carbon dioxide levels exceeded the standard of 1000 ppm. Due to instrument limitations, maximum carbon dioxide levels could not be measured in those places of musical entertainment where maximum levels exceeded 5000 ppm. A true mean value could hence not be obtained. Table 23 shows that for 83,2% of workers in music venues, carbon dioxide levels exceeded 1000 ppm for the majority of the monitoring period. Carbon dioxide levels in the offices never exceeded 1000 ppm. The mean time for the 1000 ppm standard of carbon dioxide to be exceeded in places of musical entertainment was approximately 2 hours 50 minutes. The time taken to exceed 1000 ppm varied between venues as is shown in Table 24.

Table 24 Mean time taken for carbon dioxide to exceed 1000 ppm in places of musical entertainment

Venue	N	Mean time	SD
Music	95	2 hours 50 minutes	7,18

Figures 2, 3 and 4 are included as typical examples of carbon dioxide-level progression during a work shift.

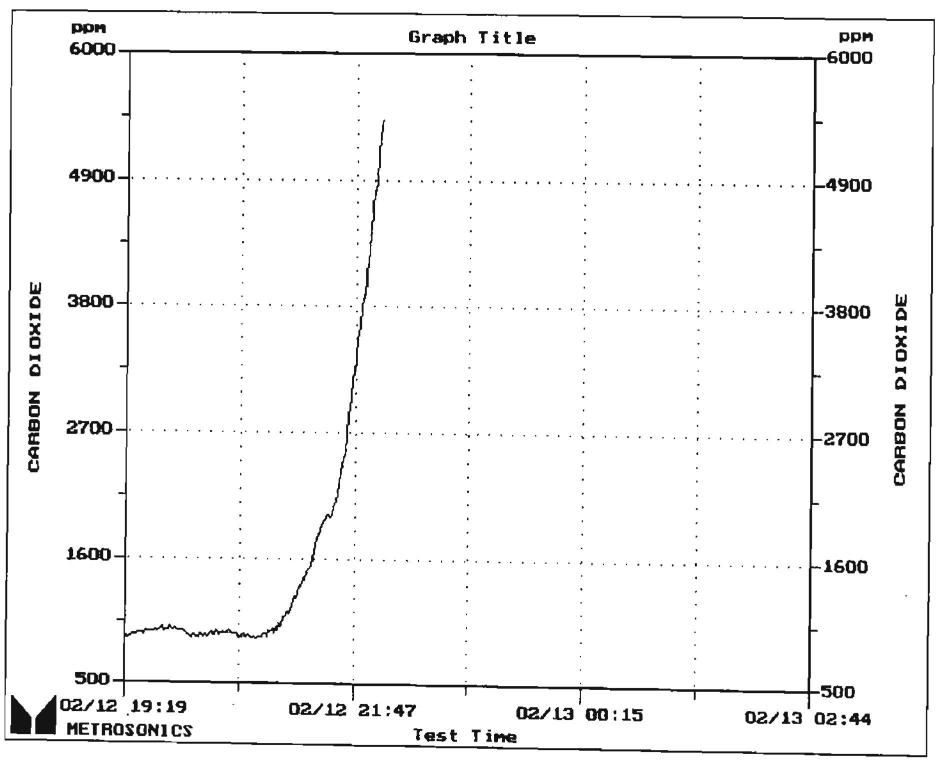

Figure 2 A typical graphic example of changes in carbon dioxide levels during the evening in a place of musical entertainment where the levels exceeded the scale of the instrument

Figure 2 clearly shows that it only took from 19h19 to approximately 21h47 to exceed the 5000 ppm limit of the indoor air quality monitor in a typical place of musical entertainment. When monitoring ceased at 02h44, the level of carbon dioxide had not returned to within the recording range of the instrument.

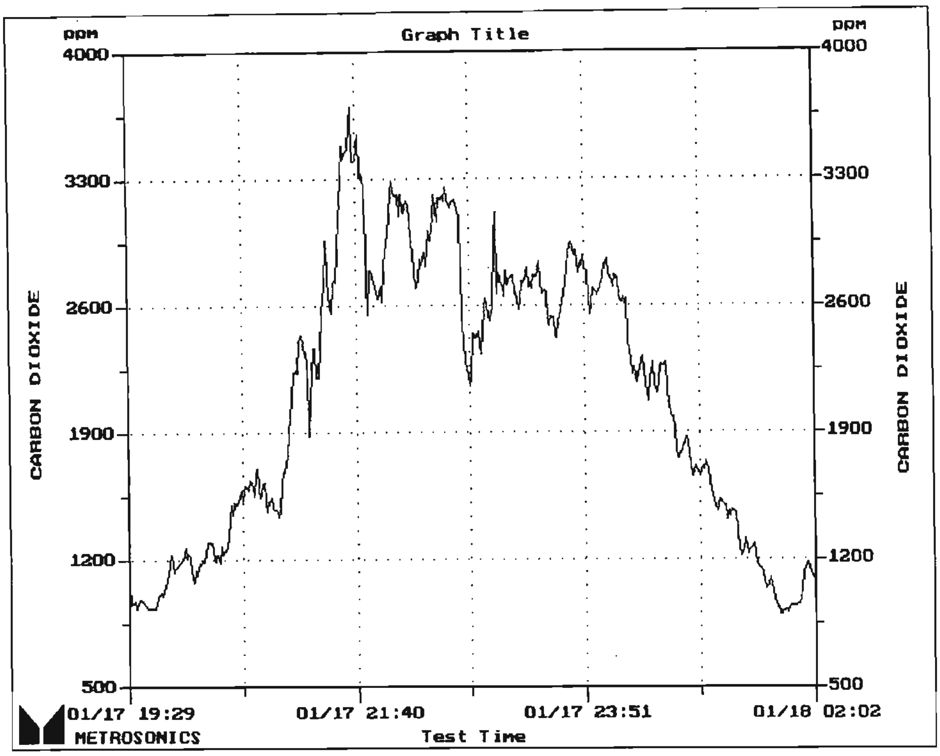

Figure 3 A typical graphic example of changes in carbon dioxide levels during the evening in a place of musical entertainment where the levels did not exceed the scale of the instrument

In another music venues, levels of carbon dioxide did not exceed the range of the instrument and an example of the progressive increase of carbon dioxide is portrayed in Figure 3. **These changes in carbon dioxide were directly related to people entering and leaving the premises and the inability of ventilation systems to maintain acceptable indoor air quality.**

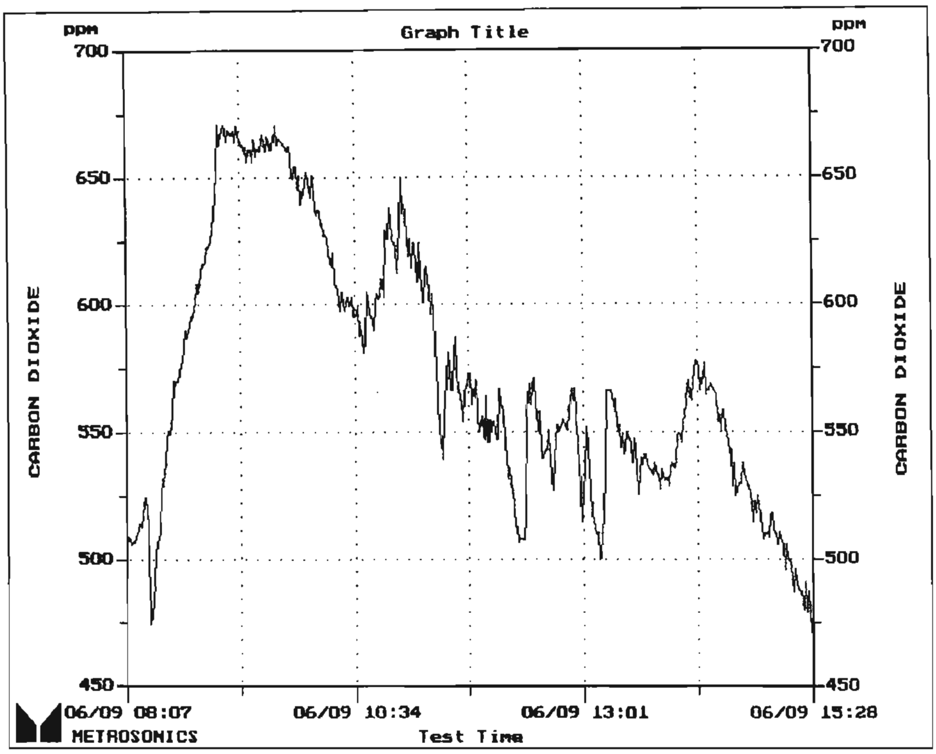

Figure 4 A typical graphic example of changes in carbon dioxide levels during the day in a non-smoking office

Figure 4 represents conditions in a non-smoking office environment. Although it is well-known that poor ventilation in offices can result in carbon dioxide levels above 1000 ppm, all offices used in this survey had levels below the standard during monitoring periods.

4.1.4.3 Air movement as a comfort indicator

Table 25 T-test of air movement data measured in m/s in music venues and offices

Venues	N	Mean	SD	Max	Min	Standard
Music	95	1,67	0,17	0,6	0,006	0,1 to 0,3m/s
Office	25	0,06	0,06	0,3	0,01	0,1 to 0,3m/s

p-value 0,0001 indicating the difference in air movements in the two venue types
(p-value < 0,05 is significant)

Table 25 demonstrated the difference between air movement means in the two venues. It is interesting to note that even though the air movement in offices was much lower, a lesser percentage of office workers complained about poor air movement when compared to music venue responses. **This shows that the indoor air climate factors of relative humidity, air temperature and air movement are interrelated stressors in music venues.** In Table 25 the mean air movement in places of entertainment was 1,67 m/s with a standard deviation of 0,17. Although this mean appears acceptable, it must be seen in the light of the influence that portable fans had in elevating air movement levels at specific fixed work positions (0,6 m/s is related to the use of a portable fan).

Table 26 Workers using portable fans to increase air movement

Venues	N	Worker percentage (%)
Music	95	11,60%
Offices	25	0%

Table 26 shows that 11,6% of staff in fixed positions in places of entertainment needed to modify their environment by increasing air movement through the use of portable fans because existing ventilation systems did not provide sufficient air movement to reduce stress.

Table 27 Workers experiencing stress/strain from insufficient air movement due to the air movement being inadequate for 50% of the time and more

N	Music venue	N	Offices
95	64,21%	25	20%

Table 27 demonstrates that poor air movement is an important stressor in places of musical entertainment in that 64,21% of the staff consider air movement to be inadequate for 50% of the time and more. The impact of fixed position work stations will be further discussed under the confounding variable section 4.2.2.11 of univariate analysis.

4.1.4.4 Relative Humidity (RH) and temperature as comfort indicators

Coastal climates during hot summer months have the tendency to exacerbate relative humidity and temperature. Conditions in crowded venues therefore may prove extremely uncomfortable unless ventilation systems cope adequately in reducing these stressors to acceptable levels.

Table 28 *t*-test of relative humidity (RH) data expressed as a percentage (%)

Venue	N	Mean RH	SD	Max RH	Min RH	Standards
Music	95	72,5%	5,57	91,8%	53%	Comfort 30-60% Microbes 70%
Offices	25	44,3%	4,7	57,2%	32,9%	Comfort 30-60% Microbes 70%

p-value 0,0001 showing the significant difference between relative humidity in the two venue types
(p-value < 0,05 is significant)

Table 28 summarises relative humidity data and shows the monitoring results to be significantly different between the two venue types. The main reasons for these differences were considered to be crowding, poor ventilation performance and that monitoring of offices took place over a cooler and less humid period of the year due to time and equipment constraints.

A mean relative humidity of 72,5% was existing in music venues with a standard deviation of 5,57. Relative humidity in offices were acceptable and the standard deviation indicates a lesser variation in levels than found in music venues. Not only can this humidity level reduce comfort, but may increase microbial growth on internal structures especially when levels are in excess of 70%.

Table 29 Distribution of staff where the relative humidity standards were exceeded for more than 50% of the time

Venue	N	Worker percentage (%) where RH >60%	Worker percentage (%) where RH <30%
Music	95	100%	0%
Offices	25	0%	0%

As shown in Table 29, all workers in entertainment venues were subjected to relative humidity higher than the applied standard of 60% for 50% and more of the time during the work shift.

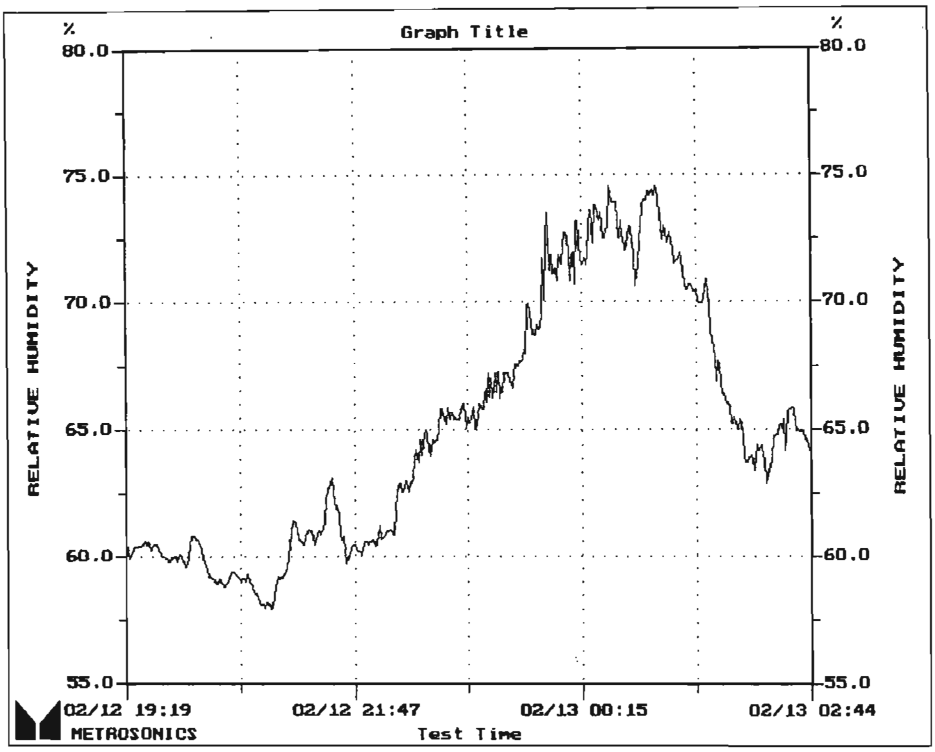

Figure 5 A typical graphical example of changes in relative humidity during the evening in a place of musical entertainment

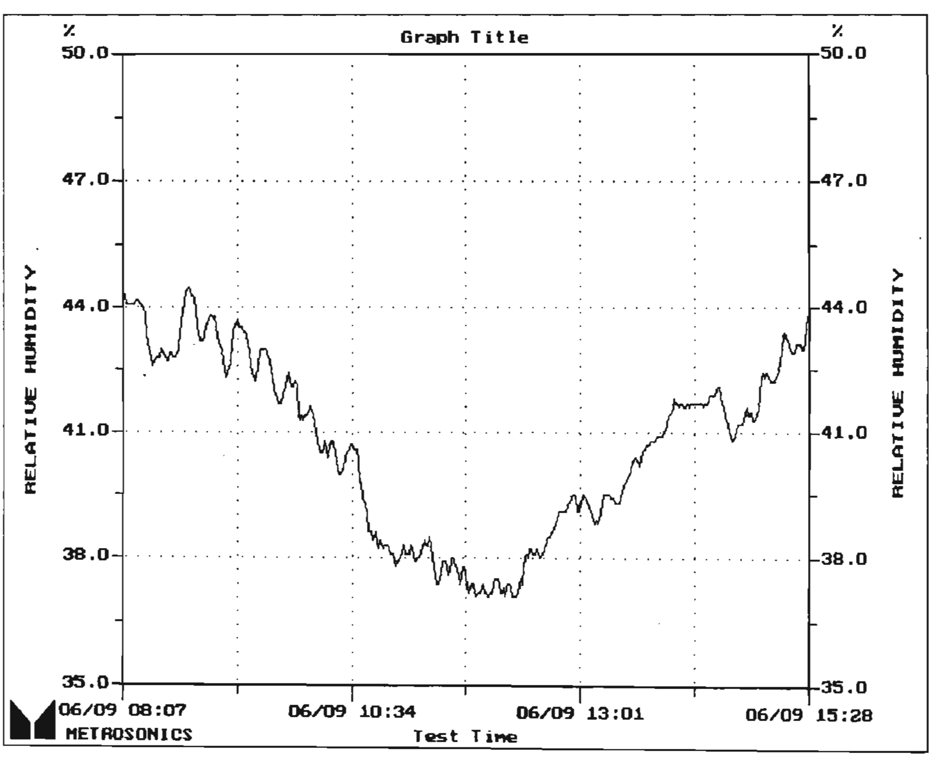

Figure 6 A typical graphical example of changes in relative humidity during the day in a non-smoking office

Figure 5 shows a typical example of how relative humidity increased in a place of musical entertainment during the monitoring period. **Relative humidity tended to follow a similar pattern to carbon dioxide levels in music venues which is related to crowding and poor ventilation.** Figure 6 represents the office environment comparison which was well within acceptable standards.

