THE IMPACT OF FOOD INSECURITY ON QUALITY OF LIFE IN WINDHOEK INFORMAL SETTLEMENTS: A STRUCTURAL EQUATION MODELLING APPROACH

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ABSTRACT

Namibia is experiencing an increase in its population living in urban areas due to rapid urbanisation. However, this growth has not been the same in all parts of the country. Currently the biggest growth rate is experienced in Windhoek, which is home to about 16% of the total population. Due to rapid population growth, Windhoek has been facing a number of challenges such as high unemployment rate, illegal land occupation, and development of informal settlements among others. As a result, over-population has led to various social problems in informal settlements such as poor health condition, lack of access to clean water, unsustainable livelihood and food insecurity among others. Given the number of challenges faced by residents of informal settlements, there is a need to assess the impact of food insecurity on quality of life, since going without food does have an impact on people's well-being.

The objective of the study is to model the relationship between food insecurity and quality of life in Windhoek informal settlements using Structural Equation Modelling (SEM) approach. Secondary data from a quantitative cross-sectional study were used. The study measured food insecurity using Household Food Insecurity Scale (HFIAS) indicators. World Health Organization Quality-of-Life Scale (WHOQOL-BREF) and European Quality of life (EQ-5D) instruments were used to measure quality of life. Multivariate statistical analysis using Exploratory Factor Analysis (EFA), Principal Component Analysis (PCA), and Hierarchal

Clustering methods were applied to reduce dimensionality in the data, and to link food insecurity to quality of life.

EFA results showed that from the set of ten (10) questions asked on food insecurity, only one component was adequate in explaining food insecurity. Similarly, results revealed that only four components (social, environmental, physical and psychological health) accounted for much variation in WHOQOL-BREF from the set of 21 questions asked. The findings further indicated that four constructs (pain/discomfort, anxiety/depression, self-care and usual activities) were sufficient in explaining quality of life based on EQ-5D instrument. All measurement scales for the constructs met the minimum condition of the Cronbach's alpha coefficient, all with $\alpha \geq 0.70$. The study further assessed the level of agreement between data driven approach and existing method of food insecurity using Kappa test of symmetric. The results showed that there was a substantial agreement between HFIAS and the data driven, with a Kappa (κ) value of 0.68 ($p < 0.001$).

Overall, latent models identified with EFA were validated using CFA before fitting SEM. Measurement models were evaluated based on goodness of fit, level of significance and coefficient signs, and non-significant models were modified by removing unstable parameters. The SEM was accepted based on the criteria used for CFA. The results showed that the model had a significant $\chi^2(1741) = 4527.90$, $p < 0.001$ and SRMR = 0.07 and a RMSEA = 0.07 (90% CI=0.071; 0.077), which indicated that the model fits the data well. More importantly, the results supported that food insecurity was a significant predictor of quality of life outcomes (physical health, environmental health, social health, pain/discomfort, anxiety/depression,

self-care and usual activities) in Windhoek informal settlements. The study further revealed that lack of access to food affect social well-being, environmental well-being and physical well-being in a negative way. Similarly, the study found that pain/discomfort, anxiety/depression, self-care, and usual activities were positively associated with food insecurity.

LIST OF CONFERENCE(S) PROCEEDINGS

1. **Shinyemba, T**., Nickanor, N., and Kazembe L. 2017. Food Insecurity and quality of Life in Windhoek Informal Settlements: A Structural Equation Modelling Approach. Paper presented at the Faculty of Science 5th Science Research Conference, 15th – 16th November 2017, University of Namibia, Main Campus, Windhoek, Namibia.
2. **Shinyemba, T**., Nickanor, N., and Kazembe L. 2017. Food Insecurity and quality of Life in Windhoek Informal Settlements: A Structural Equation Modelling Approach. Paper presented at 3rd International Conference on Global Food Security, 3 – 6 December 2017, Cape Town, South Africa.
3. **Shinyemba, T**., Nickanor, N., and Kazembe L. 2018. Food Insecurity and Quality of Life in Windhoek Informal Settlements: A Structural Equation Modelling Approach. Paper presented at National Students' Research Symposium, 18-19 October 2018, Namibia Institute of Public Administration and Management (NIPAM), Olympia, Windhoek, Namibia.

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ABBREVIATIONS AND ACRONYMS

AIC	Akaike Information Criterion
AU	Approximately Unbiased
BP	Bootstrap Probability
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
DFID	The Department for International Development
EA	Enumeration Area
EFA	Exploratory Factor Analysis
EFSA	Emergency Food Security Assessment
EQ VAS	European Quality of Life Valuation Scale
EQ-5D	European Quality of life 5 level dimension instrument
EQ-5D-3L	European Quality of life EQ-5D 3 level dimension instrument
EQ-5D-5L	European Quality of life EQ-5D 5 level dimension instrument
EuroQol	European Quality of Life
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
GFI	Goodness of Fit Index
HFIAS	Household Food Insecurity Access Scale
HHs	Households
HIV/AIDS	Human Immunodeficiency Virus and Acquired Immune Efficiency Syndrome
HLPE	High Level Panel of Experts on Food Security and Nutrition

HPP	Harambee Prosperity Plan
IBM	International Business Machines
IFAD	International Fund for Agricultural Development
ILO	International Labour Organisation
KMO	Kaiser-Meyer-Olkin
NCRST	National Commission on Research Science and Technology
NDP5	National Development Plan 5
NSA	Namibia Statistics Agency
PA	Path Analysis
PCA	Principal Component Analysis
PSU	Primary Sampling Unit
RMSEA	Root Mean Square Error Approximation
SADC	Southern Africa Development Community
SEM	Structural Equation Modelling
SPSS	Statistical Package for the Social Sciences
SRMR	Standardised Root Mean Residual
TLI	Tucker-Lewis Index
UN-DESA	The United Nations Department of Economic and Social Affairs
UN-Habitat	The United Nations Human Settlements Programme
US	United States
USAID	The United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organisation
WHOQOL	World Health Organisation Quality of Life
WHOQOL-BREF	World Health Organization Quality-of-Life Scale

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DEDICATIONS

This study is dedicated to my grandmother kuku Letta "Namadhila" Jesaya and my late aunt Selma Haliana Shiiga who passed on during my studies at the University of Cape Town in April 2015.

DECLARATION

I, Tobias Willem Shinyemba, hereby declare that this study is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any other institution.

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Tobias Willem Shinyemba		21 January 2019
Name of Student	**Signature**	**Date**

DEFINITION OF KEY TERMS

Food Security: A state whereby "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life".

Food Insecurity: A state whereby people do not have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences to live an active and healthy life.

Quality of life: A concept used to describe the health, happiness and comfort experienced by individuals or by a society. It describes how individuals live, how they feel and how they comprehend their daily lives.

Informal Settlements: Residential areas where cluster of dwelling units are built on land where individuals have no legal claim, and such housing facilities do not meet municipal planning requirements and building regulations.

Structural Equation Modelling: A multivariate statistical modelling technique that allows modelling structural relationship using latent and observed variables. The technique combines principal component analysis, factor analysis, cluster analysis, path analysis and multiple regression analysis.

CHAPTER 1: INTRODUCTION

1.1. Background of the Study

In the past 20 years the world population experienced massive growth in the urban population from 43 per cent (2.3 billion inhabitants) in mid-1990 to 54 per cent (4 billion inhabitants) in mid-2015 (UN-Habitat, 2016). The rapid growth in the world's urban population started in North America and Europe following the "industrial revolution" in the late 18th century, and the trend later begins to pick in Asia, Africa, and Latin America in the 1960s and 1970s (Wrigley, 1990; Timmer, de Vries, & de Vries, 2015; Ezeh et al., 2017). The large influx of migrants coming to urban areas led to improvements in urban centres and development of more infrastructures resulting in the urbanisation of many cities around the world.

Even though, the world is rapidly urbanising, this growth has not been equal in all parts of the world. Currently Africa has the fastest urban growth rate due to rural-urban migration, high natural increase and reclassification of rural areas (UN-Habitat, 2016). Further, UN-Habitat (2016) reported that in mid-2015, Asia had the highest number of urban inhabitants followed by Europe, Latin America, Africa, North America and Oceania.

In Namibia, the urban population has also increased from 33 per cent (604,009 inhabitants) in 2001 to 42.8 per cent (908,623 inhabitants) in 2011 and it is projected to increase to 53 per cent (1,342,607 inhabitants) in mid-2021 (NSA, 2013b, 2014). Similarly, urban population growth rate has not been the same across Namibia; the highest growth rate is currently experienced in Windhoek, which is

home to about 16 per cent (325,858 inhabitants) of the total population, making it to be the most populous urban centre in the country (NSA, 2013b).

Over the years, Windhoek has been facing a number of challenges due to a large influx of people coming to the city in search for better livelihoods (Indongo, Angombe, & Nickanor, 2013). Some of the challenges experienced by residents are high unemployment rate, high crime rate, and congestion amongst others. Furthermore, rapid urbanisation has posed challenges to the City of Windhoek to set-up and manage developmental infrastructures in the northern parts of the city in a sustainable way. Resulting in a shortage of houses in these parts of the city where most low-income earner lives (Indongo et al., 2013; Kaira, 2015). Consequently, shortage of affordable housing resulted in illegal land occupation and development of informal settlements around the northern parts of the city (Indongo et al., 2013).

An informal settlement is defined as residential areas where cluster of dwelling units are built on land where individuals have no legal claim, and such housing facilities do not meet municipal planning requirements and building regulations (Wekesa, Steyn, & Fred-Otieno, 2011). These areas mostly have limited access to basic municipal services and infrastructures such as basic amenities and tarred roads (UN-Habitat, 2015, p. 1). Verma (2017) indicated that informal settlements mostly develop when the city land administration and planning units fail to deliver housing services for its people, and these settlements are usually located on the outskirts of cities and are mostly over populated. Overtime, over population has caused various social problems in informal settlements, namely; poor health conditions; lack of access to clean water; lack of proper waste disposal and poor sewage systems;

unsustainable livelihoods and food insecurity among others (Indongo et al., 2013; Jha & Tripathi, 2014; Kimani-Murage et al., 2014). These social problems affect the quality of life of people living in these areas.

Quality of life is a term used to describe the health, happiness and comfort experienced by individuals or by a society. It has to do with how individuals live, how they feel and how they comprehend their daily lives. It is measured by examining individual psychological well-being, physical well-being, social wellbeing, functional well-being, and material well-being (Cella, 1994; Felce & Perry, 1995). Quality of life outcomes are determined by environmental, physical, psychological, economical, and social factors (Verma, 2017). The environmental factors include access to green spaces, hygienic air, and regulation of solid waste and wastewater disposal. Whereas, the physical factors include access to public services, friendly neighbourhood, and tarred roads with pedestrian sidewalks. Psychological factors include creating a quiet enjoyable and pleasurable environment by improving the current social environment. The economic component include availability of jobs and business opportunities, and the social aspects include promotion of social justice and availability of affordable houses (Verma, 2017). Unavailability of the above-mentioned aspects has led people to be dissatisfied with their living conditions, and thus resulting in a poor quality of life outcomes (Wokekoro & Owei, 2014).

Apart from developmental challenges faced by people in informal settlements, they also experience the problem of food insecurity. FAO (2003) defined food security as a state whereby “all people, at all times, have physical, social and economic

access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (p. 29). FAO, IFAD, UNICEF, WFP, and WHO (2017) reported that in 2016 there were about 815 million people in the world that were food insecure, compared to the estimated 777 million people that were food insecure in 2015. The 11 per cent increase between the two years caused greater concern among policy makers as it poses major challenges on global commitment to end hunger by 2030. In their findings, FAO et al. (2017) also documented that the situation of food insecurity has worsened in some parts of the world including the Sub-Saharan Africa, because of a number conflicts related to economic or climate shocks.

Studies have identified that the state of food insecurity occurs when food systems collapses, and it is more prevalent in areas with rapid urbanisation and limited economic growth (Friel & Ford, 2015). In most countries, food systems collapse due to the ever increasing number of residents that are living in poverty, and this has also broaden the food gap between many urban households (Crush & Frayne, 2010a).

Additionally, high prevailing poverty levels in urban areas have increased the burden of food insecurity among urban poor; this is because urban poor are more vulnerable to ever-escalating food prices in local and international markets (Friel & Ford, 2015). FAO et al. (2017) argued that recent changes in fiscal policies that safeguard poor households against ever-increasing local food prices has resulted in a reduction of food imports and reducing food availability in many countries. The issue of ever-increasing food prices has restricted most poor households from

purchasing high nutritious food, and their inability to afford refrigerators to store such food has limited them to purchasing low nutritious and less preferred food (Garvelink & Wedding, 2013).

Furthermore, poverty has subjected most urban poor to make decisions on whether to spend more on food or on other necessities due to limited resources (Pendleton, Crush, & Nickanor, 2014). As a result, most households sacrifice their food diversity and food quality over the quantity of food, to ensure that the households have enough food (Kimani-Murage et al., 2014). On other hand, other households tend to skip meals, reduce quality and variety of food, eating street food, buying food on credit, stealing, and scavenging as part of their coping strategies. Such decisions mostly affect women and dependent children, making them to be frustrated, feeling helpless, and depressed (Ivers & Cullen, 2011; Weigel, Armijos, Racines, Cevallos, & Castro, 2016). Even though these coping strategies reduce psychological hunger in the short period, they have long-term effect on human lives. Studies have also shown that lack of inadequate intake of nutrients can lead to mental or physical illnesses, because nutrients are essential for maintaining good mental health and physical health (Weigel et al., 2016, p. 8). Similarly, FAO et al. (2017) reported that about 33 per cent of women in the reproductive age group suffer from anaemia globally as a result of food insecurity. They further, argued that this puts the health and nutrition of many infants at risk.

Hunger and under-nutrition are both outcomes of food insecurity and have negative impact on health outcomes that affect the quality of life of people and at times

manifested through chronic diseases, obesity and mental health disorder (Altman, Hart, & Jacobs, 2009; Naicker, Mathee, & Teare, 2015; Atuoye & Luginaah, 2017).

1.2. Statement of the Problem

In the last decade, most scholars have focused more on addressing the issue of rural food insecurity and overlooked the prevalence of food insecurity in urban areas (Crush & Frayne, 2010a). The analysis done by Crush, Frayne, and Pendleton (2012) indicated that food insecurity has spread more widely in poor urban neighbourhoods across the fast-growing Southern African cities due to high unemployment rates. Their results found that about 57 per cent of households across 11 cities in Southern African were food insecure, of which 80 per cent were poor households.

In 2013, an assessment done by the Emergency Food Security Assessment (EFSA) in Namibia found that 16 per cent of the total population were severely food insecure, while 22 per cent were moderately food insecure (WFP, 2017, p. 1). Additionally in 2015 Namibia was rated 87th among 200 countries assessed on the Global Hunger Index, with an index count of 31.8 implying a severe food problem. The Index further showed that 43 per cent of the population proportion was undernourished, whereas the prevalence of underweight and stunting in children under-5 years stood at 13 per cent and 24 per cent respectively, and 5 per cent of under-5 child mortality WFP (2017).

Studies done to assess the state of food security in Windhoek found it to be a major challenge faced by numerous urban poor living in informal settlements. Nickanor (2013) found that 63 per cent of households included in the study sample were food

insecure. The results further differentiated occurrences of food shortage between the urban poor from informal and formal settlements, the findings indicated that poor urban residents from informal settlements experienced higher magnitude (75 per cent) of food insecurity compared to their counter parts from formal residential areas (50 per cent). She argued that, even though food insecurity was a major problem for all poor residents of informal settlements, the situation was more severe for women. The study found that 85 per cent of female-headed experienced severe food insecurity level compared to other households (Nickanor, 2013, p. 118).

Literature have pointed out that, food insecurity is an ongoing public health concern that has implications on individual life span and it contributes to poor outcomes of quality of life (Gundersen, 2013; Naicker et al., 2015; Chung et al., 2016).

Likewise, other studies have also found food insecurity to be linked to poor nutritional outcomes that are mostly associated with underweight and malnutrition in both adults and children (Black et al., 2008; Garvelink & Wedding, 2013; Chege, Ndungu, & Gitonga, 2016). Among adults, food insecurity has been reported to have had negative effect on general health, mental health, life dissatisfaction, stress, depression, social relationship, deprivation, anxiety, and poor maternal health outcome in women (Palar et al., 2015; Tesfaye et al., 2016). Furthermore, food insecurity among women also results in poor childcare, which often has consequences of children being sick and hunger. Children under-5 years requires more energy and nutrients for rapid growth and physical development (Chege et al., 2016).

If not controlled, food insecurity can have devastating long-term effect on human development (impaired physical growth, and cognitive abilities of children, poor health status, behavioural and emotional, etc.). Additionally, Hadley and Wutich (2009) stated that not having access to nutritious food has implications on human health and it is highly important to understand the consequences faced by those affected.

In urban areas, food insecurity exists because of high level of poverty and unemployment rate in informal settlements. In the context of urban food security, food access depend more on purchasing power as opposed to rural areas where residents depend on available food. With the majority of residents of informal settlements depending on informal market for income, most of them struggle to purchase food on a daily basis, and they are more likely to experience food shortage in periods related to low earnings or lack of income (Frayne et al., 2010).

Even though there are a number of studies undertaken on urban food insecurity in Namibia, there is scanty research on the impact of food insecurity on quality of life. Additionally, findings from these studies continued to show that food insecurity remain to be a health concern that is faced by many residents of informal settlements. Hence, the impact of food insecurity on quality of life in the informal settlements remains unknown, and currently policy makers and researchers cannot quantify the magnitude of food insecurity on quality of life. Therefore, there is a need to assess the impact of food insecurity on quality of life using models that consider multiple indicators and multiple causes, since going without food does have an impact on human's well-being.

Additionally, due to the complexities that exist in each construct (food insecurity and quality of life), with each construct having a set of indicators, appropriate models are required to examine the complexity between food insecurity and quality of life. Moreover, the complexity between food security and quality of life has not been explored, and the validity and reliability has not been investigated in many studies. The study wishes to derive and validate the constructs of food insecurity and quality of life in Windhoek informal settlements, and quantifies the magnitude and capture directional effect of food insecurity on quality of life.

1.3. Objectives of the Study

The purpose of this research project is to model the relationship between food insecurity and the quality of life in the informal settlements of Windhoek through Structural Equation Modelling (SEM) approach.

The specific objectives of the study are:

a) To derive and validate the components of food insecurity in Windhoek informal settlements; and compare their agreement to the structured FANTA domains.
b) To generate and validate the components of quality of life in Windhoek informal settlements; and subsequently compare their similarity to the structured WHOQOL-BREF domains and the EQ-5D domains.
c) To quantify the relationship between food insecurity and quality of life in Windhoek informal settlements.

1.4. Significance of the Study

The findings of the study may provide necessary information that may help policy makers to address issues affecting the livelihood and the quality of life of people living in informal settlements. The study may also contribute to the existing literature on food insecurity and quality of life. It may also provide developmental insights on how the Namibian government can reprogram its activities set out to achieve the national goals stipulated in the Harambee Prosperity Plan (HPP) and the National Development Plan 5 (NDP5) to end hunger, poverty, and infrastructure development. That are line with the United Nations Sustainable Development Goals to: End poverty in all its forms everywhere (goal 1.1); End hunger, achieve food security and improve nutrition and promoted sustainable agriculture (goal 2.1); Ensure healthy lives and promote well-being for all at all ages (goal 3.1); and Make cities inclusive, safe, resilient and sustainable (goal 11.1) by 2030.

