CORRELATE OF MULTIMORBIDITY AND MORTALITY AMONG IN-PATIENTS AT THE GERIATRIC CENTRE UCH, IBADAN (2013 – 2017)

BY

AFOLAYAN OLADIPO KUNLE

MATRIC NUMBER: 211348

B.Sc. Statistics, University of Ibadan.

A DISSERTATION SUBMITTED TO

THE DEPARTMENT OF EPIDEMIOLOGY AND MEDICAL STATISTICS,

FACULTY OF PUBLIC HEALTH, COLLEGE OF MEDICINE,

UNIVERSITY OF IBADAN.

IN PARTIAL FULFILMENT OF

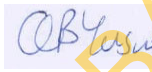
THE REQUIREMENT FOR THE AWARD OF

MASTER OF SCIENCE DEGREE IN BIOSTATISTICS,

FEBUARY, 2021

CERTIFICATION

I certify that this research work was carried out by AFOLAYAN, Oladipo Kunle in the Department of Epidemiology and Medical Statistics, Faculty of Public Health, University of Ibadan, Ibadan, Nigeria under my supervision.



……

Dr. Oyindamola B. Yusuf

B.Sc. (Ibadan). M.Sc. (Ibadan). Ph.D. (Ibadan)

Department of Epidemiology and Medical Statistics

Faculty of Public Health, College of Medicine.

University of Ibadan, Ibadan, Nigeria.

DEDICATION

I dedicate this research work to my beloved mom, Mrs Esther Temilola Afolayan.

A woman of uncommon sacrifice,
A fiercely loyal friend,
A compassionate critic,
A doting mother.

Rest on Mom.

ACKNOWLEDGEMENTS

My sincere appreciation goes to my supervisor, Dr Oyindamola B. Yusuf for her motherly advice, words of encouragements and support towards the success of this work. I am also hugely appreciative to Dr. Lawrence Adebusoye for his support especially for sharing his expertise so willing, and for being so dedicated to his role as my secondary supervisor.

I thank the Director and the entire staff of Chief Tony Anenih, Geriatric Centre of the University College Hospital, Ibadan for allowing me to use the inpatients data for my dissertation.

I appreciate the effort of my colleague in Total Quality Management Department of the University College Hospital (UCH) for impacting on me with knowledge and experience.

A very special appreciation goes to my Late mom Mrs Esther Afolayan for her untiring effort and support financially, morally, physical and spiritually towards this success. I say a big thank you to my brothers: Shola, Leye, Niyi and Dayo for their love and care and also believing in me that I could come this far.

I sincerely appreciate my best friend Jumoke Olateju for her unflinching support during this programme. I also want to say a big thank you to my classmate and colleagues for their love and for contributing to my life meaningful during my stay in the school. You guys are the best.

Most importantly my profound gratitude goes to the Almighty God who has preserved my life till now and given me grace and strength to complete my postgraduate programme. To Him be all the glory and praise.

CONTENTS

Title Page……..i

Certification……..……..……ii

Dedication……...……iii

Acknowledgment……..……iv

List of tables ……v

List of figures ……vi

Abstract……..……...ix

CHAPTER 1

INTRODUCTION 1

1.1 Background to the study 1

1.2 Statement of the Problem 2

1.3 Justification of the study 3

1.4 Research Questions 3

1.5 General Objective 4

1.5.1 Specific Objectives 4

CHAPTER TWO 5

LITERATURE REVIEW 5

2.1 Multimorbidity 5

2.2 Prevalence of Multimorbidity 6

2.3 Pattern of Multimorbidity 7

2.4 Determinants of Multimorbidity 8

2.4.1 Sex as a Determinant of Multimorbidity 8

2.4.2 Ethnicity 9

2.4.3 Socioeconomic Status 10

2.4.4 Lifestyle Determinants 11

2.4.5 Physical Activity 11

2.4.6 Obesity 12

2.4.7 Smoking 13

2.4.8 Alcohol Intake 13

2.4.9 Nutrition 14

2.5 Multimorbidity and Mortality 15

2.6 Multimorbidity and Length of Hospital Stay 16

CHAPTER THREE 18

3.1 Study Area 18
3.2 Study Design 18
3.3 Study Population 18
3.4 Inclusion Criteria 18
3.6 Sample Size 19
3.7 Study Variables 19
3.7.1 Dependent Variables 19
3.7.2 Independent Variables 19
3.8 Description of Variables 20
3.9 Data Management and Analysis 21
3.10 The statistical model approaches adopted/ utilized in the study are described below 22
3.10.1 Poisson Model 22
3.10.2 Cox Regression 24
3.11 Ethical Consideration 27
CHAPTER FOUR 28
4.0 Sociodemographic and Medical characteristics of in-patient's admission at CTAGC, January 2013 – December 2017 28
4.1 Pattern of multimorbidity among elderly inpatients at the CTAGC, UCH, Ibadan. 29
4.2 Pattern of Length of stay of inpatients admission at CTAGC, January 2013 – December 2017 41
4.3: Disease pattern of inpatients admission at CTAGC, January 2013 – December 2017
4.4: Independent sample t-test comparing the result of clinical investigations between elderly with multimorbidity and those without multimorbidity ..... 36_Toc64883716
4.5: Collinearity Check of Variables 39
4.6: Poisson regression showing predictors of multimorbidity among elderly inpatients. 40
4.7: Cox Proportional Hazards Regression showing predictors of mortality among elderly in-patients at the Chief Tony Anenih Geriatric Centre, Ibadan 42
CHAPTER FIVE 44
5.0 DISCUSSION, RECOMMENDATION AND CONCLUSION 44
5.1.1 Discussion 44
5.1.2 Pattern of Multimorbidity 44
5.1.3 Predictors of Multimorbidity 45
5.1.4 Predictors of Mortality 46
5.2 Conclusion 48
5.3 Recommendations 48

LIST OF FIGURES

Figure 4.0 Pattern of multimorbidity among elderly inpatient at the CTAGC, UCH. Ibadan..... 31

Figure 4.1. Pattern of length of stay of inpatient admission at the CTAGC, UCH. Ibadan..…... 33

Figure 4.2. Disease pattern of inpatient admission at the CTAGC, UCH. Ibadan..... 35

LIST OF TABLES

Table 3.1 Description of Variables …… 20

Table 4.1 Sociodemographic and Medical characteristics of in-patient's admission at CTAGC, January 2013 – December 2017……...29

Table 4.2: Independent sample t-test comparing the result of clinical investigations between elderly with multimorbidity and those without multimorbidity..... 37

Table 4.3 Collinearity Check of Variables 39

Table 4.4 Poisson regression showing relationship between length of stay and multimorbidity among elderly inpatients…..... 41

Table 4.5Cox Proportional Hazards Regression showing predictors of mortality among elderly in-patients at the CTAGC, Ibadan..... 43

ABSTRACT

Background of study

Multimorbidity among the elderly population has been reported to account for poor quality of life and an increased risk of mortality and hospital admissions in various studies. However, there's a paucity of available literature on the effects of length of stay on multimorbidity and mortality in the elderly population in Nigeria. This study therefore examined the prevalence, patterns, and effects of length of stay on multimorbidity and mortality amidst other variables among the elderly.

Methods

A retrospective analysis of the inpatient data at the Chief Tony Anenih Geriatric Centre of the University College Hospital, Nigeria, from 2013-2017 was conducted. The outcome variables were multimorbidity and hospital outcome (dead or alive). Patients that were "discharged, transferred out and discharged against medical advice (DAMA) were categorised as "alive" while patients that died during the period were categorised as "dead". The primary exposure was length of hospital stay while the covariates were age, sex, family type, religion, tribe, occupation, marital status, alcohol consumption, body mass index and hospital investigations. Poisson regression analysis was used to model the relationship between multimorbidity and length of stay amidst other covariates while Cox regression was used to determine the association between Multimorbidity and Mortality using length of stay as time (T) amidst other covariates listed above. Descriptive statistics, IRR/HR and 95% CI were presented.

Results

A total of 1091 patients' records were reviewed. The mean age was 73.6±8.63 years. The prevalence of multimorbidity was 68%; 46.5% of multimorbid patients had two comorbidities while 5.9% had more than four comorbidities.

The poisson regression showed that patients age 85 years and above had 26% increased risk of multimorbidity compared to patients within the age group 60-64 years (IRR=1.26, 95%CI= 1.07,1.47). There was an increase in risk of multimorbidity with length of stay. Patients that stayed for more the ten days on bed had a greater risk (35.2%) of multimorbidity compared to patients that spent less than three days (IRR = 1.35, 95% CI: 1.02, 1.80).

Results from the cox regression shows that multimorbidity also affect mortality, as morbid patients are 15.7% more likely to die during admission compared to non-morbid patients (HR=1.16, 95% CI: 1.01-1.33)

Conclusion

Our findings showed a notable high prevalence of multimorbidity among elderly patients at the Chief Tony Anenih. Geriatric Centre. Multimorbidity was associated with mortality, and was influenced by length of hospital stay. This calls for holistic management of the elderly, with a focus on improving the quality of care by promoting home care treatment

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Elderly people constitute the fastest growing population group in the world, with an apprehensive increase in developing countries (Tanyi *et al*., 2018). Those aged 65 years and above (the elderly) make up 3.1% or 5.9 million of the total population of 191 million, which in crude numbers represents an increase of 600,000 during the 5-year period 2012–2017 (Population Reference Bureau, 2012). Like other countries in the world, Nigeria is facing a growing burden of chronic diseases and the prevalence of multi-morbidity and implications for the healthcare system, research and medical education have been little researched. The elderly usually suffers from multiple health conditions. Clausen *et al* (2000) found an average of 5.2 health problems per elderly person living in Mmankgodi village, Botswana. Other characteristics of the morbidity pattern amongst the elderly are the presence of co-morbidities, non-specific presentation of diseases, impaired drug metabolism and deranged social factors (Clausen et al., 2000). Multi-morbidity becomes progressively more frequent with age (Akker *et al*, 1998; Salisbury et al., 2011) and is associated with high mortality, reduced functional status, and increased use of both inpatient and ambulatory health care (Salisbury *et al*., 2011).

Multimorbidity according to the World Health Organisation means to be affected by two or more chronic health conditions/diseases in the same individual simultaneously (WHO, 2016), and this has become more frequent among the elderly. Multi-morbidity has become a public health concern in terms of its prevalence, severity and possibility of control (Dias & Victoria, 2006). The prevalence of multimorbidity among older adults is high (>55%) (Abdulraheem *et al*., 2017). The consequences of multimorbidity include a higher risk of death and functional decline (Gijsen, *et al.* 2001) as well as a negative impact on the quality of life and life expectancy (Fortin *et al*., 2004). Studies have also shown that people with higher levels of

multimorbidity are more likely to be recommended higher numbers of medications, thereby placing them at higher risk of disease to disease and disease to drug interactions, with increased hospitalization (Dumbreck *et al*., 2015; Gallacher et al., 2014; Guthrie, Makubate, Hernandez-santiago, & Dreischulte, 2015).

In Nigeria, studies about multi-morbidity are scarce. Although multi-morbidity is possible to control, but an adequate approach to its management is a challenge for health systems and services worldwide (Salisbury, 2012).

1.2 Statement of the Problem

At present, geriatrics has not been fully established as a specialty in Nigeria and there is little information about the multi-morbidity pattern of the elderly to form the basis of any meaningful plan of action to improve the quality of life of this group of the population (Adebusoye *et al*., 2011). Multimorbidity accounts for poor physical function, impairment in quality of life, higher mortality, increased medical cost and health care utilization (Gijsen, *et al*. 2001; Glynn L.G, *et al*. 2011) among others.