Table 30 *T*-test of temperatures in music venues and offices measured in celsius (C)

Venues	N	Mean	SD	Max	Min	Standards
Music	95	25,28	2,09	29,90	18,50	20 to 24,4 C
Offices	25	21,80	0,8	24,60	17,80	20 to 24,4 C

p-value 0,0001 indicating the significant difference in temperature levels in the two venue types (p-value < 0,05 is significant)

Table 30 demonstrates the difference in indoor air temperature. The temperature mean for places of musical entertainment was 25,28 C. A standard deviation of 2,09 for music venues indicated that temperature changes were more varied than in the office situation.

Table 31 Percentages (%) of staff where indoor air temperatures exceeded the standards >50% of the monitoring period

Venues	N	Worker percentage (%) where temperature >24,4 C	Worker percentage (%) where temperature <20 C
Music	95	65,30%	0,00%
Offices	25	0,00%	0,00%

As reflected in Table 31 the standard of 24,4 C was exceeded for the majority of the time for 65,3% of the musical entertainment workers.

Table 32 Stress/strain expressed by staff regarding air temperature being too cold or too warm for 50% of the time and more

Venues	N	Too warm	Too cold
Music	95	76,64%	6,31%
Offices	25	16,00%	16%

Table 33 Percentage (%) of staff that sweat for 50% or more of the time whilst in the work environment due high temperature and humidity

Venues	N	Worker percentage (%)
Music	95	65,26%
Offices	25	4,00%

Table 34 Staff that experience discomfort from dry nose and throat for 50% or more of the time whilst in the work environment

Venues	N	Staff percentage (%)
Music	95	46,31%
Offices	25	16,00%

The stress experienced by staff confirms the findings described in the previous table. Table 32 shows that 76,64% of workers considered the music venues too warm for 50% of the time and more. Furthermore, Table 33 reveals that 65,26% of the workers were sweating in the working environment for 50% of the time and more. Table 34 indicates that 46,31% of the staff in entertainment venues experience dry nose and throat symptoms.

Although dry nose and throat symptoms may be related to other stressors, the warm environment could have an influence on the dry throat symptoms. This is further discussed in section 4.2 which deals with univariate statistics.

Figure 7 on the following page is an example of temperature level changes in places of musical entertainment.

As with carbon dioxide and relative humidity, temperature levels tend to increase in relation to people influx and poor ventilation performance.

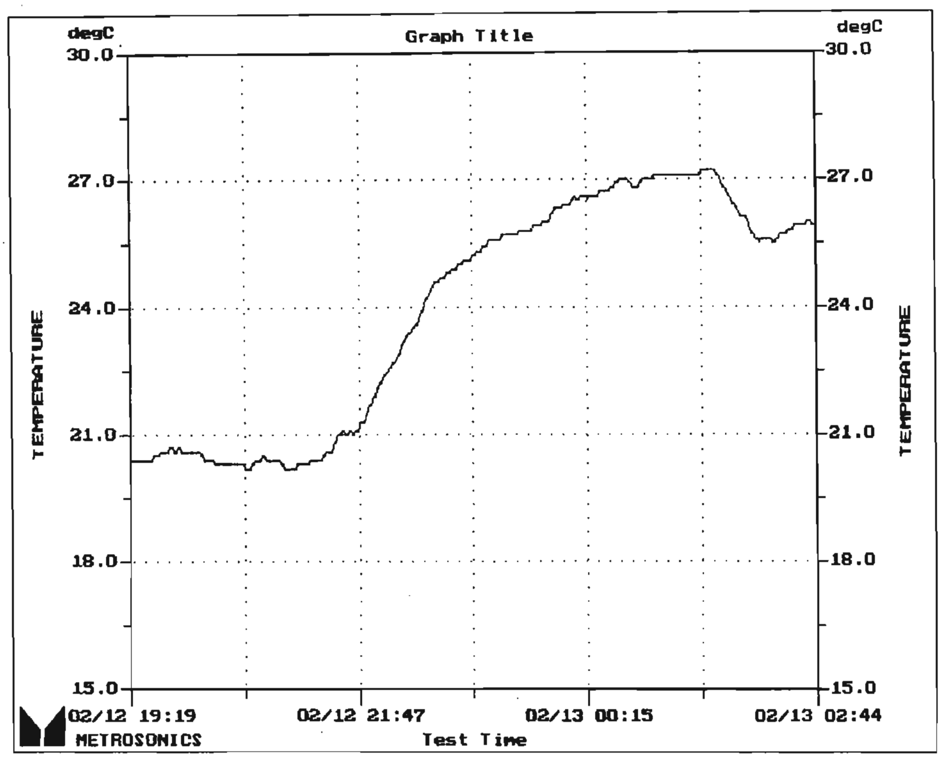

Figure 7 A typical graphic example of changes in air temperature during the evening in places of musical entertainment

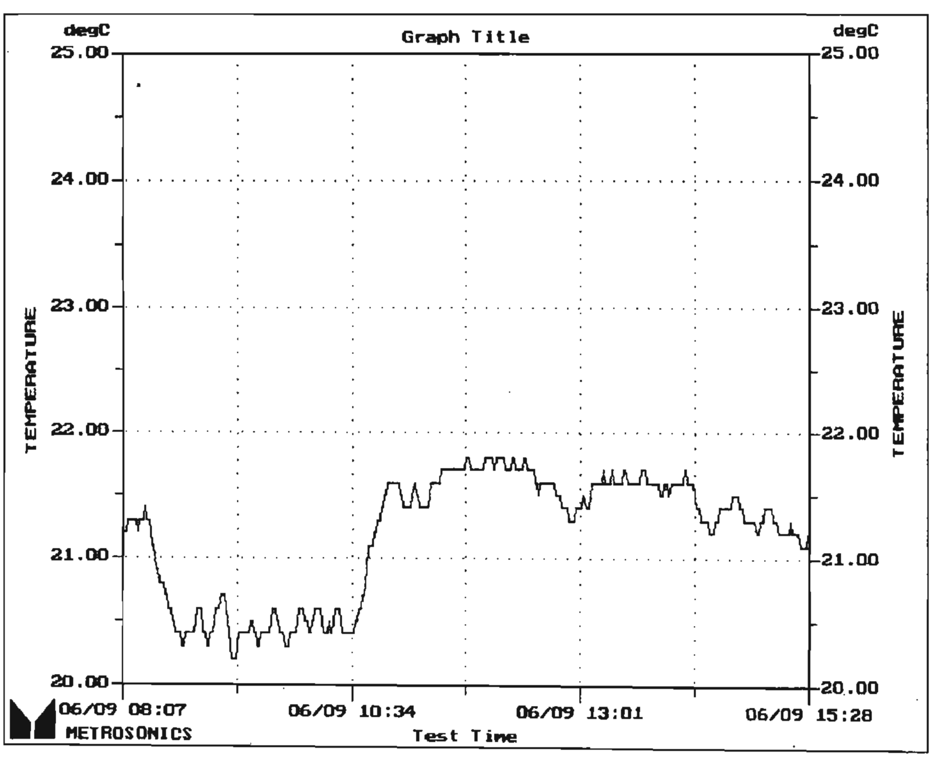

Figure 8 A typical graphic example of changes in air temperature during the day in a non-smoking office

Levels in the office example shown in Figure 8, tend to fluctuate around a specific level with only a slight increase later in the working day.

4.1.4.5 Conclusion: ventilation and comfort stressors

By combining the relative humidity mean and the temperature mean it was established that the comfort conditions in places of musical entertainment have the potential, for the majority of workers, to exceed the acceptable ranges of operative temperature and relative humidity recommended by ASHRAE (1992).

There are extreme demands placed on ventilation systems in music venues. Large numbers of people and the resultant poor indoor air quality have the potential to create an uncomfortable and unhealthy environment. The correlations between these stressors and their associated health effects are further discussed in section 4.2.

4.1.5 Odours of concern, pollutant levels and distress over pollution in crowded places of musical entertainment

4.1.5.1 Crowded environments: results and discussion

Places of musical entertainment tend to attract large numbers of young people. Musicians and disk-jockeys commented that they feel happier with large numbers of people as this is an indication that their musical approach is successful. The staff more likely to feel stressed would be bar attendants and waiters. Staff feeling stress for the majority of the work shift due to crowds was 40% as shown in Table 35.

Table 35 Staff in places of musical entertainment who experience stress/ strain due to crowded conditions for 50% or more of the time

Percentage (%) concerned over crowds
40%

N = 95

4.1.5.2 Concern regarding various odour types in comparison to tobacco smoke odour

Apart from psychological stress, crowded conditions have the potential to increase pollution levels. Table 36 serves to compare the various odour concern responses of workers in places of musical entertainment. The responses have been arranged in descending order of concern, indicating that tobacco smoke is considered the main recognisable pollutant. Theatrical smoke was not used in every venue.

Table 36 Workers in places of entertainment and offices who experience significant stress/strain for 50% of the time and more regarding odours

Odours	Music venues	Offices
Tobacco smoke	46,31%	No smoking
Stale air	41,04%	0%
Body odours	34,74%	0%
Musty odours	27,37%	4,00%
Theatrical smoke	26,83%	Not applicable
Dusty air	26,32%	4,00%
Alcohol	16,84%	Not applicable
Miscellaneous	5,27%	0%

N = 95 Music venue N = 25 Offices

From Table 36 it is evident that staff in places of musical entertainment have many noticeable potentially-allergenic pollutants to cope with psychologically and physically. Smoking odours were considered by respondents as the most important stressor. Smoking, was promoted in many of the venues by making cigarette dispensing machines available and by the provision of ash trays. The use of theatrical smoke in certain music venues was responsible for periodic peak aerosol levels. However, only 43,16% of the staff were exposed to this stressor. Theatrical smoke odour was ranked less important than the tobacco smoke odour stressor. As not all venues were utilising smoke machines and the focus of this research was tobacco smoke, theatrical smoke will be recommended as a topic for further research.

4.1.5.3 Tobacco smoke concerns

Table 37 The chi-square test on smoking habits

Venues	N	Smokers	Non-smokers	Family members who smoke
Music	95	67,37%	32,63%	57,89%
Offices	25	4%	96%	32%

p-values indicating significant differences between music venues and office controls: Smokers 0,001 ; Non-smokers 0,001; Family members who smoke 0,021
(p-value < 0,05 is significant)

Table 37 shows that **the majority of the music venue staff interviewed were smokers.** Of the group of non-smokers in places of musical entertainment, 6,32% were ex-smokers. It was also noted that 57,89% of workers in places of entertainment have immediate family members who smoke compared to 32% of the office workers. These exposures to tobacco smoke are increasing the risk of cancer for music venue workers.

The lifestyle of workers in places of entertainment in terms of exposure to the carcinogenic hazard of tobacco smoke, both from smoking and passive smoking, poses a threat to the health of these workers. The passive smoking hazard is always present.

Table 38 Staff that consider the smell of tobacco smoke on hair and clothing after leaving the work environment an important stressor for more than 50% of the time

N	Music venues	N	Offices
95	63,16%	25	0%

The staff in places of entertainment were asked to comment on how concerned they were regarding tobacco smoke pollution. Table 38 shows that 63,16% of smoking and non-smoking workers were concerned about their hair and clothes smelling of tobacco smoke on leaving the premises. Some of the staff remarked that before going the bed they would shower because of this odour.

Table 39 Tobacco smoke odour concern for 50% of the time and more by smoking and non-smoking staff in places of entertainment

N	Venue	Smoker concern	Non-smoker concern
95	Music	39,06%	64,51%

Table 39 demonstrates that a greater percentage of non-smokers considered tobacco smoke to be a major pollutant of concern in music venues compared to the smoking staff.

These results would tend to confirm that tobacco smoke pollution is also a potential psychological stressor for workers in places of entertainment.

4.1.5.4 Pollutant indicators of tobacco smoke

Table 40 *T*-test of monitoring periods for benzene, toluene, xylene, respirable particulate matter

Venues	N	Mean	SD
Music	95	5 hours 51 minutes	0,94
Office	25	6 hours 5 minutes	0,496

p-value 0,0868 shows that a significant difference did not exist between monitoring periods in the two venue types (p-value < 0,05 is significant)

Connected to the smoking habit is the emission of various harmful substances into the indoor air. Table 40 shows that the mean monitoring period for volatile and semi-volatile compounds in entertainment venues was 5 hours 51 minutes. This was similar to the monitoring period in offices.

Table 41 *t*-test chemical levels

Chemical data	Music venues	Office	P
Benzene µg/m³	12,9	0,606	0,0001
SD	12,6	0,36	
Max µg/m³	42,44	1,24	
Min µg/m³	< detection limit	0,27	
Toluene µg/m³	38,87	7,54	0,0001
SD	36,478	9,2	
Max µg/m³	106,68	32,93	
Min µg/m³	< detection limit	1,24	
Xylene µg/m³	22,8	5	0,0001
SD	17,67	4.78	
Max µg/m³	55,02	21.67	
Min µg/m³	< detection limit	1,24	

(p-value < 0,05 is significant) N = 95 Music venues N = 25 Offices
Benzo(a)pyrene levels were below the detection limit.

Benzene is ubiquitous in the environment, as confirmed by the detection in smaller quantities in the non-smoking office controls. Table 41 also shows that a significant difference existed between levels of benzene, toluene and xylene in the two venue types. **Activities in musical entertainment environments positively impact on levels of benzene, toluene and xylene.** Benzo(a)pyrene levels were below laboratory detection limits. In places of entertainment tobacco smoke is the most noticeable pollutant. Smoking of tobacco is known to produce a wide range of pollutants. Levels of benzene, toluene and xylene did not exceed threshold limit values and were reasonably comparable to the ranges reported in previous research. For example, mean levels detected in an experimental room where people were smoking were benzene 60,1 $\mu g/m^3$, toluene 286,2 $\mu g/m^3$ and xylene 24,8 to 53,8 $\mu g/m^3$ (Adlkofer et al. 1990). Levels of these substances should be lower in real-life situations. Mean benzene levels measured in public places were 20 to 317 $\mu g/m^3$ (Gold et al. 1993) and according to Sterling et al. (1982), mean benzene levels ranged from 50 to 150 $\mu g/m^3$.

Toluene levels ranged from 40 to 1040 $\mu g/m^3$. Concentration means in non-smoking environments were not provided for comparison in this previous research.

Table 42 Results from two sampling points taken in an office environment where a solvent containing benzene was used for the cleaning of drawing boards

Benzene $\mu g/m^3$	Toluene $\mu g/m^3$	Xylene $\mu g/m^3$
40,48	163,45	27,17
35,44	153,71	27,03

Details regarding the types of public places monitored and the internal conditions would have been useful for contrast, as in non-industrial working environments many substances are used that can produce low concentrations of air pollutants. As an example, analytical data are provided of air samples taken in an office environment where a solvent was occasionally used during the month to clean drawing boards. Table 42 displays benzene, toluene and xylene levels found in this office environment, which are comparable to the maximum levels found in certain places of entertainment shown in Table 41.

Table 43 Analysis of an indoor air sample in the absence of tobacco smoke where a smoke machine was producing theatrical smoke in an empty place of entertainment

Benzene $\mu g/m^3$	Toluene $\mu g/m^3$	Xylene $\mu g/m^3$
0,90	0,81	< detection limit

An air sample was collected of theatrical smoke from an empty entertainment environment where no tobacco smoking was taking place during the monitoring period. The results tend to indicate that theatrical smoke may have negligible influence on benzene, toluene and xylene levels in musical entertainment environments. Table 43 provides results of this air sample. These levels are not much different from levels in non-smoking office environments shown in Table 41.

However, theatrical smoke mixtures vary and further research is necessary to characterise potential pollutant emissions (Annexure 4 shows the mixture contents of two different samples of theatrical smoke prior to heating).

Volatile and semi-volatile substances in a crowded place of musical entertainment and a non-smoking office (where a benzene based solvent was being used) are summarised in Tables 44 and 45. Allergy-effects from exposure to such substances can result in absenteeism. This is believed to affect approximately 30% of the population in the USA (Sax 1984).

Even minute quantities of most substances can cause allergies in hypersensitive people, even though they are not in high enough concentrations to cause a systemic toxic effect (Sax 1984). A single chemical or groups of chemicals can attack the skin, eyes, sinuses, nasal and respiratory systems.