1.5. Organisation of the Thesis

Chapter 1 introduces the subject problem statement and objectives. The remaining chapters of thesis are structured as follows: Chapter 2 discusses the empirical theoretical framework and review of relevant scholarly literature on which the study is based. Chapter 3 discusses the study design, variables used in the analysis. Chapter 4 discusses the rationale behind the fitted models, and focuses on establishing the construct of food insecurity and quality of life at household level. Chapter 5 focuses on linking the constructs of quality of life to food insecurity. Chapter 6 discusses the results, make general conclusions and recommendations for further research.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Introduction

This chapter focuses on the review of literature on food insecurity and quality of life and identify outcomes from other studies that relate to the situation in Windhoek informal settlements. This chapter also reviews how the domains of FANTA, WHOQOL-BREF, and EQ-5D were derived.

2.2. Urbanisation and Urban Poverty

This section discusses the link between urbanisation and poverty. In demography, urbanisation is defined as an increase in the proportion of the population that is living in urban areas (Poston & Bouvier, 2010, p. 308). Currently, rapid urbanization is experienced in Asia and Africa, with about 80 million people being added annually on Asian urban populations and 15 million on African urban populations compared to other regions of the world (Tacoli, McGranahan, & Satterthwaite, 2015). In the future, the world urban population is projected to reach 60% (4.9 billion) by 2030, and 66% (6.5 billion) in 2050 (UN-DESA, 2015).

2.2.1. Urbanisation and Poverty in Africa

Over the years, Africa has been rapidly urbanising due to economic expansion, development of better infrastructure, and other benefits offered in urban areas compared to rural areas. As a result of high poverty levels in rural areas, most people have been migrating to urban areas in search for better standard of living, such as better employment, better health services, and better education. Even

though urban areas were perceived to offer more benefits and better employment opportunities than rural areas, UN-Habitat (2016) remarked that, currently numerous urban centres in developing countries are "facing enormous challenges and changes then they did 20 years ago" (p. 1). This is attributable to the event that in most developing countries urbanisation is primarily fuelled by high population growth rate as opposed to economic growth, resulting in failure of labour markets to absorb the fast growing urban populations, leaving the majority unemployed (Buhaug & Urdal, 2013). Additionally, Cobbinah, Erdiaw-Kwasie, and Amoateng (2015a) argued that rapid and uncontrolled urbanisation in Africa has created surplus of unskilled labour in areas with limited economic growth.

Similarly, Tacoli et al. (2015) pointed out that rural-urban migration has been a major contributor to rapid urbanisation in most low-income countries, and it has contributed to unsustainable land use, shortages of water, service delivery, infrastructure development, congestion, and overcrowding. Lack of knowledge and experience among rural-urban migrants exposes them to poverty, unemployment, economic inequality, deprivation, food insecurity and malnutrition (Mohiddin, Phelps, & Walters, 2012; Tacoli, Bukhari, & Fisher, 2013; Tacoli et al., 2015). According to Maitra and Rao (2015) poverty is one of the major aspect that increases the probability of experiencing livelihood shocks among low-income households and poor rural-urban migrants.

Cobbinah et al. (2015a) pointed out that most African cities are facing challenges of "unsustainable land development and increased urban poverty" (p. 66). They further reported that African cities are facing a risk of breakdown in terms of their

capability to absorb their ever-growing urban populations, which then result in development of informal settlements or slums. Consequently, this has also resulted in an increase in air pollution, traffic congestion, and high-level use of energy and greenhouse gases emission (Cobbinah et al., 2015a).

For many years, Africa's economic circumstances have not been fair to the urban poor, before the 21st century poverty was mostly a phenomenon experienced in rural areas. However, the current emerging realities of rapid urbanisation have worsened urban poverty that negatively influenced urban livelihoods and it undermined the world common perception of urban areas being the engines of human growth and development (Cobbinah et al., 2015a, p. 67). Tacoli et al. (2013) made a similar conclusion, that even though poverty remained intense in rural areas, its enormousness is more felt in urban areas where residents depends on income for a living. This were similar to those of Zhang (2016) who found poverty to be more significant in urban areas than rural areas, his analysis further concluded that urban poor are more poorer compared to their rural counterparts.

Although there are many aspects that describe urban poverty, gender discrimination, unemployment, rural-urban differences, vulnerability, insecurity, poor water supply, poor health, and poor governance remain to be dominant in most African countries (Cobbinah et al., 2015a; Cobbinah, Erdiaw-Kwasie, & Amoateng, 2015b).

2.2.2. Poverty and Income Inequality in Developing Countries

It is worth mentioning that there are various definitions of poverty. Cobbinah et al. (2015b) argued that even though poverty has been affecting human generations over the past centuries, it remained indefinable; it is described with attributes based on deprivation, social exclusion, and lack of participation. The current study defined poverty in monetary (deprivation) setting. Poor are referred to be those with insufficient income or consumption that is below a set minimum limit, measured using a poverty line (Khandker & Haughton, 2005). According to Khandker and Haughton (2005) poverty lines are based on "the cost of basic needs, food energy intake, and subjective evaluations" (p. 42). The World-Bank-Group (2016, p. 29) stated that a person is considered to be living in extreme poverty if he or she live on less than US$1.90 per day. In their report, World-Bank-Group (2016) pointed out that, even though there has been progress in reducing global poverty, the "levels of poverty remain unacceptably high and particularly concentrated in Sub-Saharan Africa and South Asia" (p. 32).

The World-Bank-Group (2016) historical trends of poverty reduction showed that in 1990, 37.1% (1,958.6 billion) of the world population lived in poverty, compared to 12.7% (896.7 million) in 2012. Regionally, East Asia and Pacific have shown a substantial improvement in poverty reduction. In 1990, these regions had a combined poverty rate of 60.6% (995.5 million) which decreased to 7.2% (147.2 million) in 2012. Additionally, the report revealed that South Asia and Sub-Saharan Africa have lagged behind in poverty reduction. In 1990, South Asia had a poverty rate of 50.6% (574.6 million) and 18.8% (309.2 million) in 2012. Whereas, Sub-

Saharan Africa had a poverty rate of 56.8% (287.6 million) in 1990 and this figure was only reduced to 42.7% (388.8 million) in 2012, indicating a slow progress in poverty reduction compared to South Asia (World-Bank-Group, 2016). Slow progress in poverty reduction in these regions can be attributed to following reasons; more than half of the population in these regions live in rural areas; the regions have higher rates of unemployment, higher rates of income inequality and higher rates of residents living in informal settlements among other (UN-Habitat, 2016).

Income inequality is another challenge faced by most urban residents, and it has broadened the gap between the well-off clusters and residents of low-income and informal settlements (Buhaug & Urdal, 2013; Tacoli et al., 2013; UN-Habitat, 2016). This has resulted in division and stigmatisation, by excluding a larger proportion of urban population (poor people) from living economically and socially productive life, and it confined them to poor living conditions (UN-Habitat, 2016, p. 17). Alvaredo, Chancel, Piketty, Saez, and Zucman (2017) observed that income inequality varies significantly from one place to another, they found it be lower in Europe (37%) and China (41%), and higher in the Middle East (61%), Brazil and India (55%), and Sub-Saharan Africa (54%). Alvaredo et al. (2017) further added that over the years income inequality continued to be steadily higher in Sub-Saharan Africa, Brazil, and Middle East than it is in other regions.

The highest levels of income inequality around the world can be explained by the fact that nearly 192 million (5.5%) people are unemployed, and 1.4 billion (42%) are in vulnerable employment, this number is expected to increase by 17 million per

annum between 2018 and 2019 (ILO, 2018, p. 6). Besides those in vulnerable employment, additional 300 million (10%) workers have "a per capita household income or consumption of less than US$1.90 per day in purchasing power parity" (ILO, 2018, p. 8). That is to say, most people live below the global measure of poverty; which make them to be more susceptible to changes in commodities prices in international markets.

Kimani-Murage et al. (2014) emphasised that earning an income is the most crucial aspect for persons and households in urban areas; this is because most services offered in urban areas depend on purchasing power. Frayne, Crush, and McLachlan (2014) made similar discovery, they found income to be one of the vital asset in an urban setting that provide individuals and households access to food and other resources. Thus, lack of income in a particular household results in it to be described as an underprivileged household.

On the same note, Wekesa et al. (2011) maintained that unemployment is one of major socio-economic aspects that affect most people living in urban areas, and it has consequences that are linked to family and personal stress, depressed quality of life, crime, lack of income, overcrowding in households, poor housing, and food insecurity. Lack of income affects individuals' abilities to meet their socioeconomic well-being and their abilities to develop their human dignity. It also affects individual attitudes towards conserving their environment surrounding, which then result in unsustainable land use and emergence of informal settlements or slums (Cobbinah et al., 2015b, p. 23).

2.2.3. Poverty and Inequality in Southern Africa

Frayne et al. (2010) found that Southern Africa cities are experiencing rapid urban growth that is associated with ever-growing poverty and high level of income inequality. The study found that, about 60% of households in the region are living below US$1.90 per day (moderately poor), and in most countries, the percentage of those living below poverty line is more than 50%, besides Botswana where only 30% of the household lived below US$1.90 per day. Whereas in Namibia 56% of the households indicated that they lived below US$1.90 per day. On top of that, Namibia is reported to be amongst countries with higher income inequality and high poverty rate in the world. According to SADC (2016) Namibian poverty rate in 2010 was reported to be 28.7% (with 14.6% urban poverty rate) and inequality rate of 59.7%. This is implies that poverty continue to exist in Namibia's urban centres and it mostly affect poor urban residents who experience livelihood challenges such as, food insecurity and poor well-being.

2.2.4. Poverty and Emergence of Informal Settlements in Developing Countries

According to Fox (2014); Tacoli et al. (2015) informal settlements usually develop as a result of poor migrants and poor city-born who tries to integrate themselves into a city's economic lifestyle, given that most of them cannot afford to build, buy or rent a decent housing unit that will keep them closer to employment opportunities. In other words, slums exist as a result of urban poverty, and their continuous growth can be linked to cities population growth (Fox, 2014; Tacoli et al., 2015). UN-Habitat (2016) argued that the continuous growth of informal settlements and slums continues to be the driving force of poverty, inequality and

deprivation around the world and improving the well-being of people living in informal settlements is one of the key strategies geared towards ending poverty by 2030.

Further, UN-Habitat (2016) found that there has been progress in reducing the number of people living in informal settlements globally between 2000 and 2014, when a total number of 320 million people were uplifted from informal settlements and slums. However, UN-Habitat (2016) acknowledged that even though the percentage of the population living in slums is lower than it was twenty years ago, the absolute population of slum residents still continue to grow. In 2014, Eastern Asia had about 251 million residents that lived in informal settlements, followed by Sub-Saharan Africa 200 million, Southern Asia 190 million, Latin America and the Caribbean 104 million, South-East Asia 83 million, Western Asia 37 million, Northern Africa 11 million and Oceania 500 thousand residents respectively (UN-Habitat, 2016).

2.3. Urban Food Insecurity

Literature established that food systems around the world have been changing overtime because of rapid urbanisation, and the major changes are observed in food distribution, marketing, affordability, and food preferences (Gregory, Ingram, & Brklacich, 2005; Crush & Frayne, 2010a). These changes have in-turn affected all dimension of food security (availability, accessibility, utilization, and stability) leading to the collapse of food systems, because of changes in economic, social, and climatic factors (Gregory et al., 2005; Friel & Ford, 2015). Tacoli et al. (2013) argued the progress to reduce malnutrition in the world has slowed down due to changes in international food prices in 2007 and 2008. They added that during this

period most individuals and households changed the quantity and quality of their food intake for them to adjust to food prices. This indicates that a vast proportion of people were exposed to insufficient food intake, that is associated with poor nutritional status, unhealthy life styles and poor quality of life (Chege et al., 2016).

2.3.1. Food Insecurity and Poverty in Southern Africa

Urban poverty and food insecurity are some of the major challenges encountered by many urban residents around the world as result of higher inequality and unemployment rate. Tacoli et al. (2013) acknowledged that even though there is substantial food to feed everyone in the world today to live a healthy life, not all people have access to food, especially those that live in urban areas. In the context of urban food security, food availability is no longer an issue since there are numerous supermarkets and food outlets in cities and towns. However, the challenge of urban food insecurity continues to be access to food (Crush et al., 2012; Pendleton et al., 2014). Frayne et al. (2010) reasoned that the present global economic crisis and the continuous increase in food prices have placed a burden on poor urban households' food insecurity due to lack of income. In their study, Frayne et al. (2010) found that most households experienced food shortage, due to their inability to buy food at higher prices.

As a result, high level of urban poverty has led to various individuals and households to struggle to secure adequate access to food, as food access in urban areas depends on income (purchasing power) as opposed to rural areas where households depend on available food (produced) (Abdula, 2011; Tacoli et al., 2013; Maitra & Rao, 2015). Further, Frayne (2007) found poverty to be the leading the

cause of food insecurity and hunger in most urban households. He highlighted that in order to reduce food insecurity, there is a need to increase employment among urban poor, and this will eventually improve their quality of life (Frayne, 2007; DFID, 2008).

Likewise, high level of urban poverty, led to most poor households to rely heavily on informal economies and casual jobs that provide low and irregular incomes and offer no benefits (Crush & Frayne, 2010b; Mallick & Rafi, 2010; Tacoli et al., 2013; Maitra & Rao, 2015). A study by Frayne et al. (2010) investigated the respondents' source of income and their periods of food shortage, they discovered that 78% of the households reported that in the past six months, there have been times when they have gone without food due to increase in food prices. They further found that 66% of households reported that they depended on informal wages for income, while 34% depended on formal wages from full-time employment. This implies that income plays a predominant role in accessing food in urban areas. Hence, households with low or irregular income were more likely to experience food insecurity when food prices increased.

Additionally, Frayne et al. (2010) found a positive relationship between poverty and food insecurity. They argued that poorest households were more likely to experience extreme magnitude of food insecurity, than wealthy households were. Their study cross-tabulated lived poverty index and poverty, and they found a direct significant relationship ($cc=0.395$) between the two items ($p<0.001$). The study also found a positive relationship between household income and food insecurity, similar to the findings of Pendleton, Nickanor, and Pomuti (2012); Tacoli et al.

(2013); Frayne et al. (2014) who found a close link between poverty, income and food insecurity. This suggested that households with low income were more likely to experience highest level of food insecurity. Frayne et al. (2010) backed their claim by adjusting for country currency's variation, using three income categories (i.e. least poor, less poor, and poorest). Their findings showed that 57% of food secured households belonged to high-income earners, whereas 36% of the food insecure households were from poor income category (Frayne et al., 2010, p. 36). Similarly, a study by Kirkpatrick and Tarasuk (2010) in Canada found that low income earning households and households that depended on social grants had higher odds (AOR=2.52, 95% CI 1.44; 4.43) of food insecurity compared to those from high income earning households (AOR=1.50, 95% CI 0.82; 2.74).

Similarly, a study by Pendleton et al. (2012) found a positive relationship between household's earnings and food expenditure among poor urban households in Namibia. Their results showed that amongst Windhoek residents, 57% of households from the poorest income quintile reported to have spent much of their annual income on food, compared to high income-earners who reported to have only spent 13% of their earnings on food. Their results implied that there was an inverse relationship between wealthy households' general spending and spending on food. Hence, wealthy households spend more on luxurious items such as, transport (20%), furniture and equipment (11%), and recreation, entertainment and sport (5%). As opposed to poor households spending, transport (2%), furniture and equipment (4%), and recreation, entertainment and sport (0.5%) (Pendleton et al., 2012, p. 18). These findings were similar to those of Tacoli et al. (2013) who found

food to be the most vital expenses in low-income households, since it constituted a greater portion of their budget.

In terms of food sources, Frayne et al. (2010) pointed out that informal markets/street food, supermarkets and small food outlets are the highly utilised sources of food access among poor urban residents in most Southern African cities. They found that supermarkets were least (5%) utilised on a daily basis by the urban poor, followed by small outlets (22%) and informal markets (31%). Pendleton et al. (2012) found that food insecure households in Namibia are more likely to source food from informal markets (70%) compared to food secured households (53%). This means that the lower percentage utilisation of supermarkets among the poor could be due to the following reasons. Firstly, in most urban set-ups, supermarkets are mostly located in suburbs where middle and upper income earner lives. Secondly, food prices are likely to be higher in supermarkets given the perceived quality of food, and those with lower/unstable wages may not be able to afford buying in supermarkets on a daily basis. Hence, urban poor tend to source food more frequently from small outlets and informal markets, because such establishment are located within their communities, and they do not have to travel longer distances or use additional money to pay for transport.

On household size and space, Frayne et al. (2010) found that household size was not a significant predictor of households' food insecurity outcomes. However, Kirkpatrick and Tarasuk (2010) found a positive relationship between household size and food insecurity outcomes. They pointed out that, households with more children experienced severe food insecurity compared to those with fewer children.

Similarly, Tacoli et al. (2013) found that inadequate space (overcrowding) in households was one of the obstacles why households do not buy food in large quantities. Other studies by Olayemi (2012); Maitra and Rao (2015) also made similar conclusion about household size and food insecurity.

2.3.2. Food Insecurity and Women Socioeconomic Status

Literature established that food insecurity is not only influenced by poverty. Weiser et al. (2007); Mallick and Rafi (2010); Ivers and Cullen (2011); Maitra and Rao (2015); Atuoye and Luginaah (2017) stated that there are several complex factors that affect food security such as infrastructures, age, poor sanitation, HIV/AIDS and gender amongst others. Hadley and Wutich (2009) findings pointed out that gender has implications on access to resources and basic needs such as food and water in the society. Their findings corresponded to those of Mallick and Rafi (2010); Pendleton et al. (2012); Maitra and Rao (2015) who found that female-headed households were likely to experience food insecurity compared to households headed by their male counterparts. A similar relationship was found to be true in the informal settlements of Windhoek, Namibia, by Nickanor (2013) who found female-headed households to be more food insecure and experienced food shortage compared to male-headed households.

In Bangladesh, Mallick and Rafi (2010) found that in most situations female-headed households are more exposed to food insecurity because of the "triple burden" that women face in society. According to Mallick and Rafi (2010) "women are mostly: (1) underprivileged in the economic activities, (2) responsible for taking care of children and household chores, besides working out of the household, and (3) face

higher dependency ratio of being the only breadwinner" (p. 539). They further added that in most instances other household members (male) regularly expose women, elderly, children, and the disabled members of the household to food insecurity by victimising and discriminating them. Another study done in India by Maitra and Rao (2015) found that food insecurity to be common in household headed by females, because such households are mostly deprived off assets, and they have more children (higher dependency ratio) and most of them are less literate.

On the same note, Ivers and Cullen (2011) pointed out that in most cases when women find it difficult to provide food for their households (especially those with low education attainment and limited economic prospectus), they resort to use risky coping strategies such as engaging in transactional sex, that has consequences of acquiring HIV/AIDS and other infectious diseases. As a result, ill-health reduces women's ability to produce and prepare food for their families resulting in more severe food insecurity among women and their children (Ivers & Cullen, 2011, p. 1742s).

2.4. Food Insecurity and Quality of Life in the Global South

This section examines the link between food insecurity and quality of life. The reviewed papers showed that food insecurity affects individual well-being through numerous pathways that are either related to physical or psychological conditions or in pathways that are related to dietary intake.

Jones (2017) conducted a study of 149 countries across the world, and found food insecurity to be major contributor to mental disorders through various pathways. Further, Atuoye and Luginaah (2017) found psychological and physical wellbeing among Ghanaian adults to be linked to food insecurity. They also found that there was a higher incidence of exposure and vulnerability to health problems among food insecure households, compared to food secure households. In Burkina Faso, Nanama and Frongillo (2012) reported that various non-nutritional health outcomes in both adults and children such as poor educational attainment, poor physical health and growth, behavioural problems, poor mental health, poor child development and poor parenting problems to be related to household's food insecurity.