Despite the increasing prevalence of multimorbidity, clinical guidelines for managing the health of multimorbid patients in many countries are usually built around single diseases (Fortin, *et al*. 2005). Also, length of hospitalization and in-patient deaths are on the rise with increasing multimorbidity among elderly patients (Andrea *et al*, 2016). Although, a number of studies have examined the distribution of multimorbidity among older persons in developed nations (Gijsen *et al*., 2001), there is still limited literature on multimorbidity among the elderly people in developing countries (Khanam *et. al*, 2011). Hence, this study aims to determine the correlate of multimorbidity and mortality among patients at the Geriatric Centre, University College Hospital, Ibadan.

1.3 Justification of the study

Identification of the patterns of multimorbidity would enhance a better understanding of how some chronic diseases occur together. The study will also provide knowledge about the healthcare needs that are associated with different patterns of multimorbidity. It is hoped that the results from this study will aid improved health outcomes of patients with multimorbidity.

1.4 Research Questions

1. What is the hospital-based prevalence of multimorbidity among elderly patients at the Geriatric Centre, UCH, Ibadan?

2. What are the differences between clinical investigations of elderly patients with multimorbidity and those without multimorbidity?

3. What are the predictors of multimorbidity among elderly patients at the Geriatric Centre, UCH, Ibadan?

4. What are the predictors of mortality among elderly patients at the Geriatric Centre, UCH, Ibadan?

1.5 General Objective

To determine correlate of multimorbidity and mortality among patients at the Geriatric Centre, UCH, Ibadan.

1.5.1 Specific Objectives

1. To determine the hospital-based prevalence of multimorbidity among elderly patients at the Geriatric Centre, UCH, Ibadan.

2. To compare the clinical investigations between elderly with multimorbidity and those without multimorbidity.

3. To determine the predictors of multimorbidity among patients at the Geriatric Centre, UCH, Ibadan.

4. To determine the predictors of mortality among patients at the Geriatric Centre, UCH, Ibadan.

CHAPTER TWO

LITERATURE REVIEW

This review provides an overview of the literature on multimorbidity and mortality which is limited to hospital-based outcomes as well as covariates and conditions impacting on multimorbidity among the elderly.

The bulk of this review stems from studies in past decades. However, due to the massive body of knowledge on multimorbidity research, articles reviewed are not exhaustive but the scope of this review are built around the objectives of the study.

2.1 Multimorbidity

Multimorbidity affects people of all ages, and has negative impacts on patients, carers, healthcare providers, and healthcare systems. However, it is mostly linked with aging. It is estimated that in developed countries, about 1 in 4adults experience multimorbidity, with half of older adults having 3 or more chronic conditions (Fortin *et al*., 2006). Multimorbidity impacts negatively on individuals and the health system as a whole. It is associated with increased mortality, poor quality of life and an increased demand on healthcare utilization, all of which place a strain on healthcare resources (Aarts *et al*., 2012; Glynn *et al.,* 2011).

A disease is classified as chronic if it is permanent, is caused by a nonreversible pathological alteration, and requires rehabilitation or a long period of care (Marengoni *et al.,* 2009). Some of the most prevalent chronic diseases common among the elderly are Hip Fracture, Diabetes Mellitus, Malignancy, Chronic Obstructive Pulmonary Disease, Deafness, Thyroid dysfunctions, Cerebrovascular disease, Depression, Atrial Fibrillation, Anemia, Visual Impairments, Coronary Heart Disease, Congestive Cardiac Failure, Dementia, and Hypertension.

The increased burden of non-communicable diseases in sub- Saharan Africa has potential implications on the health system and resource allocation (Nugent, 2008). Managing multimorbidity is thus very important. There is however, an increasing difficulty in doing so due to the absence of adequate information to influence priority setting and decision making. Hence, the need to understand the root causes of disease and to provide evidence of the factors affecting both single chronic diseases and multimorbidity (Taiwo, 2017).

2.2 Prevalence of Multimorbidity

Although it is difficult to reach an agreement on the prevalence of multimorbidity, some systematic reviews have reported several prevalence estimates. A systematic review of 39 observational studies across 12 countries reported estimates ranging between 13% and 95% (Fortin *et al.,* 2012), while another systematic review reported similarly variable estimates, with prevalence estimates in the general population ranging from 13% to 72% (Maiyaki and Garbati, 2014). A study by TaiwoSogunle (2017) showed a multimorbidity prevalence rate of 56% in the study population, with hypertension, diabetes mellitus and arthritis featuring as the most frequent pattern of multimorbidity. Low education, low income, older age, excess weight, physical inactivity and cigarette smoking increased the risk of developing multimorbidity in the study (Oni & Unwin, 2015).

The increase in the prevalence of multimorbidity in Low and Middle-Income Counties (LMICs) can be attributed to a demographic shift to older ages, a rise in the prevalence of NCDs adding to the well-known burden of infectious diseases, changing lifestyle and cultural behaviors, changing environmental exposures and urbanisation, and healthcare-related advances [UNGA, 2011; Salisbury *et al.,* 2011). As such changes progress further in LMICs, the scale of the problem of multimorbidity seems likely to increase.

Findings from studies that examined the prevalence of multimorbidity in older populations (those over 65 years of age) have observed a strong relationship between multimorbidity and increasing age (Garin *et al,* 2015; Academy of Medical Sciences, 2018). This poses a significant concern as this may suggest an increase in age-specific death rate among this population.

2.3 Pattern of Multimorbidity

Multimorbidity includes a combination of chronic conditions, but there is evidence that certain conditions are more likely to cluster than others. These clusters can be either concordant or discordant in nature. In defining the relationship between component conditions, co-existing diagnoses that are similar in their origin or that can be addressed by similar treatment plans are described as being 'concordant' (for example, coronary heart disease and cerebrovascular disease). Conversely, 'discordant' multimorbidity has been used to describe co-existing conditions that appear to be unrelated from each other and require different management approaches (for example, type 2 diabetes and chronic obstructive pulmonary disease (COPD) (Kone *et al*, 2015)

Multimorbidity manifests differently across individuals, as exhibited by the many different clusters of co-occurring conditions. The clusters can range from two conditions occurring together to over five conditions occurring together. An example of co-occurring cluster of two conditions is Diabetes and Hypertension. An example of a cluster of three chronic conditions is Diabetes, Hypertension, and Arthritis. While a cluster of five conditions can be chronic heart failure, chronic coronary syndrome, diabetes, hypertension and arthritis (Angela et al, 2019).

Similarly, mental health conditions can be concordant with physical health conditions. For instance, some clusters of conditions such as depression, anxiety disorders and schizophrenia can be grouped as concordant with some non-communicable diseases such as cardiovascular diseases, lung and liver diseases, diabetes and cancer on the basis of shared common

aetiological factors (.i.e., genetic and environmental risk factors) such as childhood adversities, stressful life events and tobacco use (Khanam *et al*., 2011).

2.4 Determinants of Multimorbidity

A distinct association between increasing age and higher rates of multimorbidity has been established in different populations across range of countries and contexts. It has also been shown that multimorbidity is more common and occurs earlier in those who are more socioeconomically deprived (Hall *et al*., 2018).

Multimorbidity is heterogenous, however, some efforts have been made to explore associations between multimorbidity and risk factors known to contribute to multimorbidity. This review will look at a number of determinants such as sex, ethnicity, socioeconomic status, smoking and alcohol use, physical activity, obesity, and nutrition.

2.4.1 Sex as a Determinant of Multimorbidity

Some studies have reported a sex disparity in the prevalence of multimorbidity, with reports from both High-Income Countries (HICs) and LMICs indicating that multimorbidity is more common in women (Garin *et al.,* 2015; Agrawal & Agrawal, 2016; Ahmadi *et al.,* 2016; Arokiasamy *et al.,* 2016; Olivaire *et al.,* 2017; Thompson *et al*., 2016). Some studies have however reported some disparities in findings. For example, in a systematic review of observational studies carried out across Europe, the United States, Canada, and Australia, it can be recounted that the prevalence of multimorbidity was way higher in women in nine studies, but was not significantly high in five other studies (Fortin *et al*., 2012).

We may not be able to ascertain the reason for these distinct disparities. It is also not explicitly defined if sex is proportionate to the likelihood of multimorbidity or if divergent findings rather reflect the inability of some studies to modify for age and other confounding factors, insufficient statistical power to identify differences, or the inclusion of distinctive numbers of

sex-specific conditions in each study. But it may be considered that, instead of sex essentially acting as a risk factor for multimorbidity at the biological level, it serves as a context-dependent substitute for other social and behavioural factors that impacts on the risk and detection of multimorbidity.

For instance, higher prevalence of seeking care displayed by women in some countries may indicate that they are more likely to have a condition diagnosed than men, or in certain settings, unfavourable effects of poverty and income inequality experienced by women may predispose them to regular cases of multimorbidity than men (Glynn *et al.,* 2011; Shiwaku *et al,* 2004).

2.4.2 Ethnicity

Studies have been carried out to determine if there is a relationship between ethnicity and multimorbidity. However, disparities in study population, the methodology and appellations used to describe ethnicity have made it difficult to combine results from research findings (Kone *et al.,* 2015). The following instances emphasize the complication of combining research in this area.

In terms of body mass index (BMI), the population of South Asia tend to have a higher body fat proportion than other ethnicities. This makes them more susceptible to developing abdominal obesity, which is associated with several NCDs (Kone *et al.,* 2015; Diaz *et al.,* 2015). It is therefore possible to derive an association between ethnicity and multimorbidity due to a cluster of NCDs since it has been discovered that ethnicity has a tendency of reducing resistance to certain chronic conditions.

However, many of the studies reporting an association between ethnicity and multimorbidity have investigated different ethnic groups within a single country or geographically defined population. Ethnicity, similar to sex, could thus be serving as a context-specific substitute for other psycho-socioeconomic factors such as social deprivation, or even migrant status which

has been the concentration of a few studies (Lenzi *et al.,* 2016; Academy of Medical Sciences, 2016). At an evidence-gathering workshop held in South Africa, it was remarked that beyond Southern and Sub-Saharan Africa there is a great population of immigrants who have a higher risk of multimorbidity and experience barriers to care, resulting in a higher burden of disease (Schafer *et al.,* 2012).

2.4.3 Socioeconomic Status

Some studies have shown that lower socioeconomic status is associated with an increased prevalence of multimorbidity (Barnett *et al.,* 2012; Hall *et al.,* 2018; Garin *et al.,* 2015; Agborsangaya, 2012; Warburton, 2006). Worthy of note is a cross-sectional study of a primary care population in Scotland where it was discovered that the onset of multimorbidity happened 10 to 15 years earlier among those living in the most deprived areas in comparison with those living in the most affluent areas. Also, the rate of multimorbidity, including mental health conditions, was about two times higher in the most deprived areas compared with the most affluent areas (Hall *et al.,* 2018).

Circumstances in which multimorbidity is more prevalent among those of lower socioeconomic status may arise due to the negative influence of a number of factors which are often more commonly experienced by those of lower socioeconomic status. These situations make them more prone to chronic conditions. Examples are increased rates of smoking, poor diet, psychosocial issues including increased levels of stress and poor sleep, and reduced health literacy (Kone *et al.,* 2015).

However, it is also possible to discover a high prevalence of multimorbidity among those of higher socioeconomic status, particularly those in LMICs. A way to explain this is that those in the higher income class have access to high-calorie foods, tobacco, alcohol, and other lifestyle factors that add to multiple chronic conditions. An association between multimorbidity and high socioeconomic status may also imply that individuals with higher incomes have better

access to healthcare and are more likely to get a disease diagnosis. They may also have higher survival rates from acute infections and accidents which may result in them being more likely to develop multiple chronic conditions associated with ageing (Kone *et al.,* 2015).