Table 44 Compounds identified at a place of entertainment and a non-smoking office collected on XAD-2 Adsorbent and PTFE filters (a benzene based solvent was being used in the office)

Place of entertainment	Office
Dimethylbenzene-isomer	Dimethylbenzene-isomer
2,5,6-Trimethyldecane	-
Benzaldehyde	Benzaldehyde
1-Ethyl-2-methylbenzene-isomer	-
Trimethylbenzene-isomer	Trimethylbenzene-isomer
Dichlorobenzene-isomer	Dichlorobenzene-isomer
Alkylcyclohexene-isomer	Alkylcyclohexene-isomer
Decamethylcyclopentasiloxane	-
1-Methyl-4-(1-methhylethyl)-cyclohexanol	-
Naphthalene or 1-Methylene-1H-indene	-
Methylnaphthalene-isomer	-
-	Benzenemethanol
3-(1-Methyl-2-pyrrolidinyl) -pyridine	-
-	Alkylbenzene-isomer
3,7-Dimethyl-1,6-octadien-3-ol-2-aminobenzoate	-
1.1-Biphenyl	-
Alkylphenol-isomer	-
Diethylphthalate	-
9H-Fluorene	-
Tetradecanoic	-
Hexadecanoic	-
Phthalate-isomer	-
Nonanedioic acid, dibutyl ester	-
3-Nitro-1,2-benzenedicarboxylic acid	-
2-Methylpropanoic acid, 3-hydroxy-2,4,4-trimethylpentylester	-

Table 45 Compounds identified at a place of entertainment and a non-smoking office collected on activated charcoal (a benzene based solvent was being used in the office during the monitoring period)

Places of entertainment	Offices
Benzene	Benzene
3-Methylhexane/methylhexane-isomer	3-Methylhexane
2,2,3,3-Tetramethylbutane	2,2,3,3-Tetramethylbutane
Toluene	Toluene
Dimethylbenzene-isomer	Dimethylbenzene-isomer
Alpha-Pinene-isomer	-
Ethylmethylbenzene-isomer	-
Dichlorobenzene-isomer	Dichlorobenzene-isomer
Alkylcyclohexene-isomer	Alkylcyclohexene-isomer
Decamethylcyclopentasiloxane	-
3-(1-Methyl-2-pyrrolidinyl)-pyridine	-
Methylethylbenzene-isomer or Cumene	-
-	2-Methylpropyl-acetic acid ester
-	Ethylbenzene
-	Dimethylbenzene-isomer
-	Alkylbenzene-isomer

Data were not available on all of the substances reported. Sources of information included Sax (1984), Pohanish and Greene (1993), Budavari (1989) and Hawley (1977). Data on substances are summarised as follows:

* **Benzaldehyde** is a mutagen and allergen. It can cause irritation of the eyes, nose, throat and skin. Long-term eye and lung injury may occur.

* **Benzene** is a carcinogen and mutagen. It can result in irritation of the eyes, nose, throat and cause headaches.

* **Dimethylbenzene (xylene)** can result in irritation of the eyes, skin and can cause headaches and tiredness. Long term effects include liver and kidney damage, also intestinal tract disturbance and central nervous system depression.

* **1,2,3-Trimethylbenzene and trimethylbenzene** can cause irritation of the eyes and skin, including headaches. Long-term effects can be liver problems, bronchitis, cough, difficulty in breathing, tiredness, nervousness, lung problems and blood clotting.

* **1,2-Dichlorobenzene and 1,4-dichlorobenzene** are possible carcinogens, mutagens and reproductive hazards. They can be extremely irritating to the throat and mucous membranes, resulting in coughing, and may also cause irritation of the eyes and skin. Long-term effects include damage to the lungs, kidneys and testes. Leukaemia, central nervous system effects and brain damage are possible.

* **Toluene** may be a mutagen. It can cause irritation of the eyes, nose, throat and upper respiratory tract. It may also result in dizziness, lightheadedness and headaches.

* **Naphthalene** can result in irritation of eyes, nose, throat and skin. Long term effects are headaches, fatigue, nausea, eye damage and liver damage. Some studies have indicated the possibility that the substance can cause tumours.

* **3-(1-Methyl-2-pyrrolidinyl)-pyridine (nicotine)** is a mutagen. It may cause irritation of the nose, throat, lungs, eyes and skin. With high exposures nausea, headaches, weakness, increased blood pressure, visual disturbance and increased heart rate can occur. Long term effects include birth defects, increased risk of heart

attacks and hardening of the arteries.

* **1,1-Biphenyl** is a mutagen. It can result in irritation of the eyes, nose, throat, lungs and skin. Headache, stomach pain, nausea, indigestion, fatigue, aching arms and legs can be caused. Long term effects include birth defects, brain damage, nerve damage, weakness and mood changes.

* **Methylhexane-isomer** may be irritating to the upper respiratory tract.

* **Alkylcyclohexane** is moderately toxic by inhalation and skin contact.

* **Diethyl-o-phthalate** may be teratogenic and is a human irritant.

* **Ethylbenzene** is a mutagen. It can cause eye, nose and throat irritation. Exposure can result in headaches, fatigue and skin dryness. Long-term effects may be birth defects, miscarriages, dermatitis and changes in the nervous system.

* **Cumene** is a narcotic. It can cause irritation of the eyes, nose, throat and skin. Headache, dizziness, fatigue, nausea and vomiting can occur. Long term effects are drying of the skin as well as lung, kidney and liver damage.

It is evident that the many pollutants present in places of musical entertainment have the potential to cause allergic effects, other symptoms and increase staff stress.

Table 46 T-test of real-time respirable aerosol levels comparisons

Venues	N	Mean mg/m^3	SD	Max mg/m^3	Min mg/m^3
Music	95	1,75	1,286	45,98	< detection limit
Office	25	0,02	0,02	0,58	< detection limit

p-value 0,0001 showing the difference exists between respirable aerosol levels in the two venue types (p-value < 0,05 is significant)

Particulate pollution is a another potential allergen. Table 46 represents real-time respirable particulate sampling results. Particulate level data were influenced by the presence of theatrical smoke aerosols in certain premises.

Tobacco smoke which consists of tarry droplets and liquid droplets from respired breath could influence the analytical data. The impact of aerosol pollution is clearly demonstrated when comparing music venue levels to office results. The results in Table 46 compare well with other research data. Mean concentrations of air borne particulates reported in poorly ventilated taverns have been as high as 1,5 mg/m^3 (Sterling et al. 1982). Levels in smoking sections of restaurants have been measured at 0,11 mg/m^3 (Lambert et al. 1993). A review of literature by Siegal (1993) shows that **in general the mean respirable particulate level in bars is 0,348 mg/m^3. Table 46 shows a mean value of 1,75 mg/m^3 for places of musical entertainment which suggests that some workers in music venues have to cope with higher particulate levels than workers in poorly ventilated taverns.**

Crowded places of musical entertainment have higher levels of particulates than poorly ventilated taverns, bars and restaurants due to tobacco smoke pollution and the added influence of theatrical smoke.

A mean particulate air concentration level for smoking offices was reported by Siegal (1993) as 0,057 mg/m^3. When compared to 0,02 mg/m^3 from Table 46 this demonstrates that tobacco smoking in office environments may only have a limited influence on respirable particulate levels. However, this will depend on ventilation performance and the number of cigarettes smoked. Previous studies which were reviewed did not include non-smoking office environments as a control. The approach of using a non-smoking control environment was considered essential in this thesis to demonstrate the impact of tobacco smoke on indoor air pollution.

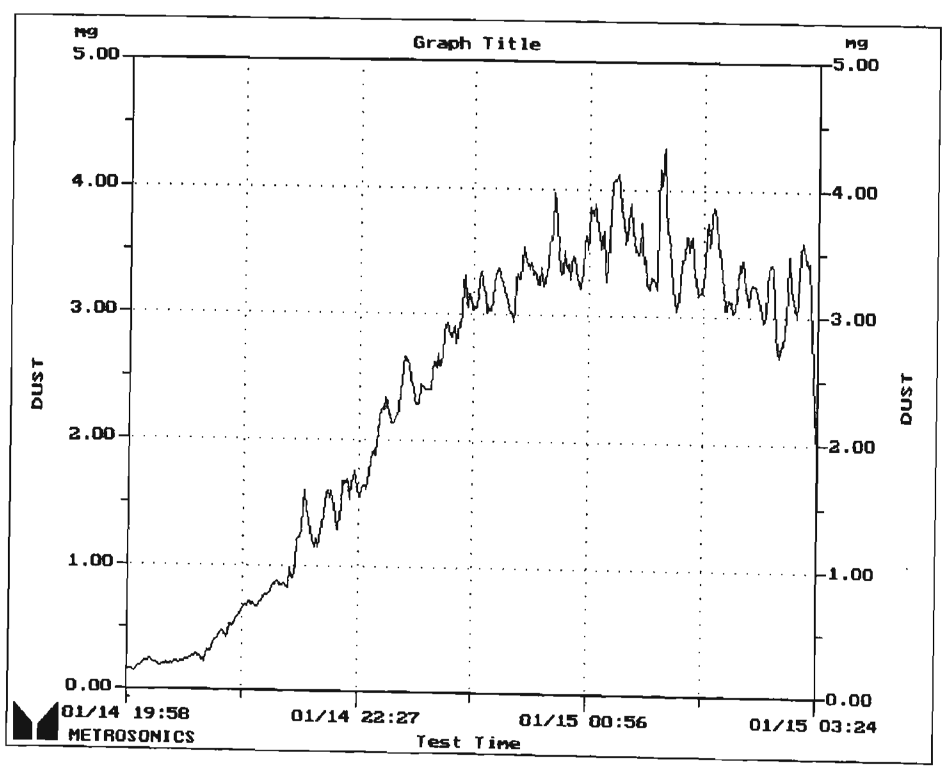

Figure 9 A typical graphic example of changes in aerosol levels during the evening in a place of entertainment not using a smoke machine

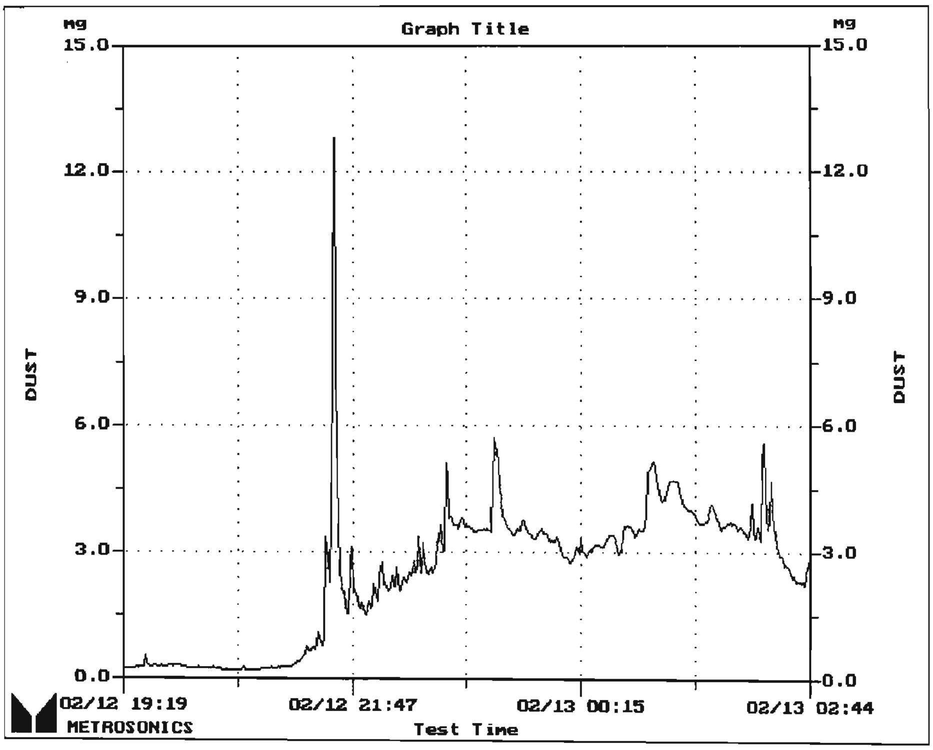

Figure 10 A typical graphic example of changes in aerosol levels during the evening in a place of entertainment using a smoke machine

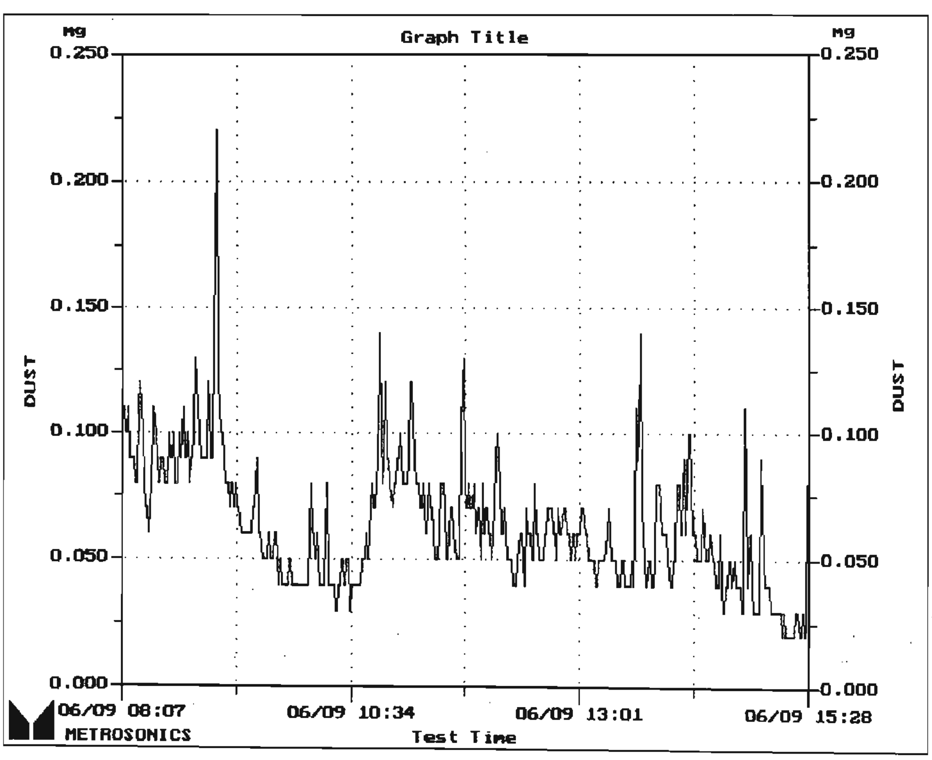

Figure 11 A typical graphic example of changes in aerosol levels during the day in a non-smoking office

Figures 9 and 10 show the difference in particulate impact in a place of entertainment not using a smoke machine and one in which this equipment was used. A gradual increase in aerosol level without the occasional extreme peak levels caused by the release of theatrical smoke into the environment can be seen. Figure 11 which represents an example of a non-smoking office clearly demonstrates the contrast.

Crowded conditions with no control over smoking habits combined with poor ventilation greatly increased aerosol levels during the evening in music venues.

4.1.5.5 Concern regarding pollution in places of entertainment

Table 47 Music venue non-smoking workers who consider their workplace to be polluted and the pollution to be a stressor for 50% of the time and more compared to smoking worker assessments

Staff	n	Staff percentage (%) recognising indoor pollution	Staff percentage (%) stressed by indoor pollution
Non-smokers	31	81,26%	43,75%
Smokers	64	80,64%	58,06%

Offices no smoking N = 95

Table 48 All workers who consider their workplace to be polluted for 50% of the time and more compared to the percentage that consider the polluted environment to be a stress/strain 50% of the time and more

Venues	Staff percentage (%) recognising indoor pollution	Staff percentage (%) stressed by indoor pollution
Music	81,06%	48,42%
Office	12,00%	8,00%

Table 48 indicates that a high percentage of staff in places of musical entertainment recognise that their work environments are polluted. As shown in Table 47, a similar percentage of smokers and non-smokers concluded that these premises are polluted for most of the work shift. However, it is interesting to note that Table 47 suggests a higher percentage of smokers than non-smokers consider pollution to be a stressor for more than 50% of the time whilst in these environments.

4.1.5.6 Conclusion: Odours of concern and pollutant levels

Many of those interviewed were able to cope with pollution. However, when compared to non-smoking office results, the significance of indoor air pollution as a stressor must be considered important, especially due to the potential synergistic and individual health effects that could result from the presence of so many pollutants.

