SEASONAL PATTERNS OF MORTALITY IN MEDICAL ADMISSIONS AT GROOTE SCHUUR HOSPITAL, CAPE TOWN: 2002-2009

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PREAMBLE

DECLARATION

I _____Vanessa Mudaly_____ Student No._____MDLVAN010____ declare that the work that I have submitted is my own. Where the work of others has been used (whether quoted verbatim, paraphrased or referred to), it has been attributed and acknowledged.

Signature: _____

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ABSTRACT

Across the world, studies have shown that hospital mortality may be influenced by seasonal factors. Very few studies examining this phenomenon have been conducted in South Africa. This study aimed to determine whether there are seasonal patterns of mortality associated with medical causes of admission to a hospital in Cape Town, and to identify demographic risk factors and specific disease categories that are associated with increased susceptibility to seasonal mortality.

Part A is the protocol that was developed for the study. It begins with a summary of key aspects of the literature review. The aim, hypotheses and objectives of the study are then described, followed by a detailed account of the study methodology, ethical issues, plans for communication of the study findings and logistics. The protocol was approved by the Research Ethics Committee at University of Cape Town.

Part B is the structured literature review, in which studies describing trends in seasonal mortality, and associated risk factors and determinants of excess seasonal mortality, are discussed. International and local studies were included, in order to provide an appropriated background for this study.

Part C is a presentation of the study findings in the form of a journal-ready manuscript for the South African Medical Journal. Graphs have been used to illustrate the trends in mortality for each year of the study period, and the relationship between mortality and average temperatures and precipitation. Interactions with seasonal mortality and gender, socioeconomic status, ethnicity and age-groups have

also been illustrated. Results have been quantified with the calculation of mortality rate ratios with 95% confidence intervals. Patterns of mortality for circulatory, respiratory and gastrointestinal diseases, and cancer, are analysed. There is a brief discussion of the findings with suggestions for further research and public health interventions to reduce excess seasonal mortality in this setting.

Part D is comprised of appendices containing relevant analyses that were not be included in the article, as well as other documents pertaining to the study. Tables and graphs have been annotated, and reference is made to these appendices in the article.

Part A: PROTOCOL

CONTENTS

List of Terms and Abbreviations 3

1. Executive Summary 4

2. Introduction 7

(a) Background 7
(b) Summary and Interpretation of Literature 8
(i) Global Trends in Seasonal Mortality 8
(ii) Seasonal Patterns of Mortality from Circulatory & Respiratory Disease 10
(iii) Determinants of Excess Winter Mortality 11
(iv) Seasonal Patterns of Mortality in South Africa 13
(c) Gaps for Further Research 15
(d) Justification for Research 15

3. Aim, Hypotheses and Objectives 16

4. Study Methodology 17

(a) Study design 17
(b) Population and Sampling 17
(c) Inclusion and Exclusion Criteria 17
(d) Measurements 18
(i) Methods of Data Collection 18
(ii) Variables 19
(iii) Validity and Reliability of Measurements 20
(e) Limitations of the Study 20

5. Data Management and Analysis Plan 21

6. Ethics and Communication 21

(a) Ethical Considerations 21
(b) Stakeholders 22
(c) Reporting and Publication 22

7. Logistics 22

8. References 23

LIST OF TERMS AND ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral Therapy
95% CI	95% Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CVA	Cerebrovascular Accident
CVD	Cardiovascular Disease
Death Rate	(Number of deaths / Number of admissions) x 100 %
GSH	Groote Schuur Hospital
HIV	Human Immunodeficiency Virus
ICD-10	International Classification of Disease version 10
IHD	Ischaemic Heart Disease
MI	Myocardial Infarction
Mortality Rate	Number of Deaths per 1 000 people per unit of time
MRR	Mortality Rate Ratio = comparison of two mortality rates
PTB	Pulmonary Tuberculosis
SA	South Africa
SES	Socioeconomic Status
UK	United Kingdom
USA	United States of America

1. EXECUTIVE SUMMARY

Background to research: Across the world, it has been found that mortality at hospitals may be influenced by seasonal factors. In most countries, there are peaks in mortality during winter, which are largely attributed to circulatory and respiratory disease. In developing countries, there may also be peaks in summer related to infectious diseases. In South Africa (SA), identification of patterns of seasonal mortality and risk factors for excess seasonal mortality may facilitate the development of public health interventions to reduce excess mortality.

Research Aim: To determine whether seasonal factors affect mortality associated with medical causes of admission to a hospital in a South African setting, and to identify demographic risk factors and specific disease categories that are associated with increased susceptibility to seasonal mortality.

Research Objectives:

1. To determine whether changes in mortality related to medical conditions are associated with seasonal factors, and to identify seasonal patterns of mortality.
2. To identify demographic risk factors for excess winter mortality in this setting.
3. To identify seasonal patterns of mortality associated with specific categories of disease which contribute significantly to all-cause mortality.

Gap in the knowledge: Thus far, very little research on seasonal mortality has been conducted in SA. Numerous risk factors for excess seasonal mortality have been identified in international studies, but it is not clear whether these factors are relevant to this setting. Further research is therefore required.

Study Design: This is a retrospective cohort study. The exposure is month and season of admission to hospital with a medical condition, and the outcome of interest is death.

Data Collection: Clinicom data was accessed with assistance from Medical Informatics at GSH. Patient data was assembled from a range of sources including admission tables, discharge tables, ICD-10 coding and billing tables. Demographic information concerning age, gender, socioeconomic status and ethnicity were recorded. The clinical outcome at discharge was recorded as dead or alive. Admission diagnoses and "cause of death" as recorded on death certificates were included where available. These diagnoses were then analysed according to the ICD-10 chapter classification of diseases, ranging from A to Z. Information regarding average monthly temperatures and precipitation for every month during the study period was collected at a weather station in Cape Town, and was available in the public domain on the internet.

Population or participants: Patients admitted to medical wards in Groote Schuur Hospital are referred from community health centres, clinics and general practitioners located in a wide feeder zone across the Cape Peninsula, as well as from surrounding areas outside the feeder zone.

Inclusion & Exclusion Criteria: Since the majority of paediatric patients in the region are treated at the Red Cross Hospital, the study will be restricted to adults over the age of 20 years. The entire study sample will be used in the analysis. However, the analysis of diagnostic disease categories using the ICD-10 classification system will be restricted to the latter four years of data, because diagnostic codes were very poorly recorded prior to 2005.

Data Analysis: Univariate, bivariate and multivariate analyses will be conducted and appropriate tables and graphs will be constructed to illustrate the findings. Poisson regression will be performed in Stata version 11, and will result in the calculation of mortality rate ratios (MMR's).

Privacy/Confidentiality: There will be no actual patient contact. Patients will identified by numbers in the data analysis. All information pertaining to patients obtained from the dataset will be viewed by the principal investigator and supervisor only, and will be kept strictly confidential.

2. INTRODUCTION

(A) BACKGROUND

Variations in climate have been known to impact on human mortality. Research has shown that there are several environmental, demographic and biological risk factors for excess seasonal mortality. Respiratory and circulatory diseases in particular, have been associated with increased winter mortality. In South Africa, the burden of mortality from circulatory and respiratory disease is high due non-communicable diseases and Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS).

Although mortality from HIV/AIDS has decreased since the introduction of Antiretroviral Therapy (ART), mortality from chronic diseases like diabetes, hypertension, renal disease and chronic obstructive airways disease (COPD), is increasing. An understanding of seasonal patterns of mortality, and identification of risk factors for excess seasonal mortality, could lead to the development of interventions to reduce excess mortality.

This study aims to describe seasonal mortality patterns in a South African setting. Patient data was collected at Groote Schuur Hospital (GSH) in Cape Town over a seven year period. Information regarding gender, age, SES and ethnicity was collected. In addition, diagnostic codes were available for most patients in the latter four years of the study. Climatic information collated at a weather station in Cape Town was available for the entire study period. In order to establish specific hypotheses and objectives for the study, a literature review of relevant studies was conducted.

(B) SUMMARY AND INTERPRETATION OF LITERATURE

(I) GLOBAL TRENDS IN SEASONAL MORTALITY

There has been a recent surge of interest in seasonal morbidity and mortality, as more scientific evidence of the phenomenon of climate change has become apparent. In 2008, McMichael et al conducted an extensive international study called the “Isothurm” project. A total of 12 countries, including Cape Town, were selected, and the association between daily mortality and environmental temperature over periods of 2-5 years was analysed using Poisson regression.

Overall, most countries demonstrated a “U-shaped” relationship between temperature and mortality. The highest mortality was associated with winter, especially in countries with relatively big fluctuations in temperature, and the lowest mortality was recorded in summer. Cardiovascular and respiratory disease was significantly associated with decreased temperatures in most European, South American and Asian countries. Elevated temperatures were associated with an increase in cardiovascular and respiratory disease in some countries with very warm climates.

In Scotland, Gemmel et al (2000) found an overall difference of about 30% between peak winter mortality and trough summer mortality, which was attributed mainly to Ischaemic Heart Disease (IHD), cerebrovascular accidents (CVA’s) and respiratory diseases, and occurred more significantly in those aged 70 years and older. Marked increases in deaths were noted after influenza epidemics, which occurred every 3-4 years. Surprisingly, social class and SES were not found to contribute to differences in mortality rates.

In Asia, Nakaji et al (2004) studied mortality, population and temperature data in Japan over a 29 year period. A “U-shaped” pattern of mortality was also identified for most diseases. The excess winter mortality observed was attributed to infections and parasitic diseases, pneumonia and influenza, as well as cardiovascular disease (CVD) and CVA, and diabetes.

In Bangladesh, Burkart et al (2011) observed a peak in winter as well as in summer mortality. The latter peak was more significant in urban areas. Urban-dwelling and high SES had a greater association with mortality related to CVD and respiratory disease, while rural-dwelling and low SES was associated with infections, and vector-borne, respiratory and diarrhoeal disease. All associations were strongly influenced by age.

In Africa, Azongo et al (2012) conducted a study between 1995 and 2010 in Northern Ghana. A significant increase in all-cause mortality of 14% was found at temperatures above 30.86 °C following a lag period of 0-1 days after the change in temperature. A 10mm increase in precipitation was also associated with a 71% increase in mortality following a lag period of 2-6 days.

In nearby Nigeria, Ansa et al (2009) found that medical admissions due to cardiac failure and hypertension at a teaching hospital increased significantly during the rainy season. In Kenya, Egondi et al (2012) also found that rainfall was significantly associated with mortality from pneumonia and non-communicable diseases.

(II) Seasonal Patterns of Mortality from Circulatory & Respiratory Disease

Woodhouse (1993) noted that there was significant evidence from studies in the United Kingdom (UK) and Unites States of America (USA) that exposure to cold temperatures, as well as various climatic and environmental factors like rain, snow, wind chill and air pollution could precipitate cardiovascular events. Outbreaks of Influenza in the UK were strongly associated with excess winter deaths. About two-thirds of these deaths were caused by respiratory disease and the remaining third by circulatory disorders.

In a systematic review, Bhaskaran et al (2009) identified positive associations for increases and decreases in outdoor temperature with the incidence of myocardial infarction (MI). Barnett et al (2005) found that the incidence of coronary events was significantly increased in people over the age of 60 years, with the risk of death being 7% higher during cold periods compared to warm periods. In addition, women were 7% more likely than men to have events during cold periods.

Many studies have shown that the incidence of respiratory disease peaks in winter. The Whitehall study (van Rossum, 2001) determined that in the UK, the mortality rate from respiratory disease was nearly twice as high in winter compared to summer, and that those aged over 65 years were most at risk. In Japan (Nakaji, 2004) and Bangladesh (Burkart, 2011), it was found that mortality from all respiratory diseases including tuberculosis (TB) peaked firstly in winter, and then again, to a lesser degree, in summer.

(III) Determinants of Excess Winter Mortality

1. Influenza

Reichart et al (2004) examined the relationship between influenza epidemics and mortality related to IHD, CVA, diabetes and pneumonia over a 40 year period from 1959 to 1999 in the USA. It was found that the size of the peak of deaths in winter for these diseases corresponded to the peak incidences of influenza. This led the authors to conclude that there is a high likelihood that the "singular cause of excess seasonal winter mortality is, in fact, influenza".

2. Cold Temperature

Eccles (2002) proposed a possible mechanism to explain the association between cold temperatures and respiratory tract infections. He suggested that exposure of respiratory epithelium in the upper respiratory tract to cold air produced a "decrease in the effectiveness of local respiratory defences, such as mucociliary clearance and leukocyte phagocytosis". This caused increased susceptibility to circulating pathogens like viruses and bacteria.

Pell and Cobbe (1999) reviewed current literature and described possible reasons for vulnerability of those with compromised cardiac function to changes in external temperatures. In cold temperatures, peripheral vasoconstriction and increased vascular resistance with a subsequent increase in blood pressure could increase stress on cardiac function and precipitate cardiac events like angina and myocardial infarction. Other relevant factors were vitamin D deficiency, obesity, lack of exercise, smoking, cholesterol levels and coagulation factors.

3. AIR POLLUTION

Wong et al (1999) conducted a retrospective ecological study in Hong Kong, in which admissions at twelve hospitals were correlated with “daily concentrations of nitrogen dioxide (NO2), sulphur dioxide (SO2), ozone (O3), and particulate matter <10 μm in aerodynamic diameter (PM10)”. Relative risks for respiratory disease and CVD were significantly increased by exposure to these pollutants, and winter was found to positively interact with air pollution to increase susceptibility to these diseases.

4. VITAMIN D DEFICIENCY

Dobnig et al (2008) conducted a cohort study in Germany, in which the 25-hydroxyvitamin D and 1.25-Dihydroxyvitamin D levels of 3299 patients referred for coronary angiograms were measured at the start of the trial. These patients were then followed up over an average of 7.7 years. Hazard ratios for heart failure and sudden cardiac deaths, and all-cause mortality were significantly elevated in those with low levels of vitamin D metabolites.

5. HYPERCHOLESTEROLAEMIA

In 1996, Grimes et al published the results of an ecological study, in which latitude of population residence was compared to the mean population cholesterol level. A positive linear relationship was found between latitude and cholesterol levels, with cholesterol levels increasing as distance from the equator increased, suggesting that cold climates adversely affect cholesterol levels.

In a cohort study, Ockene et al (2004) measured cholesterol levels in healthy participants in Massachusetts, USA over a one year period. It was found that 22.2% more people had cholesterol levels greater than 6.2mmol/l in winter than in summer. The seasonal pattern of fluctuation was also reflected in low-density and high- density lipoproteins (LDL & HDL) and triglyceride levels. These changes could increase vulnerability to cardiovascular events.

6. Excess Fibrinogen

In a similar study, Woodhouse et al (1994) measured the plasma fibrinogen and factor VII clotting activity in elderly participants over a year long period. They hypothesised that since these factors were known risk factors for IHD and CVD, seasonal fluctuations in levels could result in excess seasonal morbidity and mortality. Levels of both factors were significantly more elevated in winter compared to summer. Fibrinogen levels in winter also correlated with inflammatory markers and evidence of acute respiratory infections.

(iv) Seasonal Patterns of Mortality in South Africa

In 1978, Wyndham and Fellingham examined seasonal mortality rates in South Africans (SA) in Johannesburg and Durban. For Whites and Indians, mortality was highest in winter and lowest in summer. This corresponded to seasonal patterns described in the literature from countries in the Northern hemisphere during that time. The seasonal pattern of mortality in Coloureds and Blacks was bimodal, with an expected peak in the middle of winter, and a second peak in the middle of summer. This corresponded to the pattern seen in developing countries.

In another study, Wyndham (1986) examined mortality rates for Whites from pneumonia and chronic respiratory disease from 1979 to 1981 in eight cities in SA, including Johannesburg, Durban and Cape Town. Age-specific and age-standardised mortality rates were correlated with mean monthly temperatures. In all the cities, temperatures were inversely related to mortality rates due to pneumonia.

In 1995, Heunis et al conducted a cross-sectional study to determine the association between extreme temperatures and mortality related to cardiovascular disease (CVD) in Cape Town. CVD mortality rates were found to be significantly increased after a lag period of two days following a fall in temperature below 4 degrees Celsius or a rise in temperature above 25 degrees Celsius. In addition, large daily temperature ranges in winter were associated with higher CVD mortality rates.

More recently in 2010, Cohen et al compared excess mortality related to influenza in SA and the USA in people over the age of 65 years. In SA, peak influenza viral activity was associated with peak all-cause and pneumonia mortality. After age-standardisation, 16% of winter deaths in SA could be attributed to influenza, compared to just 6% in the USA. This difference reflected the more widespread use of influenza vaccine in the elderly in the USA compared to SA

Cohen et al (2012) conducted a similar analysis in adult participants of all ages with HIV/AIDS. Prior to the introduction of ART, it was estimated that people with HIV/AIDS had a “150-200 fold increase in risk of influenza-associated death”. After the introduction of ART in the USA, the rate remained elevated to “40-70 fold” more than in the general population. It was estimated that influenza-related deaths in young adults with HIV/AIDS in SA post-ART was at least 2-4 times more than that of adults aged >65 years.

(C) GAPS FOR FURTHER RESEARCH

Thus far, very little research has been conducted on seasonal mortality in SA. Numerous risk factors for excess seasonal mortality have been identified in international studies, but it is not clear whether factors are relevant to this setting. Further research is therefore required.

(D) JUSTIFICATION FOR RESEARCH

The profile of disease impacting on public health in SA has changed dramatically in the last two decades, largely due to rapid urbanisation, the HIV/AIDS pandemic and shifts towards more westernised lifestyles. Circulatory diseases due to obesity, hypertension and diabetes mellitus, and respiratory diseases such as pneumonia, TB and COPD, have increased. Studies conducted in other countries have shown both circulatory and respiratory diseases are associated with seasonal patterns of mortality. Demonstration of similar patterns in a South African setting could lead to the development of public health interventions to reduce excess mortality.

3. AIM, HYPOTHESES AND OBJECTIVES

Aim

To determine whether there are seasonal patterns of mortality associated with medical causes of admission to a hospital in a South African setting, and to identify demographic risk factors and specific disease categories that are associated with excess seasonal mortality.

Hypothesis 1

The seasonal trend for mortality related to medical causes in SA is likely to be bimodal, with a definitive peak in all-cause mortality associated with winter, and a second smaller peak associated with summer.

Objective 1

To determine whether changes in mortality related to medical conditions are associated with seasonal factors, and to identify seasonal patterns of mortality.

Hypothesis 2

Possible demographic risk factors for excess winter mortality in SA are age >65 years, male gender, low SES and non-White ethnicity.

Objective 2

To identify demographic risk factors for excess winter mortality in this setting.

Hypothesis 3

Excess seasonal mortality in SA can be largely attributed to circulatory and respiratory diseases.

Objective 3

To identify seasonal patterns of mortality associated with specific categories of disease which contribute significantly to all-cause mortality.

4. STUDY METHODOLOGY

(A) STUDY DESIGN

This is a retrospective cohort study. The exposure is month and season of admission to a medical ward at Groote Schuur Hospital in Cape Town during a specified period, and the outcome of interest is death.