Similarly, in Ecuador Weigel et al. (2016) found that poor mental health outcomes such as stress, depression, anxiety, and psychological stress to be linked to household food insecurity. They argued that, living in a household that has no sufficient food is stressful particularly for women and children. Their findings were similar to those of Widome, Neumark-Sztainer, Hannan, Haines, and Story (2009) in the United States (US) who found food insecure households to have had higher incidences of stress. Other studies done in Zambia (Cole & Tembo, 2011), Ethiopia (Hadley, Tessema, & Muluneh, 2012), and the US (Leung, Epel, Willett, Rimm, & Laraia, 2014) made similar conclusions about the link between poor mental health and food insecurity.

In addition, HLPE (2012) acknowledged that food insecurity has a human vulnerability component that comprises of the likelihood of being exposed to stress

of food shortage, and the ability to cope with such stress. They outlined that vulnerability and poverty are interrelated in the sense that the possibility of being exposed to stress is greater among the poor, because they spend a large portion of their resources on either buying or producing food. Therefore, this reduces their ability to cope with stress caused by food shortage, and it pushes them to starve (HLPE, 2012). Hence, this affects individual psychological well-being and thus resulting in poor quality of life outcomes.

In general, stress has been identified to be the leading cause of depression in most societies. Consequently, stress caused by food insecurity has a greater influence to trigger anxiety and depression among households' heads (Leung et al., 2014). This was also documented in the work of Coates, Swindale, and Bilinsky (2007) who found that households' heads from food insecure household carried a greater burden of ill-health, that exposed them to depression and elevated mental suffering.

Jones (2017) pointed out that depression in households' heads mostly occur when they fail to secure food in socially acceptable ways, and thus resorting to acquiring food in a socially unacceptable ways (e.g. begging or borrowing). Further, Jones (2017) argued that acquiring food in such manners often leads to a person feeling ashamed, guilty, powerless, and feeling alienated from society. His findings conformed with those of Nanama and Frongillo (2012) who found food insecurity to be the cause of social and psychological problems in most households, such as being worried or anxious about food availability, which often result in social deprivation and the sensation of alienation.

The feeling of alienation is typically common among households' heads who often feel humiliated when their household have no food. Nanama and Frongillo (2012) claimed that in times of food scarcity, households' heads have developed habits of relying on socially unacceptable ways to acquire food, and they do it either by borrowing or by asking food from neighbours. Therefore, this discloses one's food insecurity and exposes a person to judgements on their incapability to provide for their family.

Additionally, Atuoye and Luginaah (2017) found a similar link between household food insecurity and mental distress among households' heads. Their findings unfolded that in time of food shortage, women who lives in 'compound houses' uses a common method to hide thier food shortage from others. They pointed out that most women put-up pots with water on the fire while others are cooking to pretend that something is being prepared for their families. Going to the extent of failing to disclose food shortage to others can lead to elevated mental distress, that often result in depression (Atuoye & Luginaah, 2017).

Further, Atuoye and Luginaah (2017) added that women were more exposed to food related stress and depression than men were, because they face challenges of accessing economic and social resources for their households' livelihood. Similarly, women from households were men are in charge of the household well-being, still suffered from stress caused by food insecurity since their husbands are in not charge of food purchasing and preparations (Atuoye & Luginaah, 2017).

As a consequence of fear of being criticised for disclosing one's food insecurity status, most households developed ways to manage limited food that they have for them to cope with food shortage (Nanama & Frongillo, 2012; Weigel et al., 2016). Studies done by Ivers and Cullen (2011); Nanama and Frongillo (2012); Olayemi (2012); Kimani-Murage et al. (2014); Maitra and Rao (2015) found that in difficult times when households have limited resources to access food, most households resorted to using unsustainable coping strategies to address physical and psychological experience of food shortages.

The most common practiced coping strategies used were skipping meals and cutting number of meals eaten in a day, reducing quality and variety of food, sending household members to eat elsewhere, eating street food, buying food on credit, stealing, selling personal belongings, scavenging, and engaging in sex for food or money. Even though these coping strategies help to reduce psychological hunger in a shorter period, they affect individuals' nutritional intake in a long run and thus causing malnutrition and mental distress (Weigel et al., 2016). Jones (2017) argued that such behaviours could also compound to pre-existing anxiety triggered by food insecurity that have consequences of poor mental health.

Friel and Ford (2015) described that insufficient food intake leads to undernutrition, which often causes stunting, wasting, and psychological stress. In most instances, undernutrition implies lack of micronutrients intake that have consequences of blindness, impaired immunity, growth, poor reproductive outcomes, and poor cognitive functioning (Friel & Ford, 2015, p. 438). Black et al. (2008) found countries in Asia, Latin America, and Africa to have the highest proportion of

stunting compared to other part of the world. Friel and Ford (2015) added that in 2011 an estimate of 9 million children under-five years had severe malnutrition, with the majority residing in South East Asia and Africa. Over the years, undernutrition has caused a substantial increase in mortality and the overall burden of disease in low and middle-income countries (Friel & Ford, 2015). Further, Black et al. (2008) reported that over the years, undernutrition has caused over "3.5 million maternal and child deaths" (p. 243) every year.

Additionally, Friel and Ford (2015) added that if undernutrition is not controlled, it affects the health and quality of life outcomes of individual throughout their lifespan. Undernourishment has multi-generational consequences on quality of life and well-being that mostly affects children and pregnant women. If not controlled in adults' women, they are likely to give birth to underweight babies that are at increased risk of contracting chronic diseases (Black et al., 2008; Friel & Ford, 2015; Weigel et al., 2016). Further, having insufficient food and nutrients during childhood affect cognition and psychological growth, that has outcomes of poor learning ability and behavioural malformation. In adults, lack of nutrition has been associated with low productivity and low attendance in works that entail physical strength (Friel & Ford, 2015).

Similarly, To, Frongillo, Gallegos, and Moore (2014) found a positive relationship between physical activity engagement and food insecurity among the US population. Their study found that individuals from food insecure households were less likely to engage in physical activities than those from food secure households. To et al. (2014) further pointed out that the two aspects are linked in two differing

directions, “firstly, food insecurity could lead to nutrient insufficiency, distress, and poor health, and therefore, a lesser amount and lower intensity of physical activities. Secondly, a lesser amount and lower intensity of physical activities could lead to poor general health, higher health costs, lower work productivity, and therefore being unable to afford enough food” (p. 1801).

Furthermore, Burchi and De Muro (2012) found food insecurity to have a greater influence on learning and knowledge acquisition at all stages in life. They argued that food insecurity has an effect on school enrolment and attendance amongst school going children, and it reduces their ability to concentrate in class (since they are hungry). Their results further showed that school enrolment rate and pass rates are lower among children from food insecure households compared to those from food secured households. Their results also indicated that children from food insecure households, resort to doing part time jobs in order to contribute to the household’s income (Burchi & De Muro, 2012). Other similar studies in the US made conclusions that food insecurity affected academic performance, in the sense that children from food secure households tend to perform exceptionally well compared to those from food insecure households (Maroto, Snelling, & Linck, 2015; Silva et al., 2015).

2.5. Theoretical Framework

Literature confirms that there is a complex relationship between food insecurity and health status, that are linked in a number of series of mental health, behavioural, and nutritional pathways and this relationship is best described using a conceptual

framework (Weiser et al., 2011). A conceptual framework can be helpful in analysing and depicting health problems that are caused by biological and social aspects (Weiser et al., 2011). In the reviewed literature, there has not really been a single exceptional conceptual framework on studies of food security and quality of life. However, most studies have pointed out that food insecurity is structurally driven by a set of interrelated factors that operate at community level, namely economic, social and climatic factors. These factors in-turn determine food security outcomes at a household level and quality of life at individual level.

The current study adopted and modified a conceptual framework from Weiser et al. (2011) to fit the study purpose, shown in Figure 1.

The conceptual framework consisted of three levels of determinants, that is community, household, and individual level that link socio-economic well-being to food security and quality of life. At community level, food security is influenced by a set of interrelated factors such as social (gender inequality, stigmatisation, etc.), economical (unemployment, poverty, poor education, etc.), and climate (drought, flooding etc.). Any negative change that occur in these factors can affect the dimensions of food security (availability, accessibility, utilisation, and stability), which then result in collapse of food systems at community level (Altman et al., 2009).

Likewise, at household level, aspects such as social support, family size, and family structure influence food security outcomes. At this level, food security plays a predominant role in shaping individual's actions and well-being through nutritional, mental and behavioural pathways. These household aspects can either affect food

security in a positive or negative way. Kirkpatrick and Tarasuk (2010); Olayemi (2012); Tacoli et al. (2013); Maitra and Rao (2015); Chege et al. (2016) maintained that households with lack of social support and those larger in size are more likely to experience high level of food insecurity and malnutrition due to sharing limited resources among them, compared to household with good social support and those smaller in size. Hence, households with high level of food insecurity are likely to have malnourished household members. This can then result in poor health outcomes such as poor physical health and mental problems, and such household members are likely to suffer from stress induced by hunger (Casey et al., 2005; Weiser et al., 2011). Therefore, this sphere then affects the outcomes of quality of life at individual level.

The outcome of an individual's quality of life highly depend on all spheres within the framework and any change occurring in one sphere will inevitably result in changes in other spheres. For instance, lack of income will result in a collapse of food systems (inability to access food) at a household level, which then cause food shortage. Due to food shortage at household level, individuals are then exposed to starvation, malnutrition or mental health problems that might trigger them to engage in risky behaviours, such as engaging in sexual activities for monetary gain to buy food (restoring the collapsed food systems). This then result in individuals acquiring infectious diseases, such as HIV/AIDS and other diseases, therefore resulting in poor quality of life outcomes of an individual.

Even though the study stated that quality of life is more experienced at an individual level based on reviewed literature, the study acknowledge that there are studies done on community quality of life.

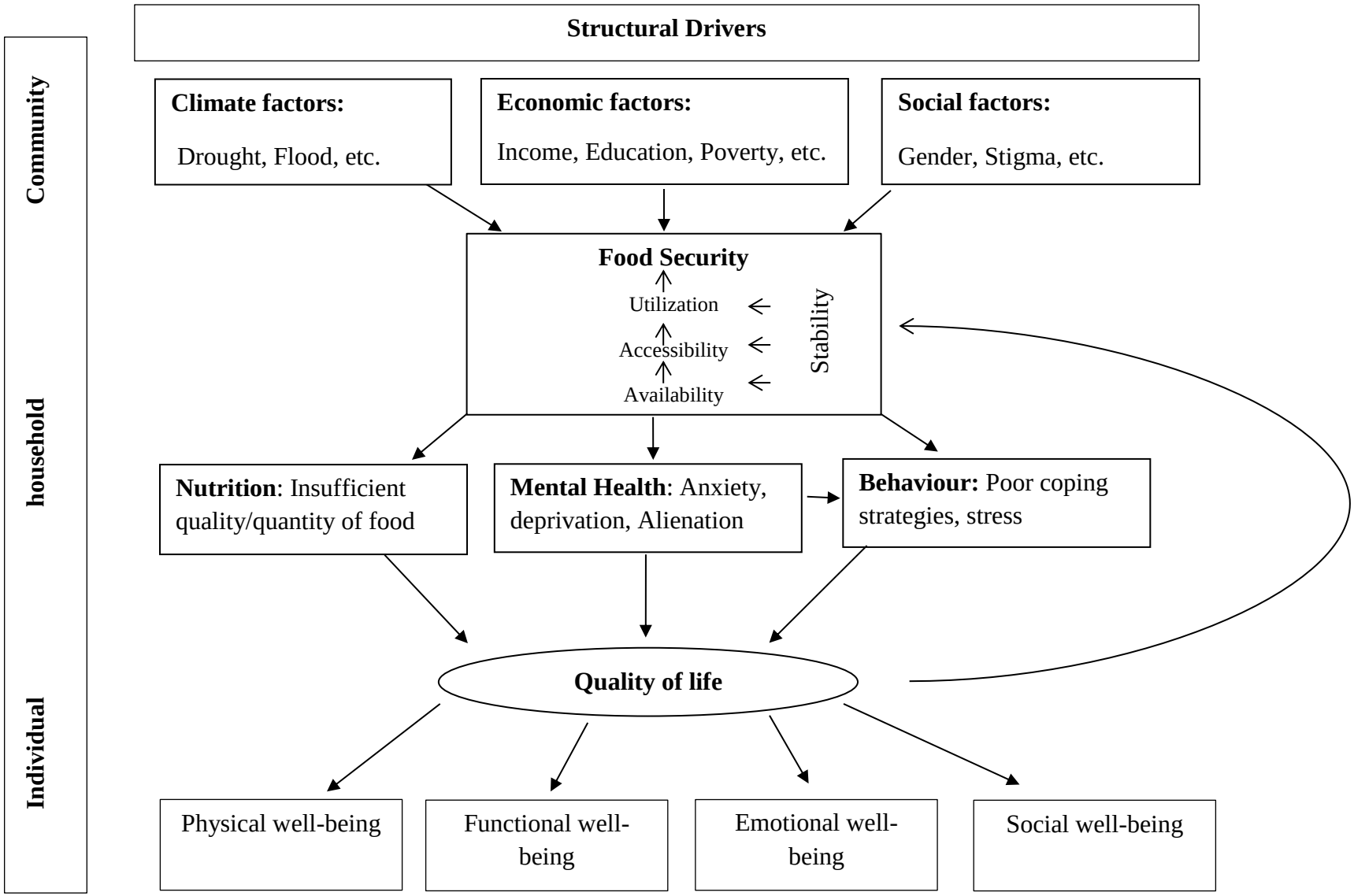


Figure 1 Conceptual framework for food security and quality of life, modified from Weiser et al. (2011).

2.6. Food Insecurity: Measurement using FANTA Approach

Over the years, measuring household food insecurity has been a challenge to many researchers and practitioners. The United States Agency for International Development (USAID)'s Food and Nutrition Technical Assistance (FANTA) group supported series of research initiatives to explore and test different options for meeting this need. One of the best options that FANTA came up with was the Household Food Insecurity Access Scale (HFIAS) indicators. These indicators were used to estimate the prevalence of food insecurity (access) in the United States (U.S.) annually (Coates et al., 2007, p. 1).

The indicators were based on the idea that they will be able to capture and quantify household's food insecurity experiences, "administered through a survey and summarised in a scale" format. After years of research in different countries around the world, FANTA was then able to coin a set of questions that distinguished food secure households from food insecure households. These set questions were used to assess food insecurity prevalence and detected food insecurity changes over time (Coates et al., 2007).

For the purpose of this study, we are more interested in reviewing how FANTA constructed the three domain of food insecurity (access) that is, "anxiety and uncertainty about household food supply", "insufficient quality", and "insufficient intake and its physical consequences" (Coates et al., 2007, p. 5). To come up with these domains, FANTA used a questionnaire administered to respondents through a survey by enumerators, using a recall period of four weeks (30 days). According to Coates et al. (2007) "the questionnaire contained of nine occurrence questions

representing a general increasing level of food insecurity (access), and nine "frequency-of-occurrence" questions that were asked as a follow-up to each of the occurrence question to determine how often the condition occurred" (p. 5). Where respondent reported that the condition did not occur, the frequency-of-occurrence questions were skipped, and where they reported that it happened they were asked how often it occurred, whether it happened rarely (once or twice), sometimes (three to ten times) or often (more than ten) in the past four weeks (Coates et al., 2007, p. 5). Some of the questions asked were as follows:

1. In the past four weeks, did you worry that your household will not have enough food?

   0 = No (Skip to Q2)

   1 = Yes

1. a). How often did this happen?

   1 = Rarely (Once or twice in the past four weeks)

   2 = Sometimes (three to ten times in the past four weeks)

These set of questions were grouped into three domains of food insecurity (access) based on cross-country literature review (FANTA, 2004, Coates, 2004) (cited in Coates et al., 2007, p. 5). The set of questions are grouped in domains as follows:

1. Anxiety and uncertainty about the household food supply:
    - Did you worry that your household would not have enough food?
2. Insufficient Quality (includes variety and preferences of the type of food):
    - Were you or any household member not able to eat the kinds of food you preferred because of a lack of resources?

- Did you or any household member have to eat a limited variety of food due to a lack of resources?
- Did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?

3. Insufficient food intake and its physical consequences:
    - "Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
    - Did you or any household member have to eat fewer meals in a day because there was not enough food?
    - Was there ever no food to eat of any kind in your household because of a lack of resources to get food?
    - Did you or any household member go to sleep at night hungry because there was not enough food?
    - Did you or any household member go a whole day and night without eating anything because there was not enough food?

These questions were adopted from Coates et al. (2007, p. 5)

Coates et al. (2007) indicated that HFIAS indicators provide information on household level, and data can be entered in any available statistical software to produce results on different HFIAS indicators. The purpose of this study is not to generate the prevalence, but rather to construct domains of food insecurity (access) using SEM, and observe if the groupings will be similar to those of FANTA domains, since the study also used HFIAS generic occurrence questions.

2.7. Quality of Life: Measurement using WHOQOL-BREF Approach

WHO (1994) argued that there was a great need to develop an instrument that assess quality of life due to various reasons. Firstly, the focus of measuring health was broadening to other measures, other than just measuring indicators of morbidity and mortality. Even though, there were devised measures on the impact of disease, there was no measure that assessed quality of life. Quality of life was described to be "the missing measurement in healthcare" (WHO, 1994, p. 24). Secondly, WHO identified that most measures of health status were developed in a single cultural set-up, and translating them to other settings was time consuming and yielded unsatisfactory results for number of reasons. Thirdly, WHO identified that increase usage of medication only focused on curing diseases and symptoms, this supported the idea to add a humanistic component in health care. Hence, WHO developed interest in having a tool that legitimately measured quality of life outcomes internationally and that conformed to their mandate of promoting health and healthcare in a holistic way (WHO, 1994, p. 25). Therefore, availability of a worldwide quality of life assessment tool such as WHOQOL, has enabled WHO to conduct relevant research in numerous centres, and compare results obtained from different part of the globe (WHO, 1994).

According WHO (1996), WHOQOL-100 is a quality of life assessment tool that was developed simultaneously with data obtained from fifteen culturally diverse international field centres by WHOQOL group, in an effort to develop a quality of life assessment tool that would be pertinent to different settings of the world. Moreover, WHO (1994) clarified that development of WHOQOL-100 comprised of

several stages. The first stage dealt with establishing and agreeing on the definition of quality of life and the international approach to quality of life. The second stage dealt with piloting drafted questions and exploring the constructs of quality of life across different cultures. The third stage dealt with piloted instruments that were administered in a standardised form in all field centres to construct the scale. The final stage, dealt with field-testing to establish psychometric properties of WHOQOL that had about 100 items selected for inclusion in the field trail version, hence the name WHOQOL-100 (WHO, 1994, 1996). Initially, WHOQOL-100 had six domains, and after recent analysis of available data using SEM, the data yielded a solution with four domains to be more appropriate, resulting in the renaming of WHOQOL-100 to WHOQOL-BREF (WHO, 1996).

WHOQOL-BREF was developed to provide a short form of quality of life assessment tool that looked at the domain level profile, and it contained a total of 26 questions that ask how individuals feel about their well-being (WHO, 1996). From these set of questions, WHOQOL-BREF (Field Trial Version) produced two individually scored items that asked individual how they rate their quality of life and how satisfied they were with their health. The four WHOQOL-BREF domains were constructed by combining set of questions using SEM technique and they are all scaled in a positive direction (WHO, 1996). The domains were grouped as follows:

Overall Quality of life and General Health

Q1. How would you rate your quality of life?

Q2. How satisfied are you with your health?