4.1.6 Sick Building Syndrome (SBS) and other health effects

4.1.6.1 Results and discussion on SBS and other health effects

Table 49 Comparison of worker symptoms as a percentage (%) of the total workers

Venues	Experience no symptoms	Symptoms are continuous	Symptoms go on leaving venue (SBS)	Medically diagnosed and made worse	Symptoms occur the next morning	Symptoms on other shift
Burning eyes						
Music	29.47	5,26	57,89	4,21	7,37	62,11
Office	84,00	8	8	0	0	12,00
Nose irritation						
Music	63,16	8,42	22,11	12,63	6,32	27,37
Office	96,00	4,00	0	0	0	8
Blocked nose						
Music	70,53	8,42	10,53	8,42	10,53	27,37
Office	92,00	8	0	4,00	0	8
Runny nose						
Music	83,16	5,26	9,47	6,32	2,11	15,79
Office	100	0	0	0	0	0
Throat irritation						
Music	52,63	11,58	24,21	7,37	11,58	40
Office	92,00	4,00	4,00	0	0	4,00
Cough						
Music	55,79	12,63	23,16	5,26	8,42	30,53
Office	96,00	0	4,00	0	0	0
Itchy skin						
Music	67,37	2,11	27,37	2,11	3,16	26,32
Office	100	0	0	0	0	0
Headaches						
Music	62,11	9,47	17,89	5,26	10,53	29,47
Office	80,00	12,00	0	4,00	8	20,00
Difficulty in breathing						
Music	76,84	2,11	20,00	6,32	1,05	21,05
Office	100	0	0	0	0	0
Body pains						
Music	83,16	1,05	8,42	0	7,37	13,68
Offices	96,00	0	0	0	4,00	4,00

The main purpose of this section of the research was to establish whether sick building syndrome symptoms were occurring amongst more than 20% of the staff in music venues. Symptoms that are continuously experienced and those that occur the following morning are considered to be as a result of allergic reactions in hypersensitive people. These symptom types are evaluated as an important part of the main focus of the multivariate analysis in section 4.3.

Table 50 Sick building syndrome symptoms (SBS) that are experienced by > 20% of the workers in places of musical entertainment compared to office controls

Symptoms	Music venues	Offices
Burning eyes	57,89%	8%
Itchy skin	27,37%	0%
Throat irritation	24,21%	4,00%
Cough	23,16%	4,00%
Nose irritation	22,11%	0%
Difficult breathing	20,00%	0%

Table 50 summarises the sick building syndrome symptoms, in descending order of occurrence, that are most likely to occur in 20% and more of the musical entertainment staff. Burning eyes was the SBS variable causing the most stress. Literature has indicated that tobacco smoke is an important stressor in this regard.

Apart from sick building syndrome symptoms staff were experiencing allergic reactions the following morning after an evening in an entertainment venue (Table 51). Although occurrence of these symptoms were lower than the sick building syndrome type reactions, the environmental effects of musical venues are highlighted when compared with office control results.

Table 51 Workers experiencing neurological symptoms and possible allergic reactions that occur the next morning after working in places of musical entertainment compared to office control situations

Symptoms	Music venue	Offices
Throat irritation	11,58%	0%
Headaches	10,53%	8%
Blocked nose	10,53%	0%
Cough	8,42%	0%
Burning eyes	7,37%	0%
Body pains	7,37%	4,00%
Nose irritation	6,32%	0%
Itchy skin	3,16%	0%
Runny nose	2,11%	0%
Difficult breathing	1,05%	0%

N = 95 Music venues N = 25 Offices

Table 52 Total percentage of worker symptoms that are experienced by staff in music venues compared to non-smoking office controls

Symptoms	Music venues: 10 and 25% of the time	Music venues: ≥50% of the time	Offices: 10 and 25% of the time	Offices: ≥50% of the time
Tiredness	16,84%	62,10%	16,00%	12,00%
Burning eyes	25,26%	45,26%	8%	8%
Nose irritation	11,58%	25,26%	0%	4,00%
Blocked nose	13,68%	16,85%	0%	0%
Runny nose	7,37%	10,53%	0%	0%
Throat irritation	17,89%	30,52%	0%	8%
Cough	26,31%	18,95%	4,00%	0%
Itchy skin	15,75%	16,84%	0%	0%
Headaches	20,00%	16,85%	12,00%	8%
Difficult breathing	5.27%	18,95%	0%	0%
Body pains	2.11%	14,74%	4,00%	0%

Table 52 highlights the total occurrence of all of the allergic type symptoms, including SBS symptoms, neurological effects and the occurrence of body pains in music venues compared to office results. It shows that apart from the symptoms of headache and coughing, a larger percentage of respondents were stressed by symptoms for the majority of their work shift in music venues.

Table 53 Occurrence of colds and flu in staff more than once a month

Music venues						Offices	
N	Smokers and non-smokers	n	Smokers	n	Non-smokers	N	Office staff
95	42,11%	64	37,50%	31	51,61%	25	12,00%

Table 53 views the occurrence of colds and flu as a general indication of health. Generally there was a much higher percentage of workers reporting colds and flu in music venues than in the non-smoking office controls. This table demonstrates that a higher incidence of colds and influenza were occurring in non-smokers. It may have been the case that certain staff were experiencing these symptoms as allergies caused by microbe growth promoted by hot humid conditions and their distribution through the work space by ventilation systems.

Research by Cohen et al. (1993) which involved actual inoculation of healthy subjects with viruses suggests that 'healthy' smokers are more prone to acute infectious respiratory illness. The present results did not concur with these findings. However, developing colds and influenza symptoms involve more than one process such as, psychological stress, exposure to infection, hygiene factors, smoking, alcoholism, nutritional deficiencies and general health (Cohen et al. 1993). These reasons, and that music venue workers interviewed in a real-life setting fell into a younger age group, may be the basis for the difference in findings. Further research into the influence of passive smoking as one of the contributors in increasing susceptibility to the common cold in these environments may be considered.

4.1.6.2 Conclusion: SBS and other health effects

Lifestyle stressors in music venues includes having to cope with many allergies and regular colds and flu. It is evident when making comparison to the office controls that the staff in places of musical entertainment are less healthy.

4.1.7 Psychosocial factors

4.1.7.1 Results and discussion on psychosocial factors

Table 54 Comparison of job satisfaction: the percentage (%) of workers that feel satisfied for 50% or more of the time

Aspects of job satisfaction	Music venues	Offices
Enjoyment of work	96,84%	100%
General satisfaction from the type of work	82,11%	92,00%
Satisfaction with the amount of work variety	73,68%	88,00%
Contributes to personal needs	88,42%	88,00%
Satisfaction with salary	36,84%	32,00%
The job as a challenge	77,90%	96,00%

Staff in places of entertainment and offices were questioned on how satisfied they felt about certain aspects of job satisfaction, self-esteem and personal confidence, and social interaction. Table 54 shows that with regards to job satisfaction, both groups of workers were generally experiencing a high level of satisfaction in their jobs. However, a slightly higher percentage of office workers expressed satisfaction with regard to work enjoyment, satisfaction from the type of work, satisfaction with the variety of work and the potential for job challenge. A similar percentage of workers in both groups were satisfied that their jobs contributed to their personal needs. The sphere of most dissatisfaction was salary. **Salaries will therefore be an important confounding variable to consider in terms of univariate analysis outlined in section 4.2.**

Table 55 Comparison of self-esteem and personal confidence: the percentage (%) of workers that expressed that they felt positive 50% or more of the time

Aspects of self-esteem and personal confidence	Music venue	Offices
Job as a contribution to society	78,94%	52,44%
Job competency	98,96%	100%
Respect by co-workers for competency	90,53%	100%
Respect by management for competency	78,95%	100%
Job responsibilities are consistent with personal values	77,90%	92,00%

With regard to self-esteem and personal confidence, most of the employees revealed positive feelings about themselves.

Table 56 Comparison of aspects of social interaction: the percentage (%) of workers that express that they feel positive 50% or more of the time

Aspects of social interaction	Music venue	Office
Good interaction with the public	100%	94%
Co-operative interaction with co-workers	96,85%	100%

A high percentage of both groups felt positive about social interaction in their workplace. All music venue workers felt that most of the time their interaction with the public was good.

4.1.7.2 Conclusion: the influence of job satisfaction, self-esteem, personal confidence and social interaction

The responses indicate that workers in both environments generally have positive feelings regarding the aspect of job satisfaction, self-esteem, personal confidence and social interaction covered in the questionnaire. These factors should hence have limited negative influences on worker stress. In fact, the psychosocial variables may positively reinforce workers in the workplace. Dissatisfaction with salary can be considered as a confounder and for most of the workers it is

seen as a stressor. The validation of the psychosocial questionnaire will be dealt with under section 4.2.1.

4.2 UNIVARIATE STATISTICAL ANALYSIS

4.2.1 Analysis of the psychosocial questionnaire

4.2.1.1 The τ-test analysis of psychosocial variables

The τ-test was used to establish whether there are significant differences between the psychosocial responses of staff in the two venue types and to establish mean satisfaction levels.

Table 57 τ-test correlations of music venue and office control psychosocial variables

Psychosocial	Premises	n	Mean	SD	p-value
Enjoy work	Music	95	4,337	0,918	0,1419
	Office	25	4,560	0,583	
Contributes to own needs	Music	95	4,074	1,307	0,6435
	Office	25	3,960	1,019	
Contributes to society	Music	95	3,684	1,539	0,0028
	Office	25	4,360	0,757	
Co-worker respect	Music	95	4,379	1,231	0,7493
	Office	25	4,440	0,712	
Management respect	Music	95	3,695	1,708	0,0002
	Office	25	4,520	0,586	
Job consistent with values	Music	95	3,611	1,439	0,0256
	Office	25	4,320	1,215	
Work is satisfying	Music	95	3,768	1,380	0,1815
	Office	25	4,160	0,898	
Public interaction	Music	95	4,705	0,634	0,0425
	Office	25	4,400	0,764	
Co-worker interaction	Music	95	4,579	0,752	0,3814
	Office	25	4,720	0,542	
Work variety	Music	95	3,568	1,642	0,2241
	Office	25	4,000	1,258	
Job competence	Music	95	4,800	0,646	0,1621
	Office	25	4,600	0,577	
Job challenge	Music	95	3,547	1,623	0,0024
	Office	25	4,320	0,900	
Questionnaire mean	Music	95	4,062	0,692	0,0440
	Office	25	4,363	0,505	

(p-value < 0,05 is significant)

Table 57 demonstrates that responses of staff from both groups were similar with respect to work enjoyment, work contributing to personal needs, co-worker respect, work being satisfying, co-worker interaction, work variety and job competence. Mean satisfaction levels with all the psychosocial variables was high for both the music venue group and the control group. There was however, prominent significant differences with "management respect". Here the office staff expressed more satisfaction than the music venue staff. Certain of the music venue staff commented that they had little or no communication with management. Other interesting differences were work contributing to society, job challenges and job consistent with values, where again the office workers expressed a higher level of satisfaction. Bar attendant jobs in places of entertainment may not be as challenging as the entertainment personnel. Furthermore, considering the observed immoral activities discussed in the preface it is understandable that certain staff would express lower satisfaction regarding the job being constant with values and the contribution of their work to society.

The mean satisfaction for "having good interaction with the public", which is an important job component for the staff employed in places of entertainment, was higher than the mean for the office controls. This demonstrates that the workers interviewed are suited to cope with this particular job demand.

The potential effect that psychosocial satisfaction may have on the reporting of psychophysical influences will be further discussed under section 4.2.2.10.

4.2.1.2 Validation of psychosocial section of the questionnaire

The Cronbach alpha coefficient is not a univariate statistical analysis method. It is a general measure of internal consistency (Kaplan et al. 1989). The test was used to intercorrelate the ordinal scale psychosocial variables for the purpose of validating the psychosocial section of the questionnaire for the entertainment group. The variable, "satisfaction with salary" which was assessed as a nominal scale, could therefore not be included in this analysis. Interpretation of results are based on the following: strong correlations are > 0,7, moderate correlations range from 0,3 to 0,7 and poor correlation are < 0,3.

Although the overall alpha coefficient was quite strong (0,772), individual variables correlated moderately with the total (correlations ranging between 0,2 and 0,56).

4.2.2 Univariate statistical correlation results of the various indoor stressors

The Pearson correlation coefficient (r) was used to establish associations between the continual data stressor variables in places of entertainment. Poor correlations are Pearson correlation coefficients < 0,3, moderate correlations are 0,3 to 0,7 and good correlations are > 0,7. Trends towards moderate correlation are also accepted as an indication of variable associations. The majority of the results in the tables to follow are moderate correlations. Moderate correlations and trends towards moderate correlations are highlighted in bold in the Pearson correlation coefficient (r) tables.

Negative associations demonstrate that certain variables may reduce stress from other stressors. In some cases, higher pollutant indicator levels are associated with lower psychophysical concern.

The τ-test was used to demonstrate associations between physical stressors and psychophysical stress concern. Correlations that have significance are those with p-value < 0,05. Only significant correlations are included in the τ-test tables.

4.2.2.1 Pearson correlation coefficients (r): odour associations

Table 58 Pearson correlation coefficients (r) of odour concern associations of worker subjective evaluations

Stressors	Alcohol	Tobacco(air)	Body	Dust	Musty
Musty	0,336	0,252	0,342	0,509	1,000
Stale	0,195	0,327	0,520	0,513	0,476
Tobacco(air)	0,068	1,000	0,288	0,216	0,252
Dust	0,089	0,216	0,325	1,000	0,509
Body	0,064	0,288	1,000	0,325	0,342

N = 95

Staff in places of musical entertainment experienced recognisable odours such as tobacco smoke, body odour and alcohol. They also responded to non-specific terms such as dusty air or musty odours. Table 58 represents associations between the recognisable odours and the non-specific odour terms. In all situations the correlations were moderate or tending towards moderate associations.

- **Stale air correlated with tobacco odour, body odours, dust and musty odours.**

- **Musty air correlating with alcohol, tobacco, body odours, dusty air.**

Odours tending towards good correlations were:

- **Stale air and body odours; stale and dusty air.**

These results signify that staff may have been associating recognisable odours of specific pollutants with the non-specific terms. This knowledge would be useful when designing questionnaires for indoor air quality evaluation of all types of entertainment venues.

4.2.2.2 Pearson correlation coefficients (r): correlations between comfort stressors and other psychophysical concerns

Table 59 Pearson Correlation Coefficients (r) of relationship between comfort indicators and odour concerns

Stressors	Alcohol concern	Body odour concern	Miscellaneous odours concern	Poor air movement concern	Stale air
Carbon dioxide level	- 0,004	- 0,329	- 0,279	0,149	- 0,158
Relative Humidity	- 0,015	- 0,111	- 0,059	0,237	0,021
Temperature level	- 0,248	0,074	0,068	0,196	0,293

N = 95

Questionable associations between carbon dioxide levels (an indicator of performance of ventilation systems), and odours are described by Pearson correlation coefficient (r) in Table 59. Previous research has indicated that increases in carbon dioxide in an environment is associated with a deterioration in indoor air quality and exacerbated odours. However, results from this investigation demonstrate that higher carbon dioxide levels are associated with lesser concern for odours. An explanation may be that in all crowded places of entertainment investigated, carbon dioxide levels were found to be high and exceeding the recommended standard of 1000 ppm due to inadequate coping of the ventilation system. However, respondents displayed variation in their coping abilities with odours. Control venues, such as non-crowded places of entertainment, with similar potential for odour stressors such as tobacco smoke and alcohol, may have provided a different picture. This will be further discussed in the context of allergy correlations with pollutant indicators under section 4.2.2.7.

Apart from the odours associated with stale air demonstrated in the previous table, Table 59 also displays a trend which suggests that higher air temperature is associated with increased concern regarding stale air.

Table 60 Pearson Correlation Coefficients (r) comfort measurement associations

Stressors	Relative humidity
Carbon dioxide levels	0,250
Air movement	0,281

N = 95

There also appears to be a trend towards a moderate correlation shown in Table 60, indicating that high relative humidity levels may be associated with poor air movement concern.

Table 61 Pearson Correlation Coefficients (r) of indoor psychophysical stressors based on worker subjective evaluations

Stressors	Too hot*	Too cold	Air movement concern	Sweating	Pollution concern
Tiredness	0,286	0,112	0,204	0,230	0,046
Tobacco (air)	0,170	0,048	0,102	0,242	0.366
Musty odour	0,285	- 0,038	0,402	0,332	0,099
Dusty air	0,384	- 0,170	0,293	0,296	0,158
Stale air	0,453	- 0,163	0,529	0,419	0,355
Sweating	0,690	- 0,304	0,599	0,100	0,202
Dry throat	0,349	0,043	0,287	0,350	- 0,073
Sore throat	0,305	- 0,026	0,225	0,277	0,280

* A correlation was also found between :
Air movement concern and concern regarding air temperature concern (0,622)
Miscellaneous odours and air temperature (- 0,254)

N = 95

Table 61 shows a trend towards a good correlation between the concern for air movement and the concern for warm air temperature.

These associations indicate that reducing relative humidity should be an important factor in ensuring a more comfortable environment, plus that attention must be given to improving air movement and temperature control.

The Pearson correlation coefficient (r) trend in Table 61 which shows that high relative humidity correlates with high air movement may seem conflicting. A possible explanation for this positive relationship may be due to moving air having the potential to increase sweat evaporation in these warm environments and to circulate stale humid air. Descriptive statistical results showed that relative humidity levels in all places of entertainment investigated were unacceptably high.

Table 61 also demonstrates an associated trend between carbon dioxide level, the indicator of comfort and air quality, and the comfort indicator relative humidity. **Therefore an increase in carbon dioxide will result in higher relative humidity which is linked to the number of people present, and poor ventilation performance.**

The table also demonstrates **the moderate correlation and trends between concern for temperature, air movement, general pollution, sweating and concern relating to the various odours, dry throat, sore throat and tiredness. The following associations signify the psychophysical and physical impacts occurring in these environments.**

- Concern regarding hot entertainment environments is associated with tiredness, musty odour and dusty air and stale air.