(B) POPULATION AND SAMPLING

All patients who were admitted and treated for medical condition at Groote Schuur Hospital between June 2002 and May 2009, and were captured in the Clinicom data system, are admissible to the study. This will provide data for seven consecutive years. Patients are referred from a wide feeder zone across the Cape Peninsula, as well as from surrounding areas outside the feeder zone.

(C) INCLUSION AND EXCLUSION CRITERIA

Since the majority of paediatric patients in the region are treated at the Red Cross Hospital, the study will be restricted to adults over the age of 20 years. The entire study sample will be used for the analysis of seasonal trends and demographic risk factors. However, the analysis of specific causes of death using the ICD classification system will be restricted to the latter four years of data in order to reduce information bias. ICD codes were very poorly recorded prior to 2005.

(D) MEASUREMENTS

(I) METHODS OF DATA COLLECTION

Clinicom data was accessed with assistance from Medical Informatics at GSH. Data concerning patients admitted to medical wards from January 2002 to July 2009 was available. Patient data was assembled from a range of sources including admission tables, discharge tables, ICD-10 coding and billing tables. Individuals were identified through a combination of folder numbers, SA identity numbers and unique combinations of date of birth, surname and first name. Demographic information concerning age, gender, SES and ethnicity was recorded.

The clinical outcome at discharge was recorded as dead or alive. The date of admission and discharge or death was recorded, making it possible to calculate the total length of stay. Admission diagnoses and "cause of death" as recorded on death certificates were included where available. These diagnoses were then analysed according to the ICD-10 chapter classification of diseases, ranging from A to Z. Information regarding average monthly temperatures and precipitation for every month during the study period was collected at the DF Malan weather station in Cape Town (Latitude: -33.96 / Longitude: 18.6 / Altitude: 42m), and was available in the public domain on the internet.

(II) VARIABLES **(**All variables are categorical)

1. Year 1-7: June 2002-May 2009

2. Admission month 1-12: January-December

3. Season 1-4:

Summer = Admission months December, January and February

Autumn = Admission months March, April and May

Winter = Admission months June, July and August

Spring = Admission months September, October and November

4. Gender: Female and Male

5. SES – Med/High income and Low income

6. Ethnicity 1-4: White, Coloured, Indian and Black

7. Age- groups (years) 1-6: 20-29; 30-39; 40-49; 50-59, 60-69 and >70 years.

8. Length of Stay – duration (days) of admission before discharge or death

9. Outcome- Alive and Died

10. Disease category 1-5:

(Five disease categories have been selected, reflecting the most significant contributors to morbidity and mortality in SA. The ICD-10 classification system ranging from A to Z is shown in Appendix 5.)

1. Respiratory Disease: all ICD-10 codes in J-group, and Pulmonary Tuberculosis.

2. Circulatory Disease- all ICD-10 codes in I-group, and Diabetes Mellitus.

3. Gastrointestinal Disease- all ICD-10 codes in K-group.

4. Cancer- all ICD codes in C-group.

5. Other diseases- all diseases coded by the ICD-10 classification, but not included in any of the above categories.

(III) Validity and Reliability of Measurements

The data is regarded as valid and reliable as they have been captured from various unbiased sources in the hospital. Missing data regarding SES, ethnicity, age and diagnosis might lead to some information bias. Missing data will therefore be quantified in the analyses, and its possible impact on the results will be discussed.

(E) Limitations of the Study

The use of ICD-10 codes for analysis was limited because diagnostic codes were missing for about 50% of deaths, and this could result in biased estimates of mortality rates. In addition, the recorded diagnoses were not verified. Furthermore, it is important to note that the results of this study may not accurately reflect the seasonal patterns of mortality that exist within this community, as it was conducted at a tertiary facility where patients with advanced disease and complex diagnoses are referred for treatment. The findings also may be of limited value in other settings, as the characteristics of this study population and the variations in climate differ from other settings.

5. Data Management and Analysis Plan

The analysis will be addressed in three parts, according to the objectives. Univariate, bivariate and multivariate analysis will be performed, and results will be tabulated. Appropriate graphs illustrating associations between variables will then be constructed using Excel. Possible sources of bias and confounding will be explored. Finally, analysis using Poisson Regression will be conducted using Stata 11, and will result in the generation of Mortality Rate Ratios (MRR's) with 95% confidence intervals

6. Ethics and Communication

(a) Ethical Considerations

(i) Privacy/Confidentiality

There will be no actual patient contact, and no patient identifiers will be used in the study. Patients will identified by numbers in the data analysis. All information pertaining to patients obtained from the dataset will be viewed by the principal investigator and supervisor only, and will be kept strictly confidential.

(ii) Benefits

The study findings could contribute significantly towards the development of public health interventions to reduce excess seasonal mortality. It could also serve as a catalyst for further research about the effects of seasonality and climate on mortality in SA.

(iii) Consent

No consent will be required from participants. Consent for the use of the dataset will be obtained from the Faculty of Health, University of Cape Town. Approval for research using this data will be obtained from the Ethics Committee.

(iv) Ethnicity

We included ethnicity since it was a proxy for socioeconomic position in South Africa.

(v) Foreseeable Harm

None

(vi) Vulnerable participants

None

(B) STAKEHOLDERS

Possible stakeholders are Groote Schuur Hospital, the University of Cape Town and the Department of Health in the Western Cape.

(C) REPORTING AND PUBLICATION

Study findings will be made available to all stakeholders. The article will also be published in the SAMJ if accepted for publication.

7. LOGISTICS

This study will require six months to complete. No budget has been allocated, as no costs are foreseen.

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Part B: STRUCTURED LITERATURE REVIEW

CONTENTS

1. Background and Objectives 3
2. Search Strategy- Inclusion & Exclusion Criteria 4
3. Quality & Relevance Criteria 4
4. Summary and Interpretation of Literature 5
(a) Global Trends in Seasonal Mortality 5
(b) Seasonal Patterns of Mortality of Circulatory Disease 9
(c) Seasonal Patterns of Mortality of Respiratory Disease 11
(d) Determinants of Excess Winter Mortality 12
(i) Cold Temperature 12
(ii) Influenza 13
(iii) Vitamin D Deficiency 13
(iv) Hypercholesterolaemia 14
(v) Fibrinogen 14
(vi) Air Pollution 15
(e) Seasonal Patterns of Mortality in South Africa 15
(f) Historical Trends in Morbidity and Mortality at GSH 17
5. Gaps for Further Research 18
6. References 19

1. BACKGROUND AND OBJECTIVES

Variations in climate have been known to impact on human mortality. Research has shown that there are several environmental and demographic risk factors for excess seasonal mortality. In particular, mortality related to circulatory and respiratory diseases may be increased during colder months. An understanding of these risk factors and disease patterns could lead to the development of appropriate interventions to reduce excess seasonal mortality.

This is particularly relevant in South Africa (SA), where the burden of mortality from circulatory and respiratory diseases is high. Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS) and non-communicable diseases are the main underlying causes of these deaths. In 2 000, they represented about 30% and 37% of total mortality respectively (Bradshaw et al, 2003). While mortality from HIV/AIDS has fallen since the introduction of Anti-retroviral Therapy (ART), mortality from non-communicable diseases like diabetes, hypertension, heart disease and renal disease, has increased appreciably as the 'health transition' continues (Mayosi et al, 2009).

This study aims to describe patterns of seasonal mortality and risk factors for excess seasonal mortality in a South African setting. The data consists of patient information collected at Groote Schuur Hospital (GSH), a large academic hospital in Cape Town, over a 7 year period. Gender, age, socioeconomic status (SES), ethnicity and outcome of discharge or death have been recorded. Diagnostic codes are also available in some cases. In order to establish specific hypotheses and objectives for the study, a literature review of relevant studies has been conducted.

2. SEARCH STRATEGY- INCLUSION & EXCLUSION CRITERIA

A focused literature search was conducted in appropriate electronic databases, including Pubmed, Africa Wide and Google Scholar. Key phrases used were “seasonal mortality”, “climate and mortality” and “winter deaths”. Studies referring to specific risk factors for excess seasonal mortality such as SES, age, gender, ethnicity and vitamin D deficiency were included. Studies examining the association between weather or climate and myocardial infarction, stroke, heart failure, pneumonia and tuberculosis were sought, as these diseases contribute significantly to mortality in South Africa (Bradshaw et al, 2003). Studies involving extreme weather conditions such as heat waves or unusually heavy snowfall were excluded, since the focus was on trends over periods of time.

3. QUALITY & RELEVANCE CRITERIA

Peer-reviewed studies representing a wide range of countries were sought. Large cohort studies conducted over long time periods were considered most useful to establish seasonal trends. Population-based (ecological) studies provided information on the relationships between weather patterns and mortality, and the demographic associations with seasonal mortality. Smaller studies were useful for establishing biological and environmental risk factors for seasonal mortality. Studies from African countries including SA were especially sought.

4. Summary and Interpretation of Literature

(a) Global Trends in Seasonal Mortality

There has been a recent surge of interest in seasonal morbidity and mortality, as more scientific evidence of the phenomenon of climate change has become apparent. McMichael et al (2008) conducted an extensive study called the “Isothurm” project. A total of 12 countries, including Cape Town, were selected, and the association between daily mortality and environmental temperature over periods of 2-5 years was analysed using Poisson regression. Information on humidity, air pollution, cause of death, age, socioeconomic status (SES) and gender were included in the analysis. Temperature thresholds above and below which mortality increased were determined for each country.

Overall, most countries demonstrated a “U-shaped” relationship between temperature and mortality. The highest mortality was associated with winter, especially in countries with relatively big fluctuations in temperature, and the lowest mortality was recorded in summer. Cardiovascular disease (CVD) and respiratory disease was significantly associated with decreased temperatures in most European, South American and Asian countries. Elevated temperatures were associated with an increase in deaths from these causes in some countries with very warm climates.

Evidence for excess winter mortality and its association with circulatory and respiratory disease can be found in many studies. In one of the largest cohort studies conducted in the United Kingdom (UK), van Rossum et al (2001) followed-up 19 019 male civil servants over a 25 year period from 1970 to 1995, to determine the effect of season on mortality. Known as the Whitehall study, it established that the

highest mortality rate from all causes occurred in January, the peak of winter. This was 22% higher than the lowest mortality rate, which was recorded in the summer months. In addition, ischaemic heart disease (IHD) and respiratory diseases accounted for about 75% of the excess number of winter deaths. These effects were most significant in those aged over 60 years.

Other studies have sought to establish risk factors for winter mortality. In a 12 year long cohort study conducted in Scotland, Gemmel et al (2000) found an overall difference of about 30% between peak winter mortality and trough summer mortality, which was attributed mainly to IHD, cerebrovascular accidents (CVA) and respiratory diseases, and occurred more significantly in those aged 70 years and older. Female patients were found to be more affected by respiratory deaths than males. Marked increases in deaths were noted after influenza epidemics, which occurred every 3-4 years. Social class and SES were not found to contribute to differences in mortality rates.

In a “cross- country analysis” of Europe, Healy (2003) confirmed that all the countries studied had excess winter mortality compared to summer mortality. The highest excess was 28% in Portugal, with the lowest being 10% in Finland. In contrast to the study conducted in Scotland, strong correlations were found between excess winter mortality and a range of socioeconomic indicators, including relative income poverty and inequality as reflected by the Gini coefficient. Weak correlations were found between quality of housing and thermal efficiency, and excess winter deaths.

In Asia, Nakaji et al (2004) studied mortality, population and temperature data for the 29 year period between1970 to 1999 in Japan. . A “U-shaped” pattern of mortality was also identified for most diseases. The excess mortality in winter compared to the other seasons was largely attributed to infections and parasitic diseases, pneumonia and influenza, as well as CVD and CVA, and diabetes, representing both communicable and non-communicable diseases.

Also in Asia, Burkart et al (2011) conducted a population-based study in Bangladesh examining seasonal mortality and associations with specific diseases, gender, location and SES. As predicted, higher mortality was found in winter, but in addition, a second peak was observed in summer. This peak was more significant in urban areas. Urban-dwelling and high SES had a greater association with mortality related to CVD and respiratory disease, while rural-dwelling and low SES was associated with infections, and vector-borne, respiratory and diarrhoeal disease. All associations were strongly influenced by age.

Across the equator in New Zealand, Davie et al (2007) found a difference of 18% between peak winter and trough summer deaths, with nearly half the excess winter mortality attributable to circulatory diseases, and a third attributable to respiratory disease. Older age and female gender were associated with higher risk of winter mortality, but contrary to what was expected, no associations were found between ethnicity (Maori versus non-Maori), region of abode or level of deprivation.

Few studies on seasonal mortality have been conducted in African countries. Azongo et al (2012) conducted a time series analysis between 1995 and 2010 in Northern Ghana. The tropical climate is characterised by high summer temperatures and heavy rainfall between May and October. A significant increase in all-cause mortality of 14% was found at temperatures above 31 degrees Celsius after a lag period of 0-1 days after the change in temperature. A 10mm increase in precipitation was also associated with a 71% increase in mortality after a lag period of 2-6 days. In nearby Nigeria, Ansa et al (2012) also found that medical admissions due to cardiac failure and hypertension at a teaching hospital increased significantly during the rainy season.

In another time series analysis, Egondi et al (2012) studied mortality data from informal settlements in Nairobi, Kenya. The East African climate is characterised by a cold dry winter with temperatures between 10-21deg Celsius, and two rainy seasons between March to May and October to December. Mortality associated with cold weather was highest in the under 5 age group. Rainfall was significantly associated with mortality from pneumonia and non-communicable diseases, with females being slightly more vulnerable. There was no significant association between high temperatures and mortality.

(B) SEASONAL PATTERNS OF MORTALITY OF CIRCULATORY DISEASE

Woodhouse (1977) explored excess winter mortality in elderly people across the world. He noted that there was significant evidence from studies in the UK and United States of America (USA) that exposure to cold temperatures, as well as various climatic and environmental factors like rain, snow, wind chill and air pollution could precipitate cardiovascular events. Outbreaks of Influenza in the UK were strongly associated with excess winter deaths, about two-thirds of which were caused by respiratory diseases and the remaining third by circulatory disorders.

In a systematic review, Bhaskaran et al (2009) reviewed studies examining the association between ambient temperature and the incidence of acute myocardial infarction (AMI). Positive associations were found for increases and decreases in outdoor temperature. Three quarters of studies identified a lag period of between 1 and 3 days from the decreased temperature to the onset of the event, with estimates of relative risk ranging from 1.01 to 1.31 per degree Celsius of temperature reduction below a threshold. Nearly half the studies reported associations with higher temperatures, with estimates varying by age and gender.

Barnett et al (2005) also investigated the effect of cold weather on the incidence of coronary events in a large population-based study, by using daily temperature and climate data and records of coronary events from a range of countries. It was found that the incidence of coronary events was significantly increased in people over the age of 60 years. The risk of death was 7% higher during cold periods compared to warm periods. Women were 7% more likely than men to have events during cold periods.

In a study in Canada, where very low temperatures and heavy snowfall occur in winter, Sheth et al (1999) found risk differences of 18.6% and 19.9% between the winter peak and summer low in AMI and CVA deaths respectively. Surprisingly, across the globe in Australia where winter conditions are much milder, Loughnan et al (2008) found a difference of 33.7% between winter peak and summer low AMI admissions at five regional hospitals. In both studies, these excesses in morbidity and mortality were more significant in those aged >60 years.

Chronic CVD may also be a risk factor for winter mortality. Stewart et al (2002) studied mortality related to cardiac failure among patients admitted to hospital between 1990 and 1996. Secondary diagnoses were available for 65% of these admissions, and were also analysed. Admission rates were highest in December (winter) and lowest in July (summer). Overall, the number of winter hospitalisations were slightly higher in females (9.2 per 100 000 population compared to 8.9 per 100 000 population). A fifth of admissions had secondary diagnoses of pneumonia. Mortality was also higher in females, and increased incrementally with age. Excess winter mortality was greatest in those aged >75 years.

(C) SEASONAL PATTERNS OF MORTALITY OF RESPIRATORY DISEASE

Many studies have shown that the incidence of respiratory disease peaks in winter. The Whitehall study (van Rossum, 2001) determined that in the UK, the mortality rate from respiratory disease was nearly twice as high in winter compared to summer, and that those aged over 65 years were most at risk. In Japan (Nakaji, 2004) and Bangladesh (Burkart, 2011), it was found that mortality from all respiratory diseases including tuberculosis (TB) peaked firstly in winter, and then again, to a lesser degree, in summer. In addition, males were found to be slightly more at risk of respiratory-related mortality in summer compared to females in Bangladesh.

A systematic review of studies on the seasonality of TB (Fares, 2011) found that the incidence of pulmonary and extra-pulmonary TB was highest in spring and summer in most countries studied. This was thought to be a result of increased transmission of TB in winter, due to staying indoors, overcrowding and poor ventilation in houses. Other contributory factors were vitamin D deficiencies and delays in presenting to health-care facilities. Some countries reported higher incidences of TB in males compared to females. This was largely attributed to differences in patterns of social interactions and behaviours.

(D) Determinants of Excess Winter Mortality

(I) Cold Temperature

Eccles (2002) proposed a possible mechanism to explain the association between cold temperatures and respiratory tract infections. He suggested that exposure of respiratory epithelium in the upper respiratory tract to cold air produced a “decrease in the effectiveness of local respiratory defences, such as mucociliary clearance and leukocyte phagocytosis”. This caused increased susceptibility to circulating pathogens like viruses and bacteria.

In support of this argument, he discussed various experiments in which mucociliary clearance in animals and in-vitro activity of phagocyte and macrophage activity were measured at different temperatures. He further suggested that fever and nasal congestion were defensive responses to warm the airways and inhibit viral colonisation.

Pell and Cobbe (1999) reviewed current literature and described possible reasons for vulnerability of those with compromised cardiac function to changes in external temperatures. In cold temperatures, peripheral vasoconstriction and increased vascular resistance with a subsequent increase in blood pressure could increase stress on cardiac function and precipitate cardiac events like angina and myocardial infarction. In addition, poor exposure to UV radiation and low vitamin D levels in cold seasons, were thought to increase risk of cardiac events.

(II) INFLUENZA

Reichart et al (2004) examined the relationship between influenza epidemics and mortality related to IHD, CVA, diabetes mellitus and LRTI over a 40 year period from 1959 to 1999. It was found that the size of the peak of deaths in winter for these diseases corresponded to the peak incidence of influenza. In addition, the age distribution of deaths from these causes reflected the pattern observed for the specific seasonal influenza sub-type for each epidemic. This led the authors to conclude that there was a high likelihood that the "singular cause" of excess seasonal winter mortality was influenza [22].

(III) VITAMIN D DEFICIENCY

Dobnig et al (2008) conducted a cohort study in Germany, in which the 25-hydroxyvitamin D and 1.25-Dihydroxyvitamin D levels of patients referred for coronary angiograms were measured at the start of the trial. These patients were then followed up over an average of 7.7 years. Hazard ratios for heart failure and sudden cardiac deaths, and all-cause mortality were significantly elevated in those with low levels of vitamin D metabolites. Positive associations were also found between low levels of vitamin D and markers of cardiovascular risk markers [23].