Domain 1: Physical Health

Q3. To what extent do you feel that physical pain prevents you from doing what you need to do? (-)

Q4. How often do you need any medical treatment to function in your daily life? (-)

Q10. Do you have enough energy for everyday life? (+)

Q15. How well are you able to get around? (+)

Q16. How satisfied are you with your sleep? (+)

Q17. How satisfied are you with your ability to perform your daily living activities? (+)

Q18. How satisfied are you with your capacity to work? (+)

Domain 2: Psychological health

Q5. How much do you enjoy your life? (+)

Q6. To what extent do you feel your life to be meaningful? (+)

Q7. How well are you able to concentrate (+)

Q11. Are you able to accept your bodily appearance? (+)

Q19. How satisfied are you with yourself? (+)

Q26. How often do you have negative feelings such as blue mood, despair, anxiety, depression? (-)

Domain 3: Social relationships

Q20. How satisfied are you with your personal relationships? (+)

Q21. How satisfied are you with your sex life? (+)

Q22. How satisfied are you with the support you get from your friends? (+)

Domain 4: Environmental health

Q8. How safe do you feel in your daily life? (+)

Q9. How healthy is your physical environment? (+)

Q12. [Do you] Have you enough money to meet your needs? (+)

Q13. How available to you is the information that you need in your day-to-day life (+)

Q14. To what extent do you have the opportunity for leisure activities? (+)

Q23. How satisfied are you with the condition of your living place (+)

Q24. How satisfied are you with your access to health services? (+)

Q25. How satisfied are you with your transport? (+)

These questions were adopted from WHO (1996, p. 10). The (+) sign indicated that the question was phrased in a positive direction and the (-) indicated that the question was phrased in the negative direction. Before scoring the (-) phrased

questions needed to be reversed to (+) scoring. For the purpose of this study, we focus more on deriving components of quality of life in Windhoek informal settlements using SEM, and compare their similarity to WHOQOL-BREF domains, since the study also used the same set of questions developed by WHOQOL group.

2.8. Quality of Life: Measurement using EuroQoL EQ-5D Approach

The EuroQol group is a group of international network of researchers that are devoted to measurement of health status. According to EuroQol (2017) the group was established in 1987 to "develop a standardised non-disease specific instrument to describe and value health-related quality of life" (para. 1). The "EQ-5D is standardised measure of health status, used to provide simple and generic measure of health for clinical and economical appraisal" (van Reenen & Janssen, 2015, p. 4). Initially, the group consisted of researchers from Europe only, it further expanded to include members from Asia, Africa, Australia, New Zealand and North America. Currently EQ-5D is used in clinical trials, observational studies, population surveys and other health surveys (van Reenen & Janssen, 2015, p. 4).

In 1990, EuroQol introduced the EQ-5D-3L, an assessment tool that comprised of "five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension had three levels: no problems, some problems, extreme problems" (van Reenen & Janssen, 2015, p. 5). In 2005, the EuroQol group identified the need to improve EQ-5D-3L's sensitivity and to reduce its ceiling effects. After the review, instead of reducing the number of dimensions, the discussion decided on the new version of EQ-5D with five levels of severity in each

five EQ-5D dimensions, resulting in EQ-5D-3L to be renamed EQ-5D-5L (van Reenen & Janssen, 2015, p. 5). The added five levels of severity to each dimension were; no problems, slight problems, moderate problems, severe problems, and extreme problems. The set of question asked in EQ-5D-5L self-administered questionnaire were as follows:

Under each heading, please tick the **ONE** box that best describes your health

TODAY

MOBILITY

I have no problems in walking about □

I have slight problems in walking about □

I have moderate problems in walking about □

I have severe problems in walking about □

I am unable to walk about □

SELF-CARE

I have no problems washing or dressing myself □

I have slight problems washing or dressing myself □

I have moderate problems washing or dressing myself □

I have severe problems washing or dressing myself □

I am unable to wash or dress myself □

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

I have no problems doing my usual activities □

I have slight problems doing my usual activities □

I have moderate problems doing my usual activities □

I have severe problems doing my usual activities □

I am unable to do my usual activities □

PAIN / DISCOMFORT

I have no pain or discomfort □

I have slight pain or discomfort □

I have moderate pain or discomfort □

I have severe pain or discomfort □

I have extreme pain or discomfort □

ANXIETY / DEPRESSION

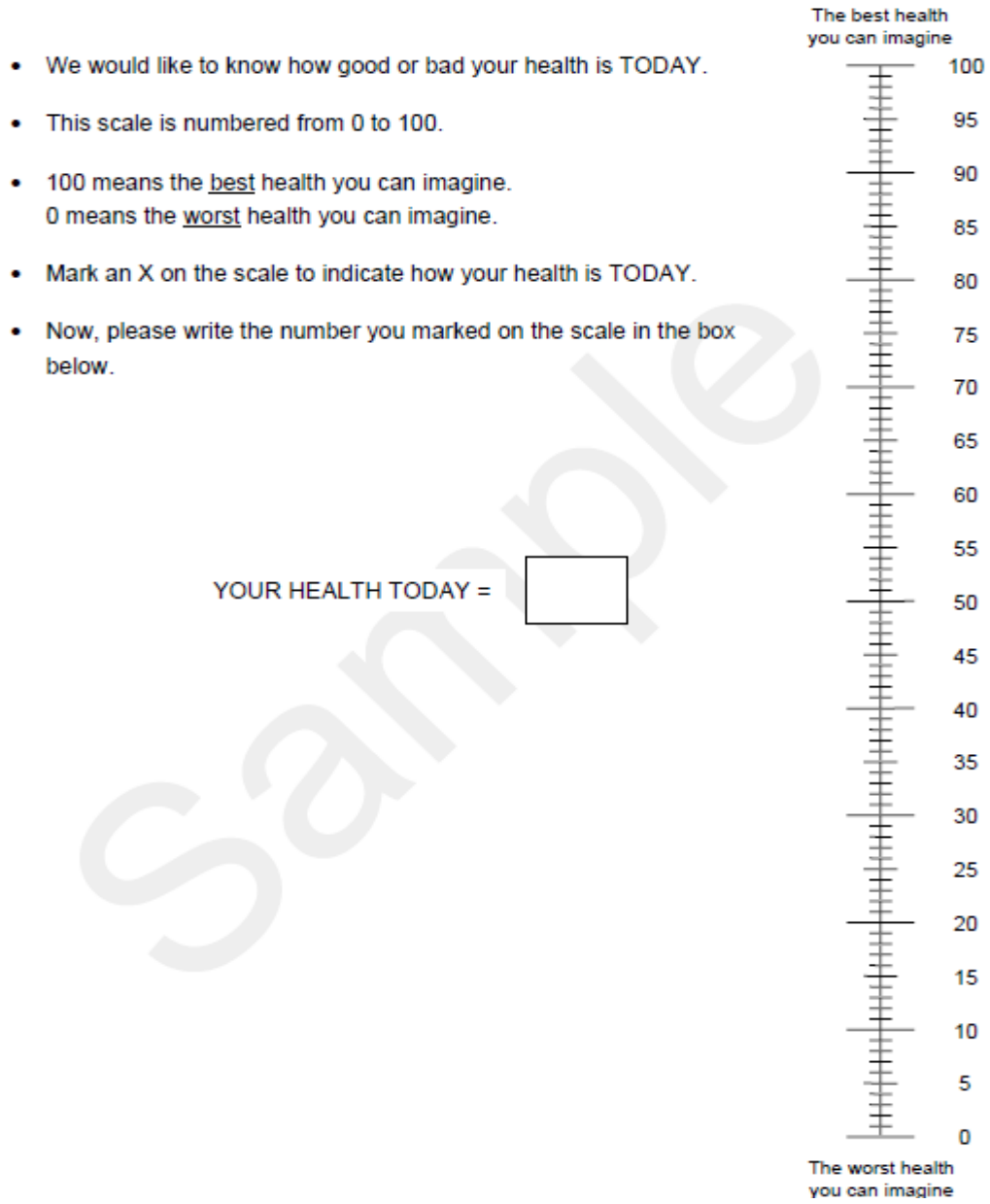
I am not anxious or depressed □

I am slightly anxious or depressed □

I am moderately anxious or depressed □

I am severely anxious or depressed □

I am extremely anxious or depressed □



Sample

Source: van Reenen and Janssen (2015, p. 3).

van Reenen and Janssen (2015) explained that the set of questions above were used as quantitative measure of health outcomes as judged by individuals. They further clarified that the numerals 1-5 assigned to these levels had no arithmetic properties and they should not be use as cardinal scores, and since respondents were only allowed to select one response per dimension in EQ-5D-5L descriptive system, the

corresponding response were used as scores. Furthermore, missing values were coded as '9', and where there was more than two score, the responses were treated as missing values. Lastly, the EuroQol Valuation Scale (EQ VAS) was scored by marking **X** on the scale and writing down the number marked on the scale in the box next to the scale. However, the EQ VAS was not included on the questionnaire used in this study.

van Reenen and Janssen (2015) further suggested that the EQ-5D-5L descriptive system can be converted into single index value, to calculate quality-adjusted life years (QALYs) that are used to inform economic evaluations of health care interventions.

2.9. Structural Equation Modelling

Research in social science does not only point towards conducting basic statistical descriptions and identifying the casual-effects among variables of interest, due to the complexity that exist hidden in social phenomenon it is essential to use more complex statistical analysis methods that permit casual analysis of numerous variables constructed using Structural Equation Modelling (SEM) (Tarka, 2018). SEM is a complex statistical modelling technique that allows modelling of multivariate data using latent variables (Sanchez, Budtz-Jorgensen, Ryan, & Howard, 2005), and it is used to test the hypothesis about the association between manifest (observed) and latent (unobserved) variables that are defined in terms of manifest variables (Teo, Tsai, & Yang, 2013, p. 3).

Everitt and Hothorn (2011) pointed out that the idea of SEM came into existence at the beginning of the 19th century when Charles Spearman first introduced it to study directional influences in his work on general intelligence in psychometrics. Later, in 1934 Sewall Wright introduced path analysis in biometrics to study direct and indirect effects of variables, represented with a diagram. This diagram shows how a set of independent variables influence the dependent variables under study. The paths are drawn to show whether the independent variables are independent causes, correlated causes, or mediated causes. Later in the years, sociologists such as Blalock (1961, 1963) and Duncan (1969) later took up the work of Wright, by adding the component of linking path-analytic graphs with simultaneous equation models. In the 1970s the prominent works of Jöreskog (1973), Browne (1974), and Bentler (1980) combined all various proposed approaches, resulting in a general method that deal with complex models in a routine manner (Everitt & Hothorn, 2011, pp. 201-202).

SEM can be viewed as a combination of principal component analysis (PCA), factor analysis (FA), cluster analysis (CA) and path analysis (PA). These models have been widely applied to study phenomenon in statistics, psychology, pedagogy, econometrics, medical science, criminology, marketing, criminology, family science, demography and sociology (Hox & Bechger, 1998, p. 354; Tarka, 2018). SEMs are useful when a researcher is interested in specifying and estimating linear relationships between manifest variables and latent variables (MacCallum & Austin, 2000), or when a researcher want to confirm or reject a theory relating a phenomenon (Teo et al., 2013). SEMs have four (4) unique features compared to

other multivariate statistical methods: (1) it follows a confirmatory approach to data analysis by specifying relationship among variables without prior knowledge; (2) it provide explicit estimates of error variance parameter; (3) its procedures incorporate both unobserved and observed variables; (4) it is capable of modelling multivariate relations, and estimating direct and indirect effects of variables understudy (Teo et al., 2013, p. 4).

The SEM analyses have five consecutive steps: model specification, model identification, model estimation, model evaluation, and model modification (MacCallum & Austin, 2000; Teo et al., 2013). SEM results can be visually illustrated using path diagrams (a graph consisting of boxes and circles that are linked by arrows), and the variables are represented as follows: observed variables are denoted by a square or a rectangular box and latent variables are denoted by an ellipse or a circle. The casual relationship between variables is represented by a single headed arrow that points in the direction of the relationship and covariance or correlation between variables is represented by double headed arrow (Hox & Bechger, 1998, p. 355).

2.10. Conclusion

The goal for this review was to identify outcomes that linked food insecurity and quality of life. It is evident that over the years, the world urban population has been increasing due to rapid urbanisation and this has brought many challenges and changes to cities and towns in developing countries such as high unemployment rates, depravation, poverty, economic inequality, food insecurity, and growth of informal settlements and slums among others. In recent years, food insecurity

became more widespread in urban areas because of urban poverty, and this has resulted in an increase in a number of research outputs on urban food insecurity and quality of life. Most studies found that food insecurity is mostly experienced during periods of low or no earnings and it has negative impacts on individual's well-being. Even though there are numbers of studies done on urban food insecurity and quality of life, there are dissimilarities in research designs, tools used in data collection, and methods of data analysis. Therefore, it becomes ambiguous to conclude that food insecurity and quality of life differs throughout diverse settings and populations. The review also identified a gap that most study had focused more on identifying the cause-effect of food insecurity on quality of life and not taking into consideration the hidden complexity between the two aspects.

Due to variations in instruments used for data collection and analysis in food insecurity and quality of life studies, this study used the HFIAS indicators developed by FANTA to measure food insecurity. This approach is more useful because the set of questions used in these indicators distinguishes food secure households from food insecure households. Further, these indicators are also useful to assess food insecurity prevalence and detect how it has changed over time.

The study assessed quality of life using WHOQOL-BREF and EQ-5D approach. The WHOQOL-BREF tool was developed by WHO with data collect from 15 culturally diverse international centres to legitimately measure quality of life internationally. Whereas, EQ-5D was developed by EuroQol to measure health status and it has been widely used in clinical trials, population surveys and other health surveys.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

This chapter discusses the study design, variables used in the analysis and the rationale behind the fitted models. In addition, the chapter further gives a brief description of the study site in terms of population size, mobility, and economic status.

3.2. Research Design

The study followed an analytical cross-sectional study design using secondary data collected for a project on Urban Livelihood and Quality of life in Windhoek Informal Settlements. A structural cluster sampling design was used. National Commission on Research Science and Technology (NCRST) funded the project in 2015. In brief, the study site and sampling are described below.

3.3. Sample

The sample of 416 households was selected using a two-stage sample design, where enumeration areas (EAs) were first selected as the Primary Sampling Units (PSU) from 2011 Namibia population and housing census, and then households were selected in each selected EAs for interviews.

A two stage sampling procedure was followed. In the first stage, 30 EAs were selected across all three selected constituencies, using proportional size sampling. In the second stage, 15 households were then systematically selected from each EA for the interview administered by field enumerators using questionnaires.

The sample size calculation was based on the following assumptions: (1) Target population size of 200,000 individuals or 300 clusters; (2) Estimated percentage in the target population with the event of interest [children malnutrition] of 25% based on the 2006/07 Namibia DHS; (3) Confidence interval width of 5% or Confidence coefficient of 95%; (4) Estimated Design Effect (DEFF) of 2; (5) Percent response rate of 60% (a combined effect of non-response and attrition) and (6) On average, there will be one (1) eligible individual per household.

3.4. Study Site

The target population for this study was households in the following constituencies that have informal settlements: Samora Machel, Tobias Hainyeko, and Moses //Garoeb. These are shown in figure 2 and their backgrounds summaries are given in Table 1 below.

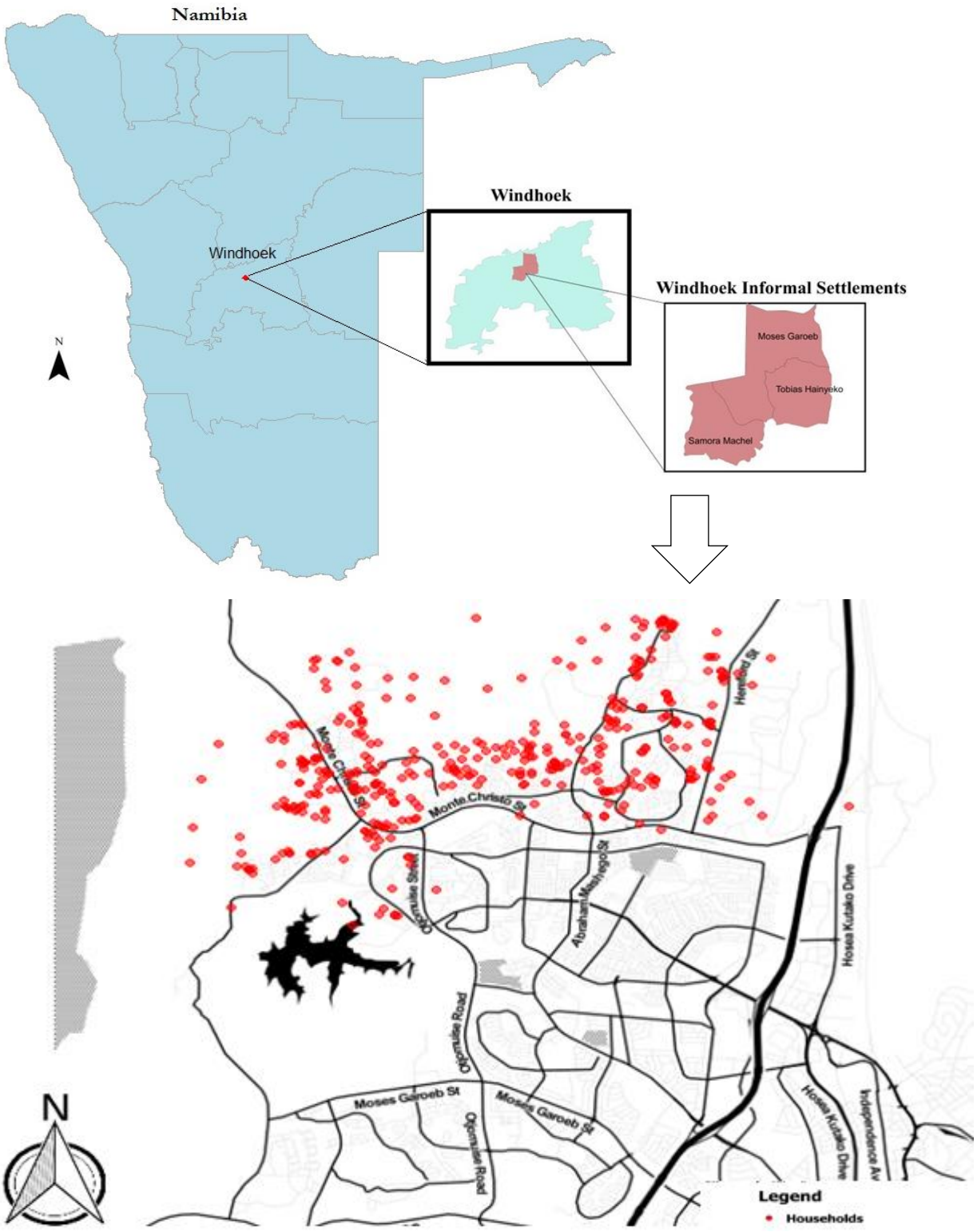


Figure 2 Enumerated households in Windhoek Informal settlements

Table 1 Demographic summary for the study sites

Indicators		Constituencies		
		Samora Machel	**Tobias Hainyeko**	**Moses //Garoeb**
Total population		50,110	45,912	45,564
Areas in square kilometres		19	19	33
Population density		2607.7	2480.7	1397.9
Number of Households (HHs)		13,250	12,428	13,804
Average household size		3.8	3.7	3.3
HHs head	Female	43%	33%	34%
	Male	57%	67%	66%
Employment rate		49%	49%	49%
Unemployment rate		29%	33%	34%
HHs main source of income	Wages & Salaries	73%	70%	70%
	Cash remittance	5%	6%	6%
	Business, non-farming	16%	19%	19%
Literacy rate		98%	96%	97%
Number of Deaths in last 12 months		292	363	377
HHs main source of water	Piped Water Inside	31.6%	13.2%	12.4%
	Piped Water Outside	28.5%	13.7%	16.7%
	Public Pipe	38.0%	71.7%	69.7%
Material used for HHs outer walls	Cement Blocks/Brick	39.6%	14.8%	15.7%
	Corrugated Iron/Zinc	58.2%	78.0%	58.2%
	Prefabricated Materials	0.5%	3.4%	1.8%
Type of housing unit and area	Detached House	32.6%	22.9%	22.4%
	Apartment/Flat	5.3%	1.6%	1.6%
	Improvised Housing Unit (Shack)	49.2%	65.8%	62.0%

Source: Namibia Statistics Agency (NSA) (2013a)

3.5.Data and Variables

The study used ten (10) variables on food insecurity based on HFIAS; variables are attached in Appendix A. On quality of life, the study used 21 variables based on WHOQOL-BREF (Appendix B) and 36 variables based on EQ-5D (Appendix C). These variables were reduced into constructs of food insecurity and quality of life respectively. In the study, food insecurity construct was used as a predicting variable for quality of life constructs outcomes.