- Air movement concern correlates with concern regarding musty odour and dusty air, stale air and sweating.

- Pollution concern was associated with tobacco smoke, stale air and sore throat. Sore throat concern was originally investigated in terms of a possible effect for workers having to raise their voices above the loud music. **However, these correlations indicate that sore throat symptoms are not only noise-related in places of entertainment.** Accordingly, the questionnaire would require modification to make the question on sore throat non-specific.

- Sweating as a stressor correlated with musty odour, dusty air and stale air concern. There was also a moderate association with dry throat and a trend towards moderate correlations associated with sore throat and tiredness.

Table 62 Pearson Correlation Coefficients (r) of discomfort concerns and associated symptoms

Stressors	Headaches	Sore throat	Dry nose and throat
Tiredness	0,293	0,267	0,150
Tobacco(air)	0,306	0,239	0,204
Stale air	0,130	0,349	0,170
Dusty air	0,258	0,285	0,213
Sweating	0,133	0,277	0,350
Body odours	0,199	0,266	0,108
Dry throat	0,189	0,362	1,000
Musty odours	0,161	0,383	0,290
Headache	1,000	0,269	0,189

N = 95

Apart from the relationships between loud noise and sore throat, sore throat with sweating and pollution concern, Table 62 shows trends and moderate correlations between sore throat and other psychophysical stressors. These are tiredness, tobacco smoke odour in the air, stale air, dusty air, body odour, musty odour and headache concern. Musty odour and tobacco smoke with their potential to cause discomfort to the upper respiratory tract in both smokers and non-smokers, could quite conceivably result in sore throat symptoms. Table 62 also demonstrates trends towards moderate correlations: sore throat with physical tiredness, sweating, headaches. There is a trend towards moderate relationships between headaches and tiredness, whereas a moderate relationship also exists between headaches and tobacco odour concern. There also appears to be a trend between dusty air and headaches. Furthermore, a moderate association between sweating and dry throat exists which could be expected to occur due to the elevated air temperatures and high activity in these crowded environments.

These correlations begin to demonstrate that this stressful lifestyle has many interrelated environmental factors that can affect health. It is also evident that air pollutants, especially tobacco smoke, create stress in staff resulting in poor health.

4.2.2.3 Pearson correlation coefficients (r): correlations between crowding concern and psychophysical stressor concern

Table 63 Pearson Correlation Coefficients (r) of psychophysical stressors associated with crowded smoky music venues

Stressors	Crowd concern
Sore throat	0,306
Throat irritation	0,324
Stale air	0,229
Tobacco smell on hair and clothes	0,315
Too hot	0,284
Air movement poor	0,265
Sweating	0,269
Music noise concern	0,307
People noise concern	0,317

N = 95

Table 63 shows that moderate correlations exist between concern for crowding and concern over sore throat, throat irritation, tobacco smell on hair and clothing, people noise and music noise level. There are also trends towards moderate correlations between crowding and concern over warm air temperatures, poor air movement and sweating. This table shows the stressors that staff may experience in poorly ventilated crowded venues where environmental pollutants such as smoking and noise are not controlled. Although the crowds are necessary for business, the control of environmental stressors, such as smoking, temperature, relative humidity and the provision of adequate outside air, will ensure a healthier lifestyle.

4.2.2.4 Pearson correlation coefficients (r): correlations between subjective evaluations of noise and psychophysical stressor concern

Table 64 Pearson correlation coefficients (r) of noise stressors and other psychophysical stressors based on worker subjective evaluations

Stressor	Music noise concern	People noise concern
Sore throat	0,298	0,175
Body odours	0,252	0,020
Stale air	0,354	0,143
People noise	0,559	1,000
Dusty air	0,243	0,275

N = 95

Insignificant correlations were found to exist between noise level readings and other psychophysical stressors, except for those displayed in Table 64. However, an interesting moderate correlation occurred between noise levels and relative humidity. The reason for this is possibly because high noise levels were occurring simultaneously with high levels of relative humidity. This emphasises the importance of using sound level monitoring equipment which would provide accurate readings where humid conditions prevail.

Results in Table 64 suggests that noisy music venues attract crowds. High levels of physical activity, such as dancing to loud music, results in the release of body odours, stale and dusty air. **A trend towards a strong correlation also demonstrates that certain staff not coping with music noise were also stressed by people noise.**

4.2.2.5 The τ-test: correlations between the subjective evaluations of flashing lights and other psychophysical stressors

Table 65 τ-test correlating the use of flashing lights with certain health symptoms and also staff concern

Flashing lights	Effect	n	Mean concern	SD	p-value
Staff exposed	Level of concern	74	1,270	1,860	0,0024
Staff not exposed	No flashing lights	21	0,000	0,000	
Staff exposed	Headaches	74	0,784	1,407	0,0348
Staff not exposed	Headaches	21	1,571	1,748	
Staff exposed	Burning eyes	74	2,027	1,813	0,0517
Staff not exposed	Burning eyes	21	2,905	1,758	

N = 95

Table 65 shows that 74 staff were exposure to flashing lights. Staff in premises where flashing lights were used expressed occasional concern regarding this stressor. This group also experienced limited occurrence of headaches. The mean for burning eyes was slightly higher, **which indicates that flashing lights may be a contributing factor in causing eye irritation and headaches in some of the workers.**

There was no correlation between tiredness and flashing lights.

4.2.2.6 Correlations relating to SBS and allergic symptoms

This discussion analyses the research focus for the multivariate correlations *"SBS symptoms and allergic health effects"*. SBS correlations examined symptoms that disappeared on leaving the workplace. Certain staff also reported allergies which tended to occur the following morning and some had persistent allergies. The symptoms were burning eyes, nose irritation, blocked nose, runny nose, throat irritation, coughing, itching skin and difficulty in breathing. The τ-test was used to correlate symptoms with pollution indicators such as, carbon dioxide, benzene, xylene, toluene and respirable particulates. Apart from environmental pollution stressors, the demanding nature of the job and long work hours could have exacerbated tiredness and headaches. These were hence not included in this evaluation, but will form part of the focus for multivariate correlations. The τ-test was used to correlate nominal scale results of symptoms with continuous environmental stressor data.

Table 66 τ-test of the respondents from the entertainment venue group not experiencing SBS and those that are experiencing SBS symptoms correlated with pollutant indicator levels

Pollutant	SBS effect	n	Mean level	SD	p-value
Benzene in µg/m³	Nose irritation	21	17,83	16,186	0,0431
	Not SBS	74	11,53	11,173	
	Blocked nose	10	21,44	18,611	0,0234
	Not SBS	85	11;92	11,482	
Toluene in µg/m³	Nose irritation	21	53,03	40,606	0,0432
	Not SBS	74	34,85	34,462	
	Blocked nose	10	65,65	43,363	0,0133
	Not SBS	85	35,72	32,528	
Xylene in µg/m³	Nose irritation	21	29,85	19,470	0,0384
	Not SBS	74	20,83	16,734	
	Blocked nose	10	33,27	21,148	0,0068
	Not SBS	85	21,59	16,942	
#Respirable particulate in mg/m³	Itchy skin	26	2,16	1,567	0,0506
	Not SBS	64	1,58	1,124	

N = 95
N = 90 for respirable particulate monitoring.

No significant correlations between carbon dioxide levels and concern for health symptoms in places of entertainment were found in association with the music venue group. Furthermore, significant correlations between the pollutant indicators toluene, xylene, benzene, respirable particulates and worker allergic health symptoms in places of entertainment were limited.

It has been documented in earlier chapters that many pollutants are present in non-industrial work environments. **The term "not SBS" used in Table 66 relates to all non-SBS type allergies and also includes staff that have not been affected by the environment.** Table 66 portrays SBS symptoms and the significant correlations with pollutant indicators benzene, toluene, Xylene and respirable particulates. **The synergistic effect of many pollutants is considered as the manner whereby the health and comfort of occupants will be effected in these environments, especially as a main elevator of pollution is tobacco smoke.** Higher mean levels of benzene, toluene, xylene and respirable particulates were associated with sick building syndrome symptoms of blocked nose, nose irritation and itching skin. **Nose irritation and blocked nose were common SBS symptoms correlating with benzene, toluene and xylene. The association between xylene and blocked nose had the highest level of statistical significance (1%).** Nose irritation and itching skin distressed 22% and 27% of the staff respectively.

Table 67 *T*-test of the respondents from the entertainment venue group not experiencing allergy symptoms, including SBS and those that are experiencing these symptoms correlated with pollutant indicator levels

Pollutant	Allergic effect	n	Mean level	SD	p-value
Benzene in $\mu g/m^3$	Nose irritation group	35	16,46	14,305	0,0366
	No symptom group	60	10,86	11,163	
	Coughing group	42	16,31	14,934	0,0193
	No symptoms group	53	10,24	9,801	
Toluene in $\mu g/m^3$	Nose irritation group	35	49,55	37,413	0,0265
	No symptom group	60	32,64	34,731	
Xylene in $\mu g/m^3$	Nose irritation group	35	29,07	18,702	0,0079
	No symptom group	60	19,18	16,105	
#Respirable particulate in mg/m^3	Coughing group	38	1,44	0,942	0,0543
	No symptom group	52	1,97	1,458	

N = 95 N = 90 for respirable particulate monitoring

Table 67 refers to all types of allergic reactions, including SBS. It is interesting that the common allergy was also nose irritation. The association between xylene and nose irritation had the highest level of significance (1%). Of the 35 staff experiencing nose irritation shown in Table 67, 21 were experiencing SBS-related nose irritation. The remaining 14 were experiencing this allergy the following morning after working in the music venue and some were being affected continuously with nose irritation. **Other interesting results were the significant correlations between benzene and coughing, as well as respirable particulates and coughing.**

Table 68 Pearson correlation coefficient (r) of pollutant indicators associated with headaches

Symptom	Benzene	Toluene	Xylene
Headache	0,222	0,184	0,236

N = 95

The Pearson correlation coefficient demonstrates a possible association between xylene levels and staff concern regarding headaches.

The preceding tables describe the impact that pollutants, primarily from tobacco smoke, have on health symptoms in these environments.

4.2.2.7 Combination of music venue and office results: allergic reactions and associated stressors

Table 69 *t*-test of the respondents from combining both the control group and entertainment venue group not experiencing SBS and those that are experiencing SBS symptoms correlated with pollutant indicator levels

Pollutant	SBS effect	n	Mean level	SD	p-value
Carbon dioxide in ppm	Burning eyes	57	3242,82	1649,800	0,0075
	Not SBS	63	2380,97	1805,266	
	Nose irritation	21	3611,38	1450,579	0,0193
	Not SBS	99	2616,19	1799.847	
	Coughing	23	3482,09	1603,975	0,0375
	Not SBS	97	2626,33	1786,795	
Benzene in µg/m³	Burning eyes	57	12,85	13,471	0,0353
	Not SBS	63	8,13	10,732	
	Nose irritation	21	17,83	16,186	0,0019
	Not SBS	99	8,79	10,744	
	Blocked nose	10	21,44	18,611	0,0026
	Not SBS	110	9,37	11,135	
	Coughing	23	16,35	15,391	0,0089
	Not SBS	97	8,96	11,060	
Toluene in µg/m³	Nose irritation	21	53,03	40,606	0,0026
	Not SBS	99	27,95	32,371	
	Blocked nose	10	65,65	43,363	0,0015
	Not SBS	110	29,32	32,839	
	Coughing	23	48,73	38,882	0,0121
	Not SBS	97	28,46	33,176	
Xylene in µg/m³	Nose irritation	21	29,85	19,470	0,0016
	Not SBS	99	16,83	16,185	
	Blocked nose	10	33,27	21,148	0,0068
	Not SBS	110	17,82	16,583	
	Coughing	23	26,74	18,879	0,0190
	Not SBS	97	17,30	16,674	
	Diff. breathing	19	26,48	17,814	0,0442
	Not SBS	101	17,73	17,102	
* Respirable particulate in mg/m³	Itchy skin	26	2,16	1,568	0,0013
	Not SBS	84	1,21	1,186	

* N = 110 for respirable particulate monitoring N = 120

Table 70 t-test of the respondents from combining both the control group and entertainment venue group not experiencing allergy symptoms including SBS and those that are experiencing these symptoms correlated with pollutant indicator levels

Pollutant	Allergic effect	n	Mean level	SD	p-value
Carbon dioxide in ppm	Burning eyes group	71	3250,65	1679,845	0,0005
	No symptom group	49	2123,39	1722,018	
	Nose irritation group	36	3537,28	1557,405	0,0023
	No symptom group	84	2470,24	1780,495	
	Coughing group	43	3393,14	1650,707	0,0051
	No symptom group	77	2453,73	1769,314	
	Throat irritation group	47	3333,79	1653,471	0,0067
	No symptom group	73	2440,47	1780,017	
Benzene in $\mu g/m^3$	Burning eyes group	71	12,37	13,018	0,0314
	No symptom group	49	7,48	10,617	
	Nose irritation group	36	16,03	14,330	0,0008
	No symptom group	84	7,95	10,493	
	Coughing group	43	15,94	14,944	0,0001
	No symptom group	77	7,26	9,254	
Toluene in $\mu g/m^3$	Nose irritation group	36	48,21	37,743	0,001
	No symptom group	84	25,54	31,766	
	Coughing group	43	45,78	37,840	0,0015
	No symptom group	77	24,84	31,271	
Xylene in $\mu g/m^3$	Nose irritation group	36	28,18	19,008	0,0001
	No symptom group	84	15,18	15,211	
	Blocked nose group	30	25,17	20,882	0,0275
	No symptom group	90	17,09	15,749	
	Throat irritation group	47	23,37	18,788	0,0312
	No symptom group	73	16,37	16,049	
	Coughing group	43	25,41	18,666	0,0028
	No symptom group	77	15,60	15,769	
	Difficult breathing group	22	26,13	17,963	0,036
	No symptom group	98	17,53	17,014	
#Respirable particulate in mg/m^3	Burning eyes group	67	1,73	1,372	0,003
	No symptom group	43	0,97	1,159	
	Itching skin group	31	2,01	1,525	0,0042
	No symptom group	79	1,21	1,199	

N = 110 for respirable particulate monitoring   N = 120

As has been demonstrated in section 4.2.2.6, significant correlations between pollution indicators and allergic response were few. Reasons for this may be that staff were coping with elevated pollution levels, crowding and inadequate ventilation. To illustrate this statement, statistical analysis combining non-smoking control staff and crowded venue staff responses were holistically examined by correlating the same pollutant indicators used in the previous section with all the sick building syndrome symptoms and also with all of the allergic-type symptoms.

Tables 69 and 70, describe the significant τ-test correlations between symptoms and pollutants. The p-values represent comparisons between groups experiencing certain symptoms and the groups not experiencing these symptoms. The carbon dioxide level was used in this project as an indicator of air quality and comfort and was not considered as a pollutant in itself. Furthermore, due to instrument limitations the carbon dioxide mean does not include carbon dioxide levels above 5000 ppm (see section 4.1.4.2). Larger carbon dioxide means were found to correlate significantly with burning eyes (1%), nose irritation (5%) and coughing (5%). More staff expressed concern about burning eyes than any other allergic stress. Sick building syndrome type burning eyes was experienced by 57 of the 120 respondents interviewed. When all allergic symptoms were correlated with carbon dioxide 71 staff reported burning eyes.

It is interesting to find that the maximum levels for the SBS symptoms of nose irritation, blocked nose and itchy skin are the same in Table 68 and Table 66. These levels pertain to the maximum levels in places of musical entertainment that associate with SBS symptoms. However, the minimum values in Table 68 are greatly influenced by pollution levels recorded in office controls, and influenced to a lesser extent by music venue staff experiencing allergies other than SBS symptoms combined with staff who experience no symptoms in places of entertainment. Table 70 depicts lower mean pollutant levels when all allergic symptoms are combined and then correlated with those staff where no symptoms were revealed. Nose irritation was a common significant correlate for staff.

From the meaningful associations found in Tables 69 and 70 it is evident that more significant correlations may have been acquired if less crowded entertainment venues were included as controls.