2.4.4 Lifestyle Determinants

A number of studies have investigated the association between lifestyle factors and the occurrence of multiple chronic conditions (multimorbidity). Some of the lifestyle factors are; physical activity in elderly patients, obesity, smoking, alcohol consumption, and nutrition (Taiwo, 2017).

2.4.5 Physical Activity

Physical inactivity has been repeatedly reported in literature as a (modifiable) prime culprit in the risk of developing obesity, hypertension, heart diseases, diabetes, cancers, and ultimately sudden death. A study by Autenrieth *et al.* in 2013, showed an inverse relationship between physical activity and multiple morbidities among the aged population (above 65 years). The likelihood of developing these diseases in physically inactive people, have been found by studies to almost double that of physically active persons (Vancampfort *et al.,* 2017).

A holistic approach to defining being physically fit, would encompass key health indicators, which include cardiopulmonary function, the degree of efficiency of the body's musculosketal framework, as well as its homeostatic and metabolic mechanisms. These factors determine the physiological status of being able to optimally perform activities of daily living.

Health professionals, more particularly physical fitness experts, have increased advocacy for an average calorie exertion of about 100kcal (4200kJ) daily, citing an associated benefit of up to one-thirds slash in current mortality rates (Vancampfort *et al.,* 2017). The elderly population would only need about half of that to sustain physical fitness and wellbeing (Autenrieth *et al.,* 2013).

The enormous benefits of Physical exercise include but not limited to: reduced risks of metabolic syndrome, as it makes for good blood pressure and glucose control, with a reduction in 'bad' cholesterol (LDL), and concomitant increase in 'good' cholesterol (HDL) levels. Physical exertion has also been well noted to bring about a reduction in hip and waist circumferences down to normal limits, improve vagal tone, as well as ridding the body system of free radicals and toxic inflammatory mediators. It also helps efficient blood distribution via a positive modulation of the cardiopulmonary and hematological mechanisms.

A cross sectional study in some selected countries of the developing world, with a twin burden of diseases (Infectious diseases and NCDs), showed a significant increase in risk of non-communicable diseases (NCDs) at suboptimal levels of physical activity {(less than the minimal 30 minutes of intense aerobic activity (like brisk walking in at least 4-5 days of the week)}. It was however noted that a significant proportion of this association was mediated by these patients with co-existing morbidities reporting depression, mobility difficulties, pain, and sleep issues (Booth, Prevost &Gulliford, 2014)

2.4.6 Obesity

Studies have shown that an increase in the category of Body Mass Index (BMI) and obesity have an association with multimorbidity. A study by Taiwo (2017) showed that 32% of multimorbidity was ascribable to overweight and obesity (Oni &Urwin, 2015). Some studies have asserted that overweight/obesity have an association with twice the risk of developing multi-morbidity in comparison with normal weight (Warbuton, 2006; Machado *et al.,* 2013; Fortin *et al.,* 2014). Another study has indicated that BMI was the only lifestyle factor associated with a likelihood of multimorbidity in both sexes (Agborsangaya *et al.,* 2015).

Due to the associations between Body Mass Index and multimorbidity, some studies are of the opinion that, if much emphasis is placed on maintaining a healthy weight, or encouraging

weight loss, this may go a long way in reducing the risk of multimorbidity. A particular study has shown that loss of weight in individuals who are severely obese at the beginning may lead to a reduction in the number of chronic conditions suffered from, hence, a reduction in the 'severity' of multimorbidity (Lim *et al.,* 2007).

2.4.7 Smoking

Chronic smokers have been shown to be three times more likely to develop multiple organ-system diseases than the non-smoking population. (Agborsangaya *et al.,* 2015; WHO mpower, 2008).

Most cigarette smokers will sometime in their lifetime, develop debilitating chronic physical and metabolic disorders, such as arteriosclerosis, hypertension, coronary artery disease, stroke, cancers, and diseases of the airway like COPD (WHO mpower, 2008).

A smoker habitually smokes tobacco, daily. The health effects of less – than – daily smoking are far less understood. Studies often take the category of occasional smokers and group them with never smoked (WHO mpower, 2008). A puff of cigarette smoke contains up to 45 carcinogenic materials that bind to, and mutate the DNA (Fowles&Dybing, 2003). Addiction and dependence on cigarettes have been found to be due to the psychoactive substance 'nicotine' present in tobacco (WHO mpower, 2008).

2.4.8 Alcohol Intake

Alcohol, in moderate portions has been proved by research to have positive effects on heath, most especially on the heart (Ronksley *et al.,* 2011). Heavy consumers of alcoholic beverages have been shown to have increased risks of up to 13% of developing co-existing diseases (Ronksley *et al.,* 2011). The deleterious effects cut across all major organ-systems, with resultant morbidities and mortality from the affected systems.

Cardiovascular complications of heavy alcohol intake include: Arrythmias, stroke, increased risk of heart failure and eventually cardiomyopathy, which is the final common pathway of all cardiac diseases (Taylor, Rehm&Gmel, 2005). Toxic levels of alcohol in the body have also been associated with some often-fatal diseases of the gastrointestinal system, such as alcoholic fatty liver disease, liver cirrhosis, and pancreatitis (Cargiulo, 2007). Oesophageal cancer, Breast cancer, Hepatic cancer, and many others have increasingly been associated with history of heavy alcohol consumption (Tolstrup *et al,* 2006).

Alcohol abuse has been repeatedly reported in literature to cause depression of the central nervous system, resulting in psychosis, as well as pathologies of the peripheral nervous system (Boeing *et al.,* 2012). Safe limits of alcohol consumption stand at a maximum of 21 drinks (140-210g), and 14 drinks (84-140g) for men and women respectively, in a week for most countries.

2.4.9 Nutrition

Recent advances in scientific research have been a washed with abundant evidence to suggest that consumption of fruits and vegetables are major determinants in the prevention of atherosclerosis, cancers, metabolic syndrome, cataract, and immune-mediated diseases like rheumatoid arthritis and asthma (Hall *et al.,* 2009). Creating more awareness on the increasing importance of adequate consumption of fruits and vegetables as a sure means of optimizing nutrition among the general populace will go a long way in cutting down disease risk, and maximizing good health.

A most recent study corroborates this with thorough scientific evidence that suggests a positive association between nutrition and evolution with co-existing morbidities (Mello, Engstrom&Alves, 2014). It went further to prove that increased consumption of fruits, vegetable and whole grain products seemed to reduce the risk of onset of multiple non-communicable diseases to less than 50%.

2.5 Multimorbidity and Mortality

Multimorbidity is one of the major determining factors for disability, frailty and poor quality of life (Fortin et al., 2004; Marengoni *et al,* 2011; Journal of American Geriatrics, 2012). This gives rise to a number of pathophysiological, social and health care events which raise the risk of death. Multimorbidity has been reported to increase the risk of complications and effects on the physiological system due to interactions between morbidities and disease treatment (Garin et al., 2015; Journal of American Geriatric, 2012; Nunes *et al.,* 2016).

Multiple factors can influence or determine the incidence of mortality in the elderly. They include environmental factors, demographic factors, socio-economic factors, geriatric conditions, the influence of social relationships, and the health actions taken (Landi *et al.,* 2007). Despite this, studies have reported a higher risk of death among elderly people with multimorbidity (regardless of its mode of operationalization) in comparison with those without diseases (Landi *et al.,* 2007; Marengoni *et al.,* 2009; Schafer *et al.,* 2014).

Also, it has been found that the co-occurrence of multimorbidity with disabilities, especially physical disabilities, can raise the expected effect of mortality (Marengoni *et al.,* 2009; Schafer et al., 2014). For example, a study by Marengoni *et al.* (2009) reported the risk of death to be 7.7 (95% CI: 4.7; 12.6) times higher for elderly adults who had a combination of multimorbidity and physical disability and made a comparison with elderly adults with multimorbidity but without disability. The risk of death for the latter group was found to have decreased to 2.5 (95%CI: 1.6; 3.8) (Schafer *et al.,* 2014).

Furthermore, the rate of mortality differs with the combination of diagnosis. Some of the common combinations among the elderly can be, hypertension and osteoarthritis combination, metabolic and cardiovascular combination (e.g. Diabetes and CCF), or musculoskeletal, metabolic and cardiovascular combination (e.g lower back pain, diabetes, and hypertension) (Willadsen *et al.,* 2018). A study by Willadsen et al. (2018) found that mortality increased with

the number of diagnosis groups. It was reported that the combination of musculoskeletal, endocrine, mental, neurological, and cardiovascular had a 70 times higher mortality when compared with people who did not belong to any of the diagnosis groups. Another example is the largest study on the impact of multimorbidity on mortality which was carried out among 413,000 patients admitted in hospitals in the UK and diagnosed with acute myocardial infarction between 2003 and 2013: patients with one additional condition were 32%more likely to die, while those with two or more additional conditions were twice as likely to die compared to those without multimorbidity (Voilan *et al.,* 2014).

2.6 Multimorbidity and Length of Hospital Stay

A few researches have been carried out to investigate the relationship between multimorbidity and length of stay. A study carried out by Siddiqui et al. reported that patients who were hospitalized with chronic medical conditions such as diabetes, ischemic heart disease (IHD), stroke, Chronic Obstructive Pulmonary Disease (COPD), and a comorbidity of mental illness experienced a longer length of stay (LOS) than those without a comorbidity of mental illness (Siddiqui *et al.,* 2018). This indicates a poor outcome for both the patients with the chronic conditions and the health system caring for them. Longer length of stay signifies a compromise to the quality of life and care experience of patients with chronic health conditions. It also reflects inefficiencies within the health system (Gruneir, 2016).

In a population-based study of nearly six million adults with at least one of 16 chronic conditions by Andrea *et al.,* (2016), they observed a high prevalence of multimorbidity was strongly associated with hospitalization. Their findings all suggested that hospitalizations also become more complicated with increasing multimorbidity as revealed with increase in the length of hospital stay, increased frequency of non-medical discharge delays and in-hospital death, high possibility of multiple hospitalizations, as well as 30-day readmissions (Gruneir, 2016).

Some literatures have established that the prevalence of multimorbidity increases with age, hence the focus on older adults (Academy of Medical Sciences, 2016; Journal of American Paediatric, 2012; Marengoni *et al*, 2009). However, the impact of gender on the relationship between multimorbidity and hospitalization have not been consistent. A study reported that men were more likely to be affected by multimorbidity when it came to hospitalization but women were more likely to be affected by multimorbidity with regards to other outcomes such as social differences, income, living arrangements, and access to informal caregivers, which tend to put them, especially older women, at higher risk of requiring supportive care services (Gruneir *et al.,* 2013).

CHAPTER THREE

METHODOLOGY

3.1 Study Area

This study was carried out at the in-patient unit of Chief Tony Anenih Geriatric Centre (CTAGC) of the University College Hospital (UCH), Ibadan. CTAGC is a purpose-built centre which was established on November 17, 2012 but commenced action on the 13th of December, 2012. The centre is made up of four buildings purposely designed to give holistic and compassionate care to elderly patients. These buildings are; (1) Outpatient building- this has the pay points, a large reception/waiting area, nurses' station, health record station, pharmacy, laboratory and four consulting rooms. (2) Theatre building- this has 2 ultra-modern theatre suites for general and specialty surgeries. (3) Inpatient building- this has six rooms with a total of nine beds to admit elderly patients needing acute medical care. (4) Administrative and rehabilitative building- this houses the physiotherapy unit, dietetics unit, a kitchen, seminar room, laundry and offices. It is the pioneer geriatric centre in Nigeria

Chief Tony Anenih geriatric centre has registered more than 17,000 patients since inception and about 1500 patients have been hospitalized in the Centre as at end of June 2019.