Vitamin D deficiency has also been correlated with vulnerability to TB infection. Martineau et al (2011) found that the odds ratio of becoming infected with TB in a South African setting in Cape Town was 5.2 and 5.6 in HIV -non-infected and HIV-infected individuals respectively in winter compared to summer. This correlated inversely with serum Vitamin D levels, which were found to be 60% lower in winter months compared to summer months.

(IV) HYPERCHOLESTEROLAEMIA

Seasonal fluctuation of cholesterol has been investigated in several studies. Grimes et al (1996) published the results of an ecological study, in which latitude of population residence was compared to the mean population cholesterol level. Participant countries were located in the Northern hemisphere, and included Central European, Eastern European and Asian countries. A positive linear relationship was found between increasing latitude away from the equator and cholesterol levels, suggesting that cholesterol levels may be higher in colder climates.

In a longitudinal study, Ockene et al (2004) measured cholesterol levels in 517 healthy participants in Massachusetts, USA over a one year period. It was found that 22.2% more people had cholesterol levels greater than 6.22mmol/l in winter than in summer. The difference was more significant in females. The seasonal pattern of fluctuation was also reflected in low-density and high- density lipoproteins (LDL & HDL), and triglyceride levels. These changes could increase vulnerability to cardiovascular events.

(V) FIBRINOGEN

Woodhouse et al (1994) measured the plasma fibrinogen and factor VII clotting activity in elderly participants over a year long period. They hypothesised that since these factors were known risk factors for IHD and CVD, seasonal fluctuations in levels could result in excess seasonal morbidity and mortality. Significant differences were found between peak winter and summer levels of both factors. Fibrinogen levels in winter correlated well with inflammatory markers and evidence of acute respiratory infections.

(VI) AIR POLLUTION

Wong et al (1999) conducted a retrospective ecological study in Hong Kong, in which admissions at twelve hospitals were correlated with “daily concentrations of nitrogen dioxide (NO2), sulphur dioxide (SO2), ozone (O3), and particulate matter <10 μm in aerodynamic diameter (PM10)”. Relative risks for respiratory and cardiovascular diseases were significantly increased, and winter was found to positively interact with air pollution. Kim et al (1996) also found strong correlations between air pollutants, namely sulphur dioxide and ozone, and invasive pneumococcal disease and influenza in winter in the USA.

(E) SEASONAL PATTERNS OF MORTALITY IN SOUTH AFRICA

Few studies on seasonal mortality have been conducted in SA. Wyndham and Fellingham (1978) examined seasonal mortality rates in South Africans in Johannesburg and Durban. They compared patterns between the four main ethnic groups, from 1968 to 1971. For Whites and Indians, there was a winter peak and summer low in mortality, which corresponded to seasonal mortality patterns described in the literature from countries in the northern hemisphere during that time. For Whites, there was a negative linear correlation between air temperature and deaths due to respiratory diseases and IHD.

It was also found that the seasonal mortality pattern in Coloureds and Blacks was bimodal, with an expected peak in the middle of winter, and a second peak in the middle of summer. No data on the causes of death was available, but it was suggested that the summer peak in mortality was attributable to the large proportion

of deaths occurring in children under the age of 1 year, mostly from gastrointestinal diseases. This pattern was similar to patterns described in developing countries.

In another study, Wyndham (1986) examined mortality rates for Whites from pneumonia and chronic respiratory disease from 1979 to 1981 in eight cities in South Africa. Age-specific and age-standardised mortality rates were correlated with mean monthly temperatures. In all the cities, temperatures were inversely related to mortality rates due to pneumonia. No seasonal pattern was observed for chronic respiratory disease.

Heunis et al (1995) conducted a cross-sectional study to determine the association between extreme temperatures and mortality related to CVD in Cape Town. Only Whites and Coloureds were included in the study. Cardiovascular-related mortality rates were found to be significantly increased after a lag period of two days following a fall in temperature below 4 degrees Celsius or a rise in temperature above 25 degrees Celsius. In addition, large daily temperature ranges in winter were associated with higher cardiovascular-related mortality rates.

More recently, Cohen et al (2010) compared excess mortality related to influenza in SA and the USA. The study related to the period 1998-2005, and involved participants over the age of 65 years only. In SA, peak influenza viral activity was associated with peak all-cause and pneumonia mortality. After age-standardisation, 16% of winter deaths in SA could be attributed to influenza, compared to just 6% in the USA. This difference reflected the more widespread use of influenza vaccine in the elderly in the USA compared to SA.

Cohen et al (2012) conducted a similar analysis in adult participants of all ages with HIV/AIDS. Prior to the introduction of ART, it was estimated that people with HIV/AIDS had a “150-200 fold increase in risk of influenza-associated death”. After the introduction of ART in the USA, the rate remained elevated to “40-70 fold” more than in the general population. It was estimated that influenza-related deaths in young adults with HIV/AIDS in SA post-ART was at least 2-4 times more than that of adults aged >65 years.

(F) Historical Trends in Morbidity and Mortality at GSH

Trends in morbidity and mortality at GSH have been described in previous studies. Brock et al (1967) compared trends in the White and Non-White wards from 1939-1965, noting an increase in geriatric diseases and MI in the White wards and a prominence of TB and syphilis in the Non-White wards. There was an increase in the incidence of CVA, hypertension, diabetes mellitus and alcoholism in both Whites and Coloureds, suggesting a shift towards a predominance of lifestyle-related non-communicable diseases.

Later, Benatar and Saven (1985) analysed admissions from 1971-1982. Circulatory disease was the most common diagnoses, representing just over 40% of admissions. The most common forms of cardiac disease were IHD in Whites and Coloureds, and rheumatic heart disease and hypertension in Blacks. Infectious diseases like TB increased in Blacks. Although admission rates increased by 44% across the study period, all-cause mortality rates declined from 14.9% to 9.6%.

In a recent analysis of admissions from 2002-2009, Myer et al (2013) identified a trend of increasing mortality rates from 17 per 1000 patient days in 2002 to 23.4 per 1000 patient days in 2009. Deaths were higher in the first two days of admission, and were positively correlated with “increasing age, non-paying patient status, Black population group and male sex”. The trend of increasing mortality rates is a reflection of the increase in prevalence of both HIV/AIDS and related diseases, and non-communicable diseases in the community.

5. GAPS FOR FURTHER RESEARCH

The profile of disease impacting on public health in SA has changed dramatically in the last twenty years. Urbanisation, the HIV/AIDS pandemic and changes in lifestyle have resulted in a huge demand for health services related to both communicable and non-communicable diseases. Circulatory diseases due to obesity, hypertension and diabetes mellitus, and respiratory diseases due to infections, TB, smoking and air pollution have increased. Studies from other countries have shown that many of these diseases display seasonal variability, and have specific seasonal risk factors. There is currently very little data on seasonal patterns of mortality, and possible interventions to reduce excess seasonal mortality, in South African settings.

(Word Count 3690)

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Part C: JOURNAL “READY” MANUSCRIPT

(For South African Medical Journal)

(Reference will be made to appendices in part D within the text of this manuscript. Refer to Appendix 9 for guidelines for publication in the South African Medical Journal)

ABSTRACT

Background: Research at hospitals in many countries has demonstrated seasonal variation in mortality. Few data on this phenomenon are available in South Africa.
Objectives: To identify seasonal patterns of mortality at a hospital in Cape Town; to determine whether there are demographic risk factors for excess winter mortality; to describe seasonal patterns of mortality within disease groups that impact on the burden at health facilities.
Methods: The study analysed adult medical admissions and outcomes at Groote Schuur Hospital from June 2002 to May 2009. Average temperatures and precipitation were included. Gender, age, and socioeconomic status (SES) as determined by income, were evaluated. Ethnicity was included as a proxy for other socioeconomic indicators such as quality of housing. ICD-10 diagnostic codes were used to categorise diseases for analysis. Poisson regression was performed to generate mortality rate ratios (MRR's) with 95% confidence intervals, which were adjusted for potential confounding factors.
Results: Overall, there was a 23% difference between the highest (July) and lowest (December) monthly admissions. All-cause mortality was highest in July and December compared to February (adjusted MRR=1.42, 95% CI 1.29-1.56 and adjusted MRR=1.43, 95% CI 1.24-1.65 respectively), and in winter compared to spring (adjusted MRR=1.18, 95% CI 1.09-1.27). Low SES, Coloured ethnicity and increasing age were associated with greater susceptibility to winter mortality. Circulatory and respiratory diseases were the main contributors to excess winter mortality.
Conclusion: Further research on patterns of seasonal mortality in South Africa and evaluation of possible interventions to reduce excess seasonal mortality is required.

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BACKGROUND

Variations in climate are known to impact on human mortality. Most urban cities demonstrate a "U-shaped" relationship between temperature and mortality, where the highest and lowest mortality is recorded in winter and summer respectively. Increases in mortality from circulatory and respiratory diseases are associated with decreased temperatures in most European, South American and Asian countries, but may also be associated with elevated temperature in countries experiencing warmer climates [1].

In the United Kingdom, mortality in winter is 22% higher than in summer [2]. Ischaemic heart disease and respiratory diseases account for 75% of these excess deaths. These effects are most significant in those aged over 60 years. In the USA, a forty year-long study found that the magnitude of winter peaks in ischaemic heart disease (IHD), stroke, diabetes and pneumonia-related mortality corresponded to the magnitude of the peak incidence of influenza for each year [3].

Similarly, all European countries experience excess mortality in winter compared to summer, ranging from 10% to 28%. Demographic factors, such as socioeconomic indicators, including relative income poverty, inequality, and quality of housing, are associated with excess winter deaths [4].

Seasonal patterns of mortality may differ in developing countries. In Bangladesh, peaks in mortality are found both in winter and summer. Urban-dwelling and high SES are associated with deaths from cardiovascular and respiratory disease in winter, while rural-dwelling and low SES are associated with deaths from vector-borne, respiratory and diarrhoeal disease in summer. All associations are strongly influenced by age [5].

Few studies on seasonal mortality have been conducted in Africa. However, in a recent study in Ghana, a significant increase in all-cause mortality of 14% was found at temperatures above 30°C following a lag period of up to 1 day after the change in temperature [6]. A 10mm increase in precipitation was also associated with a 71% increase in mortality after a lag period of 2-6 days.

There have also been few studies of seasonality of mortality in South Africa (SA). Notably, Wyndham and Fellingham examined seasonal mortality rates in Johannesburg and Durban from 1968 to 1971 [7]. Significant differences in seasonal patterns of mortality were observed between different ethnic groups. For Whites and Indians, there was a winter peak and summer low in mortality, similar to patterns described in developed countries at that time. In contrast, mortality peaked in winter and again in summer for Coloureds and Blacks, simulating patterns described in developing countries.

The burden of mortality from circulatory and respiratory conditions in SA is high. Non-communicable diseases and Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome (HIV/AIDS)-related disease are significant contributors to this burden, and represented 37% and 30% of mortality from natural causes respectively in 2000 [8]. With the introduction of Anti-retroviral Therapy (ART) at public healthcare facilities, mortality from HIV/AIDS has decreased. However, mortality from chronic non-communicable diseases such as diabetes, hypertension, renal disease and chronic obstructive airways disease (COPD), is increasing [9].

Research on seasonal changes in mortality could lead to the development of public health interventions aimed at reducing excess mortality. Therefore, this study aimed to identify seasonal patterns of mortality at a tertiary hospital in SA, to determine whether there are demographic risk factors associated with excess winter mortality, and to describe patterns of seasonal mortality associated with disease groups that impact on the burden at health facilities.

METHODS

Study Design

A retrospective cohort study was conducted. The exposure was month and season of admission to a medical ward at Groote Schuur Hospital (GSH) during a seven year study period, and the outcome of interest was death.

Study Setting

GSH is a tertiary level hospital providing services to the Cape Town metropolitan area. Patients are referred from district hospitals, community health facilities and private practitioners located in a wide feeder zone across the Cape Peninsula, as well as from surrounding areas outside the feeder zone. Cape Town experiences temperatures of between 7°C to 18°C in winter, and 15°C to 27 °C in summer. Rainfall is highest between May and August, averaging between 70-95mm per month [10].

Data Collection

Details of patients who were admitted to medical wards at Groote Schuur Hospital between January 2002 and July 2009 were captured in the Clinicom data system. Patient data was assembled from multiple sources including admission tables, discharge tables, ICD-10 coding and billing tables. Demographic information recorded included age, gender, and ethnicity. SES was determined by income.

The clinical outcome at discharge was recorded as dead or alive. ICD-10 diagnostic codes and causes of death were included, where available, and analysed according to the ICD-10 classification of diseases (appendix 1). Monthly averages of temperature and precipitation were collated at a weather station in Cape Town. This information was available in the public domain on the World Wide Web.

Data Management & Analysis

The study period was restricted to June 2002 to May 2009, thereby identifying seven consecutive years of data, consisting of four seasons each. The analysis of ICD-10 coded diagnoses was further restricted to June 2005 to May 2009, as ICD-10 codes were poorly recorded prior to that time. The use of these diagnostic codes was of limited value because diagnostic codes were unavailable for nearly 50% of deaths, and recorded codes could not be verified.

Diagnoses were grouped into five main disease categories. Univariate, bivariate and multivariate analysis of the data was conducted and appropriate tables and graphs were constructed. Poisson regression using Stata version 11 was used to generate mortality rate ratios (MRR's) with 95% confidence intervals. Possible confounding factors of gender, SES, ethnicity and age were identified in the crude analysis, and were therefore adjusted for in the statistical analysis.

Ethical Issues

No patient identifiers were used in this study. We included ethnicity as a proxy for other socioeconomic indicators, like quality of housing, in SA. Approval for the study was obtained from the Research Ethics Committee at University of Cape Town (appendix 2).

RESULTS

A summary of admissions, deaths and duration of stay is shown in table 1.The total number of admissions was 54 392, and the average duration of admission was 6.9 days. The average number of admissions per year was 7 770. Overall, there was a 23% difference between the highest and lowest number of monthly admissions, recorded in July and December respectively. There was also a 13% difference between the highest and lowest number of seasonal admissions, recorded in winter and summer respectively. These patterns of admissions did not vary significantly between the different years (appendix 3).

Potential sources of bias were identified in the data (appendix 4). There were 6.6% more female than male admissions, and nearly 85% of the patients admitted were classified as low SES, while the remaining 15% were classified as medium or high SES. Approximately two thirds of admissions were Coloured, a fifth were Black, and a tenth were White. A small number (<1.5%) were Indian. The highest number of admissions occurred in the 50-59 year old category, followed by the over 70 year old category. The lowest number of admissions was in the 20-29 year old category.

Monthly and seasonal mortality patterns were similar for the seven years (figure1). Overall, there were two peaks in mortality. The winter peak from June to August corresponded to the lowest temperature and highest precipitation (figure 2). These findings were consistent for every year (appendix 5). The summer peak in mortality was confined to the month of December and did not correspond with the highest temperature for that season. The month and season with the lowest mortality was February and spring respectively.

In the statistical analysis using Poisson regression, February and spring were used as the reference month and season respectively. Unadjusted MRR's and MRR's adjusted for gender, SES, ethnicity and age are shown in table 2. Overall, mortality increased from April until the peak in July (adjusted MRR=1.42, 95% CI 1.29-1.56), and then decreased until November. A second peak in mortality occurred in December (adjusted MRR=1.43, 95% CI 1.24-1.65). Mortality was highest in winter (adjusted MRR=1.18, 95% CI 1.09-1.27). There was no statistical difference between mortality in spring, summer and autumn.

In the demographic analysis (figure 3, appendix 6), mortality for males was higher than females throughout the year (adjusted MRR=1.19, 95% CI 1.13-1.26). The difference was more pronounced in summer. In the seasonal regression analysis (appendix 7), MRR's for females and males in winter were elevated equally compared to the rate in spring (MRR=1.21, 95% CI females: 1.09-1.33; males: 1.10-1.34), whereas in summer, only mortality for males was increased (MRR=1.10, 95% CI 0.99-1.22).

Low SES was associated with higher mortality than medium/high SES throughout the year (adjusted MRR=1.44, 95% CI 1.31-1.59). Mortality in the low SES group was highest in July and December (MRR=1.51, 95% CI 1.32-1.73 and 1.50, 95% CI 1.30-1.72 respectively), and an overall peak in mortality occurred in winter (MRR=1.21, 95% CI 1.12-1.30). For medium/high SES, there were no significant statistical differences in mortality between the different months, but there was a significant peak in summer mortality (MRR=1.26, 95% CI 1.00-1.60).

As seen in figure 3, mortality in Whites and Coloureds peaked in winter. Mortality in Coloureds was highest in July (MRR=1.53, 95% CI 1.30-1.81) and December (MRR=1.43, 95% CI 1.20-1.70), and in winter (MRR=1.25, 95% CI 1.14-1.37). Mortality in Whites were elevated in July, August and December (MRR=1.67, 95% CI 1.08-2.58; MRR=1.73, 95% CI 1.13-2.66 and MRR=2.07, 95% CI 1.32-3.24 respectively). However, the peak in mortality in winter was not statistically significant (MRR=1.20, 95% CI 0.96-1.50). Mortality in Blacks was higher than in all other ethnic groups throughout the year, with adjusted MRR=1.17 (95% CI 1.05-1.30) compared to Whites overall. There were no seasonal peaks of mortality in Blacks. There was insufficient data for analysis on Indians.

Mortality increased incrementally for all age groups compared to the 20-29 year group (figure 3). The highest rate was in the >70 year old group (adjusted MRR=3.82, 95% CI 3.42-4.27) compared to the lowest age group. All age-groups had peak mortality rates in July and winter overall. All age-groups above 40 years had second peak death rates in December. Only age-groups 40-49 years and 60-69 years had peaks in summer mortality.

ICD-10 diagnostic codes were recorded for 83% of admissions between June 2005 and May 2009 (appendix 8). In winter, the proportion of admissions from circulatory and respiratory disease was 26% & 28.5% respectively, which represented more than half of all admissions. There were corresponding increases in death rates for both these conditions in winter, as shown in table 3. The death rate for circulatory disease was also elevated in autumn. The death rates for gastrointestinal disorders and cancer did not display seasonal variation.

DISCUSSION

The results of this study concurred with the world-wide trend of excess winter mortality. In addition, an unexpected peak in mortality in the month of December was identified. In this setting, demographic risk factors associated with excess winter mortality were low SES, Coloured ethnicity, and all age-groups over 30 years. Circulatory and respiratory disease were significant contributors to this excess. There are several possible explanations for these observations.

In winter, cold temperatures have been shown to decrease the effectiveness of mucociliary clearance and leukocyte phagocytosis in the upper respiratory tract, thereby increasing vulnerability to circulating viruses and bacteria [11]. Influenza has been identified as one of the main contributors to excess winter mortality. Recently, it was found that peak mortality related to all-causes and pneumonia corresponded to peak incidences of influenza in South African individuals aged > 65 years. Notably, this mortality was nearly three times greater than that observed in a similar study population in the United States of America (USA) in a similar period, and reflected the impact of more widespread use of influenza vaccination in elderly people in the USA compared to SA [12].