4.2.2.8 The τ-test correlations of odour types with SBS symptoms and with allergy symptoms including SBS

Table 71 τ-test correlating odour concern with SBS symptoms

Odours	SBS effect	n	Mean odour concern	SD	p-value
Body odours	Burning eyes	55	2,073	1,961	0,0322
	Not SBS	40	1,275	1,450	
	Difficult breathing	19	2,579	1,677	0,0218
	Not SBS	76	1,526	1,777	
Stale air	Burning eyes	55	2,400	2,122	0,0027
	Not SBS	40	1,125	1,786	
	Nose irritation	21	2,714	2,125	0,0326
	Not SBS	74	1,622	2,012	
	Cough	22	2,682	2,009	0,0341
	Not SBS	73	1,616	2,046	
	Difficult breathing	19	3,053	1,985	0,0042
	Not SBS	76	1,566	2,002	
Tobacco odour on hair and clothing	Burning eyes	55	3,509	1,904	0,0408
	Not SBS	40	2,625	2,238	
	Difficult breathing	19	3,947	1,580	0,0579
	Not SBS	76	2,934	2,156	
Tobacco odour in the air	Nose irritation	21	3,286	1,707	0,0174
	Not SBS	74	3,216	1,807	
	Runny nose	9	3,778	1,302	0,0218
	Not SBS	86	2,314	1,830	
	Difficult breathing	19	3,316	1,635	0,0209
	Not SBS	76	2,237	1,825	

N = 95

Table 72 a   T-test correlating odour concern with allergy symptoms including SBS effects

Odours	Allergic effect	n	Mean odour concern	SD	p-value
Body odours	Burning eyes group	67	1,955	1,965	0,067
	No symptom group	28	1,214	1,197	
	Nose irritation group	35	2,314	1,937	0,0161
	No symptom group	60	1,400	1,639	
	Difficult breathing group	22	2,682	1,810	0,0044
	No symptom group	73	1,452	1,708	
Stale air	Burning eyes group	67	2,418	2,133	0,0001
	No symptom group	28	0,536	1,138	
	Nose irritation group	35	2,686	2,083	0,0027
	No symptom group	60	1,383	1,932	
	Coughing group	42	2,595	2,084	0,0018
	No symptom group	53	1,283	1,895	
	Difficult breathing group	22	3,091	2,044	0,0012
	No symptom group	73	1,493	1,952	
Tobacco odour on hair and clothing	Burning eyes group	67	3,522	1,949	0,0048
	No symptom group	28	2,214	2,149	
	Throat irritation group	45	3,667	1,859	0,0181
	No symptom group	50	2,660	2,182	
	Difficult breathing group	22	3,909	1,630	0,0471
	No symptom group	73	2,904	2,161	
Tobacco odour in the air	Burning eyes group	67	2,821	1,808	0,002
	No symptom group	28	1,571	1,597	
	Nose irritation group	35	3,314	1,568	0,0003
	No symptom group	60	1,950	1,799	
	Runny nose group	16	3,625	1,360	0,0044
	No symptom group	79	2,215	1,830	
	Throat irritation group	45	3,000	1,834	0,0051
	No symptom group	50	1,960	1,702	
	Coughing group	42	2,857	1,970	0,0549
	No symptom group	53	2,132	1,665	
	Difficult breathing group	22	3.227	1,541	0,0229
	No symptom group	73	2,219	1,858	
Alcohol odour	Burning eyes group	67	1,209	1,647	0,0452
	No symptom group	28	0,536	0,922	
	Blocked nose group	28	0,383	0,737	0,0087
	No symptom group	67	1,269	1,657	
	Throat irritation group	45	1,467	1,753	0,0043
	No symptom group	50	0,600	1,088	
	Coughing group	42	1,500	1,729	0,0040
	No symptom group	53	0,623	1,164	

N = 95

Table 72 b (continuation of previous table) T-test correlating odour concern with allergy symptoms including SBS effects

Odours	Allergic effect	n	Mean odour concern	SD	p-value
Musty odours	Burning eyes group	67	1,761	1,947	0,0084
	No symptom group	28	0,714	1,047	
	Throat irritation group	45	1,911	1,963	0,0167
	No symptom group	50	1,040	1,511	
	Coughing group	42	2,871	2,041	0,0022
	Not symptom group	53	0,962	1,386	
Dusty air	Burning eyes group	67	1,478	1,957	0,0506
	No symptom group	28	0,679	1,307	
	Nose irritation group	35	1,714	2,037	0,0530
	No symptom group	60	0,967	1,636	
	Blocked nose group	20	1,821	2,056	0,0443
	No symptom group	67	1,000	1,670	
	Runny nose group	16	2,313	2,152	0,0092
	No symptom group	79	1,025	1,679	
	Throat irritation group	45	1,644	1,944	0,0403
	No symptom group	50	0,880	1,637	
	Coughing group	42	1,881	2,027	0,0019
	No symptom group	53	0,736	1,470	

N = 95

Odour concern included tobacco smell in the indoor air, alcohol, musty odours, dusty air, body odour, stale air, miscellaneous odours (bad breath and pesticides) and tobacco odour on hair and clothing. All of these odours were correlated with the subjective evaluations of burning eyes, nose irritation, blocked nose, runny nose, throat irritation, coughing, itchy skin and difficult breathing for staff in places of musical entertainment. Only correlations with significant p-values are shown in Tables 71 and 72 a and b.

It is interesting to discover that the symptoms of significance in these tables are similar to results for the combined group depicted in Tables 68 and 69.

Table 71 demonstrates that burning eyes and difficult breathing were associated with the stressor tobacco odour on hair and clothing. The mean indicates that this tobacco odour stressor frequently to very frequently stressed certain staff in music venues. Tobacco odour in the air was also proving to be a very frequent stressor associated with nose irritation, runny nose

and difficulty in breathing. These SBS tobacco-related correlations represented the highest mean concern levels in Table 71.

SBS symptoms associated with stale air were burning eyes, nose irritation, coughing and difficult breathing. Stale air concern occurred occasionally to frequently in places of entertainment. The mean concern for body odour correlating with burning eyes and difficult breathing varied between being an occasional to frequent stressor in these environments. Tables 72 a and b which represent all allergic reactions (including SBS symptoms) and their associations with the aforementioned odour stressors, display many more significant correlations. Apart from the association between tobacco in air and difficulty in breathing, p-values in Table 72 were more significant for symptom and odour correlations than those occurring in Table 71. The highest mean levels for odour concern were again associated with tobacco smoke. These odour types were correlated with allergic symptoms of burning eyes, throat irritation, difficulty in breathing, runny nose and cough. Concern expressed by respondents pertaining to other odour types such as body odour, stale air, alcohol odour, musty air and dusty air varied between occasional to frequently.

It is evident from the large number of staff affected that air quality is not conducive to health in crowded music venues.

4.2.2.9 Correlations between concern for crowded conditions and allergies

Table 73 *T*-test correlating concern regarding crowds with SBS symptoms

Stressor	SBS effect	n	Mean crowd concern	SD	p-value
Crowds	Burning eyes	55	2,345	1,965	0,0212
	Not SBS	40	1,425	1,781	

N = 95

Table 74 *T*-test correlating concern regarding crowds with health symptom including SBS symptoms

Stressor	Health effect	n	Mean crowd concern	SD	p-value
Crowds	Burning eyes group	67	2,328	1,934	0,0034
	No symptom group	28	1,071	1,654	
	Throat irritation group	45	2,644	1,897	0,0008
	No symptom group	50	1,340	1,768	

N = 95

Only the allergic conditions of burning eyes and throat irritation symptoms correlated significantly with concern for crowding. The mean concern over crowded conditions was shown in Table 73 to be occasionally to frequently a stressor for staff experiencing SBS type burning eyes. Table 74 also shows concern to vary between occasionally and frequently for respondents reporting burning eye symptoms related to all types of allergic occurrences. The same level of concern was raised by staff experiencing throat irritation. **Crowded conditions can therefore be instrumental in exacerbating the psychophysical stressors in music venues.**

4.2.2.10 The influence of certain psychosocial variables on the reporting of allergic symptoms

Table 75 *T*-test of the respondents from the entertainment venue group correlating psychosocial variable with SBS symptoms

Psychosocial	SBS effect	n	Mean psychosocial satisfaction	SD	p-value
Work variety	Burning eyes	55	3,273	1,683	0,0388
	Not SBS	40	3,975	1,510	
	Cough	22	2,955	1,704	0,0448
	Not SBS	73	3,753	1,588	
Work satisfies needs	Blocked nose	10	4,900	0,316	0,0001
	Not SBS	85	3,976	1,345	
Respect by management	Throat irritation	23	3,087	1,881	0,0494
	Not SBS	72	3,889	1,615	
	Difficult breathing	19	2,947	1,957	0,0322
	Not SBS	76	3,882	1,600	

N = 95

Table 76 *T*-test of the respondents from the entertainment venue group correlating psychosocial variable with allergy symptoms including SBS symptoms

Psychosocial	Allergic effect	n	Mean psychosocial satisfaction	SD	p-value
Competent at job	Blocked nose	28	4,500	1,072	0,0029
	No effect	67	4,925	0,265	
	Itchy skin	31	4,613	0,989	0,0488
	No effect	64	4,891	0,362	
Work variety	Throat irritation	45	2,933	1,684	0,0002
	No effect	50	4,140	1,385	
	Cough	42	3,167	1,652	0,0330
	No effect	53	3,887	1,577	
Management respect	Throat irritation	45	3,222	1,700	0,0098
	No effect	50	4,120	1,547	
	Difficult breathing	22	3,000	1,877	0,0287
	No effect	73	3,904	1,609	
Job consistent with values	Throat irritation	45	3,244	1,433	0,0178
	No effect	50	3,940	1,376	
Job contributes to society	Cough	42	3,286	1,582	0,0238
	No effect	53	4,000	1,441	

N = 95

All psychosocial questions addressed in the questionnaire, except the question on salary, were correlated against SBS symptoms in Table 75 and against all types of allergic symptoms, including SBS, in Table 76. The issue of salary will be referred to when confounding variables are discussed (see section 4.2.2.11). Only significant correlations were included in the tables. Except for the question on salary, most people interviewed responded positively to the questions. Apart from the correlation between "my work contributes to my personal needs" and the SBS symptom "blocked nose", **less satisfaction** was reported with all of the other psychosocial variables associated with allergic type symptoms in Tables 75 and 76.

Table 77 Pearson Correlation Coefficient (r) of psychosocial variables associated with psychophysical stressors other than the SBS and health symptoms discussed in the former tables

Stressors	Work variety	Job challenge	General satisfaction	Job consistent with values	Job contributes to society
Sore throat	- 0,279	- 0,013	- 0,097	- 0,232	- 0,143
Tiredness	- 0,390	- 0,268	- 0,227	- 0,253	- 0,182
Dry throat	- 0,324	- 0,127	- 0,205	- 0,135	- 0,136
Miscellaneous odours	- 0,129	- 0,078	- 0,295	- 0,111	- 0,208
Dusty	- 0,179	- 0,077	- 0,138	- 0,207	- 0,242
Musty	- 0,078	- 0,075	- 0,074	- 0,080	- 0,265

N = 95.

The Pearson correlation coefficients (r) were also used to correlate all environmental stressors with the psychosocial variables. Table 77 depicts moderate negative associations between certain of the variables.

There are two possible scenarios that these associations may indicate. It is possible that where psychosocial factors instill a positive feeling in staff they are able to cope better with the adverse environmental conditions that they have to work under. A second possibility is that where workers feel satisfied with the psychosocial variables they merely do not wish to report negatively about the environmental health effects caused by these environments.

4.2.2.11 The chi-square tests: confounding variables associated with health symptoms

There were no significant τ-test correlations between age and SBS symptoms, nor with allergic-type symptoms, including SBS symptoms. Furthermore, chi-square tests did not display an association between fixed and non-fixed position job types with allergic type symptoms which included SBS. Tables 78, 79 and 80 only represent results associated with significant p-values.

Table 78 The chi-square test of confounding variable associated with SBS symptoms

Confounding variables	n	SBS symptoms	n	Staff reporting symptoms	p-value
Sex					
Male	59	Nose irritation	7	11,86%	0,002
Female	36	Nose irritation	14	38,89%	
Male	59	Runny nose	2	3,39%	0,010
Female	36	Runny nose	7	19,44%	
Job type					
Fixed position	74	Nose irritation	20	27,03%	0,03
Moving	21	Nose irritation	1	4,76%	
Salary					
Satisfied	35	Blocked nose	7	20%	0,022
Not satisfied	60	Blocked nose	3	5%	

N = 95

Table 79 The chi-square test of confounding variable associated all allergy symptoms including SBS symptoms

Confounding variables	n	Allergy	n	Staff reporting symptoms	p-value
Sex					
Male	59	Burning eyes	36	61,02%	0,009
Female	36	Burning eyes	31	86,11%	
Male	59	Throat irritation	23	38,98%%	0,036
Female	36	Throat irritation	22	61,11%	
Male	59	Nose irritation	14	23,73%	0,001
Female	36	Nose irritation	21	58,33%	
Male	59	Runny nose	5	8,47%	0,005
Female	36	Runny nose	11	30,56%	
Male	59	Difficult breathing	9	15,25%	0,019
Female	36	Difficult breathing	13	36,11%	
Salary					
Satisfied	35	Blocked nose	15	42,86%	0,029
Not satisfied	60	Blocked nose	13	21,67%	
Satisfied	35	Throat irritation	11	31,43%	0,017
Not satisfied	60	Throat irritation	34	56,67%	

N = 95

Table 80 T-test of confounding variable of salary associated with the symptom of sore throat

Salary	n	Mean concern for sore throat	SD	p-value
Satisfied	35	0,800	1,279	0,0011
Not satisfied	60	2,017	1,891	

N = 95

(a) Sex: confounding variables

Table 78 indicates that there were 59 males and 36 females working in music venues. The percentage of the female group reporting SBS symptoms of nose irritation and runny nose was higher than the percentage from the male group. The results described in Table 79 representing all allergic type symptoms, including SBS symptoms, also showed a higher percentage from the female group reporting symptoms of burning eyes, throat irritation, nose irritation, runny nose and difficult breathing than from the male group. SBS-related nose irritation had the highest significance level (1%). **These results demonstrate that females may not cope as well as males under adverse environmental conditions in places of musical entertainment and if more females were employed mean levels of dissatisfaction regarding SBS symptoms may have been higher in these places.**

According to Parkes (1990) little is known about gender differences in work-place coping and results of previous research appears inconsistent. Parkes (1990) reports that certain researchers have found no difference in coping strategies between genders whereas other researchers suggest that women use less effective strategies to deal with stressors, for example "selective ignoring, a form of coping found to exacerbate rather than alleviate stress" (p 400). Hedge et al. 1987 in a study of sick building syndrome symptoms in offices also found that females reported more symptoms than males. In the present study there were more smokers than non-smokers in both the male and female groups therefore this is not considered an influencing factor. Although it is not entirely clear from the literature reviewed and the present research why males report less strain the following reasons may be considered: restraint, withdrawal and ignoring the problem. However, further research would be required to establish the specific reasons for this difference.

(b) Job type: confounding variables

The influence of jobs where the staff are required to remain working at the bar for the duration of the evening is demonstrated in Table 78. The number of staff employed in fixed-position jobs was 74. Of this group 20% reported the SBS symptom of nose irritation. Of the 21 staff that could readily move around the only 4,76% reported nose irritation.

This tends to infer that staff who are free to move around in places of musical entertainment have a means of reducing the impact of environmental stressors, hence this can reduce SBS effects. However, for the majority of staff the impact is exacerbated because they have no way of avoiding adverse conditions. The advantage of this knowledge is that improvement of ventilation in the fixed work positions would assist in reducing stress.

(c) Salary: confounding variables

The majority of staff, namely 60, expressed dissatisfaction with salary and 35 staff were satisfied. The SBS symptom of blocked nose was reported in Table 78 by 20% of the group that felt satisfied with their salaries. Of the group that was dissatisfied with salary, only 5% experienced SBS type blocked nose. **Not being satisfied with salary did not appear to increase negative reporting of this SBS symptom and the symptom was entirely associated to the environmental influence.**

When all allergic type symptoms, including SBS, were combined in Table 79, a similar trend was found to exist for blocked nose in that 42,86% of the 35 satisfied workers experienced this symptom, compared to the 21,67% of the 60 dissatisfied staff. However, 56,67% of the 60 staff that were not satisfied with salary reported throat irritation, compared to 31,43% of the 35 satisfied workers. Table 80 describes the association between salary and sore throat and indicates that staff dissatisfied with salary also experience sore throat symptoms occasionally in these environments.

This demonstrates that psychophysical stressors which are experienced by a high percentage of the staff may, along with the psychosocial stressors which create dissatisfaction, compromise the coping ability of the majority of staff in places of musical entertainment.

4.3 MULTIVARIATE STATISTIC ANALYSIS

4.3.1 Proposed multivariate symptom models for places of musical entertainment

Tables 81 and 82 which follow contain all significant univariate correlations that were further analysed using multivariate regression techniques. Multiple regression analysis was defined in section 3.5.3. The purpose of this multivariate statistical analysis was to define models of allergic outcomes and their potential influencing agents.

Table 81 Associated SBS symptom outcomes with trends and correlations that may have a causal relationship

SBS outcomes	Associated trends and correlations
Burning eyes	Variety in work; concern for crowded environments; body odour; stale air; tobacco smell on clothing and hair; flashing lights.
Nose irritation	Benzene levels; toluene levels; xylene; tobacco odour in the air; stale air.
Blocked nose	Benzene; toluene; xylene; job satisfaction; job satisfies personal needs; salary.
Runny nose	Tobacco odour in air.
Throat irritation	Management respect.
Coughing	Variety in work; stale air.
Itchy skin	Respirable particulates; feeling competent at job.
Difficult breathing	Management respect; tobacco odour in air; body odour; stale air; tobacco smell on clothing and hair.
All SBS symptoms	Sex; age; occupation.