3.2 Study Design

A retrospective analysis of secondary data was conducted.

3.3 Study Population

This study includes male and female patients who have ever been admitted to the Centre since 2013-2017.

3.4 Inclusion Criteria

All records of elderly patients admitted during 2013-2017 in the Centre.

3.5 Exclusion Criteria

Patients records without Hospital outcomes (such as discharged, DAMA, transfer out and death), Length of stay and Diagnosis was excluded from the study.

3.6 Sample Size

About 1200 patients were registered from 2013-2017 but 1091 records were available for retrieval and was used for this study.

3.7 Study Variables

The study variables used in the study;

3.7.1 Dependent Variables

Multimorbidity of patients which is a count variable and Mortality among hospitalized patients which is a dichotomous variable were specified as the dependent variables for this study. Multimorbidity was defined as the number of chronic diseases and Mortality as classified as either the patient is alive or dead.

3.7.2 Independent Variables

The choice of explanatory variables was based on literature and available data which consists of age, sex, family type, occupation, length of stay, marital status, anthropometric measure such as weight and height, vital signs such as blood pressure, pulse rate, temperature and heart rate hospital investigations such as full blood count, lipid profile function and test for kidney functions were considered.

3.8 Description of Variables

Table 3.1. Description of Variables

Variables		Description
Dependent variable		
1.	Multimorbidity	Number of chronic morbidities (count)
2.	Mortality	1= Dead, 0=Alive
Independent variables		
1.	Tribe	1 = Hausa, 2 = Igbo, 3 = Yoruba, 4= Others
2.	Sex	1= Male, 2=Female
3.	Family Type	1= Monogamy, 2= Polygamy
4.	Drink alcohol	1 = Yes, 2 = No
5.	Religion	1 = Christianity, 2 = Muslim, 3 = Traditional
6.	Length of stay	Date of hospital outcome-Date of admission
7.	Occupation	1 = Retired, 2 = Not retired
8.	Age	1 = 60-64, 2 = 65-69, 3 = 70-74, 4 = 75-79, 5 = 80-84, 6= >= 85
9.	Marital status	1= Married, 2= Not married
10.	Investigations	Vital signs. Anthropometric measures, Lipid profiles, E&U creatinine
11.	Body mass index	1= Underweight, 2= Normal, 3= Overweight, 4= Obesity

3.9 Data Management and Analysis

Relevant data was extracted from patients' case notes and was inputted into IBM SPSS (version 25). Which was used for data cleaning and transformation. Categorical data were summarized with frequency tables and percentages. Means and Standard Deviations (SD) were used for continuous data which is normally distributed data and median and inter-quartile range was presented for skewed data.

Multicollinearity test of variables was checked, a variance inflated factor (VIF) greater than 4 was used as cut-off to indicate collinearity in a variable. Pearson dispersion statistics (Chi-square) greater than 1.0 indicates over dispersion and a value less than 1.0 suggest under dispersion. The mean and variance of the dependent variable (Multimorbidity) was the same which suggest a poison regression model fit.

Independent sample t-test was used to compare the clinical investigations between elderly with multimorbidity and those without multimorbidity.

Poisson regression was used to model the predictors of multimorbidity while controlling for the effect of other factors such as length of stay, age, sex, family type, alcohol consumption, religion, occupation, tribe, marital status and body mass index among elderly patients.

Cox proportional hazards models were fitted to investigate the relationship between mortality and multimorbidity while accounting for the effect of other factors such as sociodemographic lifestyle and clinical parameters among elderly in-patients. Four sets of hierarchical models were fitted. The first set were univariate models (model 0), in which the independent variables were included one at a time. Second (model 1) all sociodemographic characteristics were entered into the model to the relative importance of each of them. In the third model (model 2), clinical parameters were entered into the model. The full model (model 3) includes all the independent variables.

3.10 The statistical model approaches adopted/ utilized in the study are described below

3.10.1 Poisson Model

The Poisson and the negative binomial model belong to a class of Generalized Linear Models (GLIMs). In these models, the independent variables need not to be normally distributed, but typically assumes to follow an exponential family distribution (e.g. Binomial, Normal, and Poisson). Generalized Liner Models do not assume a linear relationship between the dependent variable but it does assume linear relationship between the independent variables through a link function. Errors need not to be normally distributed but independent, the homogeneity of variance assumption in the case of linear regression models may not be satisfied; thus allowing for over-dispersion. Contrary to Linear regression model, which uses the Least Square to estimate parameters, General Linear Models use the method of Maximum Likelihood Estimation (MLE) to estimate the parameters and thus relies on large sample approximations.

The most common technique employed to model count data is Poisson regression, so named because the error process is assumed to follow the Poisson distribution. The Poisson distribution describes the number of events that occur in a given time period where its mean μ is the average number of events per period. It has the unusual feature that its mean equals its variance. Its probability density function is

$$\Pr(Y = y) = \frac{e^{-\mu}\mu^{y}}{y!}, y = 0,1,2, \ldots \qquad (3.1)$$

Where e is the natural logarithm and y! is the factorial of y.

μ is the intensity or rate parameter; the first two moments about the central is equal to its rate parameter, that is:

$$E(Y) = V(Y) = \mu \tag{3.2}$$

The Poisson regression model is derived from Poisson distribution by the use of the exponential means parameterizing the relation in which the conditional mean of observation *i*depends on a number of covariates,

$$\mu_{i=\exp(x'_i\beta)} \;; i=1,2,\ldots,N \tag{3.3}$$

By introducing the observation subscript $_i$, attached to both y and μ, the framework extended to non-identically independently distributed data, by assumption there are k linearly independent covariates, usually including a constant. Hence $V(y_i/x_i) = \exp(x'_i\beta)$,by property (3.2). The Poisson regression is intrinsically heteroskedastic.

This model may be estimated by maximum likelihood (ML), where the parameter estimates are the solutions to the first order conditions.

$$\sum_{i=1}^{N}(yi - \exp(x'_i\beta)\, x_i = 0 \tag{3.4}$$

If x_i include a constant term then the residuals $yi - \exp(x'_i\beta)$ sum to zero by (3.4).

$$lnL(\beta) = \sum_{i=1}^{N}\{yix'_i\beta - \exp(x'_i\beta) - lny_i!\} \tag{3.5}$$

The loglikelihood function is globally concave; the estimation converges rapidly and yields unique parameters estimates. By standard maximum likelihood theory of correctly specified models, the estimator $\hat{\beta}_p$ is consistent for β and asymptotically normal with sample covariance matrix

$$V[\hat{\beta}_p] = (\sum_i^N \mu_i\, x_i x'_i)^{-1} \tag{3.6}$$

In the case where μ_i is of the exponential form (3.3). In practice an alternative more general form for the variance matric is estimated by the quasi-maximum likelihood estimation which

considers models that are even more partially parametric, such as incomplete specification of the conditional mean.

Assumptions of poisson regression

- The response variable is a count per unit of time or space , described by a Poisson distribution
- The observation must be independent of one another
- The mean of a Poisson random variable must be equal to its variance
- The log of the mean rate, log (), must be a linear function of x.

3.10.2 Cox Regression

Cox (proportional hazards) regression analysis models the relationship between a set of one or more covariates and the hazard rate. Survival data usually contain censored data and the distribution of survival times is often highly skewed.

Survival analysis refers to the analysis of elapsed time. The response variable is the time between a time origin and an end point. The end point is either the occurrence of the event of interest, referred to as a death or failure, or the end of the subject's participation in the study. These elapsed times have two properties that invalidate standard statistical techniques, such as t-tests, analysis of variance, and multiple regression. First of all, the time values are often positively skewed. Standard statistical techniques require that the data be normally distributed. Although this skewness could be corrected with a transformation, it is easier to adopt a more realistic data distribution. When analysing survival data, two functions are of fundamental interest the survivor function and the hazard function.

Survivorship function S(t)

In practice if there are no censored observations, the survivorship function is estimated as the probability that an individual surviving longer than t:

S(t) = number of patients surviving longer than t

Total number of patients

that is S(t)= Pr (t≥T)= 1- F(T)

but when censored observations are present, the numerator of this equation cannot always be determined and the relationship cannot be used.

Probability Density Function f (t)

Like any other continuous variable, T has probability density function **f (t)** defined as the **probability** of failure in a small interval per unit time**.** Thus

F (t) = lim P {an individual dying in the interval (t, t + Δt)}

Δ t →0 Δ

Properties of the density function

•f (t) is a **non-negative** function

f (t) ≥ 0 for all t ≥ 0

= 0 for t < 0 the area between the density curve and the t axis is equal to 1

Hazard function h (t)

h(t) is the probability that a subject experience the event of interest during a small interval given that the individual has survived up to the beginning of that interval.

An equivalent definition of h (t) is the limit of the probability that an individual fail in a very short interval t to t + ⍰t per unit time, given that the individual has survived to time t:

h(t) = lim P {an individual of age t fails in the time interval (t, t + Δt} ----------(1)

Δt → 0 Δt

h(t) can also be defined in terms of the cumulative distribution function F(t) and the probability density function f(t):h(t) = f(t)/{1-F(t)} ---------- (2)

h(t) is also known as the instantaneous failure rate or force of mortality or conditional mortality rate or age specific failure rate.

h(t) = number of patients dying in the interval beginning at time t

(number of patients surviving at t) (interval width)

= number of patients dying per unit time in the interval

number of patients surviving at t

The cumulative hazard function H(T)

This is the sum of the individual hazard rates from time zero to time T. the mathematical representation of cumulative hazard function H(T) is

$H(T)=\int h(t)\,dt$

Wald Test

In Cox regression, the Wald test is calculated in the same manner. The formula for the Wald statistic is

$\mathbf{Z_j = b_j / s_{bj}}$

where *sbj* is an estimate of the standard error of *bj* provided by the square root of the corresponding diagonal element of the covariance matrix, $V(\hat{\beta}) = I^{-1}$. With large sample sizes, the distribution of z_j is closely approximated by the normal distribution. With small and moderate sample sizes, the normal approximation is described as "adequate. "The Wald test is used to test the statistical significance of individual regression coefficients.

3.11 Ethical Consideration

This research used secondary data and thus there are no serious ethical concerns. All the personal identifiers have been removed from the data. As a result, the confidentiality and anonymity of the respondents was guaranteed. Also, approval for the study was obtained from the Director, Chief Tony Anenih Geriatric Centre, University College Hospital, Ibadan.

CHAPTER FOUR

RESULTS

4.0 Sociodemographic and Medical characteristics of in-patient's admission at CTAGC, January 2013 – December 2017

Table 1 below shows the frequency distribution of socio-demographic characteristics (age group, sex, family type, occupation, length of stay, mortality and alcohol consumption) of inpatients at CTAGC from January 2013 – December 2017.

The total number of inpatient admissions increased from 11.2% in 2013 to 28.8% at the end of 2017. The average age of patients admitted was 73years (SD=8.89) in 2013 and 74years (SD=9.00) in 2017. From 2013 - 2016, patients in the age group of 70-74years had the highest proportion of inpatient admissions, compared to in 2017, those in the age-group 67-69 years had the highest proportion. From 2013 - 2017, the female gender had the highest number of inpatient admissions. On average, more patients in monogamous relationships were admitted (72.5%) in CTAGC during the five-year period than patients in polygamous relationships. Furthermore, patients (58.3%) who were retired had the highest number of lengths of hospital stay over the years than patients who were working. On average, patients spent 2 (1-4) days on hospitalization. Mortality increased from 4.1% to 12.1% over the years (2013 to 2017).