3.6. Data Analysis

The data was analysed using IBM SPSS version 22 and R Studio version 3.3.1 *"Bug in Your Hair"*. Descriptive statistics and appropriate graphs were produced to give the overview of the study findings between explanatory (food insecurity) and dependant (quality of life) variable. Further, multivariate statistical analyses were carried out using SEMs to identify structural relationships between food insecurity and quality of life. All codes and syntax used to generate results in this study are attached in Appendix E and F respectively.

3.7. Research Ethics

Permission to use the data was requested from the Department of Statistics and Population Studies of the University of Namibia. The study ensured that all the information and data used was treated with confidentiality and anonymity. The researcher only used the used the data for purpose of this research. In addition, ethical clearance to conduct this research was granted by the University of Namibia Research Ethics Committee.

CHAPTER 4: APPLICATION, VALIDITY AND RELIABILITY OF CONSTRUCTS OF FOOD INSECURITY AND QUALITY OF LIFE IN URBAN INFORMAL SETTLEMENTS, WINDHOEK

4.1. Introduction

This chapter focuses on deriving measures of food insecurity and quality of life indicators using data driven approach and assess their agreement with the FANTA, WHOQOL-BREF and EQ-5D approach using Kappa and McNemer measures of agreement. The analysis also assessed internal validity and reliability of the indicators using Cronbach's alpha. The data driven approach used were based on PCA, EFA and hierarchical clustering.

4.2. Principal Component Analysis

PCA is one of the widely used old multivariate statistical techniques. It was first introduced by Pearson in 1901, and later on independently developed by Hotelling in 1933 (Dunteman, 1989; Everitt & Dunn 2001). According to Zelterman (2015), the goal of PCA is to reduce a large number of multivariate variables into relatively small number of linear combinations that can be used to account for much variability in the data, so that the first principal component have the largest variability in the data. Followed by the second component that is chosen to account for as much as possible variation in the data, and it should be uncorrelated to the first principal component. In the same manner, the third component is selected to account for much variation in the data, and it is uncorrelated to both the first and second component, and so on (Everitt & Dunn 2001; Zelterman, 2015).

In this study, since there are ten variables on food insecurity and 57 (21 on WHOQOL-BREF and 36 on EQ-5D) variables on quality of life, PCA will be the most suitable step in SEM to begin with by reducing the number of variables under these aspects into the main constructs of food insecurity and quality of life respectively.

To carry out PCA, the study begins with a multivariate random vector $x = (x_1, x_2, ..., x_q)$ with mean μ and covariance $\sum$. Everitt and Hothorn (2011, pp. 63 - 65) outlined that the sample principal components can be computed as follows:

The first principal component for this vector will be a linear combination of:

$$y_1 = w_1^T x = w_{11}x_1 + w_{12}x_2 + ... + w_{1q}x_q \qquad \textbf{4.1}$$

whose sample variance is greatest among all linear combinations, and since the variance of the first component y_1 can be increased without limits, by simply increasing the coefficients $w_1^T = (w_{11}, w_{12}, ..., w_{1q})$, the study will then need to place a restriction on these coefficients, by ensuring that the sum of squares of these coefficients takes the value of one ($w_1^T w_1 = 1$).

Further, the second principal component will be a linear combination of:

$$y_2 = w_2^T x = w_{21}x_1 + w_{22}x_2 + \ldots + w_{2q}x_q \qquad \textbf{4.2}$$

that has a greatest variance subject to the following conditions $\begin{cases} w_2^T w_2 = 1 \\ w_2^T w_1 = 0 \end{cases}$ **4.3**

these conditions ensure that y_1 and y_2 are uncorrelated.

Finally, the j^{th} principal component will be a linear combination of:

$$y_j = w_q^T x = w_{q1}x_1 + w_{q2}x_2 + \ldots + w_{qq}x_q \qquad \textbf{4.4}$$

that has a greatest variance subject to the conditions $\begin{cases} w_p^T w_p = 1 \\ w_j^T w_i = 0 \quad (i < j) \end{cases}$. **4.5**

In the above equations $y_1, y_2, ..., y_p$ denote the principal components of x, and w_{ij} denote the weights or loadings that explain how each of the original observation contributes to each of the principal components (Zelterman, 2015, p. 208).

To compute the variance for each principal component, Hair, Anderson, Babin, and Black (2009); Everitt and Hothorn (2011); Zelterman (2015) suggested that the variance can expressed as:

$$Var\, y_i = w_i^T \sum w_i \qquad \textbf{4.6}$$

Since this variance can be made arbitrarily large by multiplying w_i by a larger scalar. This can be avoided by restricting the loadings w_i to have a unit length of $w_i^T w_i = 1$.

I also wish to make y_i to be mutually uncorrelated by setting:

$$Cov\,(y_i, y_j) = w_i^T \sum w_i = 0 \qquad for\ all\ i \neq j\ \ both\ between\ 1\ and\ q. \quad \textbf{4.7}$$

Since, the study wish to make the variance in equation (**4.6**) to be as large as possible and have the covariance in equation (**4.7**) to be zero. We attain this by estimating the covariance $\sum$ using the sample variance matrix S, by examining the pairs of eigenvalues (λ_i) and eigenvectors (e_i). If the weights w_i are replaced by respective eigenvectors e_i, this maximizes the estimated variances of principal component y_i with respect to the estimated covariance matrix S, leading to the principal component y_i to be uncorrelated (Johnson & Wichern, 2007; Hair et al., 2009; Zelterman, 2015). Thus, the estimated variance is then given by:

$$\overline{Var}\, y_i = e_i^T S e_i = \lambda_i \qquad \textbf{4.8}$$

Finally, the total variance of the q principal component will be equal to the total variance of the original variable so that $\sum_{i=1}^{q} \lambda_i = s_1^2 + s_2^2 + \ldots + s_q^2$, where s_i^2 is the sample variance of x_i. This can then be rewritten as $\sum_{i=1}^{q} \lambda_i = trace(S)$ (Hair et al., 2009; Everitt & Hothorn, 2011). Then the j^{th} principal component accounts for a proportion P_j of the total variability in the original data, where:

$$P_j = \frac{\lambda_i}{trace(S)} \qquad \textbf{4.9}$$

To decide on the number of components to be retained, Rencher (2002, p. 397) suggested that the following proposed guidelines maybe used:

1. Retain components that account for a specified percentage of the total variance.
2. Retain the components whose eigenvalues are greater than the average of the eigenvalues. For a correlation matrix, the average is one.
3. Use the scree plot, and look for a natural break down between the large eigenvalues and the small eigenvalues.
4. Test the significance of the larger components, that is, the components corresponding to the larger eigenvalues.

Even though there are number of studies that have used the above stated subjective guidelines to decide on the number of components to be retained, the methods sometimes lead to under extraction or over extraction of components (Franklin, Gibson, Robertson, Pohlmann, & Fralish, 1995). Hayton, Allen, and Scarpello (2004) suggested that Parallel Analysis is the most accurate method used to determine the number of significant components. This technique work by comparing eigenvalues from the real data correlation matrix before they are rotated, to those of the random correlation matrix of the same dimensionality, this method retain components that have actual eigenvalues greater than the parallel random average eigenvalues (Franklin et al., 1995; Hayton et al., 2004).

4.3. Exploratory Factor Analysis

In addition to PCA, to identify the components, the study also uses EFA to identify the relationship between the assumed latent variables and manifest variables without making any assumption about how manifest variables are related to the factors (Everitt & Hothorn, 2011, p. 135). EFA is more like a classical regression

model, they differ in a way that in factor analysis manifest variables are linked to a set of unobserved variables, compared to the regression model where dependent variables are linked to independent variables (Everitt & Hothorn, 2011). In the later stage of the study, CFA will be used to test if whether the specified factor models produced under this section provide adequate fit for the covariance or correlation between manifest variables. This is how the two method of factor analysis differs (Everitt & Hothorn, 2011, p. 135).

At this point, I wish to mention that, even though both principal component analysis and factor analysis aim to reduce dimensionality in the data. Their difference is that: (1) in factor analysis variables are expressed as linear combinations of the factors, as opposed to principal component analysis where principal components are linear functions of the variables. (2) In principal component analysis, we emphasize on explaining the total variance, whereas in factor analysis we emphasize on explaining the covariance (Rencher, 2002).

In EFA, it is assumed that the observed relationship between manifest variables are as a result of the relationship between latent variables (Everitt & Hothorn, 2011, p. 137). Then the model of the k^{th}-factor analysis is assumed to have a set of manifest variables $x^T = (x_1, x_2, \ldots, x_q)$ that are linked to k latent variables or common factors f_1, f_2,.., f_k, where $k < q$ written mathematically as follows:

$$
\begin{aligned}
x_1 &= \lambda_{11} f_1 + \lambda_{12} f_2 + \ldots + \lambda_{1m} f_m + \varepsilon_1 \\
x_2 &= \lambda_{21} f_1 + \lambda_{22} f_2 + \ldots + \lambda_{2m} f_m + \varepsilon_2 \\
&\vdots \\
x_q &= \lambda_{q1} f_1 + \lambda_{q2} f_2 + \ldots + \lambda_{qm} f_m + \varepsilon_q .
\end{aligned}
$$

This equation can be rewritten in short as $x = \Lambda f + \varepsilon$

such that, $\Lambda = \begin{pmatrix} \lambda_{11} & . & . & \lambda_{1k} \\ . & & & . \\ . & & & . \\ \lambda_{q1} & . & . & \lambda_{qk} \end{pmatrix}$, $f = \begin{pmatrix} f_1 \\ . \\ . \\ f_q \end{pmatrix}$, $\varepsilon = \begin{pmatrix} \varepsilon_1 \\ . \\ . \\ \varepsilon_q \end{pmatrix}$. **4.10**

In this equation, it is assumed that the random disturbance terms $\varepsilon_1, \varepsilon_2 \ldots, \varepsilon_q$ are uncorrelated with each other and with the factors $f_1, f_2, .., f_k$. These assumptions implies that manifest variables are independent given any values of the factors (Everitt & Hothorn, 2011).

In addition, the variance of x_i, σ_i^2, in factor analysis model is given by:

$$\sigma_i^2 = \sum_{j=1}^{k} \lambda_{ij}^2 + \psi_i \qquad \textbf{4.11}$$

where ψ_i is the variance of ε_i

From equation (**4.11)**, the study assumed that the variance of each observed variable can be split into two parts. The first part is known as the communality of the variable that represents the variance shared with other variables through a common factor given by: $h_i^2 = \sum_{j=1}^{k} \lambda_{ij}^2$. Whereas, the second part ψ_i is known as a specific or unique variance, that is related to the variability in x_i not shared with other

variables (Everitt & Hothorn, 2011, p. 138). Similarly, the covariance of variables x_i *and* x_j in the factor model can be written as: $\sigma_{ij} = \sum_{l=1}^{k} \lambda_{il}\lambda_{jl}$ **4.12**

From equation (**4.12**), it is assumed that the covariance does not depend on any specific variate. Hence, it is only the common factors that intend to account for the relationships between manifest variables (Everitt & Hothorn, 2011, p. 138). Further, it is noted that the covariance matrix $\sum$ of the observed variable is of the form:

$$\sum = \Lambda\Lambda^T + \psi \qquad \textbf{4.13}$$

where $\psi = diag\,(\psi_i)$

However, in practice the study will estimate $\sum$ by the sample covariance matrix S, by obtaining the estimate of Λ *and* ψ so that the observed covariance matrix takes the required form of the model. To apply the above stated equations, I need to estimate the factor loadings and their specific variances. Hence, the study need to find the factor-loading matrix $\hat{\Lambda}$ and the diagonal matrix $\hat{\psi}$ that contains the specific variances. The specific variances are given by:

$$\hat{\psi}_i = s_i^2 - \sum_{j=1}^{k} \hat{\lambda}_{ij}^2 \,,\; i = 1,\ldots,q \qquad \textbf{4.14}$$

Equation (**4.14)** helps to estimate the diagonal terms in the covariance matrix S.

Further, to estimate parameters in the model, the study uses maximum likelihood methods. This method is believed to be a respectable method in factor analysis parameter estimation (Everitt & Hothorn, 2011, p. 142). It assumes that the data

follows a multivariate normal distribution, and that the model holds a likelihood function L shown to be $-\frac{1}{2}nF$, where F is given by:

$$F = \ln\left|\Lambda\Lambda^T + \psi\right| + trace\left(S\left|\Lambda\Lambda^T + \psi\right|^{-1}\right) - \ln|S| - q \qquad \textbf{4.15}$$

The function takes on the value of zero if $\Lambda\Lambda^T$ is equals to the covariance matrix S. The loading estimates are estimated by minimizing the F function with respect to these parameters (Everitt & Hothorn, 2011, p. 142).

Finally, the study estimates the factor scores that are needed in the interpretation of the fitted model. To estimate the factor scores the study introduces an orthogonal matrix M of order $k \times k$, since the variables in equation (**4.10**) are expressed in terms of factors. The calculation of factor scores requires variables to have the relationship that is in an opposite direction. Equation (**4.10**) can then be re-written as:

$$x = (\Lambda M)(M^T f) + \varepsilon \qquad \textbf{4.16}$$

This model is now associated with new factors $f^* = Mf$ and new factor loadings ΛM. The covariance matrix of observed variables in this model is then given by:

$$\Sigma = (\Lambda M)(\Lambda M)^T + \psi_i \qquad \textbf{4.17}$$

Therefore, the factor scores are calculated using $\hat{f} = \hat{\Lambda} S^T x$ **4.18**

To test if the study sample size is adequate for factor analysis, the study uses Kaiser-Meyer-Olkin (KMO) and Bartlett's Test to examine if the sample size is acceptable and if the data is appropriate for factor analysis (Rencher, 2002, p. 443).

KMO is given by: $$\frac{\sum_{i}\sum_{j\neq i} r_{ij}^2}{\sum_{i}\sum_{j\neq i} r_{ij}^2 + \sum_{i}\sum_{j\neq i} u_{ij}^2} \quad \textbf{4.19}$$

where r_{ij} is the correlation matrix, and u_{ij} is the partial covariance matrix

Bartlett's Test is given by: $$\chi^2 = -\left(n - 1 - \frac{2p+5}{6}\right) \times \ln|R| \quad \textbf{4.20}$$

such that n is the number of observation, p is the number of variables, and R is the correlation matrix.

For KMO, a correlation around 0.60 to 0.70 is deemed to be sufficient for analysing EFA and Bartlett's Test is significant when the $p < 0.05$. We also need to assess the relationship between variables using a correlation matrix, it is recommended to inspect variables with correlation coefficients over 3.0.

4.4. Cluster Analysis: Agglomerative Hierarchical Clustering

Clustering is a non-parametric statistical method used to arrange similar observations together in a graphical format that detect pattern of groupings and outliers (Zelterman, 2015). To identify grouping among components identified in EFA, the study used agglomerative hierarchical clustering method to examine if there is any similarities or dissimilarities among components. Agglomerative hierarchical clustering begins with a single cluster that has all set of observation to *n* clusters, each containing a single observation (Everitt & Hothorn, 2011). This

technique uses series of successive fusions of the *n* observation into groups, such that when two observations are placed in the same group, they cannot appear in different groups. The results are presented in a graphical figure interpreted as a tree or a dendrogram (Everitt & Hothorn, 2011; Zelterman, 2015).

The method begins by calculating the distance between pairs of observation, using the Euclidean distance given by:

$$d_{ij} = \sqrt{\sum_{k=1}^{q} (x_{ik} - x_{jk})^2} \qquad \textbf{4.21}$$

such that d_{ij}, is the Euclidean distance between individual i with values $x_{i1}, x_{i2}, ..., x_{iq}$ and individual j with variable values $x_{j1}, x_{j2}, ..., x_{jq}$. The desistance between individual groups is then given by:

$$d_{AB} = \min_{\substack{i \in A \\ i \in B}} (d_{ij}) \quad ,$$

$$d_{AB} = \max_{\substack{i \in A \\ j \in B}} (d_{ij}) \qquad \textbf{4.22}$$

where d_{AB} is the distance cluster A and B, whereas d_{ij} is the distance between individuals i and j computed from the initial inter-individual distance matrix (Everitt & Hothorn, 2011, p. 167). Given the above equation for calculating inter-group distance, the discrimination of the groups will be based on ward linkage clustering techniques. Furthermore, fusion that will be made at each stage of the

analysis will be represented using a dendrogram, which is a two-dimensional diagram that will help to determine the number of clusters (Everitt & Hothorn, 2011). However, Mooi and Sarstedt (2011) argued that using a dendrogram to identify the number of clusters to retain from the data has limited guidance. They proposed that this limitation can be tackled by plotting number of clusters on the *x-axis* against the distance at which objects are combined on the *y-axis* or the decision can be based on a theory underlying the constructs (Mooi & Sarstedt, 2011, p. 254).

Nevertheless, this approach does not answer the questions of cluster's consistency and significance. Shimodaira (2002) recommended the use of multiscale bootstrap resampling method to assess these questions, which is a technique that estimates *p-values* of hypotheses by way of resampling data (Suzuki & Shimodaira, 2004, p. 1). Santos, Martins Filho, Alves, and Resende (2015) outlined that in multiscale bootstrap resampling technique, "the sample size is reduced, equalled, or augmented, considering the size *n* of the initial sample" (p. 170), as opposed to bootstrap resampling where the original sample size is replaced by generated pseudo-sample of the same size that denominate bootstrap samples.

The method produces both the probabilities (bootstrap probability (BP) values) and *p-values* (approximately unbiased (AU) *p*-values) for each of the nodes that represent the chances of the nodes to be true. Shimodaira (2002, p. 492) reported that, the greater the *p-value*, the greater the chances of the node to be true. However, Shimodaira (2002) discouraged the use of BP, he stated that the measure is biased in practical, since it is an approximation estimated from bootstrap resampling. He proposed the use of AU in cluster selection process, since it is an

approximation computed in multiscale bootstrap resampling. The AU *p-values* are obtained by correcting for selection bias of the *p-values* (in multiscale bootstrap resampling) attained in standard bootstrap resampling (Santos et al., 2015, p. 170). Thus, the higher AU *p-value* between clusters indicates that those within that cluster have similar characteristics. This study used the R package "*pvclust*" developed by Suzuki and Shimodaira (2014) to assess the cluster significance. The study generated 10,000 replications for each scale value, as recommended by Suzuki and Shimodaira (2004).

4.5. Application to Food Insecurity

In this section, the study derived the construct of food insecurity using PCA and EFA. Furthermore, the study assessed the validity and reliability between the construct of food insecurity and the existing method of FANTA. Variables used in this section are attached in Appendix A.

4.5.1. Principal Component Analysis and Exploratory Factor Analysis

To assess whether the scale used in the ten questions was consistent, a reliability analysis test was carried out. Table 2 shows a Cronbach's alpha (α) of 0.96, indicating a high level of internal consistency in the scale used in food insecurity questions.