Table 82 Associated all health symptom outcomes (including SBS) with trends and correlations that may have a causal relationship

Health outcomes	Associated trends and correlations
Burning eyes	Concern for crowded environments; tobacco odours in air; alcohol odour; musty air; dusty air; stale air; tobacco smell on clothing and hair; flashing lights; body odour.
Nose irritation	Benzene levels; toluene levels; xylene; tobacco odour in the air; dusty air; body odour concern; stale air.
Blocked nose	Salary; competent at job; alcohol odour; dusty air; variety in the job.
Runny nose	Tobacco odour in air; dusty air.
Throat irritation	Variety in work; salary; management respect; job responsibilities consistent with values; concern for crowds; tobacco odour in air; alcohol odour; musty air; dusty air; stale air; tobacco smell on clothes and hair.
Cough	Benzene, respirable particulates; variety in work; work contributes to society; tobacco odour in air; alcohol odour; musty air; dusty air; stale air.
Itchy skin	Competent at job.
Difficult breathing	Management respect; tobacco odour in air; body odour; stale air; tobacco smell on clothing and hair.
Headaches	Xylene; tiredness; tobacco odour in the air; dusty air; sore throat; flashing lights.
Sore throat	Tiredness; tobacco odour in the air; stale air; dusty air; sweating; body odour; variety in work; concern for crowding; dry throat; headaches; musty odours; salary; pollution concern; music noise; air too warm.
Dry throat	Air too warm; Poor air movement concern; variety in work.
Tiredness.	Air too warm; headaches; variety in work; job challenging; job consistent with values.
All SBS symptoms	Sex; age; occupation.

4.3.2 Stepwise logistical regression models

The stepwise logistical regression statistical method was used to correlate allergic health outcomes, measured on a nominal scale, with psychophysical stressors which were acquired as ordinal data. Table 83 will demonstrate allergic symptoms which include SBS symptoms and Table 84 will focus on SBS symptoms.

Table 83 Stepwise logistic regression correlating allergic type symptom (including SBS) outcomes with variables of significance

Symptom	Variables	Parameter estimate	Standard error	Probability > chi-square
Burning eyes	INTERCEPT	0,3907	0,3580	0,2751
	Crowding	- 0,3231	0,1487	0,0298
	Stale air odour	- 0,5570	0,1703	0,0011
Nose irritation	INTERCEPT	4,1916	0,9444	0,0001
	Sex	- 0,2385	0,4982	0,0129
	Xylene	- 0,0331	0,0140	0,0182
	Tobacco odour in air	- 0,4219	0,1485	0,0045
Blocked nose	INTERCEPT	- 2,5640	1,1440	0,0250
	Salary	1,3985	0,5578	0,0122
	Alcohol odour	0,7769	0,3144	0,0135
	Dusty air	- 0,3480	0,1462	0,0173
	Job variety	0,3363	0,1596	0,0351
Runny nose	INTERCEPT	6,3085	1,5605	0,0001
	Sex	- 0,8177	0,7039	0,0098
	Occupation type	- 0,2946	0,1497	0,0490
	Tobacco odour in air	- 0,3949	0,1821	0,0301
Throat irritation	INTERCEPT	- 0,6388	0,6459	0,3226
	Job variety	0,4826	0,1517	0,0015
	Crowds	- 0,3007	0,1281	0,0189
	alcohol odour	- 0,3774	0,1659	0,0229
Cough	INTERCEPT	- 0,3956	0,7826	0,6133
	Benzene	- 0,0930	0,0271	0,0006
	Respirable particulates	0,8812	0,2838	0,0019
	Work contributes to society	0,3959	0,1780	0,0261
	Stale air odour	- 0,5383	0,1514	0,0004
Difficult breathing	INTERCEPT	0,8853	0,5878	0,1320
	Respect by management	0,3852	0,1532	0,0119
	Stale air odour	- 0,4405	0,1361	0,0012

Table 83 defines models which assign various influences present in places of musical entertainment to allergies which include SBS symptoms. **Models involving burning eyes, nose irritation, runny nose, throat irritation and difficult breathing demonstrate that psychophysical stressors increase the potential for allergies. In this table, negative parameter estimate results indicate this trend.** This multivariate analysis also considers that for each allergy type there was a "no symptom group." Data on staff numbers experiencing symptoms and those not experiencing symptoms can be referred to in the univariate tables (see section 4.2).

These results confirm that in music venues there are groups of hypersensitive people who are experiencing stress due to indoor air pollution. The symptom which effected the majority of staff was burning eyes. Throat irritation was the symptom of second highest occurrence.

In some of the models in Table 83 it was confirmed that high satisfaction with certain psychosocial components perform a supporting role to staff in music venues. This was discussed in section 4.2.2.10.

Coughing and blocked nose models had associated psychophysical variables which elicited less concern than the psychophysical variables in the burning eyes and throat irritation models. Coughing was associated with respirable particulate levels lower than those experienced by the "no symptom" group. A possible reason for this is that the hypersensitive group may become sensitised to aerosol pollution at much lower particulate levels. This interpretation may also explain the similar relationship between blocked nose and alcohol odour concern.

Confounding variables are present in three of the models. As discussed in section 4.2.2.11, females experienced more symptoms than the males. This would explain the influence of the sex confounder in these models which is shown to increase allergy potential. The models for nose irritation and runny nose, which included the variable "concern for tobacco smoke in air," also included this sex confounder. In the case of runny nose, the confounder "occupation type" was also associated. This was of interest as, **staff in jobs that were not free to move from their work positions experience higher allergy** concern and many of these jobs were carried out by females. This job factor may also have influenced female susceptibility.

Models of causes of nose irritation and coughing confirmed that tobacco smoke-related substances were affecting health. Concern for tobacco smoke in air was also associated with nose irritation. The model on runny nose showed that concern for odours in air was the prominent psychophysical variable. Stale air concern was the stressor common in models for burning eyes, coughing and difficulty in breathing. Univariate analysis demonstrated correlations between stale air and concern regarding tobacco odour in the air, body odour, dusty air and musty odours. There also appeared to be a weak trend between stale air and concern about crowding. Models for burning eyes and throat irritation were associated with tobacco odour on clothing and hair.

These correlations show that in most of the models, tobacco smoke plays an important role in increasing stress in places of musical entertainment, but is not the only contributor to poor indoor air quality in these environments.

Table 84 Stepwise logistic regression correlating SBS outcomes with variables of significance

Symptom	Variables	Parameter estimate	Standard error	Probability > chi-square
Burning eyes	INTERCEPT	0,2378	0,2793	0,3945
	Stale air odour	- 0,3224	0,1117	0,0039
Nose irritation	INTERCEPT	3,5587	0,8748	0,0001
	Sex	- 1,5533	0,5282	0,0033
Blocked nose	INTERCEPT	3,1949	0,6606	0,0001
	Toluene	- 0,0210	0,0091	0,0213
Runny nose	INTERCEPT	5,2784	1,4992	0,0004
	Sex	- 1,9285	0,8336	0,0207
Cough	INTERCEPT	1,7260	0,3792	0,0001
	Stale air odour	- 0,2460	0,1185	0,0378
Difficult breathing	INTERCEPT	1,0362	0,6045	0,0865
	Respect by management	0,3797	0,1570	0,0156
	Stale air odour	- 0,4076	0,1408	0,0038

Most of the models for SBS described in Table 84, included only one associated variable for each symptom. In the models for nose irritation and runny nose only the confounder "sex" was present, confirming that females were more likely to experience SBS in places of musical entertainment than males. The other interesting finding was that burning eyes, coughing and difficulty in breathing were associated with stale air. This suggests that there may be other contributors to SBS symptoms apart from tobacco smoke in places of musical entertainment not discovered in this present study. Blocked nose was the only SBS symptom associated with a tobacco smoke indicator, namely toluene.

4.3.3 Stepwise multiple regression model

Table 85 Stepwise multiple regression correlating health symptoms with variables of significance

Symptoms	Variables	Parameter estimate	Standard error	Probability > F test	Partial R^2
Headaches	INTERCEPT	- 1,3936	0,5312	0,0102	
	Tobacco odour in air	0,1552	0,0798	0,0548	0,0935
	Tiredness	0,1624	0,0753	0,0338	0,0569
	Xylene	0,0186	0,0081	0,0243	0,0364
	Flashing lights	0,7637	0,3436	0,0288	0,0450
	Dusty air	0,1205	0,0793	0,1323	0,0194
Sore throat	INTERCEPT	- 0,7697	0,5790	0,0030	
	Musty odours	0,1620	0,0908	0,0777	0,1464
	Dry throat	0,2981	0,0922	0,0017	0,0689
	Pollution concern	0,2054	0,0730	0,0060	0,0743
	Salary	0,9485	0,3181	0,0037	0,0640
	Headaches	0,1748	0,1026	0,0921	0,0291
	Music noise	0,1437	0,0893	0,1109	0,0177
Dry throat	INTERCEPT	2,5741	0,5208	0,0001	
	Heat	0,2846	0,0844	0,0011	0,1221
	Work variety	- 0,2651	0,0983	0,0083	0,0785
	Occupation type	- 0,1286	0,0759	0,0935	0,0245
Tiredness	INTERCEPT	3,5574	0,5833	0,0001	
	Work variety	- 0,2867	0,1256	0,0249	0,1520
	Too hot	0,2217	0,0956	0,0227	0,0556
	Headaches	0,2438	0,1190	0,0435	0,0319
	Job challenge	- 0,1810	0,1245	0,1494	0,0175

The Stepwise multiple regression statistical method was used to correlate certain health outcomes, measured on an ordinal scale, with psychophysical stressors which were also acquired as ordinal data. Table 85 will demonstrate these associations.

Table 85 describes models representing potential causes of symptoms of headaches, sore throat, dry throat and tiredness that staff experienced in these environments. The models also demonstrated that environmental stress resulted in poor health whereas psychosocial factors contained in the models of tiredness and dry throat helped reduce stress. In the sore throat model dissatisfaction with salary was related to increased complaints about sore throat. It was interesting to find that the stressors flashing lights, music noise and dissatisfaction with air temperature, occurred in certain of these models. **Only the headache model included specific references to tobacco smoke pollution.** Sore throat model was the only model associated with music noise level concern.

The dry throat model included the variable " air too warm" and the confounding variable "occupation type." Respondents in fixed work positions were experiencing temperature discomfort and in fact many did comment during the interviews that their throat felt continually dry in these environments.

Models contain certain stressors that are considered responsible for symptoms. Model R^2 estimated the influence that these stressor variables had on producing a symptom in these multivariate models. The following is a summary of these results.

- **The associated variables with the symptom headaches were only 25% of the cause.**

- **Associated variables with the symptom sore throat were 40% of the cause.**

- **The associated variables with the symptom dry throat were only 22,5% of the cause.**

- **Associated variables with the symptom tiredness were only 25,69% of the cause.**

The Model R^2 results suggest that there are many other variables in music environments that will influence worker stress. Possible areas for future research will be included under recommendations in Chapter 5.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 HYPOTHESES TESTING

The majority of staff in places of musical entertainment were tobacco smokers. Workers in crowded places of musical entertainment encounter many stressors such as:

- Allergic health symptoms.
- Exposure to passive smoking which can increase the risk of cancer.
- Exposure to loud music and people noise which can result in hearing loss over a period of time. Furthermore, psychological stress may occur in certain staff.
- Increased susceptibility to colds and influenza.
- Tiredness from long work hours and job demands which may reduce physical and mental performance.
- Psychological stress from various psychophysical stressors over which staff have limited control.

Factors that may assist in reducing stress or the reporting of stress:

- Certain psychosocial influences were seen to provide psychological support for the majority of music venue staff.

The following is a review of the results.

5.1.1 The personal habit of smoking

The average age of staff in music venues was 25 years with the youngest person being 18 years old and the oldest 44 years of age. Of the workers interviewed most were taking health-risks by smoking tobacco. It was interesting to discover that many of the smokers also considered tobacco smoke odour in places of musical entertainment a psychological stressor.

This demonstrates that the presence of higher levels of tobacco-related chemicals has the potential to stress smokers as well as non-smokers in poorly ventilated and crowded musical entertainment venues.

Sources of tobacco smoke included staff that smoked plus the many smoking patrons that frequent these venues. The allergic symptom of highest occurrence amongst the staff was burning eyes. Analysis showed this symptom was associated with concern over tobacco smoke odour in the air and tobacco odour on hair and clothing. Results indicated that the smell of tobacco smoke residue on clothing and hair was a stressor for the majority of music venue staff. Most non-smokers reported that they were stressed by tobacco smoke pollution in these environments.

Univariate correlations demonstrated an association between concern for tobacco odour in the air and stress from exposure to body odour and stale air. Furthermore, those people reporting that general pollution was a stressor were also stressed by tobacco smoke odour. Associations were demonstrated between tobacco odour and stressors such as: burning eyes, nose irritation, difficulty in breathing, runny nose, coughing, blocked nose and throat irritation in these environments. Tobacco odour concern in these correlations was higher than all other odour/allergy symptom associations.

Multivariate allergy models which included sick building syndrome (SBS) symptoms, showed that in most models tobacco smoke was a stressor. Multivariate SBS symptom models highlighted that stale air, of which tobacco smoke would be one of the contributors, was an important causal element for SBS type burning eyes, coughing and difficulty in breathing. Toluene, a tobacco smoke indicator, was the stressor in the blocked nose model. Females were found to have a higher response rate to pollutant stressors in these environments than the males, especially when employed in fixed position functions such as bar attendants. In the headache model, tobacco smoke odour in air and xylene were contributing stressors. The tobacco smoke indicator xylene was described in section 4.1.5.4 as a cause of headaches.

Accordingly, the personal habit of smoking in crowded places of entertainment is considered to be harmful psychologically and ultimately, the physical health of both smoking and non-smoking staff can be affected.

5.1.2 Carcinogenic substances in places of musical entertainment

The implications of cancer and tobacco smoke is well documented and the impact of tobacco smoke pollution on music venues disclosed some interesting findings.

Benzo(a)pyrene was not detected in any of the samples and was considered to be at levels below laboratory detection limits. The carcinogen benzene was found in all musical entertainment venues and in all the non-smoking office controls. This result supports previous research which concluded that benzene is ubiquitously found in the environment. The results showed that a significant difference existed between mean office benzene levels and mean levels in places of entertainment. However, levels in places of musical entertainment varied quite considerably when compared to levels in offices. Both the lowest and highest levels recorded occurred in music venues. This demonstrates that an adequate and effectively distributed outside air supply was able to reduce benzene levels to below detection limits in certain sections of crowded places of musical entertainment. An interesting finding was that the highest benzene level recorded in music venues compared closely to levels detected in an office situation where a benzene-based solvent was being used during the monitoring period. This finding highlights the potential impact of tobacco smoke in music venues. It was also found that the benzene mean for music venues was somewhat lower than the means reported in research carried out in environments such as an experimental room and other types of public places. Inconsistency in data tends to indicate that ventilation influences and local circumstances are important factors that may influence results. This emphasises the importance of acquiring data related to South African environmental conditions.

It has been stated in the literature review under section 2.3.5.1 that tobacco smoke is a Class A carcinogen having 4500 compounds present in the vapour and particulate phase, 60 of which are known or suspected carcinogens. The discussion in section 4.1.5.4 on some of the constituents of indoor air in a place of musical entertainment verified the presence of substances which are confirmed or suspected carcinogens, mutagens and teratogens.

Smoking increases levels of carcinogenic substances in places of musical entertainment. Permitting tobacco smoking in these environments increases the risk of cancer.

5.1.3 Staff dissatisfaction with environmental conditions and the stress it causes

Musicians and management in these venues considered their jobs as being permanent careers. Many of the staff interviewed were students who commented that their salaries provide an income whilst studying. Furthermore, job shortages may result in a change in these employment trends in the future. Psychophysical stressors contributing to worker stress will now be discussed.

5.1.3.1 Noise

Although noise levels were extremely high, few of the workers in entertainment venues considered music noise to be stressful and fewer felt that people noise was a stressor. Analysis showed that many of the staff stressed by music noise also experienced concern regarding people noise. Music noise was found to be a stress contributor in the multivariate model of sore throat.

5.1.3.2 Tiredness

Causes of tiredness amongst the staff were shown in the multivariate model to be partly precipitated by hot air temperatures and headaches. However, during discussions it was discovered that certain of the staff also worked during the day Therefore long working hours in these venues plus a day job could have exacerbated this lifestyle stressor. Results showed that only a few of the staff working in music venues were not stressed by tiredness.

5.1.3.3 Flashing lights

Statistics indicated that not all of the workers in music venues were exposed to flashing lights. This stressor was shown to be a stress contributor in the headache model.