Table 1: Sociodemographic and Medical characteristics of in-patient's admission at CTAGC, January 2013 – December 2017

	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)	Total n (%)
Total admissions, *N (%)*	122 (11.2)	154 (14.1)	218 (20.0)	283 (25.9)	314 (28.8)	1091 (100.0)
Age (Mean±SD)	73.02±8.89	71.88± 8.09	71.98± 7.95	74.50± 8.92	74.37 ± 9.00	73.58± 8.63
Age group (Years)						
60 – 64	22 (18.0)	30 (19.5)	41 (18.8)	44 (15.5)	43 (13.7)	180 (16.5)
65 – 69	20 (16.4)	34 (22.1)	41 (18.8)	39 (13.8)	65 (20.7)	199 (18.2)
70 – 74	35 (28.7)	35 (22.7)	60 (27.5)	66 (23.3)	59 (18.8)	255 (23.4)
75 – 79	17 (13.9)	26 (16.9)	33 (15.1)	48 (17.0)	47 (15.0)	171 (15.7)
80 – 84	12 (9.8)	16 (10.4)	28 (12.8)	46 (16.3)	59 (18.8)	161 (14.8)
≥ 85	16 (13.1)	13 (8.4)	15 (6.9)	40 (14.1)	41 (13.1)	125 (11.5)
Sex						
Male	54 (42.6)	71 (46.1)	89 (40.8)	120 (42.4)	136 (43.3)	468 (42.9)
Female	70 (57.4)	83 (53.9)	129 (59.2)	163 (57.6)	178 (56.7)	623 (57.1)
Types of family						
Monogamy	68 (55.7)	109 (70.8)	143 (65.6)	212 (74.9)	259 (82.5)	791 (72.5)
Polygamy	54 (44.3)	45 (29.2)	75 (34.4)	71 (25.9)	55 (17.5)	300 (27.5)
Occupational status						
Still working	63 (51.6)	68 (44.2)	122 (56.0)	98 (34.6)	104 (33.1)	455 (41.7)
Retired	59 (48.4)	86 (55.8)	96 (44.0)	185 (65.4)	210 (66.9)	636 (58.3)
Length of stay *Median (IQR)*	1 (0 – 3)	0 (0 – 1)	1 (0 – 3)	3 (1 – 5)	4 (2 – 5)	2 (1 – 4)
Deaths on admission	5 (4.1)	7 (4.5)	13 (6.0)	35 (12.4)	38 (12.1)	98 (9.0)
Alcohol consumption						
Yes	8 (6.6)	12 (7.8)	11 (5.0)	14 (4.9)	10 (3.2)	55 (5.0)
No	113 (93.4)	142 (92.2)	207 (95.0)	269 (95.1)	304 (96.8)	1035 (95.0)
Multimorbidity						
Yes	68(55.7)	126(81.8)	167(76.6)	191(67.5)	191(60.8)	743(68.1)
No	54(44.3)	28(18.2)	51(23.4)	92(32.5)	123(39.2)	348(31.9)

4.1 Pattern of multimorbidity among elderly inpatients at the CTAGC, UCH, Ibadan.

Figure1 shows the pattern of multimorbidity among elderly inpatients. Of the patients with multimorbidity, almost half (46.5%) of the patients had two comorbidities, while 55.5% of the elderly patients had more than two comorbidities.

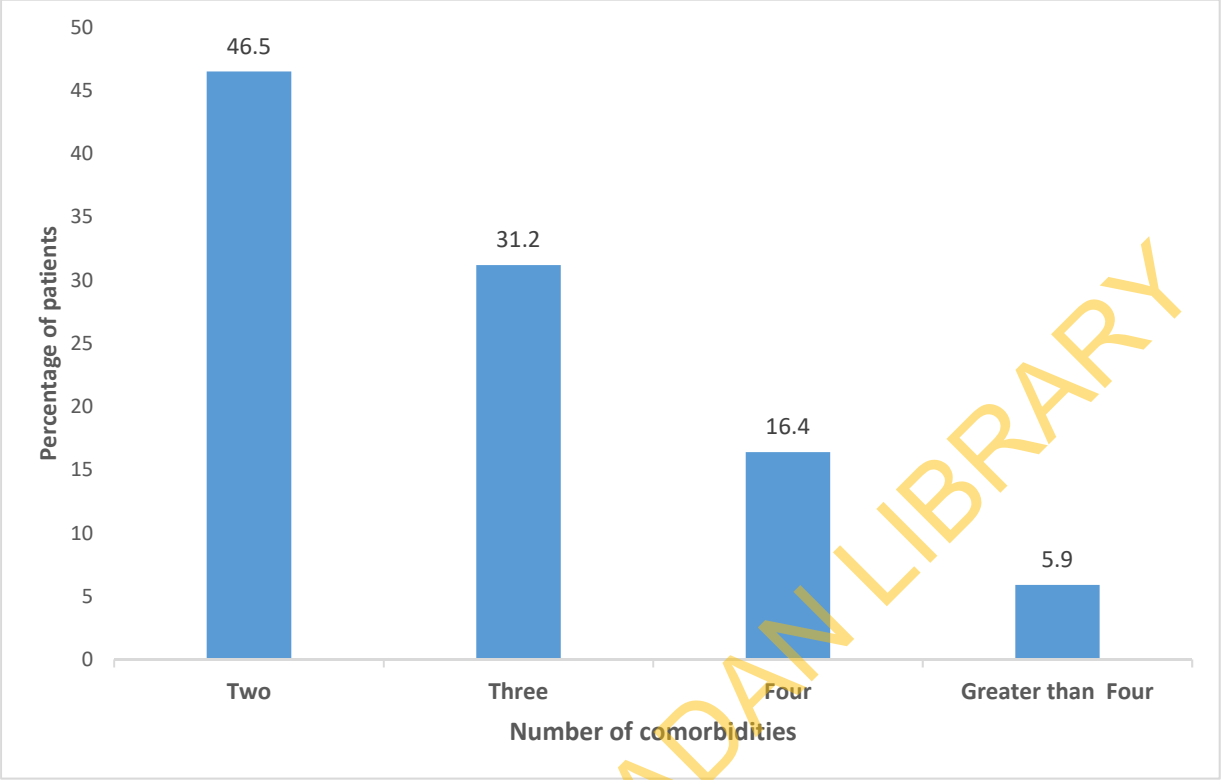


Figure 1: Pattern of multimorbidity among elderly inpatients at the CTAGC, UCH, Ibadan

4.2 Pattern of Length of stay of inpatients admission at CTAGC, January 2013 – December 2017.

Figure 2 shows the pattern of length of stay of inpatient admissions at CTAGC between January 2013 and December 2017. There was an increase in number of patients on admission for 0 to 2 days from 2013 to 2015, with a decline in 2016 and 2017. The graph shows an upward trend in the number of patients admitted for 3-4, 5-7, 8-10, and 11-14 days from 2013 to 2017. However, there was a slight decline in 2014 for these categories of length of stay. There were no patients on admission for more than 14 days in 2013 and 2014, but there were patients on admission for more than 14 days in 2015 to 2017. The number of patients on admission for more than 14 days remained the same in 2015 and 2016, with a slight decline in 2017.

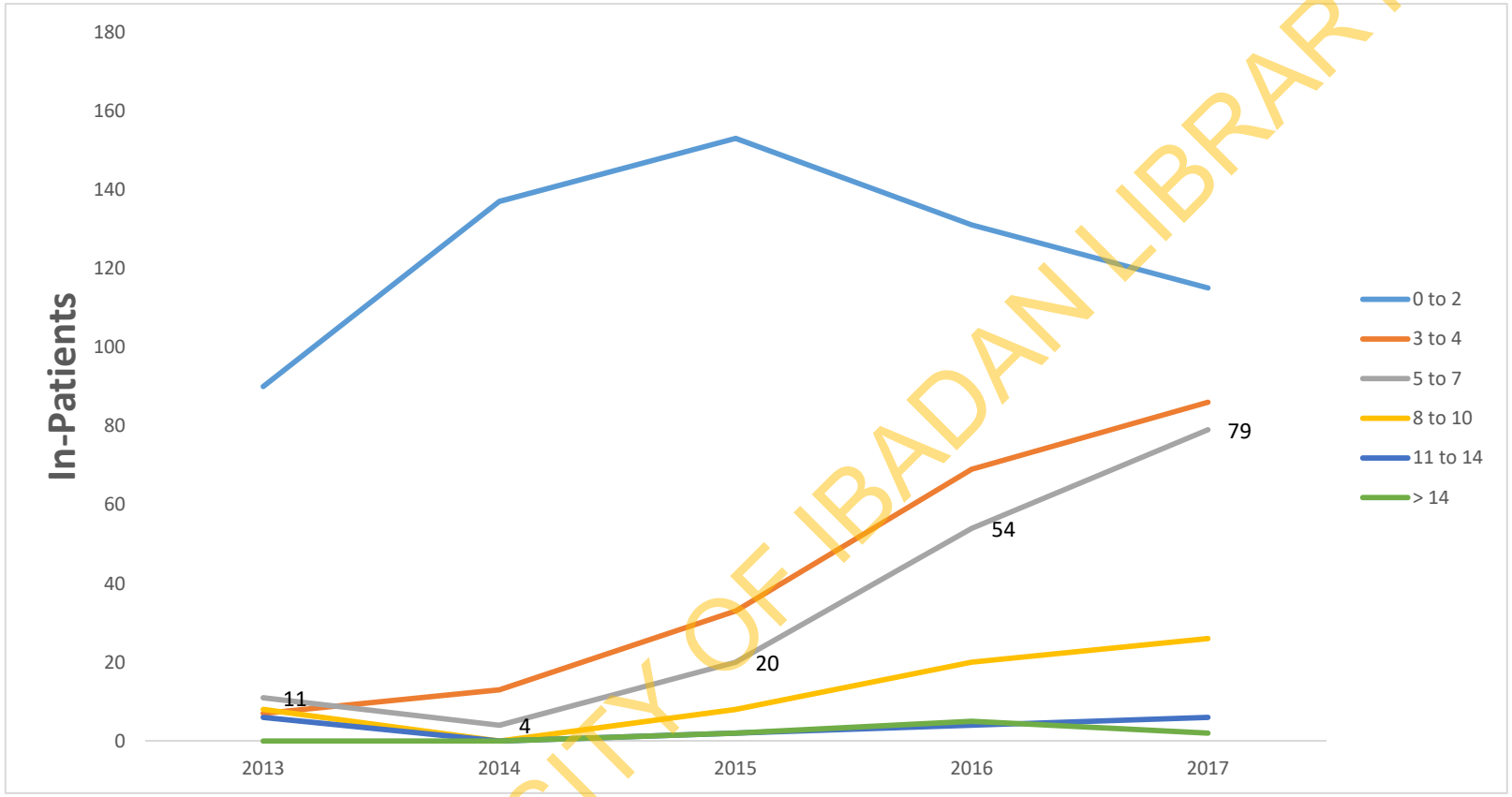


Figure 2: Line graph showing the pattern of Length of stay of inpatients admission at CTAGC, January 2013 – December 2017

4.3: Disease pattern of inpatients admission at CTAGC, January 2013 – December 2017

Figure 3, shows the distribution of the disease profile of inpatients admissions at CTAGC from January 2013 – December 2017. The prevalence of hypertension was found to be higher (10.7%) compared to the other comorbid conditions and 0.3% of the patients had prostate enlargement and depression.