Younger adults may also be vulnerable to infections. Influenza-associated mortality in adults with HIV/AIDS in the period following the introduction of ART in SA, was estimated to be at least 2-4 times higher than that of adults aged >65 years. In those eligible for ART but not yet accessing medication, it could be estimated that influenza-related mortality is "150 times greater than in the general population", as was the case in the USA [13].

In addition in SA, low SES may be associated with prolonged exposure to cold temperatures due to poor quality of housing, outdoor employment and daily commuting between residential and metropolitan areas. Overcrowding may increase exposure to infections, and co-existing poor nutrition may impair immune system responses to infections.

Older people may be at higher risk for circulatory disease–related mortality in winter than younger people due to biological factors. It has been found that there are significant differences between winter and summer levels of plasma fibrinogen levels and factor VII clotting activity in elderly people [14]. Elevations of these factors are known risk factors for cardiovascular disease.

It has also been shown that fibrinogen levels in winter correlate with inflammatory markers and evidence of acute respiratory infections, suggesting a mechanism whereby respiratory tract infections could precipitate circulatory events [15]. Furthermore, cold temperatures can cause peripheral vasoconstriction and increased vascular resistance, with subsequent increases in blood pressure, thereby increasing the risk of circulatory events in susceptible individuals [16].

There are other factors that may affect vulnerability to cardiovascular and respiratory mortality in winter in all age groups, such as vitamin D deficiency. In a study conducted in Germany, hazard ratios for heart failure and sudden cardiac deaths were significantly elevated in those with low levels of vitamin D metabolites [17]. In a study based in Cape Town, serum Vitamin D levels were found to be 60% lower in winter compared to summer, and correlated with vulnerability to TB infection in both HIV infected and HIV non-infected individuals[18].

The identification of a peak in all-cause mortality in the month of December, but not in the other summer months, was surprising. This peak was associated with male more than female gender, low SES, all ethnicities except Indians, and the 40-49, 60-69 and over 70 year age-groups. According to the literature, peaks in summer mortality are usually related to elevated temperatures, and are accompanied by increases in morbidity. We therefore suggest that the peak in December mortality may be due to factors not described in previous data.

One possible explanation is that since December is the main month of the holiday season in SA, it is the period during which many healthcare workers take annual leave. Health services may not be operating at full capacity, and patients may thus experience delays in receiving treatment. Consequently, they may deteriorate after admission to hospital. In addition, more chronically ill patients may be admitted in the month of December compared to other months, as some families may be reluctant to take sick relatives on holiday, while others may transport ill relatives from rural areas to the city to seek treatment at tertiary hospitals.

Another surprising finding was that mortality in Black patients did not show seasonal variation, except for the peak in December. Mortality was higher than all the other ethnic groups throughout the year. This could be attributed to the high prevalence of HIV/AIDS in this population at the time of the study. It could also indicate the presence of a very low SES category of people, with extremely poor living conditions.

It is important to note that the results of this study may not accurately reflect the seasonal patterns of mortality that exist within this community, as it was conducted at a tertiary facility where patients with advanced disease and complex diagnoses are referred for treatment. Also, the findings may be of limited value in other settings, as the characteristics of this study population and the variations in climate differ from other settings.

CONCLUSION

This study demonstrates significant seasonal variations in mortality in a hospital setting. Possible public health strategies to reduce excess winter mortality could include increased health monitoring of vulnerable groups prior to winter months, more widespread use of influenza vaccination, and screening for vitamin D deficiency. Improvement of health service delivery may be indicated during vacation periods. Further research on these aspects is indicated in SA.

Word Count: 2931

Table 1: Summary of Admissions, Deaths and Length of Stay (LOS)			
	Admissions (%)	Deaths (%)	LOS (days)
Total	54 392 (100)	6 059 (100)	6.9
Year			
Jun02-May03	8 139 (15.0)	814 (13.4)	6.9
Jun03-May04	8 658 (15.9)	809 (13.4)	6.6
Jun04-May05	7 532 (13.9)	778 (12.8)	7.2
Jun05-May06	7 676 (14.1)	883 (14.6)	6.8
Jun06-May07	7 546 (13.9)	779 (12.9)	6.9
Jun07-May08	7 165 (13.2)	913 (15.1)	7.2
Jun08-May09	7 676 (14.1)	1 083 (17.9)	7.1
Month			
June	4 563 (8.4)	521 (8.6)	6.8
July	4 967 (9.1)	641 (10.6)	6.8
August	4 746 (8.7)	598 (9.9)	6.9
September	4 727 (8.7)	527 (8.7)	6.9
October	4 786 (8.8)	506 (8.4)	7.0
November	4 507 (8.3)	427 (7.1)	7.0
December	4 037 (7.4)	520 (8.6)	6.8
January	4 419 (8.1)	478 (7.9)	7.0
February	4 184 (7.7)	371 (6.1)	6.9
March	4 466 (8.2)	415 (6.9)	7.0
April	4 216 (7.8)	495 (8.2)	7.1
May	4 774 (8.8)	560 (9.2)	7.1
Season			
Winter	14 276 (26.3)	1 760 (29.1)	6.8
Spring	14 020 (25.8)	1 460 (24.1)	7.0
Summer	12 640 (23.2)	1 369 (22.6)	6.9
Autumn	13 456 (24.7)	1 470 (24.3)	7.1
Gender			
Female	28 993 (53.3)	3 057 (50.5)	7.0
Male	25 399 (46.7)	3 002 (49.6)	6.9
Socioeconomic Status			
Med/High	8 208 (15.1)	572 (9.4)	6.8
Low	46 182 (84.9)	5 487 (90.6)	7.0
Ethnicity			
White	5 469 (10.1)	539 (8.9)	6.4
Coloured	34 119 (62.7)	3 521 (58.1)	6.1
Indian	687 (1.3)	62 (1.0)	5.5
Black	10 625 (19.5)	1 348 (22.3)	9.5
Unknown	3 492 (6.4)	589 (9.7)	8.2
Age-groups (years)			
20-29	6 572 (12.1)	505 (8.3)	9.1
30-39	8 272 (15.2)	784 (12.9)	8.8
40-49	9 345 (17.2)	893 (14.7)	7.6
50-59	10 534 (19.4)	1 178 (19.4)	6.8
60-69	9 644 (17.7)	1 205 (19.9)	5.4
>70	10 025 (18.4)	1 494 (24.7)	4.9

Figure 1: Monthly and Seasonal Death Rates per year (%)

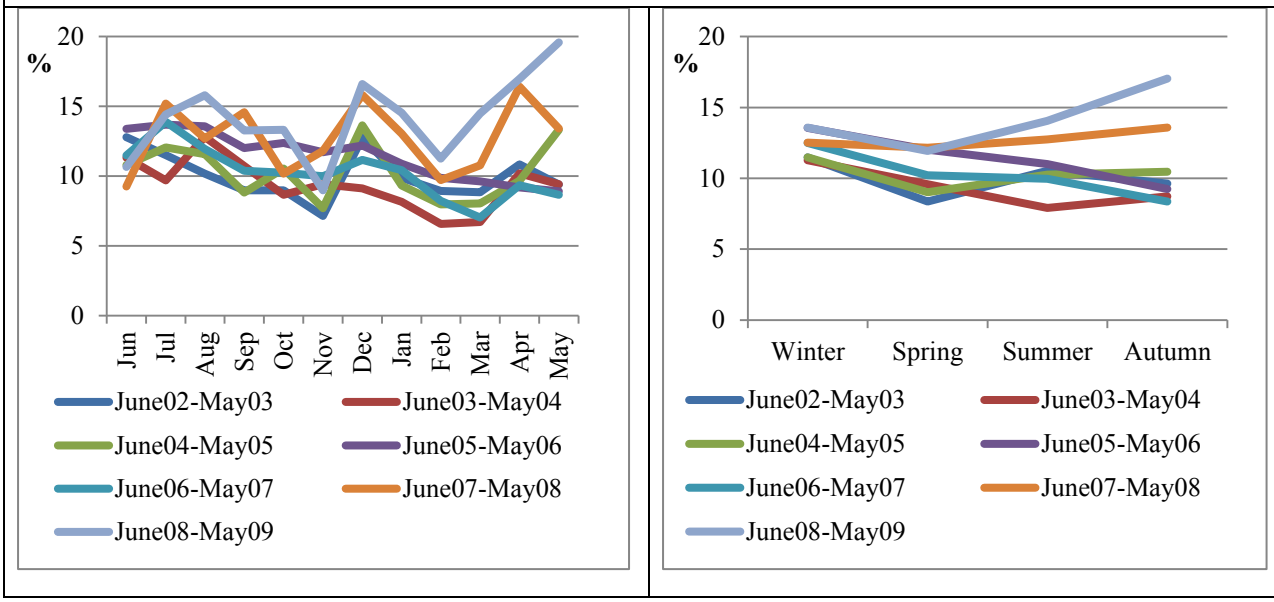

Figure 2: Patterns of Monthly and Seasonal Temperatures (°C), Precipitation (mm) and Death Rates (%)

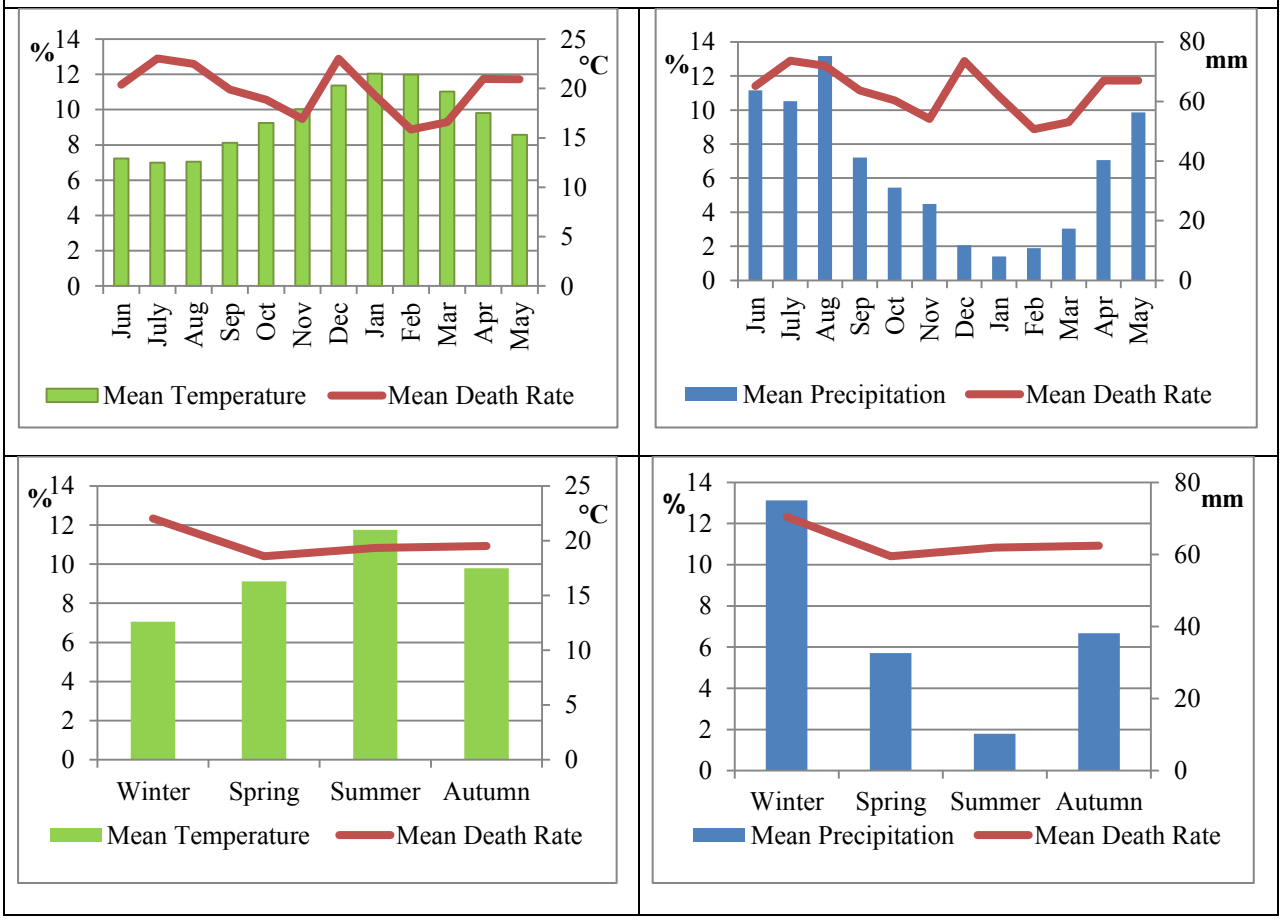

Table 2: Univariate and Multivariate Mortality Rate Ratios (MRR's)				
	Univariate		Multivariate	
	MRR	95% CI	MRR	95% CI
Year				
June02-May03	1.00	--------	1.00	--------
June03-May04	0.89	0.89-1.00	0.98	0.89-1.09
June04-May05	0.89	0.89-1.08	1.01	0.91-1.12
June05-May06	1.17	1.06-1.29	1.20	1.08-1.32
June06-May0	1.02	0.93-1.13	1.04	0.94-1.16
June07-May0	1.22	1.11-1.34	1.29	1.17-1.42
June08-May09	1.38	1.26-1.51	1.41	1.28-1.56
Admission Month				
June	1.30	1.14-1.48	1.31	1.14-1.51
July	1.48	1.30-1.68	1.42	1.29-1.56
August	1.42	1.25-1.62	1.43	1.25-1.64
September	1.26	1.10-1.44	1.26	1.09-1.44
October	1.18	1.03-1.34	1.20	1.04-1.38
November	1.04	0.91-1.20	1.09	0.94-1.26
December	1.46	1.28-1.67	1.43	1.24-1.65
January	1.20	1.05-1.37	1.19	1.03-1.37
February	1.00	-------	1.00	--------
March	1.03	0.89-1.18	1.05	0.91-1.22
April	1.29	1.12-1.47	1.26	1.10-1.46
May	1.27	1.12-1.45	1.25	1.08-1.43
Season				
Winter	1.21	1.13-1.30	1.18	1.09-1.27
Spring	1.00	--------	1.00	--------
Summer	1.05	0.97-1.13	1.02	0.95-1.10
Autumn	1.03	0.96-1.11	1.01	0.93-1.09
Gender				
Female	1.00	--------	1.00	--------
Male	1.13	1.08-1.19	1.19	1.13-1.26
SES				
High/Med	1.00	--------	1.00	--------
Low	1.67	1.53-1.82	1.44	1.31-1.59
Ethnicity				
White	1.00	--------	1.00	--------
Coloured	1.09	1.00-1.20	1.08	0.99-1.19
Indian	1.07	0.82-1.39	1.02	0.78-1.33
Black	0.86	0.78-0.96	1.17	1.05-1.30
Age-groups (years)				
20-29	1.00	--------	1.00	--------
30-39	1.27	1.14-1.42	1.20	1.07-1.36
40-49	1.48	1.33-1.65	1.48	1.32-1.67
50-59	1.93	1.74-2.15	1.97	1.76-2.21
60-69	2.72	2.45-3.02	2.78	2.48-3.11
>70	3.63	3.28-4.01	3.82	3.42-4.27

Figure 3: Demographic Analysis of Monthly and Seasonal Death Rates (%)

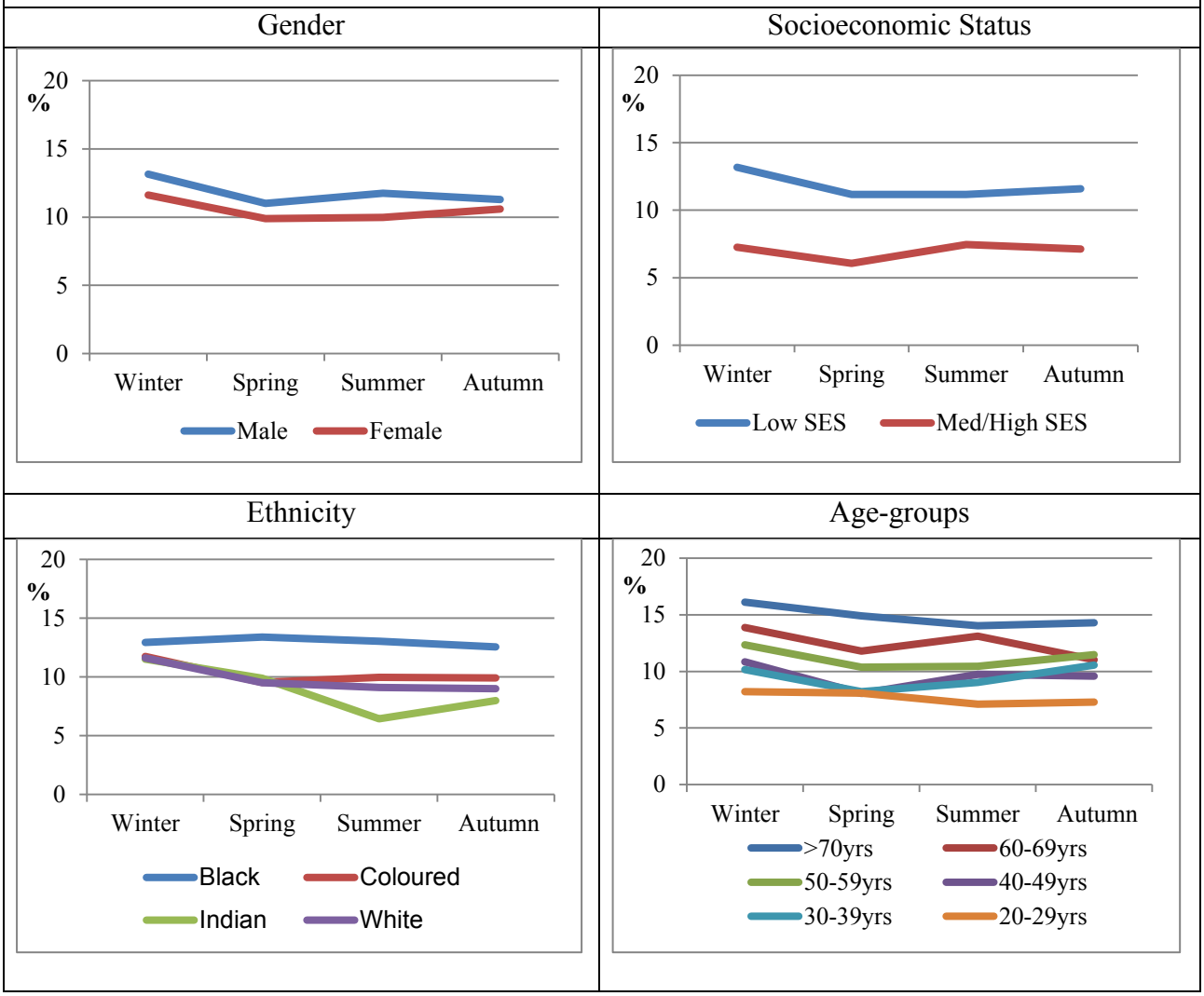

Table 3: Seasonal Death Rates for Diagnostic Disease Categories (%)