5.1.3.4 Pollution concern

A large percentage of staff considered air in their work environments to be polluted. However, not all of these workers were stressed by these conditions. Polluted air as a stressor was associated with both tobacco odour in the air and concern regarding stale air through univariate analysis. Multivariate models demonstrated that concern over indoor air pollution was associated with sore throat. This may be partly due to the irritant affects that indoor air pollutants can have on the upper respiratory tract.

5.1.3.5 Odours

Of the definable odour types in places of entertainment tobacco smoke was ranked the odour of highest concern. Body odour and alcohol odour were the other definable stressors present in all venues. Theatrical smoke was a stressor not used in all places of entertainment and was an important stressor for some of the exposed workers.

The univariate analysis demonstrated that associations existed between some of the aforementioned recognisable odours and the non-defined odour concern such as stale air, musty air and dusty air. Multivariate models further defined the associations between recognisable and non-defined odours and their associations with allergic reactions. These associations confirm that tobacco smoke is the main contributor to indoor air pollution in these venues.

The results did not indicate that the majority of workers in music venues were dissatisfied with the psychophysical factors. Furthermore, it was shown in many of the multivariate models that certain of the psychosocial variables provide psychological support to workers. The impact of adverse conditions in these environments is underscored when comparing the results with non-smoking office staff responses. It is also evident that not all of the contributing factors to odours are fully defined in the results.

5.1.3.6 Ventilation system performance and comfort in crowded places of musical entertainment

The majority of the music venues visited relied totally on air conditioning systems for ventilation. The impact of large numbers of patrons in places of entertainment on indoor air quality was described by real-time analysis. In all premises these data clearly demonstrated that environmental pollution and comfort indicators would increase and decrease according to changes in patron numbers. In certain of these premises carbon dioxide levels exceeded the 5000 ppm limit of the indoor air quality monitor. Temperature and relative humidity were also above acceptable comfort levels. Respirable aerosol levels followed a similar pattern to the other pollution and comfort indicators.

A large percentage of staff considered temperature to be too warm for most of the work period. In addition to the aforementioned indicators, air movement in these premises varied greatly. Higher air speeds were mostly due to portable fans that staff working in fixed positions had placed at their work stations to reduce discomfort. The majority of the staff felt that poor air movement was a stressor for the most of their work period. Furthermore, the combined effect of these stressors were causing many workers to sweat.

The univariate analysis was useful in drawing certain comfort indicators together, namely poor air movement with relative humidity, temperature with stale air, carbon dioxide with relative humidity levels, air movement with relative humidity levels. Poor air movement and dissatisfaction with warm air temperature were also associated with odour concern in the music venues. Concern regarding crowding was weakly associated with stressors such as poor air movement, air temperature and sweating.

The tiredness model was the only model where indoor air temperature was a contributing stressor.

Ventilation systems in the crowded places of musical entertainment did not cope adequately in reducing indoor air pollution and ensuring comfort.

5.1.3.7 Stress and the sick building syndrome

Sick building syndrome was found to exist in places of entertainment. It was also reported by certain of the staff that allergic symptoms, not occurring whilst in the work environment, were being experienced the following morning after awakening. Furthermore, some of the respondents had continuous allergic conditions which were aggravated by workplace environmental conditions. Respiratory infection due to colds and influenza was found to be higher than those occurring in the office staff.

Tobacco smoke plays an important role in increasing stress in places of musical entertainment, but may not be the only contributor to poor indoor air quality in these environments.

Burning eyes was the only SBS symptom experienced by the majority of staff. Stress does exist in places of musical entertainment with regards to the occurrence of SBS type symptoms, increased allergies, colds and influenza.

5.2 RECOMMENDATIONS TO IMPROVE INDOOR AIR QUALITY IN PLACES OF MUSICAL ENTERTAINMENT

The biopsychosocial model described in Table 3 in section 2.3.9 was an important focus for this quasi-experimental research. Although the research design was successful in investigating many of the stressors it is evident from the results that the stressor list is far from complete. Before detailing future research proposals environmental stressor control measures will be discussed.

5.2.1 Environmental stressors of concern: their control

It is apparent that certain environmental stressors require urgent attention in places of musical entertainment to attain a healthier lifestyle for the staff. These include:

5.2.1.1 Tobacco smoking

Educating club owners and managers of the health-risks associated with tobacco smoking and their responsibilities in ensuring a healthier work environment for staff is a priority. Programs are necessary to assist existing staff to give up the smoking habit. Employing of non-smokers in these environments could be another consideration as the educational programme gains momentum. However, of greater priority would be the creation of tobacco smoke-free environments through legislative means such as the recently promulgated South African legislation " The Tobacco Products Control Act." Without a means of control to reduce the impact from smoking patrons in all venues, no major indoor air quality improvements will be achieved in these environments or any other workplace where people are permitted to smoke.

5.2.1.2 Ventilation

Improved ventilation design is considered necessary to ensure adequate outside air provision and the effective distribution of air to work stations. This is especially important for workers in fixed positions who have limited personal control over their environment. Carbon filter systems for the control of volatile organic compounds and high performance dust arresting systems are available on the South African market. However, the first priority should be the reduction of tobacco smoking in these environments.

Effective temperature, air movement and relative humidity control is vital to ensure adequate comfort in these environments, especially during the hot summer months.

5.2.1.3 Noise levels

Loud music is one of the main factors that attract the youth to places of musical entertainment and hence this stressor will always be present. Personal protection against noise-induced hearing loss should be considered by management and staff in these environments. The fact that in one place of entertainment workers were voluntarily wearing ear plugs tends to suggest that an educational program may succeed in encouraging others to follow this example.

5.3 RECOMMENDATIONS FOR FURTHER RESEARCH

5.3.1 Microbes

Establishing the contribution that microbes may have on SBS in places of musical entertainment is considered important as high relative humidity and temperatures would tend to increase growth. Other factors that encourage growth include spillage of drinks on carpeted areas and condensation taking place on cooler surfaces. The reporting of musty odours may have been an indication of microbial growth which could have contributed to allergic reactions.

5.3.2 Psychosocial contributors to stress

Further lifestyle research in these venues should include staff anxiety over moral challenges that exist in entertainment environments, stress caused from personal relationships, eating habits, the use of psycho-active drugs, drinking and sexual habits of staff in music venues, physical exercise routines, investigating the total hours of work at music venues and day jobs and the stress this causes.

5.3.3 Attitude surveys

Research should investigate the attitudes of workers, management and patrons to non-smoking in musical entertainment venues in South Africa as well as the attitudes of staff in places of entertainment on having to wear hearing protection.

5.3.4 Indoor air analysis

Establishing the various types of theatrical smoke used in entertainment venues in South Africa and investigating their hazard and nuisance potential.

5.4 FINAL CONCLUSIONS

This multidisciplinary research project has made a significant contribution towards further development of the biopsychosocial model for assessment of stress in places of musical entertainment and other public venues.

This project resulted in the design of an entirely new validated questionnaire which provided data within limits of statistical significance. This questionnaire will be useful for research in entertainment venues and other workplace types.

Statistical methods utilised will provide a means of interpreting information gathered in entertainment venues and other environments.

The literature review was an essential part of the investigation and was covered quite extensively, to provide a general perspective on the various stressors present in places of musical entertainment. It also highlighted the need for a multidisciplinary approach to research of this nature.

The general methodologies developed and tested in this research can be applied in studies of biopsychosocial stress-related phenomena in many workplace environments.

It is anticipated that guidelines developed in this investigation will form the basis for further studies into worker stress in a variety of public places in South Africa.

CHAPTER 6

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CHAPTER 7

ANNEXURES

Annexure 1

DEPARTMENT OF HEALTH CARE SERVICES

TO WHOM IT MAY CONCERN

RESEARCH ON WORKER HEALTH

IN

PLACES OF PUBLIC ENTERTAINMENT

Mr A Shadwell is employed by M L Sultan Technikon as a lecturer in Environmental Health. He is at present undertaking a research project. To complete his research it is required of him to obtain indoor air samples and have five staff members complete a short questionnaire at their convenience. He is required to undertake this work on one evening at each venue. It is stressed that there will be no interference with customer service at all and there will be no communication with customers. All data collected would be strictly confidential and at no time will the researcher refer to the names of the premises or staff names.

Management will be provided with a set of results from their premises should they so wish.

Accordingly it would be greatly appreciated if you would permit Mr Shadwell to utilise your premises as part of his study.

N G NEWBERRY

HEAD : HEALTH CARE SERVICES

FACULTY OF SCIENCE.

Date :

Annexure 2

HEALTH, COMFORT AND JOB SATISFACTION QUESTIONNAIRE

GENERAL INFORMATION

I would firstly like to introduce myself. My name is Tony Shadwell and I am undertaking a study into health, comfort and stress of workers employed in places of musical entertainment.

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.

The data will be used towards my Masters Degree in Medical Science.

The questionnaire is designed to obtain your personal opinions of your work environment.

Please assist by answering all questions. However, should you wish to withdraw at any time you will in no way suffer any disadvantage.

Thank you for your help in completing this questionnaire.

Tony Shadwell

Annexure 3

Final questionnaire design

A. General Information and job details

1. Premises ______________________________

2. Address ______________________________
____

Please answer questions 3 to 9 by filling in the blocks.

3.Sex: 1. Male 2. Female

4.Age Yrs

5.Job function: 1. Bar attendant.

2. Waitress/Waiter.

3. Musician.

4. Disk-jockey. (D J)

5. Any other please state:
____

Please answer questions 6 and 7 by referring to the following codes and choose the period applicable to you:

1 = 0 - 6 months
2 = 6 months - 1 year
3 = 1 year and more

6.Length of employment in present job.

1	2	3

7.How long have you worked in this type of job?

1	2	3

8.Please indicate how many hours a night you work.

9.How many nights/days do you work at these premises during the week?

B. Health

This section contains questions relating to health. Please respond to these statements using the following choices and circle your response.

5 - Almost always (90% or more of the time)

4 - Very frequently (approximately 75% of the time)

3 - Frequently (approximately 50% of the time)

2 - Occasionally (approximately 25% of the time)

1 - Almost never (less than 10% of the time)

* If an item does not apply to you **do not** mark the item.

1. Please indicate how the feeling of tiredness effects you.

   Refer to the aforementioned list of responses and indicate the severity of tiredness in the relevant box in Table 1.

   Refer to the last two columns and indicate with a cross how soon the symptoms occur after entering the environment.

Table 1

SYMPTOM	5	4	3	2	1	IN 1Hr	AFTER 1Hr
TIREDNESS							

Please note : If you do not experience tiredness at work **disregard** questions relating to Table 2.

2. Refer to Table 2 below and only cross the block next to the responses of tiredness that apply to you.

Table 2.

	tiredness never goes.
	tiredness goes after leaving the workplace.
	tiredness only goes after a sleep.
	tiredness also occurs on other nights in the workplace.
	tiredness has been medically diagnosed.
	tiredness that has been medically diagnosed is made worse by the work environment.

3. Please refer to Table 3 on physical symptoms. Should you experience any of the symptoms listed in the first column whilst present in your work environment, please indicate how often they occur during the evening by ticking your response in the relevant column.

   Refer to the last three columns and indicate with a tick how soon the symptoms occur.

   Please indicate <u>any</u> other effects/condition not mentioned that you experience in the blank boxes at the end of the symptoms list and their occurrence as you did with the listed symptoms.

Table 3

SYMPTOMS	5	4	3	2	1	IN 1HR	AFTER 1 HR	NEXT DAY
BURNING EYES								
NOSE IRRITATION								
BLOCKED NOSE								
RUNNY NOSE								
THROAT IRRITATION								
COUGHING								
ITCHING SKIN								
FREQUENT HEADACHES								
DIFFICULTY IN BREATHING								

4. Please refer to Table 4.

   Indicate with a tick in **column 1**, the symptoms you **experience** whist in the work environment.

   Refer to **columns 2 and 3** indicate when you have relief from the symptoms listed in the **column 1**.

   Refer to **column 4** and indicate with a tick the conditions which continue for a limited period at **home** after leaving work which you suspect **might be related to your work environment.**

   Please refer to **column 5** and indicate the symptoms that you experience on other nights/days in this environment.

   Please refer to **column 6** and indicate any of these symptoms that may have been medically diagnosed.

   If you responded positively to the previous question, please indicate in **column 7** whether the medically diagnose symptoms are **aggravated** by your work environment.

Table 4

COLUMNS	1	2	3	4	5	6	7
Symptoms	N/A	NEVER GOES	AFTER LEAV-ING WORK				
BURNING EYES							
NOSE IRRITATION							
BLOCKED NOSE							
RUNNY NOSE							
THROAT IRRITATION							
COUGHING							
ITCHING SKIN							
FREQUENT HEADACHES							
DIFFICULTY IN BREATHING							

5. Do you smoke tobacco? 1. YES 2. NO

6. Are you an ex - tobacco smoker? 1. YES 2. NO

7. Does your spouse or other family members smoke in the home?

1. YES 2. NO

8. Does tobacco smoke bother you at work? 5 4 3 2 1

9. Do you suffer regularly from colds and flu?

1. YES 2. NO

C. The physical work environment

This section contains questions relating to air quality, temperature, humidity and air movement. Please respond to these statements using the following choices and circle your response.

5 - Almost always (90% or more of the time)

4 - Very frequently (approximately 75% of the time)

3 - Frequently (approximately 50% of the time)

2 - Occasionally (approximately 25% of the time)

1 - Almost never (less than 10% of the time)

If the item does not apply to you do not mark item.

1. If odours concern you in the work environment, please indicate the type and level of concern in terms of the above rating.

   Please note if there are any other odour not mentioned write them in the blank boxes at the end of the table and indicate the level of concern.

Table 5

ODOUR	5	4	3	2	1
TOBACCO SMOKE					
ALCOHOL					
MUSTY ODOURS(other than tobacco smoke)					
dusty air					
body odours					
stale air					

2 Is a smoke machine used?

1 Yes 2 No

Table 6 Indicate your concern regarding smoke machine pollution.

Level of concern	5	4	3	2	1
Theatrical smoke effect					

3. The air in my work environment is polluted. 5 4 3 2 1

4. I worry about polluted air in my work environment. 5 4 3 2 1

5. It concerns me that my clothes and hair smell of cigarette after I leave the work environment. 5 4 3 2 1

6. The air temperature is too warm. 5 4 3 2 1

7. The air temperature is too cold. 5 4 3 2 1

8. My nose and throat feel dry. 5 4 3 2 1

9. I feel sticky due to me being continuously sweaty in my work environment. 5 4 3 2 1

10. The air movement in my work environment is insufficient. 5 4 3 2 1

11. I feel concerned when my environment is crowded. 5 4 3 2 1

12. Raising my voice above the level of sound causes a sore throat. 5 4 3 2 1

13. Are flashing lights used?

1 Yes 2 No

14. If sound levels and lighting cause you concern please indicate what aspects are relevant and the level of concern using the previously listed rating system.

Please indicate any other physical environmental source causes you problems in the blank boxes.

Table 7

PHYSICAL STRESSORS	**5**	**4**	**3**	**2**	**1**
Low level lighting					
flashing lights					
people noise					
music loudness					

D. Occupational

This section contains questions relating to job satisfaction. Please respond to these statements using the following choices and circle your response.

5 - Almost always (90% or more of the time)

4 - Very frequently (approximately 75% of the time)

3 - Frequently (approximately 50% of the time)

2 - Occasionally (approximately 25% of the time)

1 - Almost never (less than 10% of the time)

If the item does not apply to you do not mark the items.

1. I enjoy my work.	5 4 3 2 1
2. My work contributes to my personal needs.	5 4 3 2 1
3. I feel my job in some way contributes to others and/or society.	5 4 3 2 1
4. My co-workers respect me as a competent individual.	5 4 3 2 1
5. Management respect me as a competent individual.	5 4 3 2 1
6. I feel my job responsibilities are consistent with my values.	5 4 3 2 1
7. I find satisfaction from the work I do.	5 4 3 2 1
8. I interact well with the public.	5 4 3 2 1
9. I interact co-operatively with my co-workers.	5 4 3 2 1
10. I am satisfied with the amount of variety in my work.	5 4 3 2 1
11. I believe I am competent in my job.	5 4 3 2 1
12. My job is challenging.	5 4 3 2 1

13. I am satisfied with my salary.

1.YES 2.NO

Thank you for completing this questionnaire, T. Shadwell.

Annexure 4

Table 86 Varied compounds in two different theatrical smoke machine samples before heating the mixtures.

Sample 1	Sample 2
Acetic acid, ethyl ester	2-Propanone
Butanoic acid, ethyl ester	Methyl-1,3-dioxane-isomer
3-Methyl-1-butanol acetate	2,2,4-Trimethyl-1,3-Dioxolane
1,2,3-Propanetriol	2.Ethyl-4-methyl-1,3-dioxolane
-	1,2-Propanediol
-	Triethylene glycol