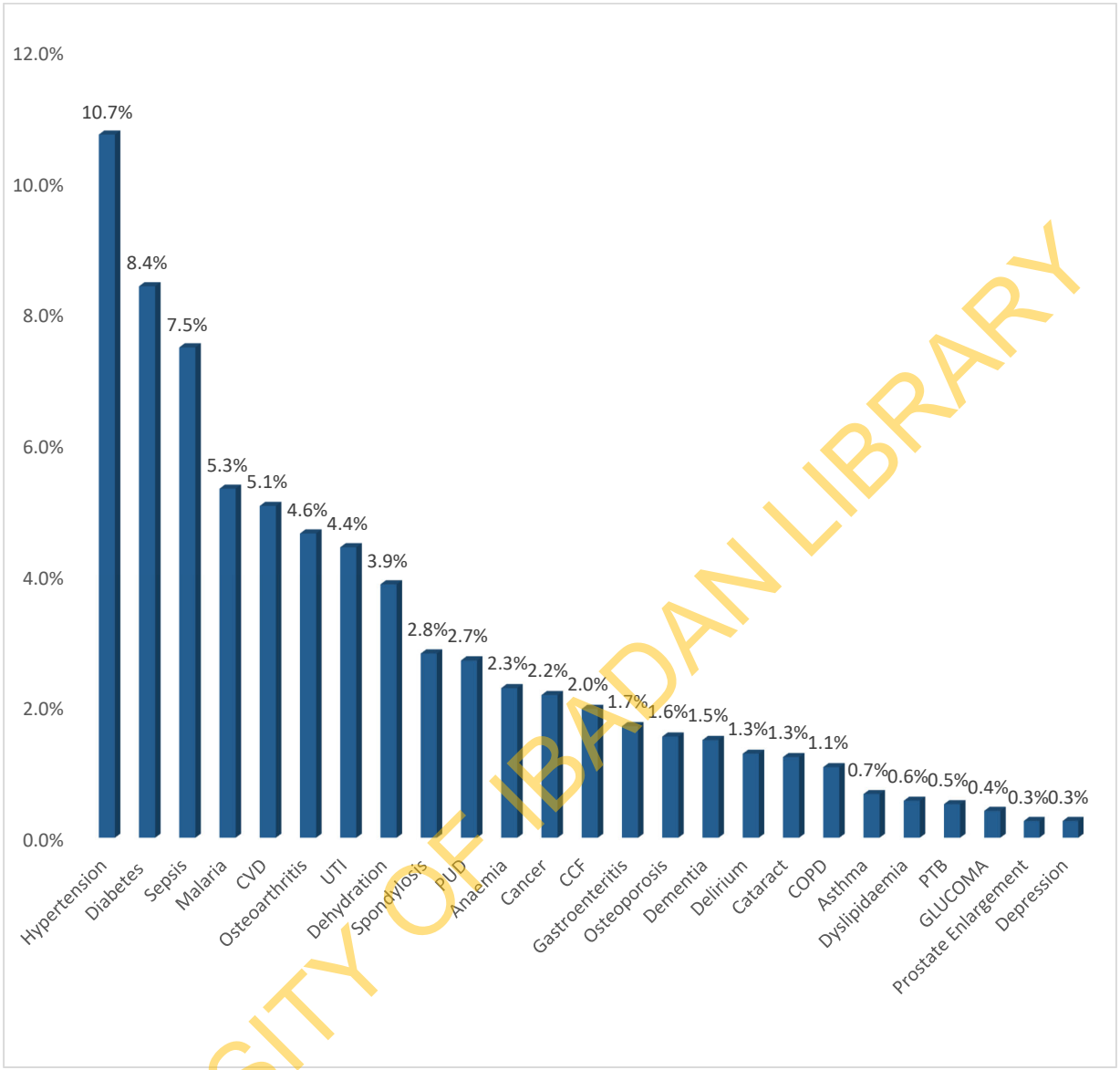


Figure 3: Disease pattern of inpatients admission at CTAGC, January 2013 – December 2017

4.4: Independent sample t-test comparing the result of clinical investigations between elderly with multimorbidity and those without multimorbidity.

Table 4.5 shows the differences in results of clinical investigations performed in patients with and without multimorbidity and the significance of these differences. The variables that the means were found to be significantly difference with multimorbidity were respiratory rate at admission, sodium, urea, total cholesterol and LDL levels ($p<0.05$). The Respiratory rate and urea levels of patients with multimorbidity were higher than those without multimorbidity while sodium levels, total cholesterol and LDL levels were lower in multimorbid patients. The respiratory rates in both non-multimorbid (23.12±4.19) and multimorbid (24.03±6.15) patients were higher than normal rate. Comparing the urea levels found in normal healthy individuals (70-20mg/dL) to those in the study population, the urea levels in both non-multimorbid (38.10mg/dL±33.83) and multimorbid patients (45.85mg/dL±47.02) are higher than normal. The difference in sodium levels in both groups (137.51mEq/L±6.24 in non-multimorbid patients and 136.33mEq/L±7.73 in multimorbid patients respectively) is not of clinical significance since they are both within the normal reference range (135-145mEq/L).

Total cholesterol and LDL cholesterol levels should be kept low (less than 200md/dL and less than 100mg/dL respectively). From the findings however, patients with no multimorbidity have higher levels of total cholesterol (202.59mg/dL±57.96) and LDL (122.99mg/dL±45.10) compared with those with multimorbidity (184mg/dL±48.93 and 109.49mg/dL±45.15 respectively), signifying higher levels of the cholesterols that poses health risk for the patients.

Table 2: Independent sample t-test comparing the result of clinical investigations between elderly with multimorbidity and those without multimorbidity.

Variable	n	Multimorbidity		t- value	p-value
		No	Yes		
		Mean± SD	Mean± SD		
Weight	1091	1.57±0.75	1.566±0.07	1.730	0.084
Height	1091	68.21±12.62	67.29±13.12	1.097	0.273
Respiratory rate at admission	986	23.12±4.19	24.03±6.15	-2.966	0.003*
Temperature at admission	852	36.59±3.36	36.55±2.89	0.156	0.876
Pulse rate at admission	1016	84.87±15.47	83.62±21.41	-1.821	0.069
Diastolic BP	1032	85.30±22.44	83.62±21.41	1.129	0.259
Systolic BP	1032	147.84±40.44	146.77±40.35	0.386	0.700
Sodium	780	137.51±6.24	136.33±7.73	2.205	0.028*
Potassium	789	3.98±0.66	4.14±5.94	-0.399	0.690
Bicarbonate	778	22.74±3.73	22.44±5.74	0.703	0.482
Chloride	781	100.44±7.36	100.44±8.43	0.001	0.999
Urea	782	38.10±33.83	45.85±47.02	-2.549	0.011*
Creatinine	779	1.41±2.03	1.64±3.24	-1.002	0.317
Total cholesterol	383	202.59±57.96	184±48.93	3.125	0.002*
Triglyceride	382	107.77±45.37	115.07±65.63	-1.254	0.211
HDL	381	54.44±17.28	51.27±23.56	1.009	0.314
LDL	381	122.99±45.10	109.49±45.15	2.687	0.008*

4.5 Collinearity Check of Variables

Table 3.0 shows the results for multicollinearity test of independents variables used. Nine (9) independent variables: gender, age, religion, occupation, ethnicity, family type, body mass index, length of stay and alcohol consumption were extracted for the analysis.

The collinearity test showed that ethnicity has the lowest VIF (1.029) and Religion has the highest VIF (1.473)

4.5.1 Over dispersion test

The result of the over dispersion test using Pearson dispersion statistics (Chi-square) test was 0.758 which was less than 1.0 which suggest under dispersion. The mean and variance of the dependent variable (Multimorbidity) was 2.23 &2.02 respectively.

Table 3 Collinearity Check of Variables

	Collinearity Statistics	
Model Variables	**Tolerance**	**VIF**
Gender	0.878	1.139
Age	0.906	1.104
Religion	0.679	1.473
Occupation	0.858	1.166
Ethnicity	0.972	1.029
Family type	0.728	1.374
Body Mass Index	0.941	1.063
Length of stay	0.968	1.033
Alcohol consumption	0.930	1.075

4.6: Poisson regression showing predictors of multimorbidity among elderly inpatients.

Females compared to males are expected to have a rate 1.024 times greater risk of multimorbidity (IRR=1.024, CI= 0.940, 0.116). Patients aged 85years and above are expected to have a rate 1.257 times greater risk of multimorbidity when compared to patients aged 60-64 years (IRR=1.257, CI= 1.072, 1.474). However, patients in the other age categories had no difference in the risk of multimorbidity, when compared to patients aged 85 and above. Elderly patients in polygamous family settings are expected to have a rate 0.987 times lesser risk of multimorbidity compared to those in monogamous family settings; however, this difference was not statistically significant (IRR=0.987) (CI=0.889, 1.096). There was no difference in the risk of multimorbidity between retirees and non-retirees. There was an increase in the risk of multimorbidity with increasing length of stay, Patients that stayed for 11-14 days are expected to have a rate 1.352 times greater of risk of multimorbidity compared to patients that stayed 0-2 days and it was statistically significant at $p < 0.05$ (IRR=1.352, CI= 1.015, 1.801). Patients who consumed alcohol are expected to have a rate 1.050times (1RR=1.050, CI= 0.869, 1.269) greater risk of multimorbidity than those who did not consume alcohol; however, this difference was not statistically significant at $p < 0.05$. Elderly patients who have normal body mass index are expected to have a rate 0.905times (1RR=0.905, CI= 0.729, 1.122) less risk of multimorbidity compared with those whose body mass index indicate that they are underweight.

Table 4: Poisson regression showing predictors of multimorbidity among elderly inpatients.

Variables	IRR	Confidence interval		p-value
		LCL	UCL	
Sex				
Male (**ref**)	1			
Female	1.024	0.940	1.116	0.587
Age-group				
60-64years (**ref**)	1			
65-69 years	1.166	1.011	1.343	0.035*
70-74 years	1.205	1.051	1.382	0.008*
75-79 years	1.067	0.916	1.243	0.406
80-84years	1.194	1.025	1.391	0.023*
85years & above(**ref**)	1.257	1.072	1.474	0.005*
Family type				
Monogamous (**ref**)	1			
Polygamous	0.987	0.889	1.096	0.804
Occupation				
Retired (**ref**)	1			
Not retired	1.004	0.919	1.097	0.934
Length of stay (days)				
0-2 (**ref**)	1			
3-4	1.123	1.010	1.248	0.033*
5-7	1.108	0.986	1.246	0.086
8-10	1.237	1.046	1.463	0.013*
11-14	1.352	1.015	1.801	0.039*
>14	1.130	0.740	1.725	0.572
Body Mass Index				
Normal				
Underweight	0.905	0.729	1.122	0.361
Overweight	0.928	0.753	1.138	0.463
Obese	0.862	0.691	1.076	0.189
Alcohol Consumption				
No (**ref**)	1			
Yes	1.050	0.869	1.269	0.612
Religion				
Christianity(**ref**)	1			
Islam	0.425	0.059	1.252	0.384
Traditional	1.047	0.944	3.042	0.394
Ethnicity				
Hausa (**ref**)	1			
Yoruba	0.905	0.520	1.575	0.725
Igbo	0.898	0.496	1.618	0.720
Others	0.728	0.582	1.484	0.382

4.7**: Cox Proportional Hazards Regression showing predictors of mortality among elderly in-patients at the Chief Tony Anenih Geriatric Centre, Ibadan**

Table 5, shows the result of Cox Proportional Hazards Regression. The result showed that the hazard ratio for the females compared to the males was 0.728 (HR= 0.728, CI: 0.476 - 1.114). Patients aged 65 – 69 years and 70 – 74 years have an increased risk of 32% (HR= 1.321, CI: 1.034 - 1.688) and 34% (HR= 1.338, CI: 1.055 - 1.696) respectively compared with than patients aged 60 – 64 years.

Patients in polygamous family settings had an increased hazard risk of 19% (HR= 1.190, CI: 1.012 - 1.481). Patients who were not retired had a hazard ratio of 0.687 compared to those who were retired (HR= 0.687, CI: 0.419 - 1.127). The obese patients had a reduced hazard risk of 18% than patients with normal BMI (HR= 0.816, CI: 0.690 – 0.907).