	Winter	Spring	Summer	Autumn
Respiratory	14.4	12.9	13.2	12.2
Circulatory	7.2	5.8	5.9	7.3
GIT	7.1	7.1	3.4	7.1
Cancer	12.2	14.4	15.7	16.9
Other	8.1	6.8	6.6	7.4

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Part D: APPENDICES

Appendix 1: Letter of Approval by Research Ethics Committee, UCT 2

Appendix 2: ICD-10 Classification of Diseases (A to Z) 3

Appendix 3: Monthly and Seasonal Admissions and Deaths 5

Appendix 4 : Possible Sources of Bias & Confounding 9

Appendix 5: Monthly and Seasonal Associations between Temperature (°C), Precipitation (mm) and Death Rates (%) per Year 13

Appendix 6: Monthly and Seasonal Admissions and Deaths in ..... 17 Demographic Categories 17

Appendix 7: Unadjusted Monthly and Seasonal Mortality Rate Ratios 23

Appendix 8- Monthly and Seasonal Admissions and Deaths in Diagnostic Disease Categories..... 26

Appendix 9: Guidelines for Publication in the South African Medical Journal (SAMJ) 32

Appendix 1: Letter of Approval by Research Ethics Committee, UCT

UNIVERSITY OF CAPE TOWN

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Human Research Ethics Committee
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12 September 2013

HREC REF: 541/2013

Dr V Mudaly
c/o A/Prof L Myer
Public Health & Family Medicine
Falmouth Building

Dear Dr Mudaly

PROJECT TITLE: PATTERNS OF SEASONAL MORTALITY IN MEDICAL ADMISSIONS AT GROOTE SCHUUR HOSPITAL, CAPE TOWN FROM 2002-2009

Thank you for your letter to the Faculty of Health Sciences Human Research Ethics Committee dated 5th September 2013.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30th September 2014

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/research/humanethics/forms)

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC. REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN ETHICS
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.
The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

s.thomas

Appendix 2: ICD-10 Classification of Diseases (A to Z)

1. Certain infectious and parasitic diseases - A00 – B99
2. Neoplasms- C00 – D48
3. Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism- D50 – D89
4. Endocrine, nutritional and metabolic diseases- E00 – E90
5. Mental and behavioural disorders- F00 – F99
6. Diseases of the nervous system- G00 –G99
7. Diseases of the eye and adnexa- H00 – H59
8. Diseases of the ear and mastoid process- H60 – H95
9. Diseases of the circulatory system- I00 – I99
10. Diseases of the respiratory system- J00 – J99
11. Diseases of the digestive system- K00 – K93
12. Diseases of the skin and subcutaneous tissue- L00 – L99
13. Diseases of the musculoskeletal system and connective tissue- M00 – M99
14. Diseases of the genitourinary system- N00 – N99
15. Diseases of Pregnancy, Childbirth and the Puerperium- O00 – O99
16. Certain conditions originating in the perinatal period- P00 – P96
17. Congenital malformations, deformations and chromosomal abnormalities- Q00 – Q99
18. Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified- R00 – R99

19. Injury, poisoning and certain other consequences of external causes- S00 – T98

20. External causes of morbidity and mortality- V01 – Y98

21. Factors influencing health status and contact with health services- Z00 – Z99)

22. Codes for special purposes- U00 – U99

Source:

http://www.bhfglobal.com/files/bhf/SA%20ICD%20Coding%20Standards%20doc%20Sept%202007.pdf

Appendix 3: Monthly and Seasonal Admissions and Deaths

Table 1: Monthly Admissions per Year (%)							
	Jun02-May03	Jun03-May04	Jun04-May05	Jun05-May06	Jun06-May07	Jun07-May08	Jun08-May09
June	720	618	695	635	627	573	695
	(8.9)	(7.1)	(9.2)	(8.3)	(8.8)	(8.0)	(9.1)
July	774	701	680	672	720	651	769
	(9.5)	(8.1)	(9.0)	(8.8)	(9.5)	(9.1)	(10.0)
August	728	702	674	693	670	646	633
	(9.0)	(8.1)	(9.0)	(9.0)	(8.9)	(9.0)	(8.3)
September	757	737	657	675	656	590	655
	(9.3)	(8.5)	(8.7)	(8.8)	(8.7)	(8.2)	(8.5)
October	690	796	636	671	683	619	691
	(8.5)	(9.2)	(8.4)	(8.7)	(9.1)	(8.6)	(9.0)
November	728	669	624	649	620	593	624
	(9.0)	(7.7)	(8.3)	(8.5)	(8.2)	(8.2)	(8.1)
December	612	657	543	607	564	518	536
	(7.5)	(7.6)	(7.2)	(7.9)	(7.5)	(7.2)	(7.0)
January	668	723	568	615	643	590	612
	(8.2)	(8.4)	(7.5)	(8.0)	(8.5)	(8.2)	(8.0)
February	582	730	564	567	559	587	595
	(7.2)	(8.4)	(7.5)	(7.4)	(7.4)	(8.2)	(7.8)
March	633	804	584	675	569	566	635
	(7.8)	(9.1)	(7.8)	(8.8)	(7.5)	(7.9)	(8.3)
April	545	745	631	555	577	591	572
	(6.7)	(8.6)	(8.4)	(7.2)	(7.7)	(8.3)	(7.5)
May	702	776	676	662	658	641	659
	(8.6)	(9.0)	(9.0)	(8.6)	(8.7)	(9.0)	(8.6)
Total	8 139	8 658	7 532	7 676	7 546	7 165	7 676
	(100)	(100)	(100)	(100)	(100)	(100)	(100)

Table 2: Seasonal Admissions per Year (%)							
	Jun02-May03	Jun03-May04	Jun04-May05	Jun05-May06	Jun06-May07	Jun07-May08	Jun08-May09
Winter	2 222	2 021	2 049	2 000	2 017	1 870	2 097
	(27.3)	(23.3)	(27.2)	(26.1)	(26.7)	(26.1)	(27.3)
Spring	2 175	2 202	1 917	1 995	1 959	1 802	1 970
	(26.7)	(25.4)	(25.5)	(26.0)	(26.0)	(25.2)	(25.7)
Summer	1 862	2 110	1 675	1 789	1 766	1 695	1 743
	(22.9)	(24.4)	(22.2)	(23.3)	(23.4)	(23.7)	(22.7)
Autumn	1 880	2 325	1 891	1 892	1 804	1 798	1 866
	(23.1)	(26.9)	(25.1)	(24.7)	(23.9)	(25.1)	(24.3)
Total	8 139	8 658	7 532	7 676	7 546	7 165	7 676
	(100)	(100)	(100)	(100)	(100)	(100)	(100)

The year with the highest admissions was Jun03-May04, and the year with the lowest admissions was Jun07-May08. The greatest proportion of admissions was in winter in all years except Jun03-May04.

Table 3.1: Monthly Death Rates per Year- June-November (%)						
	June	July	August	September	October	November
Jun02-May03	12.78	11.50	10.17	8.98	8.99	7.14
Jun03-May04	11.33	9.70	12.82	10.72	8.67	9.42
Jun04-May05	10.79	12.06	11.57	8.83	10.54	7.69
Jun05-May06	13.39	13.69	13.56	12.00	12.37	11.71
Jun06-May07	11.48	13.89	11.94	10.37	10.25	10.00
Jun07-May08	9.25	15.21	12.69	14.58	10.18	11.80
Jun08-May09	10.65	14.43	15.80	13.28	13.31	8.97
Average	11.42	12.91	12.60	11.15	10.57	9.47

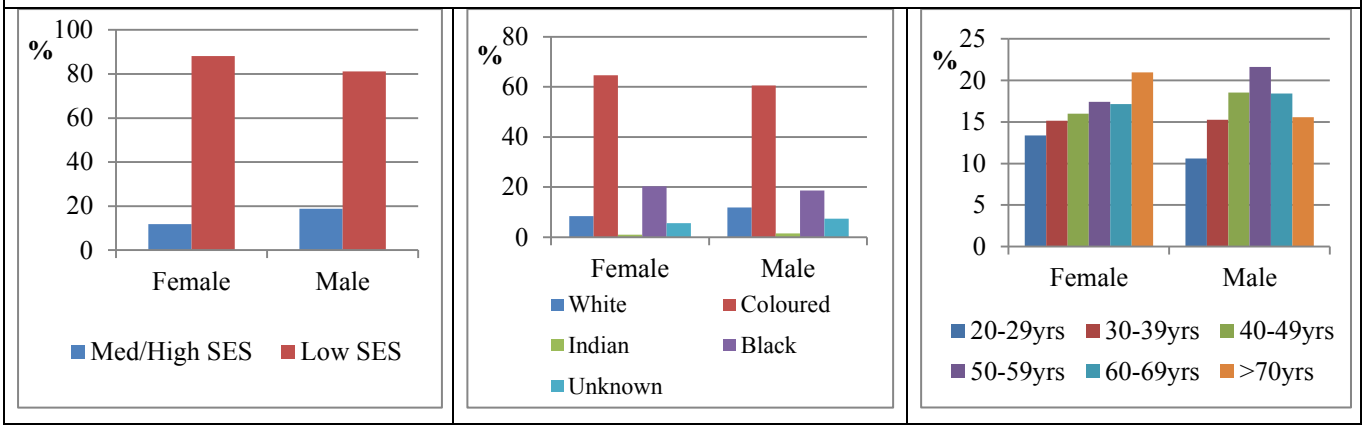
Table 3.2: Monthly Death Rates per Year- December-May (%)						
	December	January	February	March	April	May
Jun02-May03	12.75	9.88	8.93	8.85	10.83	9.40
Jun03-May04	9.13	8.16	6.58	6.72	10.20	9.41
Jun04-May05	13.63	9.33	7.98	8.05	9.67	13.31
Jun05-May06	12.19	10.89	9.88	9.63	9.19	8.91
Jun06-May07	11.17	10.42	8.22	7.03	9.36	8.66
Jun07-May08	15.83	13.05	9.71	10.78	16.41	13.42
Jun08-May09	16.60	14.54	11.26	14.49	16.96	19.58
Average	12.88	10.82	8.87	9.29	11.74	11.73

Table 4: Seasonal Death Rates per Year (%)				
	Winter	Spring	Summer	Autumn
Jun02-May03	11.48	8.37	10.53	9.63
Jun03-May04	11.28	9.58	7.92	8.73
Jun04-May05	11.47	9.03	10.27	10.47
Jun05-May06	13.55	12.03	11.01	9.25
Jun06-May07	12.49	10.21	9.97	8.37
Jun07-May08	12.51	12.15	12.74	13.57
Jun08-May09	13.59	11.93	14.06	17.04
Average	12.33	10.41	10.83	10.93

Death rates were highest in winter in all years except the Jun07-May08 and Jun08-May09, where death rates were highest in autumn. Death rates were lowest in spring or summer.

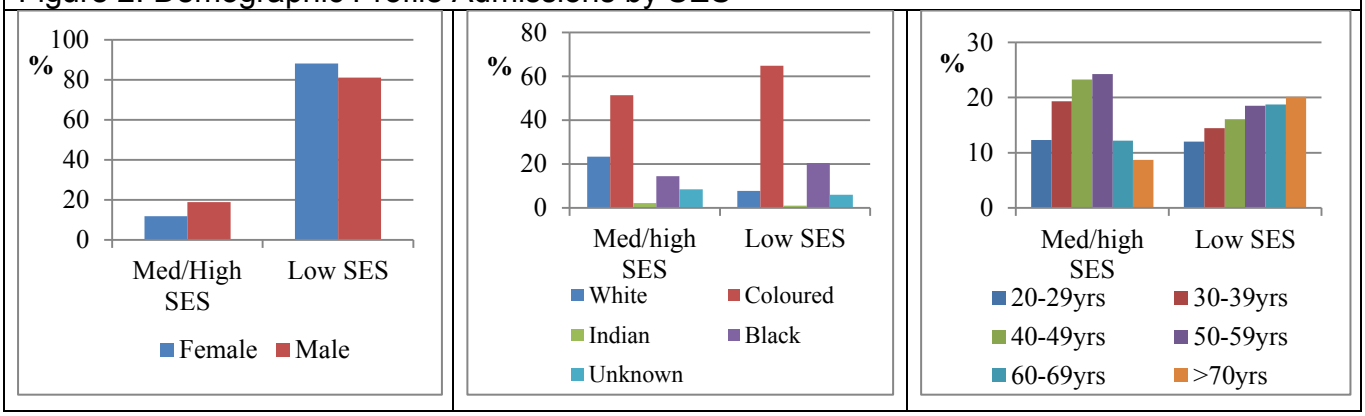
Appendix 4 : Possible Sources of Bias & Confounding

Figure 1: Demographic Profile of Admissions by Gender



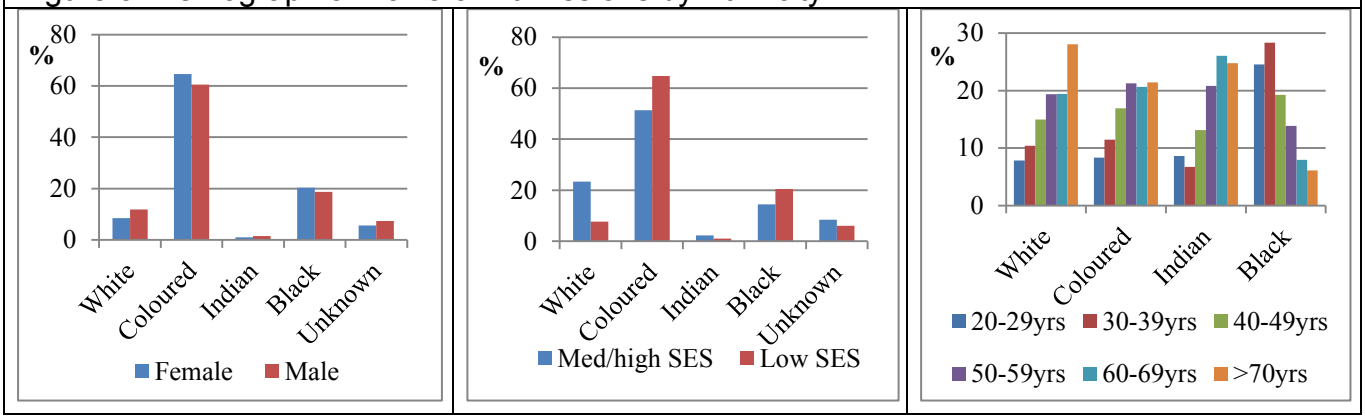
Low SES dominated both male and female sub-groups. About 60% of males and females were Coloured. The age distribution for males and females was different, with the average age of males being lower than that of females.

Figure 2: Demographic Profile Admissions by SES



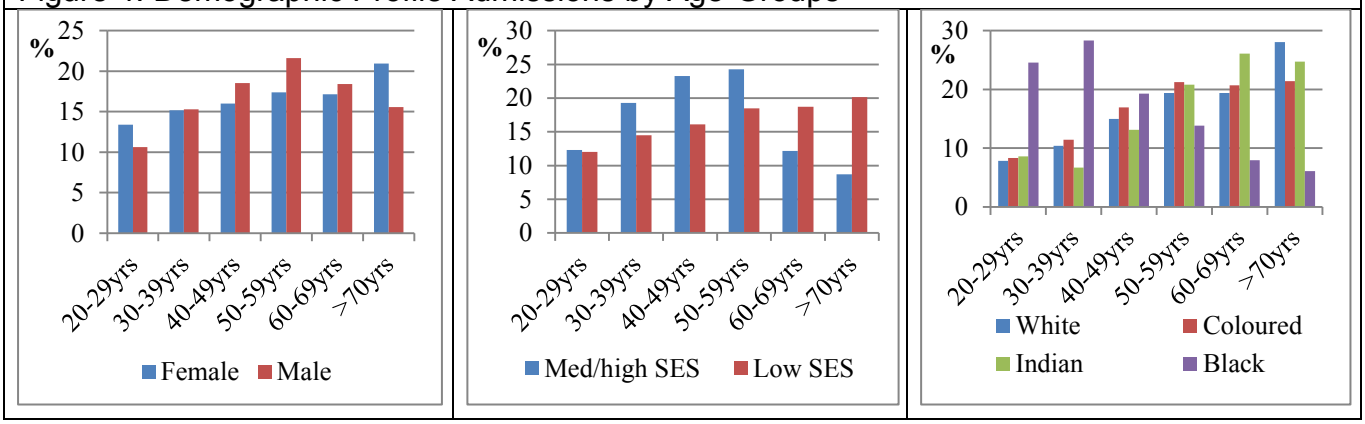
There were more females than males in the low SES group, but more males than females in the med/high SES group. There was larger proportion of Whites in the med/high SES group compared to the low SES group. The proportion of Blacks was slightly higher in the low SES group compared to the med/high SES group. The age distribution was different in both groups, with a greater proportion of patients falling into the < 60 year groups in the med/high SES group than in the low SES group.

Figure 3: Demographic Profile of Admissions by Ethnicity



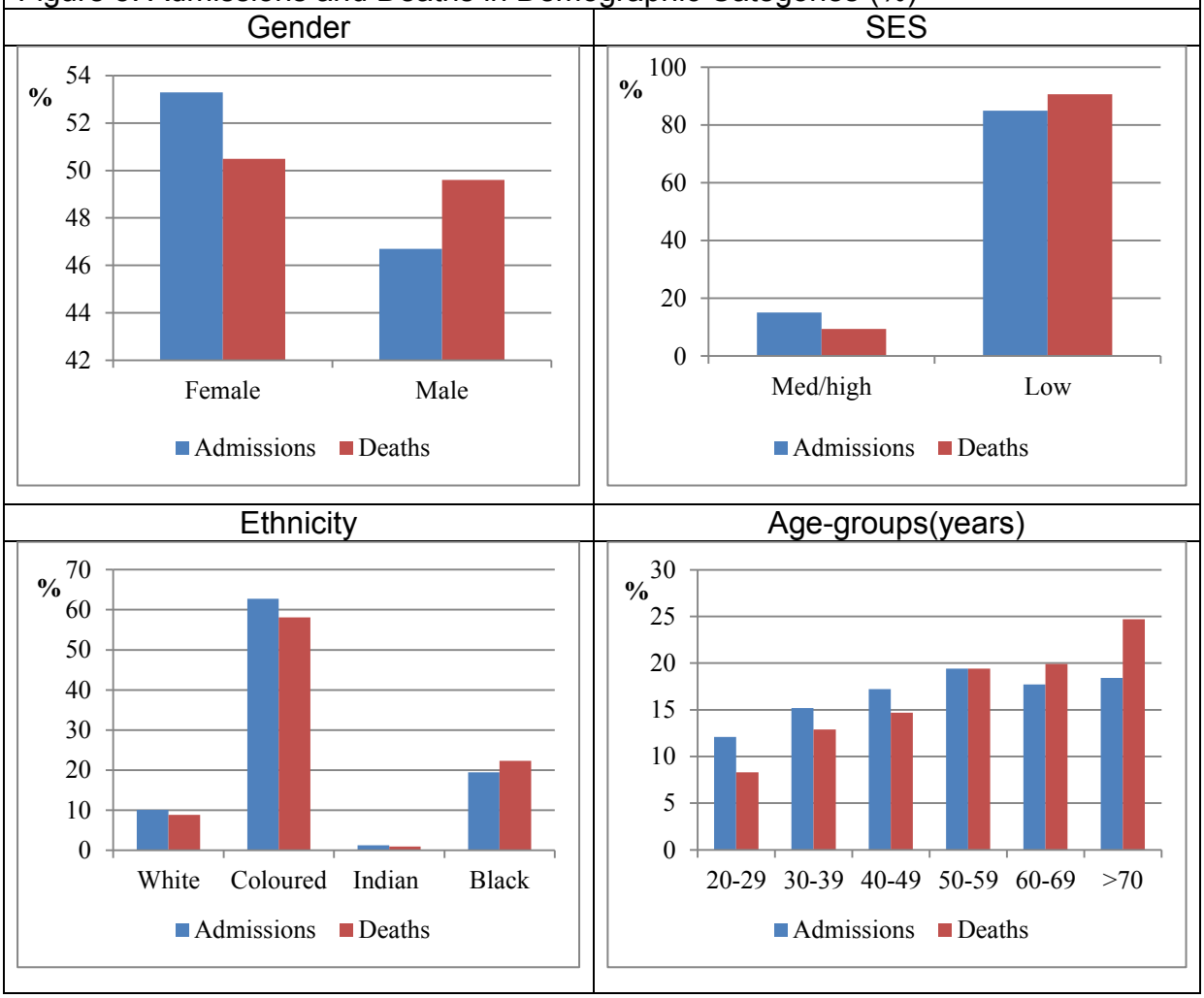
There were slightly more females in both the Coloured and Black groups, which collectively represented more than three quarters of all the admissions. More patients in the Coloured and Black groups were classified as low SES than med/high SES, whereas more Whites were classified as med/high SES than low SES. The age distributions for Whites, Coloureds and Indians were similar; with admissions increasing as age increased, but the age distribution for Blacks was the opposite, with the highest proportion of admissions in the <50 year old groups.