Table 2 Reliability statistics for food insecurity questions

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.96	0.96	10

Table 3 shows that the sample size used in the study was adequate to carry out EFA on the set of food insecurity (access) questions. The test yields an overall KMO of 0.95 (marvellous), above the set sufficient correlation value of 0.60 to 0.70 (middling) and Bartlett's test of sphericity was significant ($\chi^2(45) = 5658.88$, $p < 0.001$). Based on the study results, we reject the null hypothesis that all variables in the dataset are uncorrelated.

Table 3 Kaiser-Meyer-Olkin and Bartlett's Test

KMO Measure of Sampling Adequacy (N=416)		0.95
Bartlett's Test of Sphericity	Approx. Chi-Square	5658.88
	Degree of freedom	45
	Significance	<0.001***

*** $p < 0.001$

Table 4 Components extracted for food insecurity

Components	**Initial Eigenvalues**		
	Total	**% of Variance**	**Cumulative %**
1	8.16	81.62	81.62
2	0.58	5.84	87.46
3	0.34	3.37	90.83
4	0.25	2.53	93.36
5	0.19	1.85	95.21
6	0.15	1.46	96.67
7	0.11	1.17	97.79
8	0.09	0.93	98.72
9	0.07	0.74	99.45
10	0.06	0.55	100

Table 4 shows the eigenvalues and percentage of variance explained by each of the indicators of food insecurity. The extraction generated 10 components with eigenvalues ranging from 8.16 to 0.06. Based on this extraction, only one component had an eigenvalue greater than one. Hence, the study only retained one component for food insecurity. This component accounted for 81.62% variation in the data and the remaining 18.38% variation was explained by the remaining nine components. The study concluded that, one factor solution is sufficient to explain food insecurity in Windhoek informal settlements.

Additionally, the above conclusion was supported by findings presented in Figure 3, which shows a scree plot of food insecurity components against the eigenvalues. On this figure, eigenvalues were plotted against the component numbers, and we observed where we had a biggest drop in eigenvalues to decide on the number of components to be retained. Based on Figure 3, we observed that the biggest drop in eigenvalues before the second component. For this reason, we concluded that one component was sufficient for this data. Similarly, the results of parallel analysis also confirmed that one component is sufficient for this extraction.

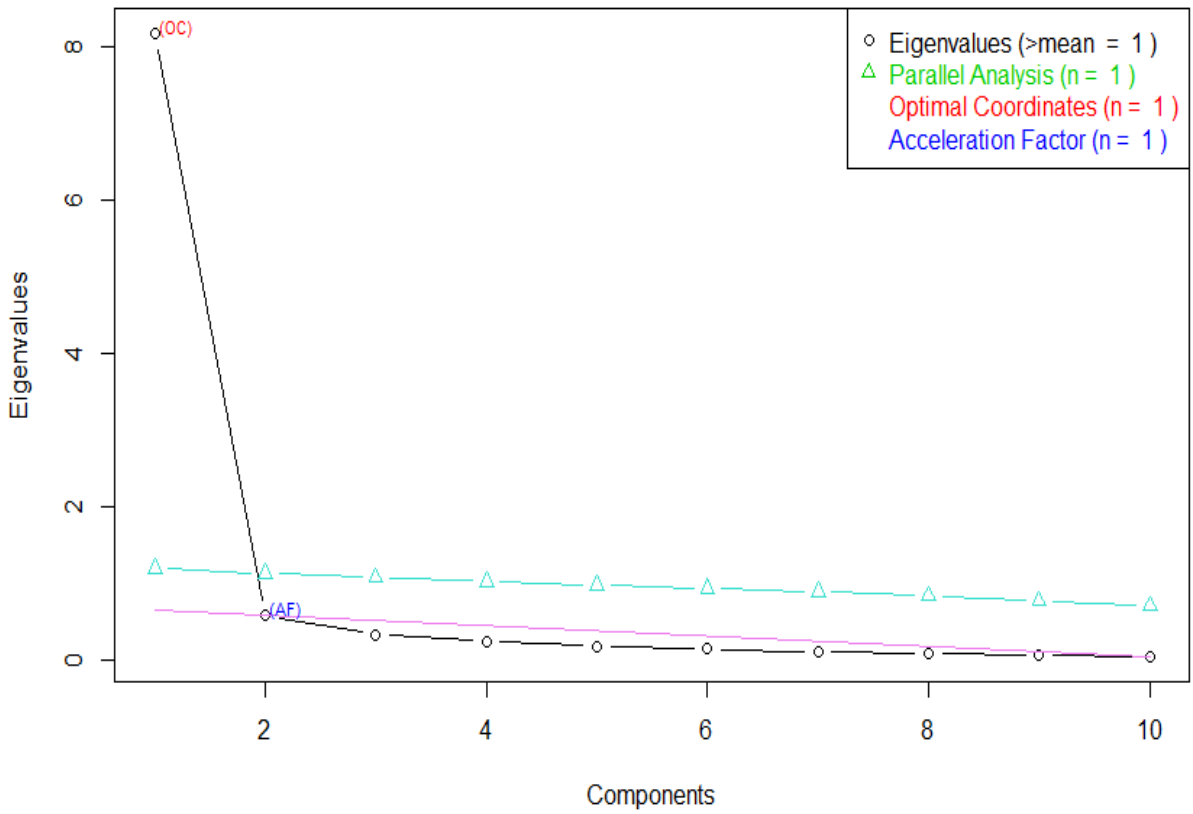


Figure 3 Scree plot for food insecurity components

Table 5 shows the results of how food insecurity variables contributed to factor one. Their contributions were sorted in the order of their contribution. Hair et al. (2009) suggested that standardised factor loadings of 0.30 and above are sufficient for sample size of 350 or greater. As illustrated in Table 5 all factor loadings were greater than 0.30. The generated component was named food insecurity. The component included all food insecurity questions that were asked during the survey. The results are summarised graphically in Figure 4.

Table 5 Factor analysis for food insecurity component

Factor	Item	Factor Loadings	Factor Name
1	Was there no food to eat of any kind in your household because of lack of resources to get food	0.94	**Food insecurity**
	Did you or any household member have to eat a smaller meal than you felt needed because there was no enough food	0.94	
	Did you or any household member have to eat fewer meals in a day because there was no enough food	0.93	
	Did you or any household member go to sleep at night hungry because there was not enough food?	0.93	
	Did you or any household member go a whole day and night without eating anything because there because there was not enough food	0.92	
	Did you or any household member eat a cooked meal less than once a day	0.91	
	Did you or any household member have to eat some food that you really did not want to eat because of lack of resources to obtain other types of food	0.90	
	Did you or any household member have to eat a limited variety of foods due to lack of resources	0.88	
	Were you or any member of your household not able to eat the kind of foods you preferred because of lack of resources	0.87	
	Did you worry that your household would not have enough food	0.83	

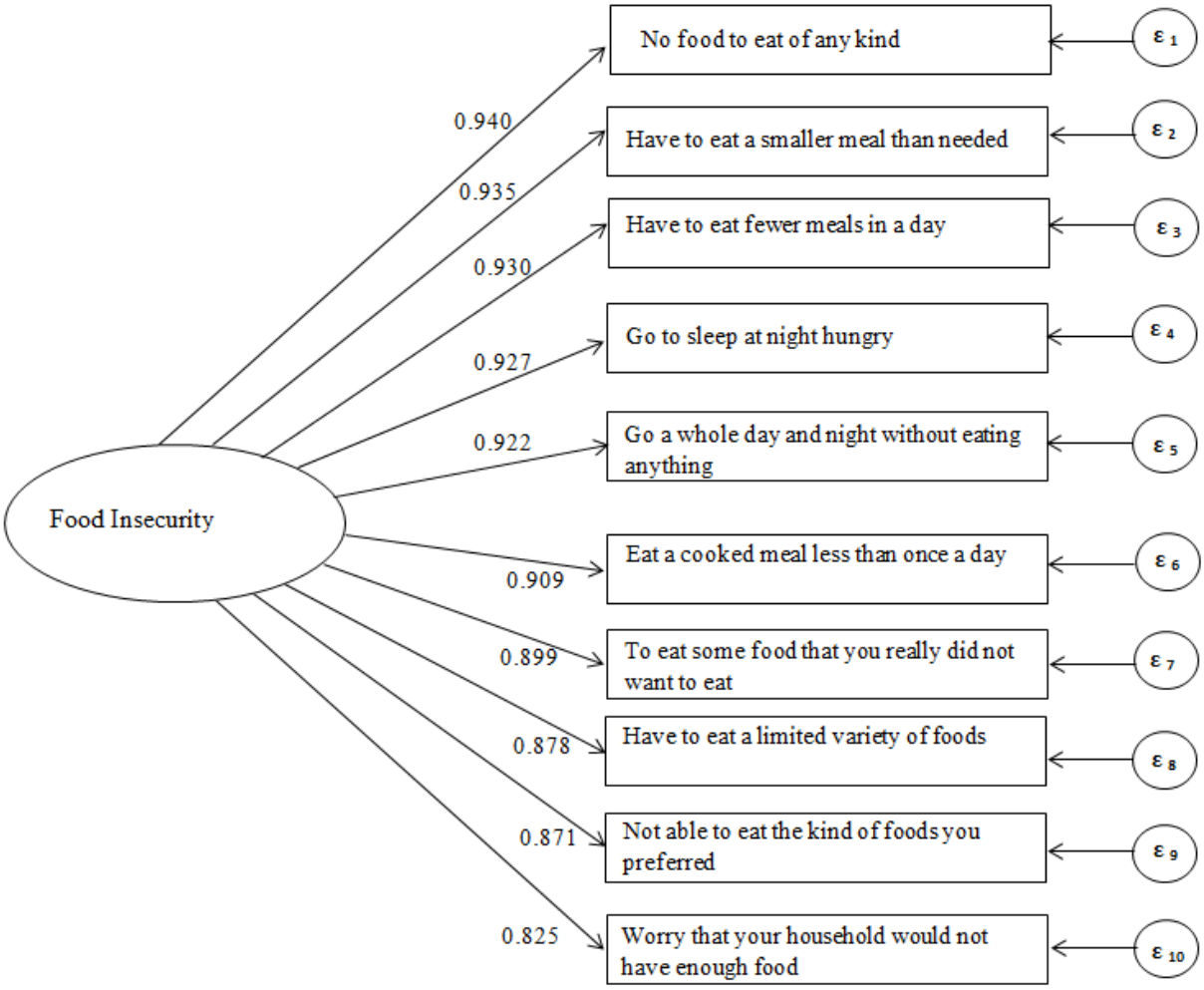
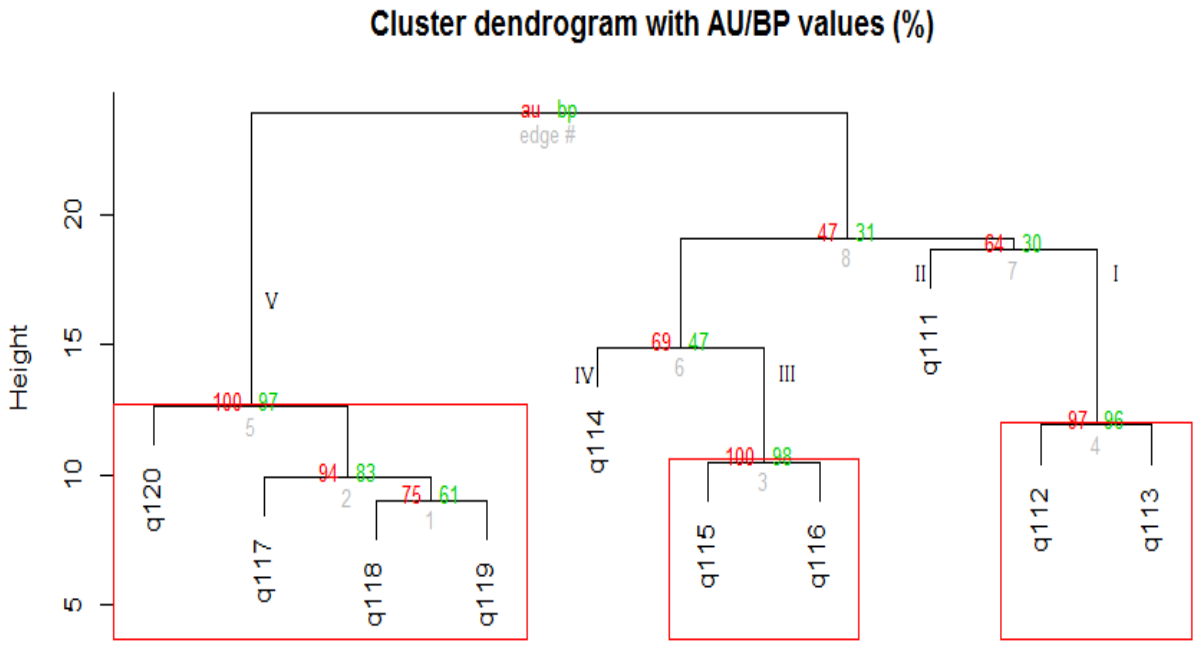


Figure 4 Summary of food insecurity results

The generated factor scores from the analysis were added to the data set as standardised scores for each participant in the study, predicted using regression equations. The standardised scores ranged from -1.02 to 1.79, with the mean zero and a standard deviation one, which shows that this is a standardised variable.

4.5.2. Agglomerative Hierarchical Clustering

According to the FANTA module, food insecurity (access) has three domains (*Anxiety and uncertainty about the household food supply, insufficient food quality, and insufficient food intake and its physical consequences*). Since it is quite difficult to identify the number of clusters at different cut off points, the study used the distance between food insecurity indicators to determine food insecurity clusters and AU *p-values* to comment on the consistency and significance of the clusters.



AU p-values (red), BP (green)

Figure 5 Food Insecurity dendrogram

Figure 5 illustrates the findings of hierarchical clustering method with multiscale bootstrap resampling method that grouped food insecurity variables into five clusters. The graph further showed that only three clusters were significant (*p-value* AU $\geq$ 0.95) for this data (cluster III, V, and I). Significance was assessed by testing

the hypothesis that "grouping does not exist between two nodes" rejected at $p = 0.05$. Furthermore, the study used the results in Figure 5 to identify the cluster characteristics between households. Variables in Figure 5 were grouped in a top-down approach to allow observations to be placed in groups, represented as leaves. The vertical scale indicated how far the groups were from each other. Moving from right to left along the *x-axis,* we observed that households that experienced insufficient food quality (including variety and preferences of the food type) were not similar to households that experienced insufficient food intake and its physical consequences.

During the analysis, variables positions were changed to observe if there would be any changes in the groupings. After several repositioning of variables, the groupings did not change at all; this was done to ensure the groupings were valid and stable.

The comparison between the subjective method and data driven method yield a significant Kappa (κ) of 0.68, $p < 0.001$, indicating that there was substantial agreement between the FANTA method and the data driven method used in this study.

4.6. Application to WHOQOL-BREF

In this section, the study derived constructs of quality of life based on WHOQOL-BREF module using PCA and EFA. Additionally, the study assessed the validity and reliability between the derived constructs and the existing method of WHOQOL-BREF. Variables used in this section are attached in Appendix B.

4.6.1. Principal Component Analysis and Exploratory Factor Analysis

A reliability test was conducted to assess if the scale used in the 21 questions of quality of life was consistent. Table 6 shows a Cronbach's alpha of 0.80, indicating a high level of internal consistency in the scale used in 21 questions.

Table 6 Reliability statistics for WHOQOL-BREF questions

Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.80	0.81	21

Table 7 presents that the sample size used in the study was adequate to carry out EFA on the set of 21 questions asked on WHOQOL-BREF module. The test yields an overall KMO of 0.83 (meritorious), greater than the commonly set sufficient correlation value of 0.60 to 0.70 (middling), and a significant Bartlett's test of sphericity ($\chi^2(210) = 1789.96$, $p < 0.001$). Since we had a significant *p-value*, we reject the null hypothesis, that not all variables in the dataset are correlated.

Table 7 Kaiser-Meyer-Olkin and Bartlett's Test

KMO Measure of Sampling Adequacy (N=416)		0.83
Bartlett's Test of Sphericity	Approx. Chi-Square	1789.96
	Degree of freedom	210
	Significance	<0.001***

*** $p < 0.001$

Table 8 shows a cropped table with the results of eigenvalues and percentage of variance explained by each of the twenty-one questions. The extraction generated 21 components with eigenvalues ranging from 5.18 to 0.30. Based on the results of this extraction, six components had eigenvalues greater than one. Component one

explained about 24.67% variation in the data, followed by component two that accounted for 9.61% variation, followed by component three, four, five and six respectively. Altogether, six components accounted for 57.81% variation in the data and the remaining 42.19% variation was explained by the last 15 components.

Table 8 Components extracted for WHOQOL-BREF

Component	**Initial Eigenvalues**		
	Total	**% of Variance**	**Cumulative %**
1	5.18	24.67	24.67
2	2.02	9.61	34.28
3	1.53	7.27	41.55
4	1.28	6.11	47.66
5	1.13	5.37	53.03
6	1.01	4.79	57.81
7	0.90	4.29	62.10
.	.	.	.
.	.	.	.
.	.	.	.
18	0.42	2.00	95.21
19	0.37	1.75	97.00
20	0.34	1.63	98.59
21	0.30	1.41	100

To decide on the number of components to be retained, the study used Figure 6 to observe where we have the biggest drop in eigenvalues and the number of

components suggested by parallel analysis results. Figure 6 showed that the biggest drop in eigenvalues was observed before the fifth component. Similarly, parallel analysis results also suggested that four components were sufficient for the study. In other words, much of the variation in this data was explained by four components.

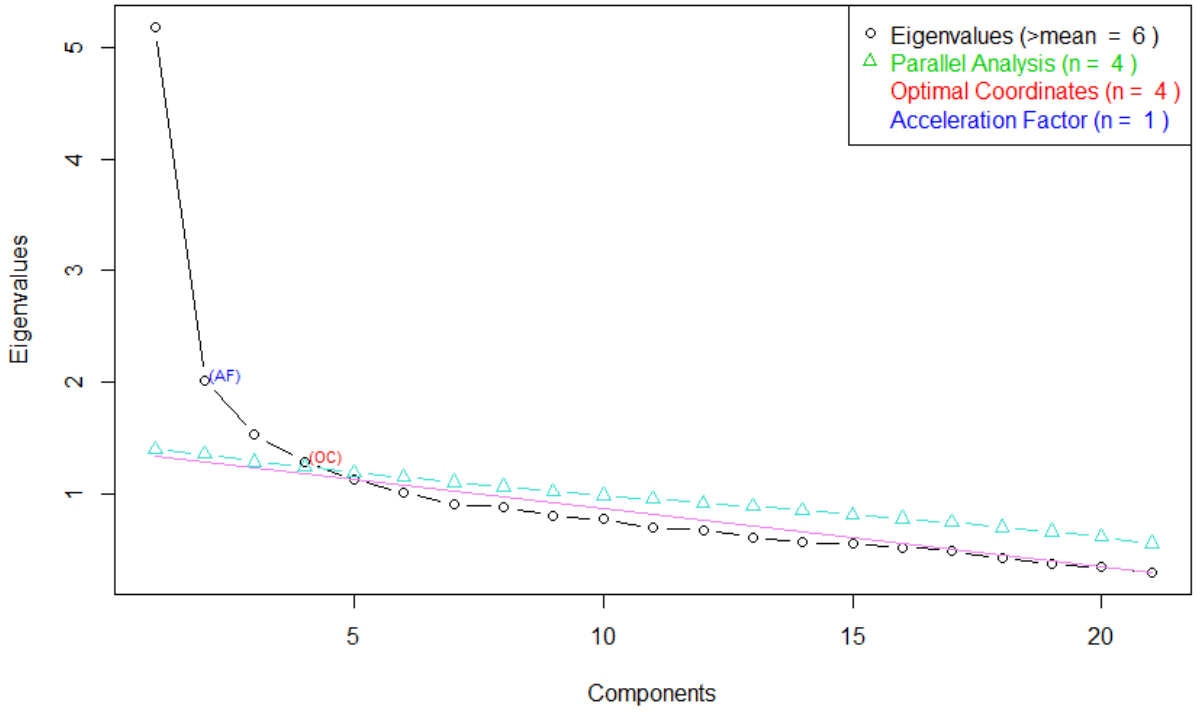


Figure 6 Scree plot of WHOQOL-BREF

Table 9 shows the results of how each question on WHOQOL-BREF contributed to the four components. Their contributions was captured in the way that, on each component a variable contribution was only considered where it had the highest loading, and their contributions were sorted from the highest contributing variable to the lowest contributing variable, and variables that had factor loadings less than 0.30 were discarded from the study. Hair et al. (2009) suggested that for a sample size of 350 or greater, factor loadings of 0.30 or greater are significant.