The Islam had reduced hazard risk of 31% compared to the Christians (HR= 0.678, CI: 0.391-1.176). Alcohol consumption had reduced hazard risk of 1% compared to non-alcohol consumption patients (HR= 0.994, CI: 0.381 – 2.591). Patients with multimorbidity had an increased hazard risk of 16% compared to patients without multimorbidity (HR= 1.157, CI: 1.009 – 1.328).

Table 5: Cox Proportional Hazards Regression showing predictors of mortality among elderly in-patients at the Chief Tony Anenih Geriatric Centre, Ibadan

Variables	Model 0 HR (95% CI)	Model 1 HR (95% CI)	Model 2 HR (95% CI)	Model 3 HR (95% CI)
Sex				
Female(**ref**)				
Male	1.434 (0.964-2.135)	0.690 (0.458-1.039)		0.728 (0.476-1.114)
Age-group				
60-64years (**ref**)				
65-69 years	0.878 (0.365-2.112)	0.751 (0.309-1.826)		1.321 (1.034-1.688) *
70-74 years	1.283 (0.615-2.676)	1.129 (0.538-2.371)		1.338 (1.055-1.696) *
75-79 years	0.974 (0.420-2.259)	0.712 (0.299-1.693)		0.887 (0.710-1.110)
80-84years	1.618 (0.767-3.416)	1.264 (0.588-2.715)		0.758 (0.604-0.952) *
85 years & above	1.514 (0.691-3.319)	1.151 (0.513-2.579)		0.757 (0.592-0.967) *
Family type				
Monogamous(**ref**)				
Polygamous	0.845 (0.539-1.325)	0.998 (0.588-1.695)		1.190 (1.012-1.481) *
Occupation				
Retired (**ref**)				
Not retired	0.582 (0.368-0.919) *	0.646 (0.395-1.056)		0.687 (0.419-1.127)
Religion				
Christianity (**ref**)				
Islam	0.750 (0.473-1.189)	0.753 (0.440-1.287)		0.678 (0.391-1.176)
Ethnicity				
Non-Yoruba (**ref**)				
Yoruba	2.098 (0.852-5.168)	2.303 (0.925-5.736)		2.497 (1.015-6.244) *
Alcohol Consumption				
No(**ref**)				
Yes	1.141 (0.462-2.816)		1.049 (0.423-2.601)	0.994 (0.381-2.591)
Body Mass Index				
Normal (**ref**)				
Underweight	0.898 (0.363-3.177)		1.041 (0.351-3.088)	0.996 (0.332-2.988)
Overweight	1.104 (0.655-1.860)		1.099 (0.651-1.855)	0.965 (0.563-1.654)
Obese	0.393 (0.163-0.946) *		0.386 (0.160-0.932) *	0.816 (0.690-0.907) *
Multimorbidity				
No (**ref**)				
Yes	1.301 (0.799-2.117)		1.342 (0.824-2.186)	1.157 (1.009-1.328) *

CHAPTER FIVE

5.0 DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1.1 Discussion

Multimorbidity presents significant challenges in the care of the elderly, and is associated with increased mortality and a poorer quality of life reference. This study showed a high prevalence of multimorbidity among elderly inpatients in CTAGC, Ibadan. This is similar to estimates by Fortin et al, 2012 which reported 71.8%, and slightly higher than reports by Taiwo Sogunle, which reported prevalence of multimorbidity as 56% in a study in Nigeria (Taiwo Sogunle, 2017). As CTAGC primarily caters to patients within Oyo State, this study suggests that there is a high prevalence of multimorbidity among the elderly in Oyo State.

5.1.2 Pattern of Multimorbidity

Hypertension, diabetes, sepsis, malaria and cardiovascular disease were the major causes of in-patient admission and constituted one-third of diagnoses among elderly inpatient admissions. Hypertension and diabetes were the leading causes of admissions among elderly patients in the CTAGC centre. When compared to results from previous studies, this provides evidence that there is an increasing prevalence of non-communicable disease in Nigeria, as posited by UNGA, 2011; Salisbury et al., 2011. Although malaria is more predominant in children (WHO, 2020), this study shows that malaria was a cause of hospital admissions among the elderly too. This suggests that elderly patients are also equally at risk for malaria, and thus should be included in malaria prevention campaigns and programmes.

Over half of elderly patients with multimorbidity were diagnosed with more than two diseases during admission. These high levels of multimorbidity greatly affects patients' quality of life, cost of healthcare and risk of disability (Fortin et al., 2004; Marengoni et al, 2011; Journal of American Geriatrics, 2012). Thus, healthcare providers should seek out ways to reduce multimorbidity among elderly patients.

Both infectious and non-communicable diseases were causes of inpatient admissions, however, infectious diseases accounted for only minority of hospital admissions among the elderly. Non-communicable diseases accounted for majority of hospital admissions, with a prevalence of 79.4%. These results show that elderly patients experience and are more at risk of non-communicable diseases.

About 3% of elderly inpatients in this study had mental health conditions such as depression, dementia and delirium. This is similar to a research by Khanam et al., 2011 which suggested that both physical and mental health conditions may have similar aetiological factors.

5.1.3 Predictors of Multimorbidity

Although there was no significant difference in the occurrence of multimorbidity between males and females in this population, over half of inpatient admissions were females. This suggests a possible relationship between sex and morbidity among elderly populations. The similarity in risk occurrence of morbidity between sexes is in contrast to studies in both developing and developed countries which state that females have a higher experience of multimorbidity (Garin et al., 2015; Agrawal & Agrawal, 2016; Ahmadi et al., 2016; Arokiasamy et al., 2016; Olivaire et al., 2017; Thompson et al., 2016). A possible explanation may be the inclusion of sex-specific conditions like prostate cancer in this study

There was an increased risk of multimorbidity with increasing age in the population studied. This is consistent with similar studies which have reported increasing age as a determinant of multimorbidity (Oni & Unwin, 2015). This is also biologically plausible, because as people age, their immune systems grow weaker and they are more at risk of chronic, non-communicable diseases (Academy of Medical Sciences, 2016; Marengoni et al, 2009).

Patients who spent 3-4, 8-10 and 11-14 days on admission were at a higher risk of multimorbidity compared to patients who spent 0-2 days on admission. This relationship shows that patients with more chronic conditions have longer admission stays. (Gruneir, 2016; Andrea *et al.,* 2016). This adversely affects cost of care, medications and treatment.

In this population, alcohol consumption and body mass index had no significant association with the occurrence of multimorbidity. This is in contrast to previous studies that reported alcohol use and increasing BMI as lifestyle determinants of multimorbidity (Warbuton, 2006; Machado et al., 2013; Fortin et al., 2014, Ronksley et al., 2011). This might be because data on alcohol use in this study only captured current alcohol intake

5.1.4 Predictors of Mortality

In this study, sex was not associated with increased mortality. Female patients with multimorbidity had the same risk of mortality as males. Elderly patients aged 65-74 years had 32% increased risk of mortality, as compared with elderly patients aged 60-64. There was however, no difference in risk of mortality between patients aged 75 years and above when compared to patients aged 60-64. This is in contrast to other studies that have reported consistent increase in mortality with increasing age (Oni & Unwin, 2015; Landi et al., 2007; Marengoni et al., 2009; Schafer et al.,

2014). However, this means that clinicians and healthcare providers should take particular care when treating elderly patients aged 65 to 74, as they are at a higher risk of mortality.

Patients in polygamous settings had a 19% increase in risk of mortality, as compared to those in monogamous family settings. This points to socio-cultural factors associated with mortality among the elderly, particularly in this context. Polygamous families experience more conflict, and such may adversely affect the health of the aged. This relationship should be further explored through qualitative studies.

This study reported an inverse relationship between BMI and mortality. As compared to underweight patients, obesity was protective of mortality. This is in contrast to previous studies, where an increased BMI was associated with an increased risk of mortality (Taiwo, 2017; Oni &Urwin, 2015). However, clinicians and healthcare providers caring for elderly patients should also take particular note of underweight patients.

Patients with multimorbidity had a 16% increase in the risk of mortality. This is consistent with other studies that have reported a direct association between multimorbidity and mortality in elderly populations. (Landi et al., 2007; Marengoni et al., 2009; Schafer et al., 2014). Clinicians therefore should pay particular attention to elderly patients with multimorbidity, across all age groups, in order to prevent mortality.

5.2 Conclusion

Majority of the comorbidities that we have found to influence length of hospital admission and mortality in the elderly can only be managed, they cannot be treated. As such, more effort has to be put into prevention of these disease conditions. Visual aids of likely complications from these diseases as well as statistics covering mortality should be included in campaigns to further reiterate the importance of adherence of publicized strategies to the general populace. Also, the elderly are a peculiar group and close attention has to be paid to them as they may present with atypical symptoms and signs. If these are not properly managed, it can significantly affect their length of stay in the hospital as well as their overall health outcome. Ultimately, ensuring optimum psychological wellbeing of the elderly is essential as healing flows from inwards out.

5.3 Recommendations

- Healthcare providers should develop effective strategies to reduce the high levels of multimorbidity among elderly patients.
- Since increasing length of stay is associated with multimorbidity and causes mortality in elderly patients, home care treatment should be encouraged so as to reduce the mortality rate among elderly patients with multimorbidity. This is particularly important as nosocomial infections have been linked to increased mortality in the elderly, in the light of spread of infectious diseases such as the Covid-19, this may also be of significance as increased contacts with health workers and patients can lead to the spread of such diseases.
- Qualitative studies to explore the relationship between socio cultural factors like polygamy, multimorbidity and mortality.

REFERENCES

Aarts, S., van den Akker, M., Bosma, H., Tan, F., Verhey, F., Metsemakers, J., and van Boxtel, M. (2012). The effect of multimorbidity on health related functioning: temporary or persistent? Results from a longitudinal cohort study.Journal of psychosomatic research, 73(3):211–217.

Adebusoye, L., Owoaje, E., & Ogunbode, A. M. (2011). Morbidity pattern amongst elderly patients presenting at a primary care clinic in Nigeria, (February). https://doi.org/10.4102/phcfm.v4i1.211

Academy of Medical Sciences (2016). Addressing the global challenge of multimorbidity: Lessons from South Africa. https://acmedsci.ac.uk/policy/policy-projects/addressing-the-global-challenge-of-multimorbiditylessons-from-south-africa.

Academy of Medical Sciences (2018). Multimorbidity: a priority for global health research.

Agborsangaya CB, et al. (2012). Multimorbidity prevalence and patterns across socioeconomic determinants: a cross-sectional survey. BMC Public Health 12, 201.

Agborsangaya CB, et al. (2015). Multimorbidity in a prospective cohort: prevalence and associations with weight loss and health status in severely obese patients. Obesity 23, 707–712.

Agrawal S & Agrawal PK (2016). Association Between Body Mass index and Prevalence of Multimorbidity in Low-and Middle-income Countries: A Cross-Sectional Study. Int J Med Public Health 6(2), 73-83.

Ahmadi B, et al. (2016). Multimorbidity: Epidemiology and Risk Factors in the Golestan Cohort Study, Iran. Medicine (Baltimore) 95(7), e2756.

Akker M, Buntinx F, Metsemakers JF, Roos S, Knottnerus JA. Multimorbidity in general practice: prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. J Clin Epidemiol. 1998 May;51(5):367-75. doi: 10.1016/s0895-4356(97)00306-5. PMID: 9619963.

American Geriatrics Society Expert Panel on the Care of Older Adults with Multimorbidity (2012). Guiding principles for the care of older adults with multimorbidity: An approach for clinicians. Journal of the American Geriatrics Society, 60, E1-e25.