Figure 4: Demographic Profile Admissions by Age-Groups



There were more males than females in the age-groups between 40-69 years, but more females than males in the >70 years group. There were more patients in the med/high SES group than in the low SES group in the <60 years groups, whereas the patients in the older groups were predominantly in the low SES group. There was a large proportion of Black patients in the <40 year groups, while there was a large proportion of White patients in the >70 year group.

Figure 5: Admissions and Deaths in Demographic Categories (%)

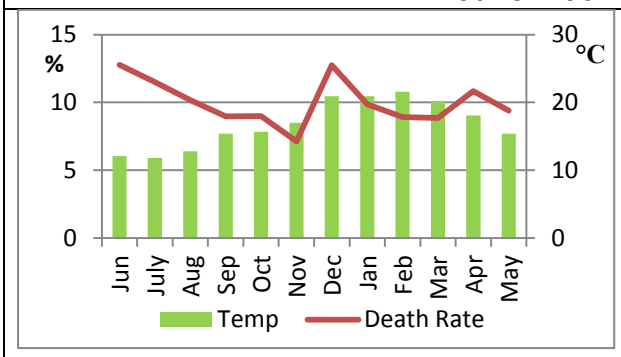


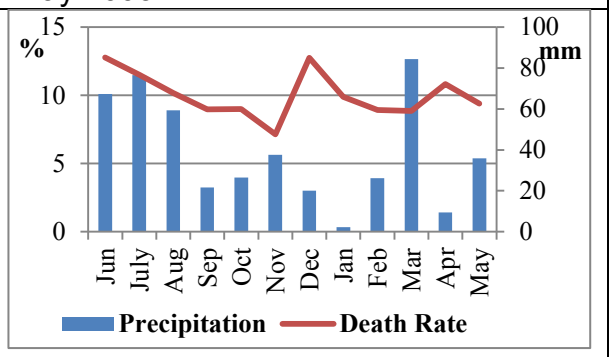
There were a greater proportion of female admissions compared to male admissions, but the proportion of deaths for males was higher than for females. There was a greater proportion of low SES admissions compared to med/high admissions, but the proportion of deaths for low SES was higher than for med/high SES. The proportion of deaths in Blacks was disproportionately high compared to admissions, while the proportion of deaths in Whites and Coloureds was disproportionately low compared to admissions. Deaths in the >60 year groups were high compared to admissions, whereas deaths in the <50 year groups were low compared to admissions. Thus male gender, low SES, Black ethnicity and increasing age were positively associated with mortality, and could act as confounding factors.

Appendix 5: Monthly and Seasonal Associations between Temperature (°C), Precipitation (mm) and Death Rates (%) per Year

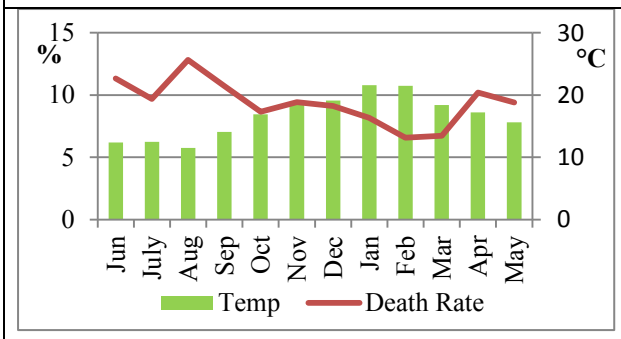
Figure1.1: Monthly Associations between Temperature (°C), Precipitation (mm) and Death Rates (%) per Year (June 2002-May 2006)

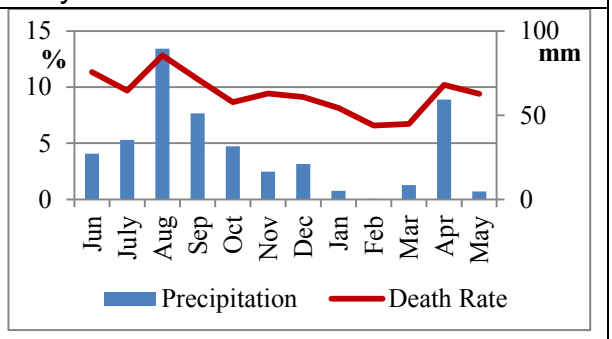
June 2002 - May 2003



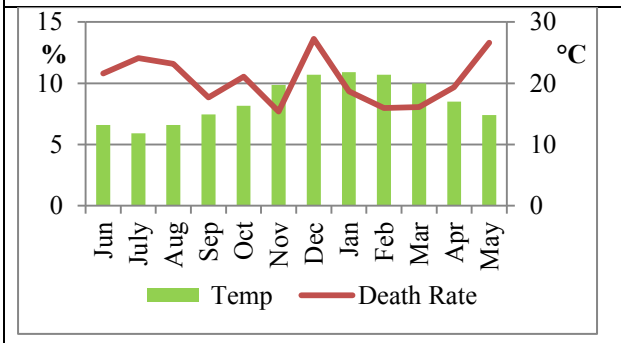


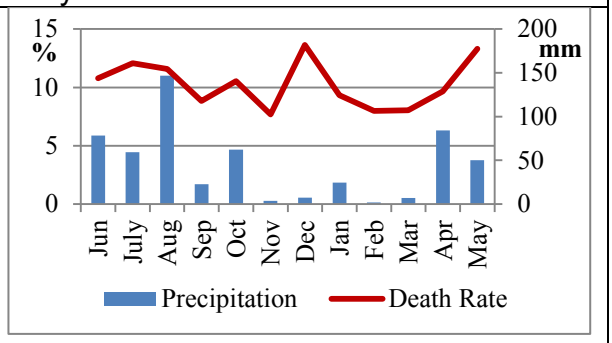
June 2003 - May 2004



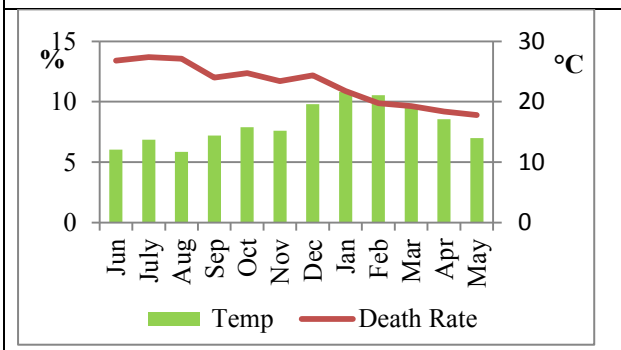


June 2004 - May 2005





June 2005 - May 2006



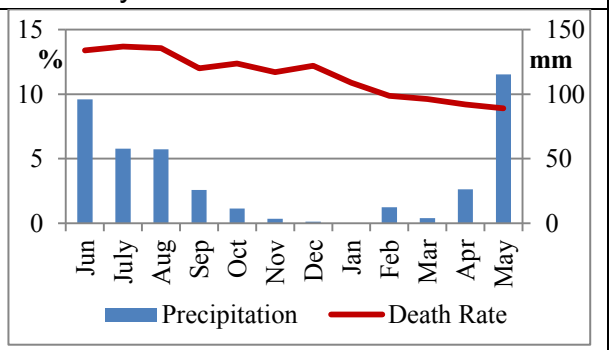
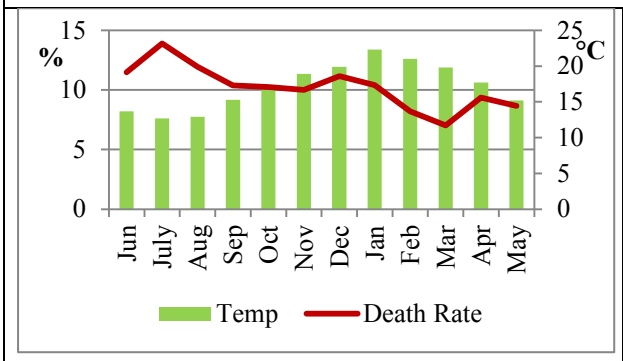
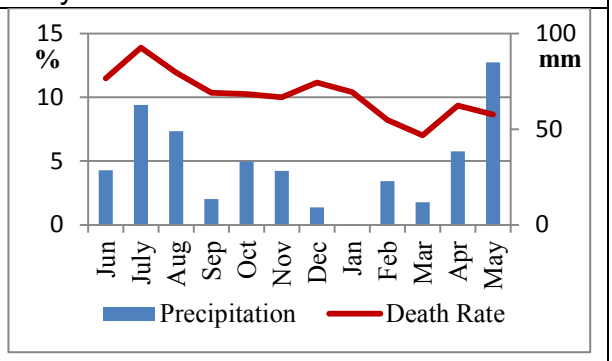


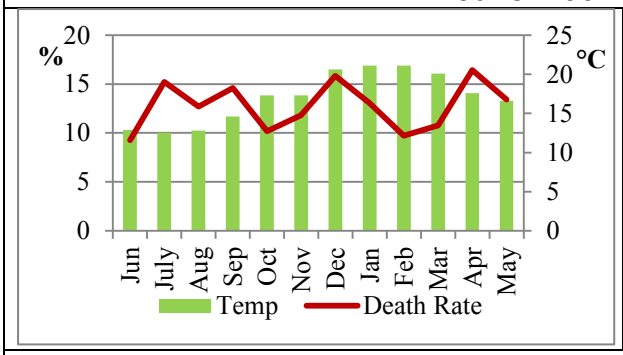
Figure1.2: Monthly Associations between Temperature (°C), Precipitation (mm) and Death Rates (%) per Year(June 2006-May2009)

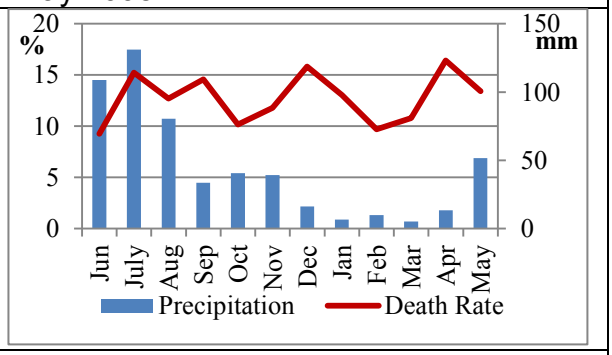
June 2006 - May 2007



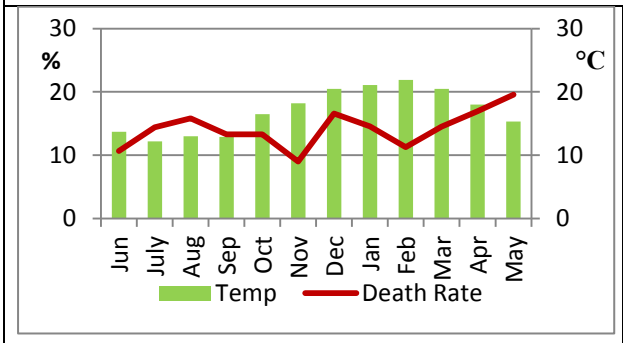


June 2007 - May 2008





June 2008 - May 2009



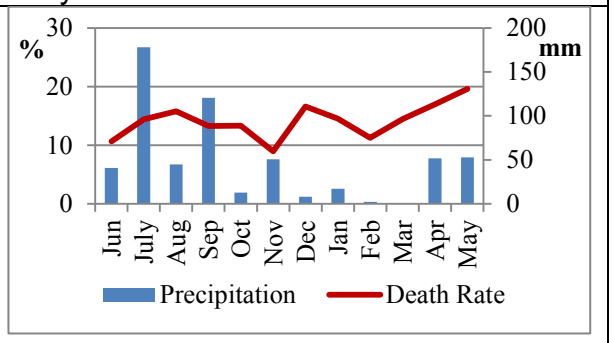
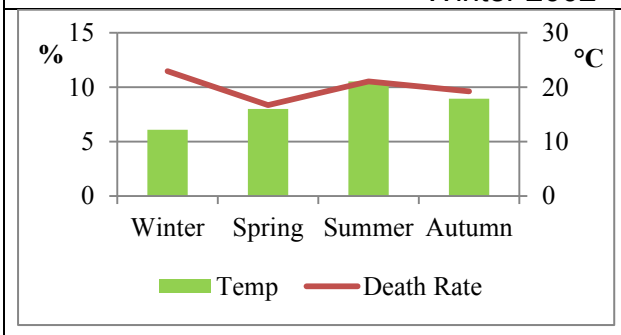
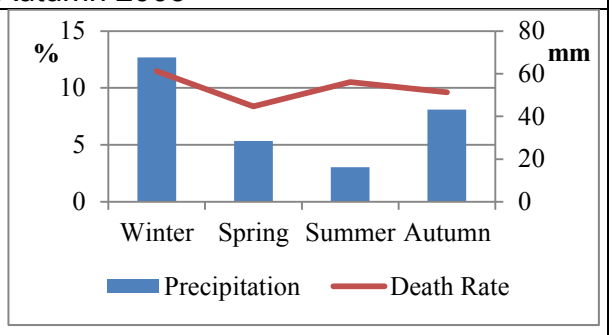


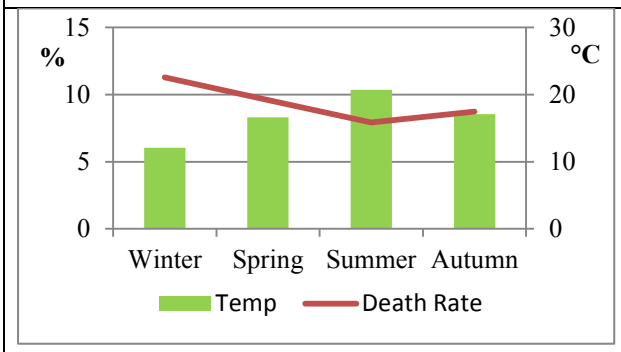
Figure 2.1: Seasonal Associations between Temperature (°C), Precipitation (mm) and Death Rates (%) per Year (Winter 2002-Autumn 2006)

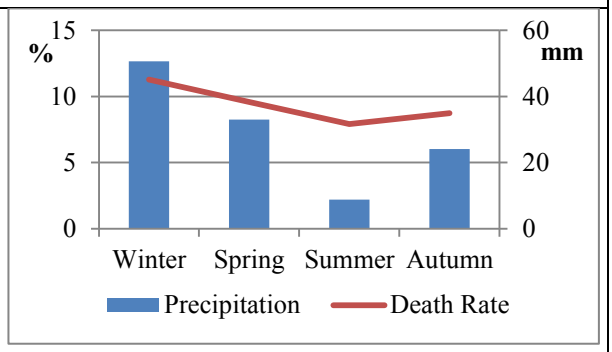
Winter 2002 - Autumn 2003



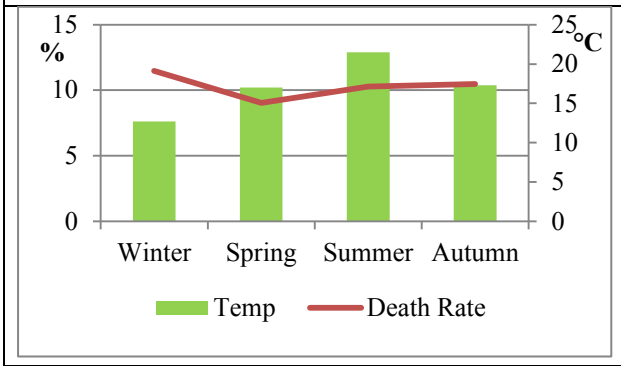


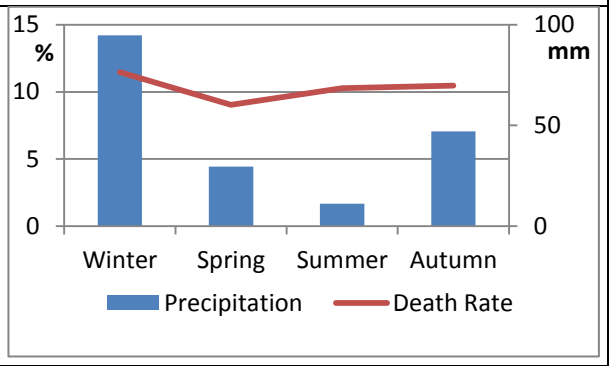
Winter 2003 - Autumn 2004

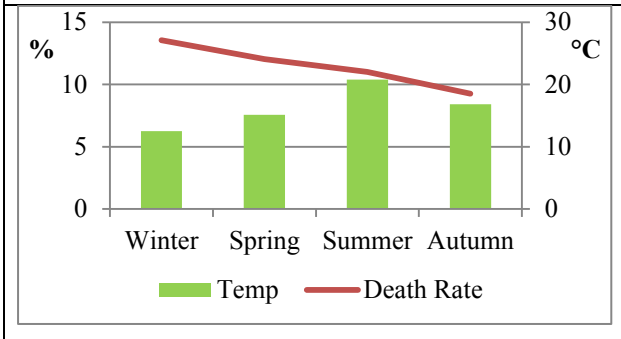




Winter 2004 - Autumn 2005







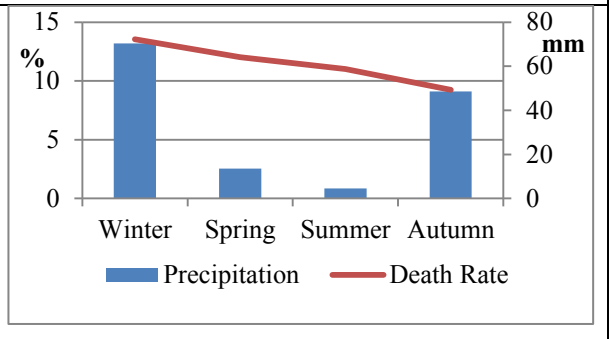
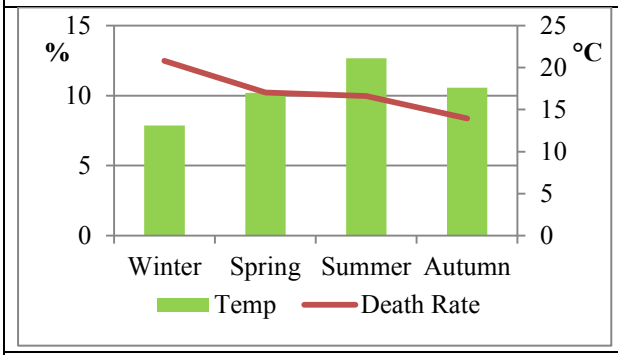
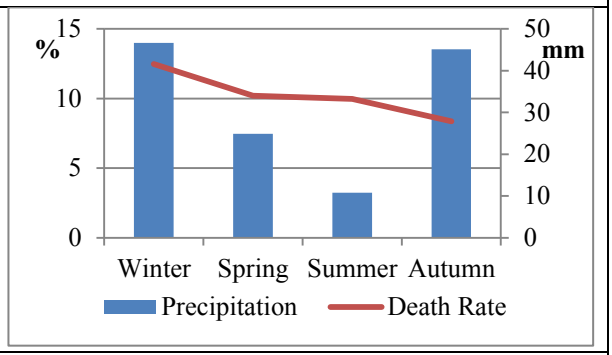