Table 9 Rotated principal component loadings of WHOQOL-BREF

Variables	Components			
	1	2	3	4
How satisfied are you with your personal relationships?	0.77			
How satisfied are you with yourself?	0.76			
How satisfied are you with your capacity for work?	0.71			
How satisfied are you with your ability to perform your daily living activities?	0.63			
How satisfied are you with your sleep?	0.61			
How satisfied are you with your sex life?	0.50			
How satisfied are you with the conditions of your living place?		0.60		
Do you have enough money to meet your daily needs?		0.58		
How satisfied are you with your access to health services?		0.55		
How satisfied are you with the support you get from friends?		0.55		
How satisfied are you with your transport?		0.51		
How available to you is the information that you need in your day-to-day life?		0.51		
How safe do you feel in your daily life?		0.50		
Do you have enough energy for everyday life?			0.72	
How well are you able to concentrate			0.70	
Are you able to accept your bodily appearance?			0.69	
To what extend do you have the opportunity for leisure activities?			0.38	
How often do you need any medical treatment to function in your daily life?				-0.62
How healthy is your physical environment?				0.55
To what extend do you feel your life is to be meaningful				0.51
How well are you able to get around				0.49

Note: Blanks are component with loadings < 0.30

Table 10 Factor analysis of WHOQOL-BREF

Factor	Variables	Factor Loadings	Factor Name
1	How satisfied are you with your personal relationships?	0.77	Social relationships
	How satisfied are you with yourself?	0.76	
	How satisfied are you with your capacity for work?	0.71	
	How satisfied are you with your ability to perform your daily living activities?	0.63	
	How satisfied are you with your sleep?	0.61	
	How satisfied are you with your sex life?	0.50	
2	How satisfied are you with the conditions of your living place?	0.60	Environmental
	Do you have enough money to meet your daily needs?	0.58	
	How satisfied are you with your access to health services?	0.55	
	How satisfied are you with the support you get from friends?	0.55	
	How satisfied are you with your transport?	0.51	
	How available to you is the information that you need in your day-to-day life?	0.51	
	How safe do you feel in your daily life?	0.50	
3	Do you have enough energy for everyday life?	0.72	Physical Health
	How well are you able to concentrate	0.70	
	Are you able to accept your bodily appearance?	0.69	
	To what extend do you have the opportunity for leisure activities?	0.383	
4	How often do you need any medical treatment to function in your daily life?	-0.62	Psychological
	How healthy is your physical environment?	0.55	
	To what extend do you feel your life is to be meaningful	0.51	
	How well are you able to get around	0.49	

Table 10 shows the result of how each question on WHOQOL-BREF module contributed to each of the four constructs. Constructs were named according the highest contributing variable, named as social relationships, environmental, physical health, and psychological health. Items included on each construct listed in table 10 were summarised graphically in Figure **7**.

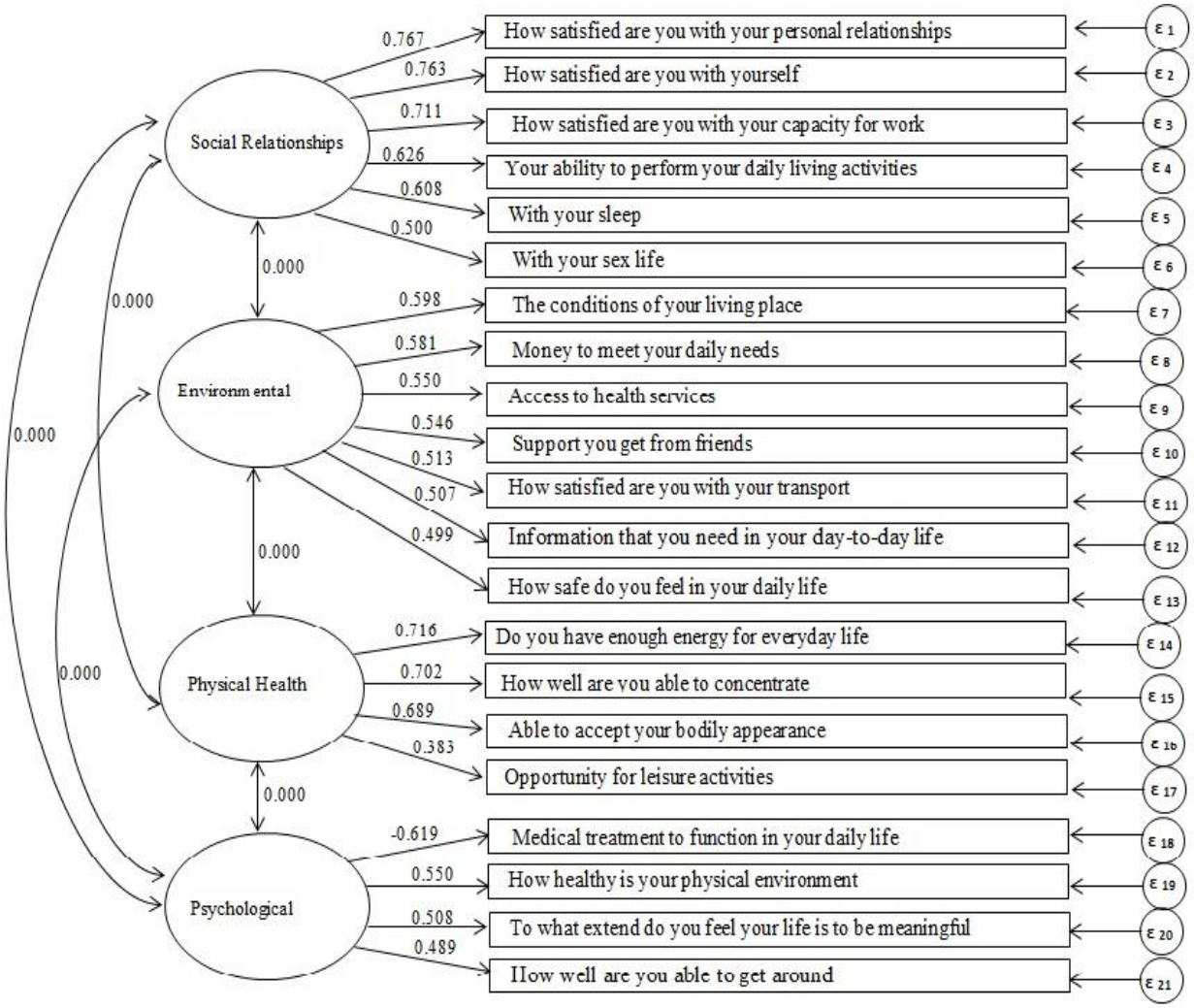
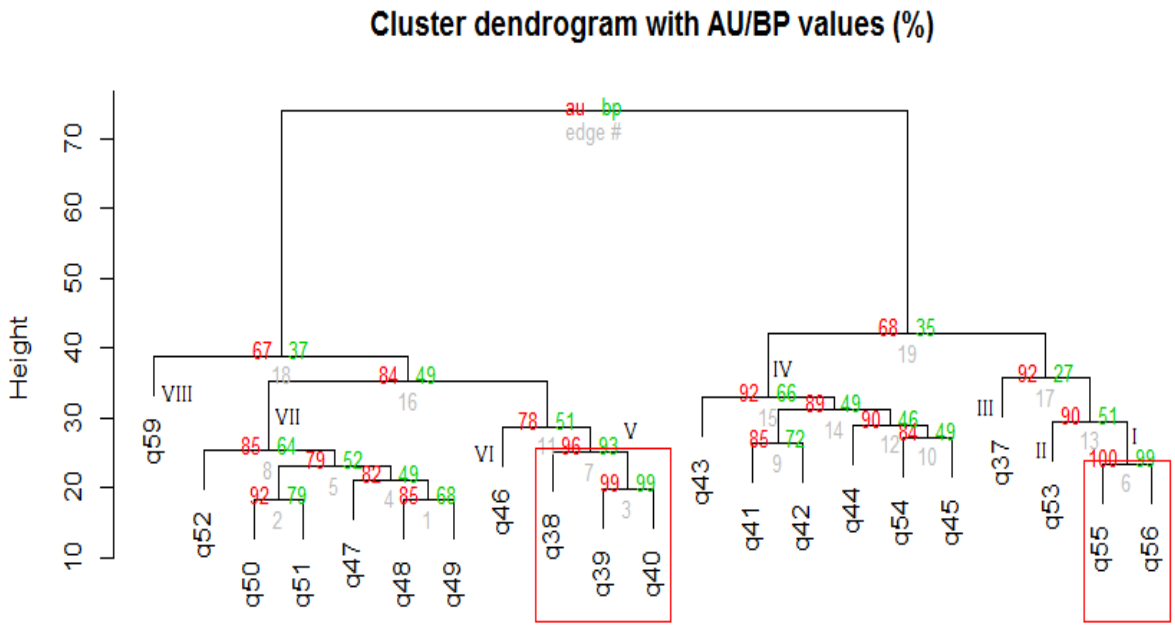


Figure 7 Summary for WHOQOL-BREF domains

The results of the four components were added on the data set, as standardised scores for each participant predicted using regression equations.

4.6.2. Agglomerative Hierarchical Clustering

To determine the number of clusters that will be required for the generated constructs of WHOQOL-BREF, the study used the distance between WHOQOL-BREF indicators to determine their groupings and AU *p-values* to comment on the consistency and significance of the clusters.



AU p-values (red), BP (green)

Figure 8 WHOQOL-BREF dendrogram

Figure 8 shows the results of hierarchical clustering method with multiscale bootstrap resampling method that grouped WHOQOL-BREF variables into eight clusters. However, the results suggested that only two clusters existed (*p-value* AU ≥ 0.95) for this data (i.e. cluster V and I). The significance was assessed by testing the hypothesis that "grouping does not exist between two nodes" rejected at 5% level of significance. To validate if the analysis produced stable and valid

groupings, variables were changed from their initial positions to observe if the groupings will change.

The comparison between the subjective method and data driven method yielded the following Kappa (κ) values: for physical health $\kappa = 0.10\,(p < 0.005)$, psychological health $\kappa = 0.11$ $(p < 0.001)$, social health $\kappa = 0.24\,(p < 0.001)$, and environmental health $\kappa = 0.37$. The values $0.10 \le \kappa \le 0.20$ indicate a slight agreement, whereas the values $0.21 \le \kappa \le 0.40$ indicate a fair agreement between the existing WHOQOL-BREF domains and the data driven domains.

4.7. Application to EQ-5D

In this section, the study derived constructs of quality of life based on EQ-5D module using PCA and EFA. Furthermore, the study assessed the validity and reliability between the constructs and the existing method of EQ-5D. Variables used in this section are attached in Appendix C.

4.7.1. Principal Component Analysis and Exploratory Factor Analysis

To assess if the scale used in the 36 questions was consistent, the study used a reliability analysis test. Table 11 shows a Cronbach's alpha of 0.92, indicating a high level of internal consistency in the scale used in 36 EQ-5D questions.

Table 11 Reliability statistics for EQ-5D questions

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.92	0.94	36

The results in Table 12 suggested that the sample size used in the study was sufficient to continue with EFA on the set of 36 questions on EQ-5D module. The test yields an overall KMO of 0.93 (marvellous), above the set sufficient correlation value of 0.60 to 0.70 (middling), and a significant Bartlett's test spherecity ($\chi^2(666) = 9261.84\,9261.84$, $p < 0.001$). Based on the study results, the null hypothesis was rejected and we conclude that all variables in the dataset are uncorrelated.

Table 12 Kaiser-Meyer-Olkin and Bartlett's Test

KMO Measure of Sampling Adequacy (N=416)		0.93
Bartlett's Test of Sphericity	Approx. Chi-Square	9261.84
	df	666
	Sig.	<0.001***

****p < 0.001*

Table 13 presents a cropped table with results of eigenvalues and percentage of variance explained by each of the indicators of EQ-5D. The extraction generated 36 components with eigenvalues ranging from 13.94 to 0.11. Based on the study findings, seven components were found to have eigenvalues greater than one. With component one explaining 38.73% variation in the data, followed by the second component that accounted for 8.72 % variation, followed by component three that accounted for 5.34% variation, followed by component four, five, six and component seven respectively. Overall, seven components accounted for about 66.82% variation in the data and the remaining 33.18% variation was explained by the remaining 29 components.

Table 13 Components extracted for EQ-5D

Component	Initial Eigenvalues		
	Total	**% of Variance**	**Cumulative %**
1	13.94	38.73	38.73
2	3.14	8.72	47.45
3	1.92	5.34	52.79
4	1.55	4.30	57.09
5	1.35	3.74	60.83
6	1.10	3.06	63.89
.	.	.	.
.	.	.	.
.	.	.	.
33	0.16	0.45	98.89
34	0.15	0.42	99.30
35	0.14	0.39	99.69
36	0.11	0.31	100

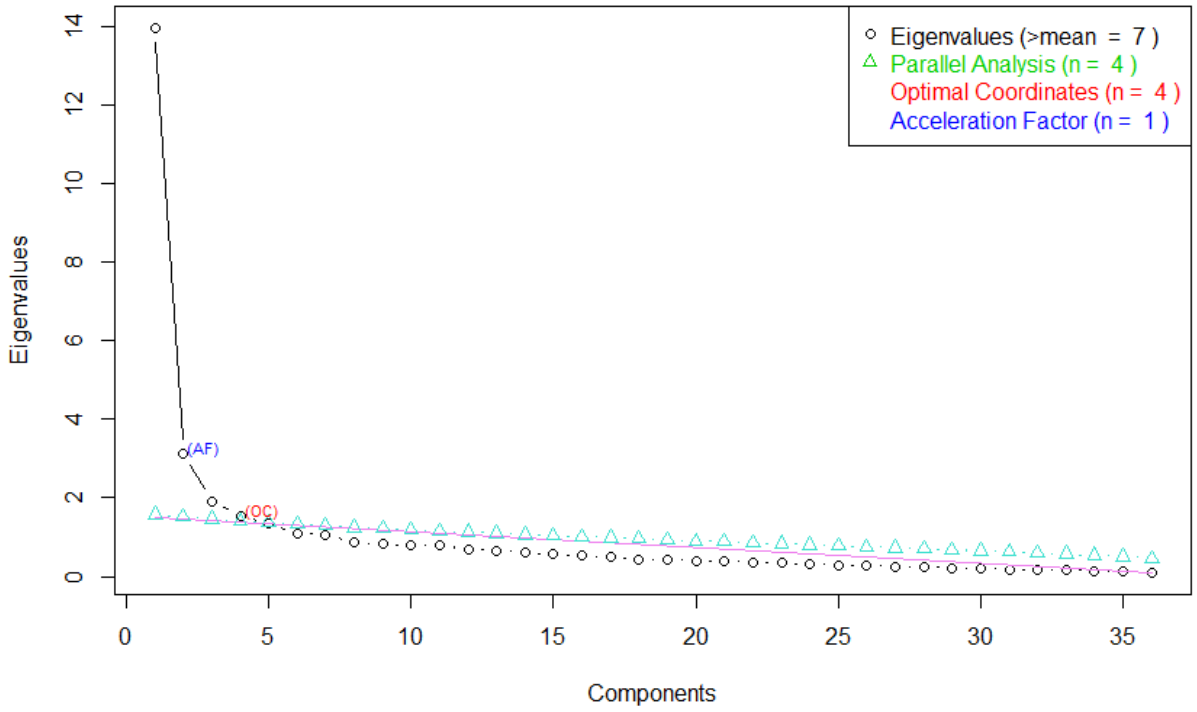


Figure 9 Scree plot of EQ-5D components

Figure 9 was used to determine the number of components to be retained, by observing where we have the biggest drop in eigenvalues and inspecting the number of components suggested by parallel analysis results. Based on Figure 9, we identified that the biggest drop in eigenvalues was observed before the fifth component, implying that we should only retain four components. Moreover, parallel analysis results also suggested that four-factor solution was sufficient for the current study. The study concludes that much of the variation in the data was explained by only four components.

Table 14 Rotated principal component loadings of EQ-5D

Variables	Components			
	1	2	3	4
How much difficulty did you have in extending your arms above shoulder level?	0.73			
How much difficulty did you have in bathing/washing your whole body?	0.69			
How much difficulty did you have with climbing on stairs or going uphill?	0.68			
How much difficulty did you have with stooping, kneeling or crouching?	0.69			
How much difficulty did you have in walking a long distance such as one kilometre (many soccer fields)?	0.67			
How much difficulty did you have with picking up things with your fingers (such as picking up a coin from a table)?	0.66			
How much difficulty did you have in joining community activities (festivities, religious) in the same way as anyone else?	0.65			
How much difficulty did you have in standing up from sitting down?	0.65			
How much difficulty did you have in walking up to 100 meters (e.g. sports field)?	0.64			
How much difficulty did you have in standing for long periods?	0.62			
How much have you been emotionally affected by your health conditions?	0.62			
How much difficulty did you have in taking care of your household responsibilities?	0.61			
How much difficulty did you have in sitting for long periods?	0.52			
How much difficulty did you have with getting where you want to go, using private or public transport if needed?	0.47			
How much difficulty did you have in seeing and recognizing an object or a person you know across	0.47			

the road?				
How much of a problem did you have with worry or anxiety?		0.81		
How much of a problem did you have with feeling sad, low or depressed?		-0.78		
How much difficulty did you have in your daily life because of your pain?		0.71		
How much of a problem did you have due to not feeling rested and refreshed during the day (e.g. feeling tired, not having energy)?		0.68		
How much of bodily aches or pains did you have?		0.67		
How much bodily discomfort did you have?		0.637		
How much of a problem did you have with sleeping, waking up frequently during the night or waking up too early in the morning?		0.62		
How much difficulty did you have with concentrating or remembering things		0.55		
How much difficulty did you have in dealing with conflicts and tensions with others?		0.55		
How much difficulty did you have concentrating on doing something?		0.54		
How much difficulty did you have with personal relationships or participation in the community?		0.53		
How much difficulty did you have in learning a new task (e.g. how to get to a new place, learning a new game, learning a new recipe, etc.)?		0.50		
How much difficulty did you have with self-care, such as, bathing/washing or dressing yourself?			0.79	
How much difficulty did you have in taking care of and maintaining your general appearance (e.g. grooming, looking neat and tidy)?			0.77	
How much difficulty did you have with moving around?			0.68	
How much difficulty did you have in vigorous activities (activities that require hard physical effort and cause large increases in breathing or heart rate)?			0.64	

Overall, How much difficulty did you have with work or household activities?			-0.63	
How much difficulty did you have in staying by yourself for a few days (3 to 7 days)?			0.59	
How much difficulty did you have with making new friendships or maintaining current friendships?				0.65
How much difficulty did you have with dealing with strangers?				0.63
How much difficulty did you have in seeing and recognizing an object very close (reading)?				0.49

Note: Blanks are component with loadings < 0.30

Table 14 presents the result of how each question on EQ-5D contributed to the four constructs. Their contributions were captured in the way that, on each component a variable contribution was only considered where it had the highest loadings. Their contributions were sorted from the highest contributing variable to the lowest contributing variable.