Andrea Gruneir, Susan E. Bronskill et al. (2016). The association between multimorbidity and hospitalization is modified by individual demographics and physician continuity of care: a retrospective cohort study. BMC Health Services Research (2016) 16:154.

Angela Y Chang et al (2019). Multimorbidity and care for hypertension, diabetes and HIV among older adults in rural South Africa. Bulletin of World Health Organisation2019;97:10–23

Arokiasamy P, et al. (2015). The impact of multimorbidity on adult physical and mental health in low- and middle-income countries: what does the study on global ageing and adult health (SAGE) reveal? BMC Medicine 13, 178.

Autenrieth, C. S., Kirchberger, I., Heier, M., Zimmermann, A.-K., Peters, A., Döring, A., and Thorand, B. (2013). Physical activity is inversely associated with multimorbidity in elderly men: results from the kora-age augsburg study. Preventive medicine, 57(1):17–19.

B.P. Nunes,Thaynã Ramos Flores et al. (2016). Multimorbidity and mortality in older adults: A systematic review and meta-analysis. Archives of Gerontology and Geriatrics 67 (2016) 130–138.

Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet 2012;380:37–43.

Boeing, H., Bechthold, A., Bub, A., Ellinger, S., Haller, D., Kroke, A., Leschik-Bonnet, E., Müller, M. J., Oberritter, H., Schulze, M., et al. (2012). Critical review: vegetables and fruit in the prevention of chronic diseases. European journal of nutrition, 51(6):637–663. doi:10.1007/s00394-012-0380-y.

Booth, H. P., Prevost, A. T., and Gulliford, M. C. (2014). Impact of body mass index on prevalence of multimorbidity in primary care: cohort study. Family practice, 31(1):38–43.

Cargiulo, T. (2007). Understanding the health impact of alcohol dependence. American journal of health-system pharmacy: AJHP: official journal of the American Society of Health-System Pharmacists, 64(5 Suppl 3):S5.

Clausen, F., Sandberg, E., Ingstad, B., & Hjortdahl, P. (2000). Morbidity and health care utilisation among elderly people in Mmankgodi village, Botswana. *Journal of epidemiology and community health*, *54*(1), 58–63. https://doi.org/10.1136/jech.54.1.58

Diaz E, et al. (2015). Multimorbidity among registered immigrants in Norway: the role of reason for migration and length of stay. Tropical Medicine & International Health 20(12), 1805-1814.

Fortin M, et al. (2012). A Systematic Review of Prevalence Studies on Multimorbidity: Toward a More Uniform Approach. Ann Fam Med 10(2),142–151.

Fortin, M., Bravo, G., Hudon, C., Lapointe, L., Almirall, J., Dubois, M.-F.,andVanasse, A. (2006). Relationship between multimorbidity and health-related quality of life of patients in primary care. Quality of Life Research, 15(1):83-91

Fortin, M., Haggerty, J., Almirall, J., Bouhali, T., Sasseville, M., and Lemieux, M. (2014). Lifestyle factors and multimorbidity: a cross sectional study. http://www.biomedcentral.com/1471-2458/14/686. Viewed August 3, 2014.

Fortin, M., Lapointe, L., Hudon, C., Vanasse, A., Ntetu, A., &Maltais, D. (2004). Multimorbidity and quality of life in primary care: A systematic review. Health and Quality of Life Outcomes, 2, 51.

Fowles, J. and Dybing, E. (2003). Application of toxicological risk assessment principles to the chemical constituents of cigarette smoke. Tobacco Control, 12(4):424–430.

Garin N, et al. (2016). Global Multimorbidity Patterns: A Cross-Sectional, Population-Based, Multi-Country Study. J Gerontol A BiolSci Med Sci 71(2), 205-214.

Glynn, L. G., Valderas, J. M., Healy, P., Burke, E., Newell, J., Gillespie, P., and Murphy, A. W. (2011). The prevalence of multimorbidity in primary care and its effect on health care utilization and cost. Family practice, 28(5):516–523.

Gruneir A, Forrester J, Camacho X, Gill SS, Bronskill SE. Gender differences in home care clients and admission to long-term care in Ontario, Canada: a population-based retrospective cohort study. BMC Geriatr. 2013;13:48.

Hall M, et al. (2018). Multimorbidity and survival for patients with acute myocardial infarction in England and Wales: Latent class analysis of a nationwide population-based cohort. PLoS Med. 15(3), e1002501.

Hall, J. N., Moore, S., Harper, S. B., and Lynch, J. W. (2009). Global variability in fruit and vegetable consumption. American journal of preventive medicine, 36(5):402–409.

Khanam MA, et al. (2011). Prevalence and Patterns of Multimorbidity Among Elderly People in Rural Bangladesh: A Cross-sectional Study. J Health PopulNutr 29, 406-414.

KonéPefoyo et al. BMC Public Health (2015). The increasing burden and complexity of multimorbidity. 15:415

Landi, F., Liperoti, R., Russo, A., Capoluongo, E., Barillaro, C., Pahor, M., et al. (2010). Disability, more than multimorbidity, was predictive of mortality among older persons aged 80 years and older. Journal of Clinical Epidemiology, 63, 752–759.

Lenzi J, et al. (2016). Burden of multimorbidity in relation to age, gender and immigrant status: a cross-sectional study based on administrative data. BMJ Open 6, e012812.

Lim, W.-Y., Ma, S., Heng, D., Bhalla, V., and Chew, S. K. (2007). Gender, ethnicity, health behaviour& self-rated health in singapore. BMC Public Health, 7(1):184.

Machado, V. d. S. S., Valadares, A. L. R., Costa-Paiva, L. H., Osis, M. J., Sousa, M. H., and Pinto-Neto, A. M. (2013). Aging, obesity, and multimorbidity in women 50 years or older: a population-based study. Menopause, 20(8):818–824.

Maiyaki, M. B. and Garbati, M. A. (2014). The burden of non-communicable diseases in Nigeria; in the context of globalization. Annals of African medicine,13(1):1–10.

Marengoni, A., Angleman, S., Melis, R., Mangialasche, F., Karp, A., Garmen, A., et al. (2011). Aging with multimorbidity: A systematic review of the literature. Ageing Research Reviews, 10, 430–439.

Marengoni, A., Rizzuto, D., Wang, H.-X., Winblad, B., and Fratiglioni, L. (2009a). Patterns of chronic multimorbidity in the elderly population. Journal of the American Geriatrics Society, 57(2):225–230.

Marengoni, A., von Strauss, E., Rizzuto, D., Winblad, B., &Fratiglioni, L. (2009). The impact of chronic multimorbidity and disability on functional decline and survival in elderly persons. A community-based, longitudinal study. Journal of Internal Medicine, 265, 288–295.

Mello, A. D. C., Engstrom, E. M., & Alves, L. C. (2014). Health-related and socio-demographic factors associated with frailty in the elderly: A systematic literature review. Cadernos de SaudePublica, 30, 1143–1168.

Nazlee Siddiqui, Mitchell Dwyer et al. (2018). Hospital length of stay variation and comorbidity of mental illness: a retrospective study of five common chronic medical conditions. BMC Health Services Research (2018) 18:498.

Nugent, R. (2008). Chronic diseases in developing countries. Annals of the NewYork Academy of Sciences, 1136(1):70–79.

Olivares DE, et al. (2017). Risk Factors for Chronic Diseases and Multimorbidity in a Primary Care Context of Central Argentina: A Web-Based Interactive and Cross-Sectional Study. Int J Environ Res Public Health 14(3), 251-273.

Oni T & Unwin N (2015). Why the communicable/non-communicable disease dichotomy is problematic for public health control strategies: implications of multimorbidity for health systems in an era of health transition. Int Health 7(6), 390-399.

Organization, W. H. et al. (2008). Who report on the global tobacco epidemic, 2008: the mpowerpackage. Retrieved September 19, 2014.

Patel V &Chatterji S (2015). Integrating Mental Health In Care For Noncommunicable Diseases: An Imperative For Person-Centred Care. Health Affairs 34(9), 1498-1505.

Perpetua Lum Tanyi, Pelser André & Peter Mbah | (2018). Care of the elderly in Nigeria: Implications for policy, Cogent Social Sciences, DOI:10.1080/23311886.2018.1555201.

Ronksley, P. E., Brien, S. E., Turner, B. J., Mukamal, K. J., and Ghali, W. A. (2011). Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. Bmj, 342:d671. doi:10.1136/bmj.d671.

Salisbury C, et al. (2011). Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. Br J Gen Pract 61(582), e12-21.

Schafer I KH, Wagner HO, Scho¨n G, et al (2014). Reducing complexity: a visualisation of multimorbidity by combining disease clusters and triads. BMC Public Health 2014; 14: 1285.

Schäfer I, et al. (2012). The influence of age, gender and socio-economic status on multimorbidity patterns in primary care. First results from the multicare cohort study. BMC Health Services Research 12, 89.

Shiwaku K, et al. (2004). Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The Lancet, 363(9403), 157–63.

TaiwoSogunle (2017). Multimorbidity and Lifestyle in Western Nigeria.

Taylor, B., Rehm, J., and Gmel, G. (2005). Moderate alcohol consumption and the gastrointestinal tract. Digestive Diseases, 23(3-4):170–176.

Thompson A, et al. (2016). The influence of gender and other patient characteristics on health care-seeking behaviour: a QUALICOPC study. BMC Family Practice 17, 38.

Timmreck TC, Cole GE, James G et al. Health education and health promotion: A look at the jungle of supportive fields, philosophies and theoretical foundations. Health Educ 1987;18:23–28.

Tolstrup, J., Jensen, M. K., Anne, T., Overvad, K., Mukamal, K. J., and Grønbæk, M. (2006). Prospective study of alcohol drinking patterns and coronary heart disease in women and men. Bmj, 332(7552):1244.

United Nations, General Assembly (2011). Prevention and control of non-communicable diseases. http://www.un.org/ga/search/view_doc.asp?symbol=A/66/83&Lang=E

Valderas, J. M., Starfield, B., Sibbald, B., Salisbury, C., and Roland, M. (2009). Defining comorbidity: implications for understanding health and health services. The Annals of Family Medicine, 7(4):357–363.

Vancampfort D, et al. (2017). Chronic physical conditions, multimorbidity and physical activity across 46 low- and middle-income countries. International Journal of Behavioral Nutrition and Physical Activity 14, 6.

Victorian Auditor-General's Report. Hospital Performance: Length of Stay. 2016(https://www.audit.vic.gov.au/report/hospital-performance-length-stay).

Violan C, et al. (2014). Burden of multimorbidity, socioeconomic status and use of health services across stages of life in urban areas: a cross-sectional study. BMC Public Health 14, 530.

Violan C, et al. (2014). Prevalence, Determinants and Patterns of Multimorbidity in Primary Care: A Systematic Review of Observational Studies. PLoS ONE 9(7).

Warburton, D. E., Nicol, C. W., and Bredin, S. S. (2006a). Health benefits of physical activity: the evidence. Canadian medical association journal, 174(6):801-809. doi:10.1503/cmaj.051351. PMCID: PMC1402378.

Willadsen T.G., Siersma V. et al. (2018). Multimorbidity and mortality: A 15-year longitudinal registry-based nationwide Danish population study. Journal of Comorbidity. Volume 8: 1–9.

Williams, P. T. (2001). Physical fitness and activity as separate heart disease risk factors: a meta-analysis. Medicine and science in sports and exercise, 33(5):754–761. [PMC free article] [PubMed] Accessed August 18, 2014.

World Health Organisation (2020). Malaria report factsheet.

World Health Organization (2016). Multimorbidity. http://apps.who.int/iris/handle/10665/252275