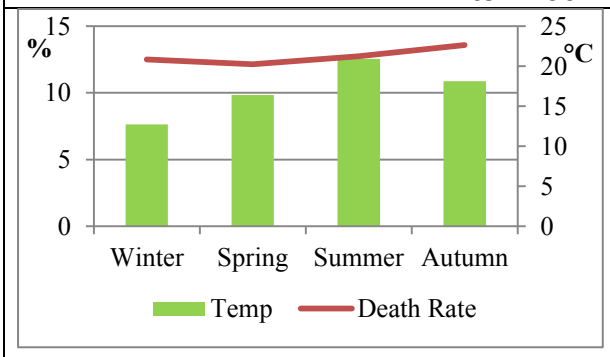
Figure 2.2: Seasonal Associations between Temperature (°C), Precipitation (mm) and Death Rates (%) per Year (Winter 2006-Autumn 2009)

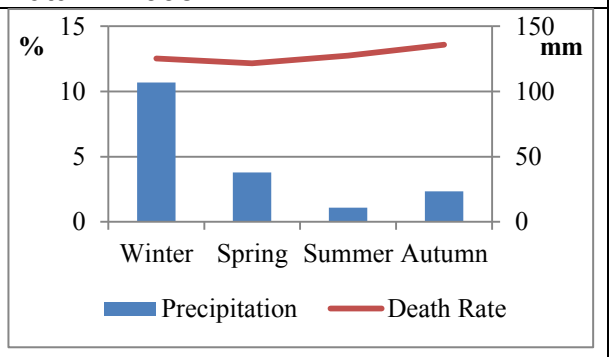
Winter 2006 - Autumn 2007



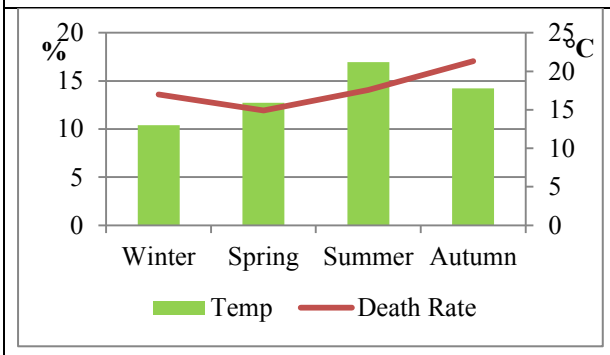


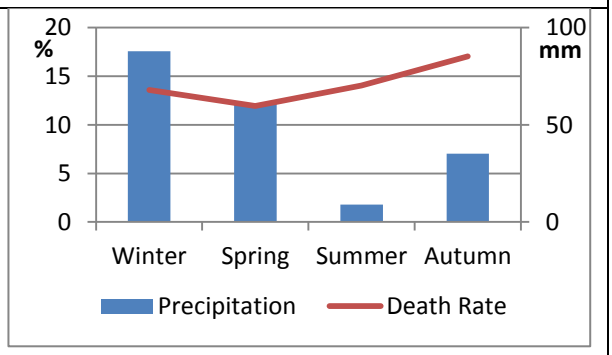
Winter 2007 - Autumn 2008





Winter 2008 - Autumn 2009





Source of temperature and precipitation data:

http://www.tutiempo.net/en/Climate/Cape_Town_D_F_Malan/05-2009/688160.htm

Appendix 6: Monthly and Seasonal Admissions and Deaths in Demographic Categories

Table 1.1: Demographic Profile of Admissions per Month: June-November (%)						
	June	July	August	September	October	November
Gender						
Female	2 433 (53.3)	2 674 (53.8)	2 525 (53.2)	2 561 (54.2)	2 560 (53.5)	2 371 (52.6)
Male	2 130 (46.7)	2 293 (46.2)	2 221 (46.8)	2 166 (45.8)	2 226 (46.5)	2 136 (47.4)
Socioeconomic Status						
Med/High	667 (14.6)	746 (15.0)	653 (13.8)	713 (15.1)	703 (14.7)	694 (15.4)
Low	3 896 (85.4)	4 221 (85.0)	4 093 (86.2)	4 014 (84.9)	4 083 (85.3)	3 813 (84.6)
Ethnicity						
White	470 (10.3)	508 (10.2)	446 (9.4)	479 (10.1)	464 (9.70)	497 (11.03)
Coloured	2 924 (64.1)	3 177 (64.0)	3 043 (64.1)	2 956 (62.5)	2 958 (61.8)	2 726 (60.5)
Indian	53 (1.2)	55 (1.1)	57 (1.2)	71 (1.5)	56 (1.2)	65 (1.4)
Black	829 (18.2)	915 (18.4)	890 (18.8)	952 (20.1)	1 003 (21.0)	918 (20.4)
Unknown	287 (6.3)	312 (6.3)	310 (6.5)	269 (5.7)	305 (6.4)	301 (6.7)
Age-groups (years)						
20-29	487 (10.7)	559 (11.3)	550 (11.6)	575 (12.2)	606 (12.7)	562 (12.5)
30-39	692 (15.2)	722 (14.5)	691 (14.6)	669 (14.2)	783 (16.4)	726 (16.1)
40-49	796 (17.4)	817 (16.5)	828 (17.5)	772 (16.3)	821 (17.2)	805 (17.9)
50-59	885 (19.4)	986 (19.9)	883 (18.6)	928 (19.6)	940 (19.6)	852 (18.9)
60-69	823 (18.0)	893 (18.0)	868 (18.3)	899 (19.0)	817 (17.1)	776 (17.2)
>70	880 (19.3)	990 (19.9)	926 (19.5)	884 (18.7)	819 (17.1)	786 (17.4)

Table 1.2: Demographic Profile of Admissions per Month: December - May (%)						
	December	January	February	March	April	May
Gender						
Female	2 123	2 281	2 241	2 371	2 271	2 582
	(52.6)	(51.6)	(53.6)	(53.1)	(53.9)	(54.1)
Male	1 914	2 138	1 943	2 095	1 945	2 192
	(47.4)	(48.4)	(46.4)	(46.9)	(46.1)	(45.9)
SES						
Med/High	622	764	654	660	612	720
	(15.4)	(17.3)	(15.6)	(14.8)	(14.5)	(15.1)
Low	3 414	3 655	3 530	3 806	3 603	4 054
	(84.6)	(82.7)	(84.4)	(85.2)	(85.5)	(84.9)
Ethnicity						
White	402	466	418	441	388	470
	(10.0)	(10.6)	(10.0)	(9.9)	(9.2)	(9.9)
Coloured	2 526	2 766	2 637	2 763	2 647	2 996
	(62.6)	(62.6)	(63.0)	(61.9)	(62.8)	(62.8)
Indian	49	47	59	59	50	66
	(1.2)	(1.1)	(1.4)	(1.3)	(1.9)	(1.4)
Black	783	845	812	901	860	917
	(19.4)	(19.1)	(19.4)	(20.2)	(20.4)	(19.2)
Unknown	277	295	258	302	271	325
	(6.9)	(6.7)	(6.2)	(6.8)	(6.4)	(6.8)
Age-groups (years)						
20-29	483	510	515	575	568	582
	(12.0)	(11.5)	(12.3)	(12.9)	(13.5)	(12.2)
30-39	568	720	681	690	634	696
	(14.1)	(16.3)	(16.3)	(15.5)	(15.0)	(14.6)
40-49	686	744	748	796	729	803
	(17.0)	(16.8)	(17.9)	(17.8)	(17.3)	(16.8)
50-59	760	889	773	891	794	953
	(18.8)	(20.1)	(18.5)	(20.0)	(18.8)	(20.0)
60-69	786	784	733	751	700	814
	(19.5)	(17.7)	(17.5)	(16.8)	(16.6)	(17.1)
>70	754	772	734	763	791	926
	(18.7)	(17.5)	(17.5)	(17.1)	(18.8)	(19.4)

Table 2: Demographic Profile of Admissions per Season (%)				
	Winter	Spring	Summer	Autumn
Gender				
Female	7 632	7 492	6 645	7 224
	(53.5)	(53.4)	(52.6)	(53.7)
Male	6 644	6 528	5 995	6 232
	(46.5)	(46.6)	(47.4)	(46.3)
SES				
Med/High	2 066	2 110	2 040	1 992
	(14.5)	(15.1)	(16.1)	(14.8)
Low (%)	12 210	11 910	10 599	11 463
	(85.5)	(85.0)	(83.9)	(85.2)
Ethnicity				
White	1 444	1 440	1 286	1 299
	(10.1)	(10.3)	(10.2)	(9.7)
Coloured	9 144	8 640	7 929	8 406
	(64.1)	(61.6)	(62.7)	(62.5)
Indian	165	192	155	175
	(1.2)	(1.4)	(1.3)	(1.3)
Black	2 634	2 873	2 440	2 678
	(18.5)	(20.5)	(19.3)	(19.9)
Unknown	889	875	830	898
	(6.2)	(6.2)	(6.6)	(6.7)
Age-groups (years)				
20-29	1 596	1 743	1 508	1 725
	(11.2)	(12.4)	(11.9)	(12.8)
30-39	2 105	2 178	1 969	2 020
	(14.8)	(15.5)	(15.6)	(15.0)
40-49	2 441	2 398	2 178	2 328
	(17.1)	(17.1)	(17.2)	(17.3)
50-59	2 754	2 720	2 422	2 638
	(19.3)	(19.4)	(19.7)	(19.6)
60-69	2 584	2 492	2 303	2 265
	(18.1)	(17.8)	(18.2)	(16.8)
>70	2 796	2 489	2 206	2 480
	(19.6)	(17.8)	(17.9)	(18.4)

Admissions were greater in females than male in every month and season. About 85% of admissions in all months and seasons were represented by low socioeconomic status, while just over 60% of admissions in all months and seasons were of Coloured ethnicity. These factors could cause skewing of results.

Table 4.1: Monthly Death Rates for Demographic Categories: June -November (%)						
	June	July	August	September	October	November
Gender						
Female	11.30	12.27	11.21	11.17	9.45	8.98
Male	11.55	13.65	14.18	11.13	11.86	10.02
Socioeconomic Status						
Med/High	6.00	7.78	7.96	5.33	6.54	6.34
Low	12.35	13.81	13.34	12.18	11.27	10.05
Ethnicity						
White	10.21	11.42	13.31	9.60	10.56	8.45
Coloured	10.94	12.56	11.67	10.08	9.74	8.69
Indian	9.43	12.72	12.28	7.04	12.50	10.77
Black	12.91	12.13	13.82	13.66	11.37	11.87
Age-groups (years)						
20-29	5.96	9.84	8.55	9.74	5.06	6.94
30-39	10.41	10.80	9.26	8.67	7.79	8.26
40-49	9.05	12.00	11.47	9.07	7.67	7.45
50-59	11.86	12.58	12.57	10.02	12.02	8.92
60-69	13.73	14.11	13.83	13.01	11.38	10.83
>70	14.77	16.16	17.28	15.05	15.87	13.74

Table 4.2: Monthly Death Rates for Demographic Categories: December – May (%)						
	December	January	February	March	April	May
Gender						
Female	11.59	9.73	8.75	9.79	11.58	10.50
Male	14.32	11.97	9.01	8.73	11.93	13.18
Socioeconomic Status						
Med/High	7.07	8.38	6.73	6.21	7.68	7.50
Low	13.94	11.33	9.26	9.83	12.43	12.48
Ethnicity						
White	12.44	7.73	7.42	8.62	7.73	10.43
Coloured	11.92	9.87	8.23	8.22	10.96	10.55
Indian	6.12	10.64	3.39	5.08	8.00	10.60
Black	14.94	13.61	10.59	11.88	13.26	12.54
Age-groups (years)						
20-29	7.04	8.43	5.83	5.39	8.45	8.08
30-39	9.16	10.28	7.64	8.41	11.99	11.35
40-49	13.85	8.74	6.95	8.92	9.74	10.09
50-59	11.18	10.01	10.22	9.43	12.97	12.17
60-69	16.67	13.01	9.41	9.72	12.29	11.18
>70	16.31	13.60	12.13	12.84	14.03	15.77

Death rates for females and males were highest in July and August respectively, and rates were higher in males than females for most months. Death rates for the med/high SES were highest in August and January, whereas the rates for low SES were highest in July and January. The rates for the low SES group were significantly higher than those for the med/high group. Death rates for Blacks were higher than all other ethnic groups in all months, with the highest rate occurring in January. For Coloureds, the rates were highest in July and January. For Whites, the rates were highest in August and January. There was wide variation in the rates for Indians due to the low number of admissions for that group.

Table 5: Seasonal Death Rates for Demographic Categories (%)				
	Winter	Spring	Summer	Autumn
Gender				
Female	11.61	9.90	9.99	10.60
Male	13.15	11.00	11.76	11.30
SES				
Med/High	7.26	6.07	7.45	7.13
Low	13.19	11.18	11.18	11.59
Ethnicity				
White	11.63	9.51	9.10	9.01
Coloured	11.75	9.53	9.98	9.91
Indian	11.52	9.90	6.45	8.00
Black	12.95	13.40	13.03	12.55
Age- groups (years)				
20-29	8.21	8.09	7.10	7.30
30-39	10.17	8.22	9.04	10.55
40-49	10.86	8.05	9.73	9.58
50-59	12.35	10.37	10.45	11.49
60-69	13.89	11.80	13.11	11.04
>70	16.13	14.91	14.03	14.31

In this table, death rates in both males and females were highest in winter compared to the other seasons, and the rate for males was higher than that of females in all seasons. The death rate for the low SES group was highest in winter, whereas the rates for winter, summer and autumn were similar in the med/high SES group. Death rates were highest in the White, Coloured and Indian groups in winter, while the rates for Blacks did not vary much between seasons. Death rates increased as age increased in all seasons, and were highest in winter for all the age-groups. These findings suggest that gender, SES, ethnicity and age are possible confounding factors in this study.

Appendix 7: Unadjusted Monthly and Seasonal Mortality Rate Ratios

Table 1.1: Unadjusted Monthly Mortality Rate Ratios- June - November (95% Confidence Intervals)						
	June	**July**	**August**	**September**	**October**	**November**
Year						
June02-May03	1.62 (1.15-2.27)	1.41 (1.00-1.98)	1.33 (0.93-1.90)	1.13 (0.79-1.62)	1.07 (0.74-1.54)	0.88 (0.60-1.29)
June03-May04	1.65 (1.14-2.38)	1.39 (0.96-2.01)	1.86 (1.31-2.63)	1.51 (1.06-2.16)	1.27 (0.88-1.84)	1.35 (0.93-1.97)
June04-May05	1.38 (0.96-2.00)	1.60 (1.11-2.30)	1.33 (0.92-1.92)	1.15 (0.78-1.69)	1.24 (0.85-1.81)	0.90 (0.60-1.34)
June05-May06	1.02 (0.73-1.43)	1.01 (0.72-1.41)	0.94 (0.67-1.31)	0.91 (0.64-1.27)	0.86 (0.61-1.21)	0.85 (0.60-1.20)
June06-May07	1.41 (0.98-2.04)	1.94 (1.37-2.75)	1.44 (1.00-2.07)	1.41 (0.97-2.05)	1.43 (0.99-2.07)	1.30 (0.89-1.90)
June07-May08	0.96 (0.66-1.39)	1.56 (1.13-2.16)	1.33 (0.95-1.86)	1.51 (1.08-2.11)	1.08 (0.76-1.55)	1.25 (0.88-1.77)
June08-May09	1.12 (0.80-1.55)	1.48 (1.09-2.00)	2.03 (1.49-2.76)	1.26 (0.92-1.73)	1.30 (0.95-1.77)	0.84 (0.59-1.20)
Gender						
Female	1.32 (1.10-1.58)	1.46 (1.22-1.74)	1.30 (1.08-1.56)	1.29 (1.08-1.55)	1.06 (0.88-1.28)	1.03 (0.85-1.25)
Male	1.28 (1.05-1.55)	1.49 (1.29-1.87)	1.56 (1.29-1.87)	1.22 (1.01-1.49)	1.30 (1.08-1.58)	1.05 (0.86-1.29)
SES						
Med/High	0.88 (0.58-1.36)	1.18 (0.80-1.75)	1.20 (0.80-1.80)	0.80 (0.52-1.24)	1.00 (0.66-1.51)	0.91 (0.60-1.38)
Low	1.35 (1.17-1.55)	1.51 (1.32-1.73)	1.44 (1.26-1.65)	1.31 (1.14-1.51)	1.19 (1.03-1.37)	1.06 (0.91-1.23)
Ethnicity						
White	1.30 (0.83-2.05)	1.67 (1.08-2.58)	1.73 (1.13-2.66)	1.39 (0.88-2.20)	1.32 (0.84-2.07)	1.21 (0.76-1.93)
Coloured	1.37 (1.15-1.62)	1.53 (1.30-1.81)	1.40 (1.18-1.66)	1.22 (1.03-1.46)	1.19 (0.99-1.41)	1.03 (0.85-1.23)
Indian	2.10 (0.41-10.82)	4.01 (0.83-19.30)	3.18 (0.66-15.33)	2.24 (0.43-11.54)	3.72 (0.77-17.92)	2.35 (0.49-11.33)
Black	1.21 (0.91-1.61)	1.16 (0.87-1.53)	1.36 (1.03-1.79)	1.34 (1.02-1.75)	1.11 (0.84-1.46)	1`.12 (0.85-1.49)
Age-groups (years)						
20-29	1.05 (0.63-1.75)	1.75 (1.12-2.74)	1.46 (0.93-2.31)	1.56 (1.00-2.43)	1.39 (0.88-2.20)	1.28 (0.80-2.06)
30-39	1.26 (0.88-1.80)	1.32 (0.94-1.90)	1.11 (0.77-1.59)	1.05 (0.72-1.53)	0.90 (0.62-1.30)	0.98 (0.68-1.43)
40-49	1.24 (0.87-1.77)	1.75 (1.25-2.45)	1.61 (1.15-2.26)	1.34 (0.94-1.92)	1.17 (0.81-1.69)	1.03 (0.71-1.49)
50-59	1.13 (0.84-1.51)	1.22 (0.92-1.61)	1.25 (0.94-1.67)	1.00 (0.74-1.35)	1.14 (0.86-1.53)	0.83 (0.60-1.13)
60-69	1.62 (1.20-2.18)	1.49 (1.11-2.00)	1.40 (1.04-1.88)	1.46 (1.09-1.97)	1.20 (0.88-1.64)	1.13 (0.82-1.55)
>70	1.25 (0.95-1.64)	1.35 (1.04-1.75)	1.60 (1.24-2.07)	1.22 (0.94-1.60)	1.30 (0.99-1.70)	1.18 (0.89-1.56)

Table 1.2: Unadjusted Monthly Mortality Rate Ratios- December - May (95% Confidence Intervals)						
	December	**January**	**February**	**March**	**April**	**May**
Year						
June02-May03	1.70 (1.19-2.41)	1.29 (0.90-1.86)	1.00 --------	1.09 (0.75-1.59)	1.24 (0.85-1.80)	1.17 (0.81-1.68)
June03-May04	1.49 (1.02-2.18)	1.14 (0.78-1.67)	1.00 --------	1.04 (0.71-1.53)	1.54 (1.07-2.20)	1.40 (0.97-2.01
June04-May05	1.61 (1.11-2.33)	1.15 (0.78-1.72)	1.00 --------	0.98 (0.65-1.48)	1.17 (0.80-1.72)	1.55 (1.09-2.22)
June05-May06	0.92 (0.65-1.30)	0.84 (0.59-1.20)	1.00 --------	0.75 (0.53-1.08)	0.72 (0.49-1.05)	0.67 (0.46-0.96)
June06-May07	1.39 (0.95-2.04)	1.37 (0.94-1.99)	1.00 --------	0.86 (0.56-1.31)	1.20 (0.81-1.78)	1.03 (0.70-1.52)
June07-May08	1.71 (1.22-2.39)	1.35 (0.96-1.90)	1.00 --------	1.06 (0.74-1.51)	1.61 (1.16-2.23)	1.37 (0.98-1.91)
June08-May09	1.49 (1.09-2.05)	1.26 (0.92-1.73)	1.00 --------	1.27 (0.92-1.74)	1.53 (1.12-2.09)	1.77 (1.31-2.37)
Gender						
Female	1.31 (1.08-1.57)	1.09 (0.90-1.32)	1.00 --------	1.11 (0.92-1.35)	1.26 (1.05-1.52)	1.17 (0.97-1.40)
Male	1.64 (1.35-1.98)	1.32 (1.09-1.60)	1.00 --------	0.93 (0.76-1.14)	1.31 (1.08-1.60)	1.39 (1.16-1.68)
SES						
Med/High	1.13 (0.74-1.71)	1.28 (0.87-1.87)	1.00 --------	0.91 (0.60-1.40)	1.16 (0.77-1.75)	1.05 (0.71-1.56)
Low	1.50 (1.30-1.72)	1.19 (1.03-1.38)	1.00 --------	1.04 (0.89-1.20)	1.29 (1.12-1.49)	1.30 (1.13-1.50)
Ethnicity						
White	2.07 (1.32-3.24)	1.00 (0.62-1.61)	1.00 --------	1.35 (0.84-2.16)	1.00 (0.67-1.81)	1.43 (0.91-2.24)
Coloured	1.43 (1.20-1.70)	1.19 (0.99-1.42)	1.00 --------	0.97 (0.80-1.16)	1.27 (1.07-1.52)	1.24 (1.05-1.48)
Indian	1.72 (0.29-10.29)	3.35 (0.65-17.28)	1.00 --------	1.20 (0.20-7.16)	1.61 (0.30-8.78)	2.42 (0.50-11.66)
Black	1.42 (1.08-1.88)	1.30 (0.98-1.72)	1.00 --------	1.12 (0.84-1.49)	1.29 (0.97-1.71)	1.13 (0.86-1.49)
Age-groups (years)						
20-29	1.29 (0.79-2.10)	1.56 (0.98-2.48)	1.00 --------	0.92 (0.56-1.52)	1.45 (0.92-2.29)	1.38 (0.87-2.18)
30-39	1.08 (0.74-1.59)	1.28 (0.90-1.82)	1.00 --------	0.99 (0.68-1.44)	1.43 (1.00-2.03)	1.22 (0.86-1.73)
40-49	2.08 (1.48-2.92)	1.16 (0.81-1.68)	1.00 --------	1.29 (0.90-1.84)	1.51 (1.05-2.15)	1.44 (1.02-2.04)
50-59	1.06 (0.78-1.44)	0.98 (0.72-1.32)	1.00 --------	0.88 (0.65-1.20)	1.17 (0.87-1.57)	1.09 (0.82-1.46)
60-69	1.75 (1.31-2.35)	1.34 (0.99-1.82)	1.00 --------	1.07 (0.77-1.48)	1.26 (0.92-1.73)	1.31 (0.96-1.79)
>70	1.34 (1.02-1.76)	1.10 (0.83-1.45)	1.00 --------	1.11 (0.84-1.48)	1.11 (0.84-1.47)	1.28 (0.98-1.66)

Table 2: Unadjusted Seasonal Mortality Rate Ratios- Winter – Autumn (95% Confidence Intervals)				
	Winter	**Spring**	**Summer**	**Autumn**
Year				
June02-May03	1.42 (1.17-1.71)	1.00 -------	1.28 (1.05-1.57)	1.14 (0.92-1.39)
June03-May04	1.18 (0.98-1.43)	1.00 -------	0.87 (0.71-1.06)	0.96 (0.79-1.16)
June04-May05	1.31 (1.08-1.59)	1.00 -------	1.15 (0.93-1.42)	1.15 (0.93-1.40)
June05-May06	1.13 (0.95-1.35)	1.00 -------	1.05 (0.87-1.27)	0.82 (0.67-1.00)
June06-May07	1.16 (0.96-1.39)	1.00 -------	0.91 (0.74-1.11)	0.75 (0.60-0.92)
June07-May08	1.02 (0.84-1.22)	1.00 -------	1.04 (0.86-1.26)	1.05 (0.88-1.26)
June08-May09	1.31 (1.10-1.56)	1.00 -------	1.09 (0.91-1.30)	1.34 (1.13-1.58)
Gender				
Female	1.21 (1.09-1.33)	1.00 -------	1.00 (0.90-1.11)	1.05 (0.95-1.16)
Male	1.21 (1.10-1.34	1.00 -------	1.10 (0.99-1.22)	1.02 (0.92-1.13)
SES				
Med/High	1.21 (0.95-1.53)	1.00 -------	1.26 (1.00-1.60)	1.15 (0.90-1.46)
Low	1.21 (1.12-1.30)	1.00 -------	1.03 (0.95-1.11)	1.02 (0.94-1.10)
Ethnicity				
White	1.20 (0.96-1.50)	1.00 -------	0.98 (0.77-1.26)	1.00 (0.78-1.28)
Coloured	1.25 (1.14-1.37)	1.00 -------	1.05 (0.95-1.16)	1.01 (0.92-1.12)
Indian	1.12 (0.59-2.12)	1.00 -------	0.71 (0.33-1.53)	0.66 (0.33-1.32)
Black	1.04 (0.90-1.21)	1.00 -------	1.04 (0.90-1.21)	0.99 (0.85-1.15)
Age-groups (years)				
20-29	1.02 (0.80-1.29)	1.00 -------	0.90 (0.70-1.16)	0.88 (0.69-1.12)
30-39	1.27 (1.04-1.55)	1.00 -------	1.16 (0.94-1.43)	1.24 (1.02-1.51)
40-49	1.31 (1.09-1.57)	1.00 -------	1.18 (0.97-1.43)	1.20 (0.99-1.45)
50-59	1.21 (1.03-1.41)	1.00 -------	1.02 (0.86-1.21)	1.06 (0.90-1.24)
60-69	1.18 (1.01-1.38)	1.00 -------	1.08 (0.92-1.27)	0.96 (0.81-1.13)
>70	1.13 (0.99-1.30)	1.00 -------	0.93 (0.80-1.08)	0.95 (0.82-1.10)

Appendix 8- Monthly and Seasonal Admissions and Deaths in Diagnostic Disease Categories

ICD-10 Category	Admissions (%)	ICD-10 Category	Admissions (%)
A	1 012 (3.4)	O	44 (0.2)
B	605 (2.0)	P	21 (0.1)
C	1 204 (4.0)	Q	133 (0.4)
D	387 (1.3)	R	851 (2.8)
E	1 108 (3.7)	S	55 (0.2)
F	212 (0.7)	T	192 (0.6)
G	1 079 (3.6)	U	42 (0.1)
H	16 (0.1)	V	0
I	9 010 (30.0)	W	5 (<0.1)
J	3 527 (11.7)	X	37 (0.1)
K	1 662 (5.5)	Y	9 (<0.1)
L	1 020 (3.4)	Z	177 (0.6)
M	602 (2.0)	Unknown	5 018 (16.7)
N	2 035 (6.8)	Total	30 063 (100)

Table 2: Diagnostic Disease Categories- Jun05-May09		
	Admissions	Percent
Respiratory	4 128	13.73
Circulatory	10 680	35.53
GIT	1 672	5.56
Cancer	1 220	4.06
Other	7 345	24.43
Unknown	5 018	16.69
Total	30 063	100

Table 3: Outcomes of Diagnostic Disease Categories (%)		
	Alive	Died
Respiratory	3 583 (86.8)	545 (13.2)
Circulatory	9 980 (93.5)	700 (6.6)
GIT	1 568 (93.8)	104 (6.2)
Cancer	1 040 (85.3)	180 (14.8)
Other	6 814 (92.8)	531 (7.2)
Unknown	3 420 (68.4)	1 598 (31.6)
Total	26 405 (87.8)	3 658 (12.2)

Table 4.1: Average Monthly Admissions for Diagnostic Disease Categories: Jun-Nov (%)						
	June	July	August	September	October	November
Respiratory	390	374	413	368	365	364
	(15.4)	(13.3)	(15.6)	(14.3)	993(13.7)	(14.6)
Circulatory	847	962	962	923	948	860
	(33.5)	(34.2)	(36.4)	(35.8)	(35.6)	(34.6)
GIT	128	144	136	153	146	150
	(5.1)	(5.1)	(5.2)	(6.1)	(5.5)	(6.0)
Cancer	96	102	90	113	111	117
	(3.8)	(3.6)	(3.4)	(4.4)	(4.2)	(4.7)
Other	537	609	644	605	634	624
	(21.2)	(21.7)	(24.4)	(23.5)	(23.8)	(25.1)
Unknown	532	621	397	414	460	371
	(21.0)	(22.1)	(15.0)	(16.1)	(17.3)	(14.9)
Total	2530	2812	2642	2576	2664	2486
	(100)	(100)	(100)	(100)	(100)	(100)

Table 4.2: Average Monthly Admissions for Diagnostic Disease Categories: Dec-May (%)						
	December	January	February	March	April	May
Respiratory	288	266	265	317	325	393
	(12.9)	(10.8)	(11.5)	(13.0)	(14.2)	(15.0)
Circulatory	749	925	835	914	788	967
	(33.7)	(37.6)	(36.2)	(37.4)	(34.3)	(36.9)
GIT	123	135	151	158	123	125
	(5.5)	(5.5)	(6.5)	(6.5)	(5.4)	(4.8)
Cancer	100	112	100	89	75	115
	(4.5)	(4.6)	(4.3)	(3.6)	(3.3)	(4.4)
Other	550	638	578	662	586	678
	(24.7)	(25.9)	(25.0)	(27.1)	(25.5)	(25.9)
Unknown	415	384	379	305	398	342
	(18.7)	(15.6)	(16.4)	(12.5)	(17.3)	(13.1)
Total	2225	2460	2308	2445	2295	2620
	(100)	(100)	(100)	(100)	(100)	(100)

Table 5: Average Admissions for Diagnostic Disease Categories per Month (%)						
	Respiratory	Circulatory	GIT	Cancer	Other	Unknown
June	390	847	128	96	537	532
	(9.5)	(7.9)	(7.7)	(7.9)	(7.3)	(10.6)
July	374	962	144	102	609	621
	(9.1)	(9.0)	(8.6)	(8.4)	(8.3)	(12.4)
August	413	962	136	90	644	397
	(10.0)	(9.0)	(8.1)	(7.4)	(8.8)	(7.9)
Sept	368	923	153	113	605	414
	(8.9)	(8.6)	(9.2)	(9.3)	(8.2)	(8.3)
Oct	365	948	146	111	634	460
	(8.8)	(8.9)	(8.7)	(9.1)	(8.6)	(9.2)
Nov	364	860	150	117	624	371
	(8.8)	(8.1)	(9.0)	(9.6)	(8.5)	(7.4)
Dec	288	749	123	100	550	415
	(7.0)	(7.0)	(7.4)	(8.2)	(7.5)	(8.3)
Jan	266	925	135	112	638	384
	(6.4)	(8.7)	(8.1)	(9.2)	(8.7)	(7.7)
Feb	265	835	151	100	578	379
	(6.4)	(7.8)	(9.0)	(8.2)	(7.9)	(7.6)
March	317	914	158	89	662	305
	(7.7)	(8.6)	(9.5)	(7.3)	(9.0)	(6.1)
April	325	788	123	75	586	398
	(7.9)	(7.4)	(7.4)	(6.2)	(8.0)	(7.9)
May	393	967	125	115	678	342
	(9.5)	(9.1)	(7.5)	(9.4)	(9.2)	(6.8)
Total	4 128	10 680	1 672	1 220	7 345	5 018
	(100)	(100)	(100)	(100)	(100)	(100)

Table 6: Average Seasonal Admissions per Diagnostic Disease Category (%)				
	Winter	Spring	Summer	Autumn
Respiratory	1 177	1 097	819	1 035
	(14.7)	(14.2)	(11.7)	(14.1)
Circulatory	2 771	2 731	2 509	2 669
	(34.7)	(35.4)	(35.9)	(36.1)
GIT	408	449	409	406
	(5.1)	(5.8)	(5.9)	(5.5)
Cancer	288	341	312	279
	(3.6)	(4.4)	(4.5)	(3.8)
Other	1 790	1 863	1 766	1 926
	(22.4)	(24.1)	(25.3)	(26.2)
Unknown	1 550	1 245	1 178	1 045
	(19.4)	(16.1)	(16.9)	(14.2)
Total	7984	7726	6993	7360
	(100)	(100)	(100)	(100)

Table 7: Average Admissions for Diagnostic Disease Categories per Season (%)						
	Respiratory	Circulatory	GIT	Cancer	Other	Unknown
Winter	1 177	2 771	408	288	1 790	1 550
	(28.5)	(26.0)	(24.4)	(23.6)	(24.4)	(30.9)
Spring	1 097	2 731	449	341	1 863	1 245
	(26.6)	(25.6)	(26.9)	(28.0)	(25.4)	(24.8)
Summer	819	2 509	409	312	1 766	1 178
	(19.8)	(23.5)	(24.5)	(25.6)	(24.0)	(23.5)
Autumn	1 035	2 669	406	279	1 926	1 045
	(25.1)	(25.0)	(24.3)	(22.9)	(26.2)	(20.8)
Total	4 128	10 680	1 672	1 220	7 345	5 018
	(100)	(100)	(100)	(100)	(100)	(100)

Table 8.1: Average Monthly Death Rates for Diagnostic Disease Categories-: June –Nov (%)						
	June	July	August	September	October	November
Respiratory	12.3	13.1	17.4	13.9	13.7	11.3
Circulatory	5.7	8.4	7.4	6.2	5.6	5.5
GIT	6.3	6.9	8.1	6.5	8.2	6.7
Cancer	11.5	13.7	11.1	13.3	13.5	16.2
Other	5.6	7.1	11.2	7.1	5.8	7.4
Unknown	26.1	33.0	30.2	35.3	30.7	27.2
Total	11.2	14.3	13.5	12.5	11.6	10.6

Table 8.2: Average Monthly Death Rates for Diagnostic Disease Categories: Dec -May (%)						
	December	January	February	March	April	May
Respiratory	12.9	14.3	12.5	9.2	11.7	15.0
Circulatory	6.5	6.3	5.0	6.4	6.2	9.0
GIT	4.9	2.2	3.3	4.4	8.1	6.4
Cancer	18.0	18.8	10.0	11.2	24.0	16.5
Other	7.3	6.7	5.9	6.5	8.5	7.4
Unknown	38.1	35.7	26.9	34.8	34.4	31.0
Total	13.8	12.2	9.8	10.6	13.0	12.6

Appendix 9: Guidelines for Publication in the South African Medical Journal (SAMJ)

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Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, and will delay publication.

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Named authors must consent to publication. Authorship should be based on: (i) substantial contribution to conception, design, analysis and interpretation of data; (ii) drafting or critical revision for important intellectual content; or (iii) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to www.icmje.org).

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References to ethnic classification must indicate the rationale for this.

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Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Research articles (previously 'Original articles') not exceeding 3 000 words, with up to 6 tables or illustrations, are usually observations or research of relevance to clinical medicine and related fields. References should be limited to no more than 15. Please provide a structured abstract not exceeding 250 words, with the following recommended headings: Background, Objectives, Methods, Results, and Conclusion.

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Editorials, Opinions, etc. should be about 1000 words and are welcome, but unless invited, will be subjected to the SAMJ peer review process.

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Book reviews should be about 400 words and must be accompanied by the publication details of the book.

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Guidelines must be endorsed by an appropriate body prior to consideration and all conflicts of interest expressed. A structured abstract not exceeding 250 words (recommended sub-headings: Background, Recommendations, Conclusion) is required. Sections and sub-sections must be numbered consecutively (e.g. 1.

Introduction; 1.1 Definitions; 2. etc.) and summarised in a Table of Contents. References, appendices, figures and tables must be kept to a minimum.

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Qualification, affiliation and contact details of ALL authors must be provided in the manuscript and in the online submission process.

Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

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Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160...

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Journal references: Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. Stat Med 1998;289(1):350-355. [http://dx.doi.org/10.1000/hgjr.182] [PMID: 2764753]

Book references: Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101. Chapter/section in a book: Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.

Internet references: World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).

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