Table 15 Factor analysis of EQ-5D components

Factor	Variables	Factor Loadings	Factor Name
1	How much difficulty did you have in extending your arms above shoulder level?	0.73	Pain/Discomfort
	How much difficulty did you have in bathing/washing your whole body?	0.69	
	How much difficulty did you have with climbing on stairs or going uphill?	0.68	
	how much difficulty did you have with stooping, kneeling or crouching?	0.68	
	How much difficulty did you have in walking a long distance such as one kilometre (many soccer fields)?	0.67	
	How much difficulty did you have with picking up things with your fingers (such as picking up a coin from a table)?	0.66	
	How much difficulty did you have in joining community activities (festivities, religious) in the same way as anyone else?	0.65	
	How much difficulty did you have in standing up from sitting down?	0.65	
	How much difficulty did you have in walking up to 100 meters (e.g. sports field)?	0.64	
	How much difficulty did you have in standing for long periods?	0.62	
	How much have you been emotionally affected by your health conditions?	0.62	
	How much difficulty did you have in taking care of your household responsibilities?	0.61	
	How much difficulty did you have in sitting for long periods?	0.52	
	How much difficulty did you have with getting where you	0.47	

	want to go, using private or public transport if needed?		
	How much difficulty did you have in seeing and recognizing an object or a person you know across the road?	0.47	
2	How much of a problem did you have with worry or anxiety?	0.81	Anxiety/Depression
	How much of a problem did you have with feeling sad, low or depressed?	-0.78	
	How much difficulty did you have in your daily life because of your pain?	0.71	
	How much of a problem did you have due to not feeling rested and refreshed during the day (e.g. feeling tired, not having energy)?	0.68	
	How much of bodily aches or pains did you have?	0.67	
	How much bodily discomfort did you have?	0.64	
	How much of a problem did you have with sleeping, waking up frequently during the night or waking up too early in the morning?	0.62	
	How much difficulty did you have with concentrating or remembering things	0.55	
	How much difficulty did you have in dealing with conflicts and tensions with others?	0.55	
	How much difficulty did you have concentrating on doing something?	0.54	
	How much difficulty did you have with personal relationships or participation in the community?	0.53	
	How much difficulty did you have in learning a new task (e.g. how to get to a new place, learning a new game, learning a new recipe, etc.)?	0.50	
3	How much difficulty did you have with self-care, such as, bathing/washing or dressing yourself?	0.79	Self-Care
	How much difficulty did you have in taking care of and	0.77	

	maintaining your general appearance (e.g. grooming, looking neat and tidy)?		
	How much difficulty did you have with moving around?	0.68	
	How much difficulty did you have in vigorous activities (activities that require hard physical effort and cause large increases in breathing or heart rate)?	0.64	
	Overall, How much difficulty did you have with work or household activities?	-0.63	
	How much difficulty did you have in staying by yourself for a few days (3 to 7 days)?	0.59	
4	How much difficulty did you have with making new friendships or maintaining current friendships?	0.65	Usual Activities
	How much difficulty did you have with dealing with strangers?	0.63	
	How much difficulty did you have in seeing and recognizing an object very close (reading)?	0.49	

Table 15 illustrates results of how each question on EQ-5D module contributed to each of the four components. Constructs were named according the highest contributing variables, identified as pain/discomfort, anxiety/depression, self-care, and usual activities. Items included on each factor are summarised in Figure 10.

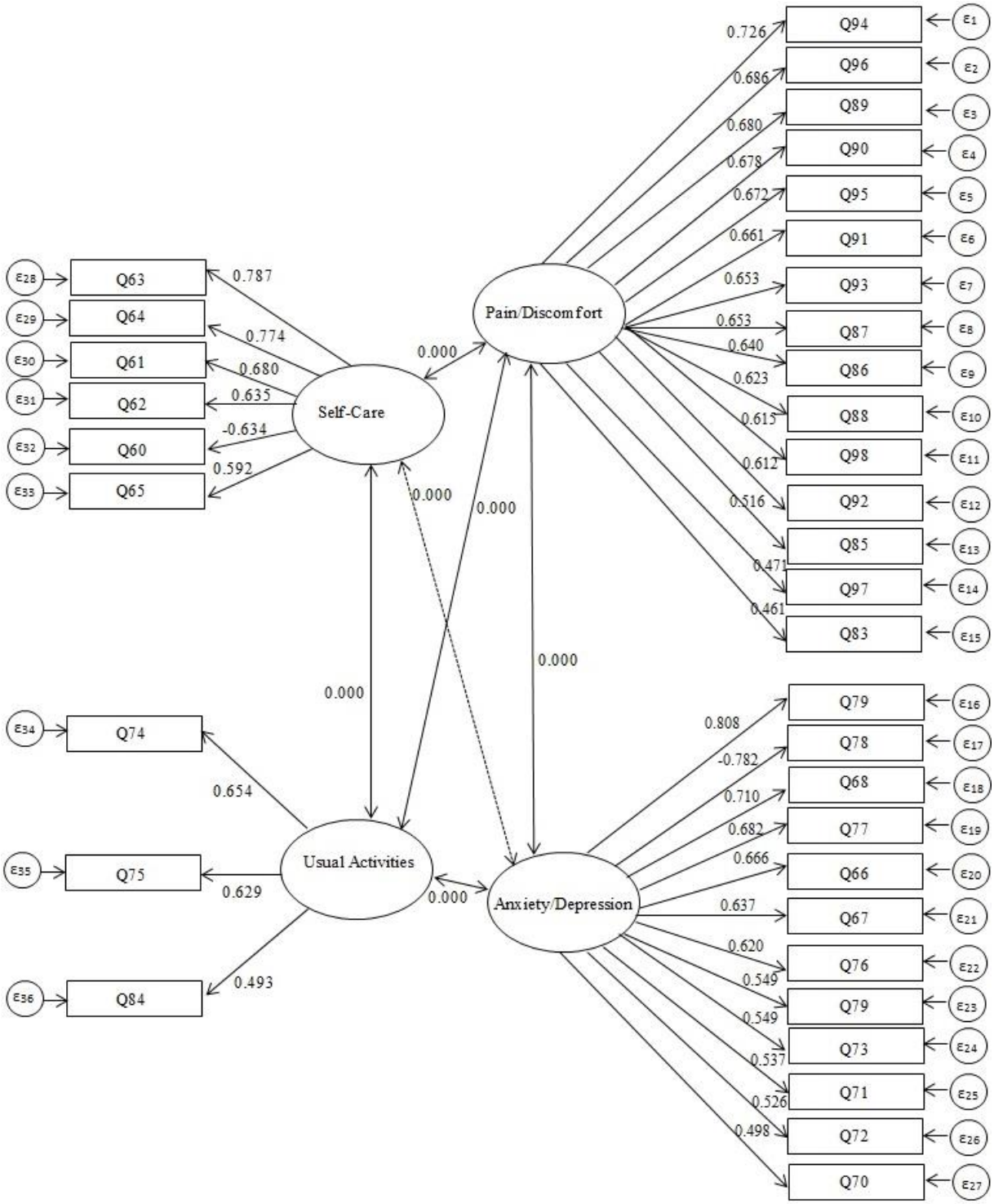
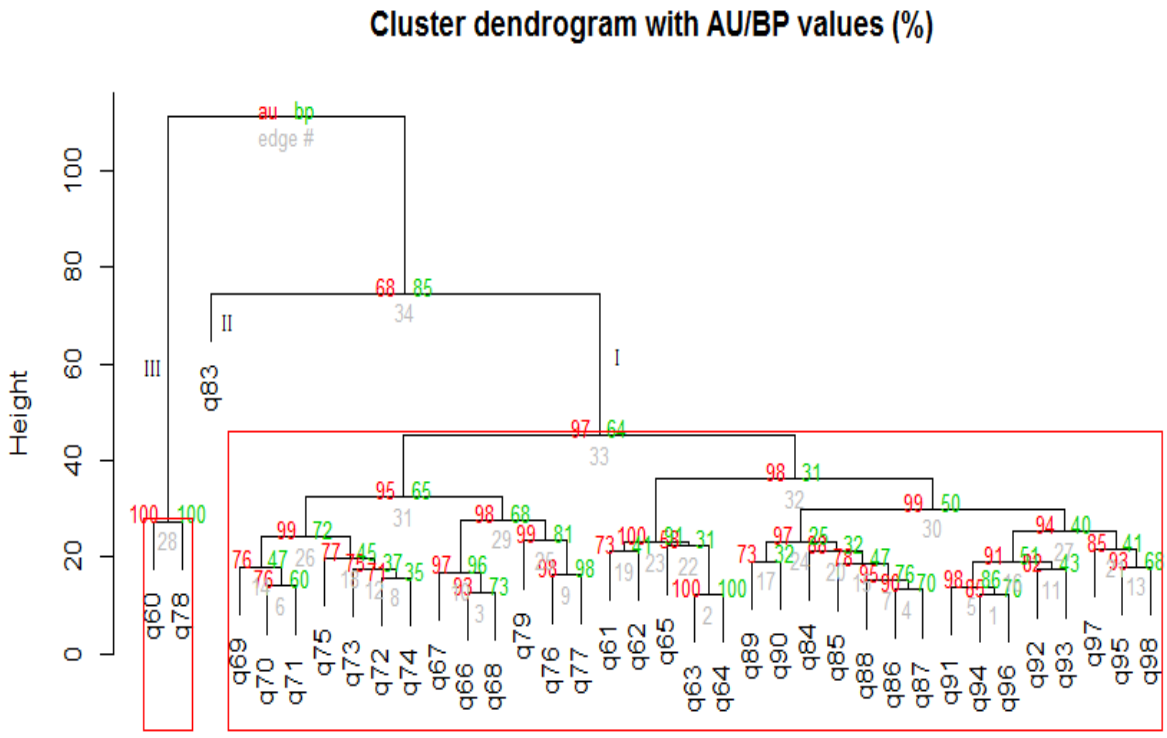


Figure 10 Summary for EQ-5D domains

4.7.2. Agglomerative Hierarchical Clustering

Given that EQ-5D module only specified five dimensions that have five levels of severity (that is, no problems, slight problems, moderate problems, severe problems, and extreme problems), whereby participants are only able to select one level in each dimension that described their health on that particular day of the survey. However, this was slightly different in our study. The study had added several questions on each dimension, and it allowed multiple responses per dimension. In this section, we use the distance between indicators of quality of life (EQ-5D) to determine the groupings, and AU *p-values* to comment on the consistency and significance of the clusters.



AU p-values (red), BP (green)

Figure 11 EQ-5D dendrogram

Figure 11 shows the results of hierarchical clustering with multiscale bootstrap resampling method that grouped EQ-5D variables into three clusters. However, the results supported that only two clusters were significant (*p-value* AU $\geq$ 0.95) for this data (i.e. cluster II and I). Clusters significance was assessed by testing a hypothesis that "grouping does not exist between two nodes" rejected at $p = 0.05$. To ensure that the analysis produced stable and valid groups, variables were changed from their initial positions in the analysis to observe if their grouping will change. The results obtained in this step were used for further analysis in the study.

The Kappa Cohen's comparison test between EQ-5D domains and the data driven method was not assessed in this section because the study had additional questions that required multiple responses unlike the EQ-5D that permitted only one response per dimension.

4.8. Conclusion

This chapter generated the constructs of food insecurity and quality of life constructs for both WHOQOL-BREF and EQ-5D. The generated constructs of food security, was identified as food insecurity. The study findings supported that the derived construct differed from the existing FANTA method. However, when cluster memberships was applied to the construct, the study groupings classified households with similar food insecurity characteristics in groups that matched the three domains of FANTA.

In addition, the study derived four constructs of quality of life based on WHOQOL-BREF module, and they were identified as social relationships, environmental

health, physical health and psychological health. Even though the constructs names matched those of WHOQOL-BREF, some manifest variables contributed to other domains, other than on their intended domains. However, when cluster memberships were applied, the grouping appeared to be somewhat similar to that of WHOQOL-BREF domains.

On the other hand, the study derived four components of EQ-5D, classified as pain/discomfort, anxiety/depression, self-care, and usual activities. The study acknowledged that there was a difference between variables used in the study and those in the EQ-5D questionnaire. The study questionnaire had several questions added on each domain, resulting in participants giving multiple responses, whereas the EQ-5D only allowed for single response per dimension. The constructs derived in this study had serval manifest variables on each as opposed to EQ-5D that only have one variable per dimension.

CHAPTER 5: LINKING FOOD INSECURITY TO QUALITY OF LIFE USING SEM

5.1. Introduction

This chapter focuses on testing the preconceived models identified in Chapter 4 using CFA method. In this chapter, the study tested if the identified constructs are useful in describing the underlying relationship between manifest and latent variables. The chapter also focuses on linking the two constructs of quality of life to food insecurity construct in a process that completes SEM.

5.2. Confirmatory Factor Analysis

Section 4.3, described how EFA works in a set of multivariate data to identify whether factors identified in the model are useful in describing and accounting for the relationship between manifest and latent variables (Everitt & Hothorn, 2011, p. 201). In this section, the study briefly discusses how CFA is carried out. CFA models enable us to either confirm or reject our preconceived theory that we established using EFA (Hair et al., 2009). Earlier, I mentioned that CFA forms part of SEMs that aims to explain how both explanatory and latent variables are linked in series of linear combinations.

In CFA, there are three steps involved in model building. The first step, begin by estimating the values of model parameters that minimises the discrepancy function between the elements of the observed covariance matrix **S** of manifest variables and the covariance matrix $\Sigma(\theta)$ implied by the fitted model, contained in the vector $\theta = (\theta_1, \theta_2, ..., \theta_t)^T$. Everitt and Hothorn (2011, p. 202) stated that maximum

likelihood estimation method, is the most commonly used method for estimating parameters in CFA. The method assumes that the observed data follows a multivariate normal distribution. The maximum likelihood for minimizing the discrepancy function (FML) is given by:

$$FML = (S, \Sigma(\theta)) = \log|\Sigma(\theta)| - \log|S| + trace\left(S\Sigma(\theta)^{-1}\right) - q \quad \textbf{5.1}$$

The second step, deals with parameter identification in the model. In CFA, model identifiability depends on the choice of the model, specification of fixed constraints, and number of free parameters in the model (Everitt & Hothorn, 2011, p. 204). They further stated that model identification in CFA can be difficult times, since there are no universally applicable rules for evaluating model identification. However, there is a simple but not sufficient condition for identification, that states that the number of free parameters in a model *t*, need to be less than $q(q+1)/2$.

The third step, assess how the model predicts well the covariance matrix of manifest variables using the likelihood ratio statistic given by:

$$\chi^2 = (N-1)FML_{\min} \quad \textbf{5.2}$$

Where N is a sample size and FML_{min} is the minimized value of the maximum likelihood discrepancy function given in equation (**5.1**). Everitt and Hothorn (2011, p. 204) noted that even though the likelihood ratio statistic is the only measure used to assess the model goodness of fit, sometimes it is impractical to use this method when the sample size is large, and when manifest variables have a non-normal distribution. Hence, the likelihood ratio statistics should be used alongside any of

the following procedures: (1) visual inspection of residual covariance, (2) examination of the standard errors of the parameters and the correlations between estimates, and (3) inspecting the estimated values outside their range. For instance, inspecting results that are showing negative variances indicate that the fitted model is wrong (Everitt & Hothorn, 2011).

CFA forms part of SEMs, the technique uses standardised regression scores to link latent variables to manifest variables and this relationship is visualised using path diagrams. The method aims to test the null hypothesis that, there is no difference between the patterns of manifest variables in the data set and the specified model.

The study used the following R packages to fit CFA and SEM: *lavaan*, *semPlot*, *semTools*, and *nonnest2*. The models were fitted in R version 3.3.1. *"Bug in Your Hair".*

5.2.1. Application to Food Insecurity

Based on the data driven approach-using EFA, we hypothesise that households' food insecurity in Windhoek informal settlements only had one factor, food insecurity. In this section, the study used CFA to test if the underlying latent model fits the data well. Variables used in this section are attached in Appendix A.

Table 16 shows that the overall goodness of fit of the one-factor model was adequate with $\chi^2(35) = 679.42$, $p < 0.001$, greater than the required χ^2 = 200. Additionally, the results of the absolute fit suggested that the study had a good fit with a Standardized Root Mean Square Residual (SRMR) = 0.05 and a Root Mean Square Error of Approximation (RMSEA) = 0.22 (90% CI=0.20; 0.23). According

to Hu and Bentler (1999), SRMR values should be close to 0.08 or less, with a value of zero indicating a perfect fit and the RMSEA value should be close to 0.06 or below, with zero being a perfect fit. Even though the RMSEA value was greater than 0.06, it was found to be statistically significant ($p < 0.001$).

Table 16 Baseline model and fit indices of food insecurity

	N=393
Estimator	ML
Minimum Function Test Statistic	679.42
Degrees of freedom	35
P-value	<0.001***
User model versus baseline model	
Comparative Fit Index (CFI)	0.89
Tucker-Lewis Index (TLI)	0.85
Log likelihood and Information Criteria	
Log likelihood user model (H0)	-3708.36
Log likelihood unrestricted model (H1)	-3368.65
Number of free parameters	20
Akaike (AIC)	7456.73
Root Mean Square Error of Approximation	
RMSEA	0.22
90 Percent Confidence Interval	0.20 ; 0.23
P-value RMSEA <= 0.05	<0.001***
Standardized Root Mean Square Residual	
SRMR	0.05

****p < 0.001*

Additionally, the results in Table 16 shows a Tucker-Lewis Index (TLI) = 0.85 and a Comparative Fit Index (CFI) = 0.89, which is below the suggested cut-off point of 0.95 or greater, with a value of one indicating a perfect fit. Since these fit indexes measures comparability between the proposed model and the null model, their resulting low values might be due to low correlation in the data. Prudon (2014) argued that the values of TLI and CFI are likely to approach one, when there is high

correlations among variables. Hence, based on Table 17 the result confirms that the study has identified the best-fit model for food insecurity in Windhoek informal settlements using CFA.

Table 17 Model fit for food insecurity

Indicator	**model magnitude**	**Ideal Magnitude**	
Chi.sq.	679.42	> 200	Yes
RMSEA	0.22	≤ 0.05	No
SRMR	0.05	< 0.1	Yes
GFI	0.69	> 0.9	No

Table 18 presents the model estimates. Estimates, standard errors and z-values were computed to determine if the distribution assumptions are met. The results supported that all estimates had z-values that were greater than 1.96, this also indicate that estimates were significantly different from zero (*p = 0.05*). The covariance was not given for this model, because it only had one factor.

Table 18 Model estimates of food insecurity

Parameter Estimates (N=393)				
Information		Expected		
Standard Errors		Standard		
Latent Variables	**Estimate**	**Std.Err**	**Z-value**	**P(>|z|)**
factor1 =~				
q111	1.00			
q112	1.05	0.06	18.65	<0.001***
q113	1.08	0.06	18.95	<0.001***
q114	0.09	0.06	19.58	<0.001***
q115	0.21	0.06	21.89	<0.001***
q116	1.20	0.06	21.97	<0.001***
q117	1.21	0.05	22.75	<0.001***
q118	1.23	0.05	22.61	<0.001***
q119	1.20	0.05	22.42	<0.001***
q120	1.16	0.05	21.42	<0.001***

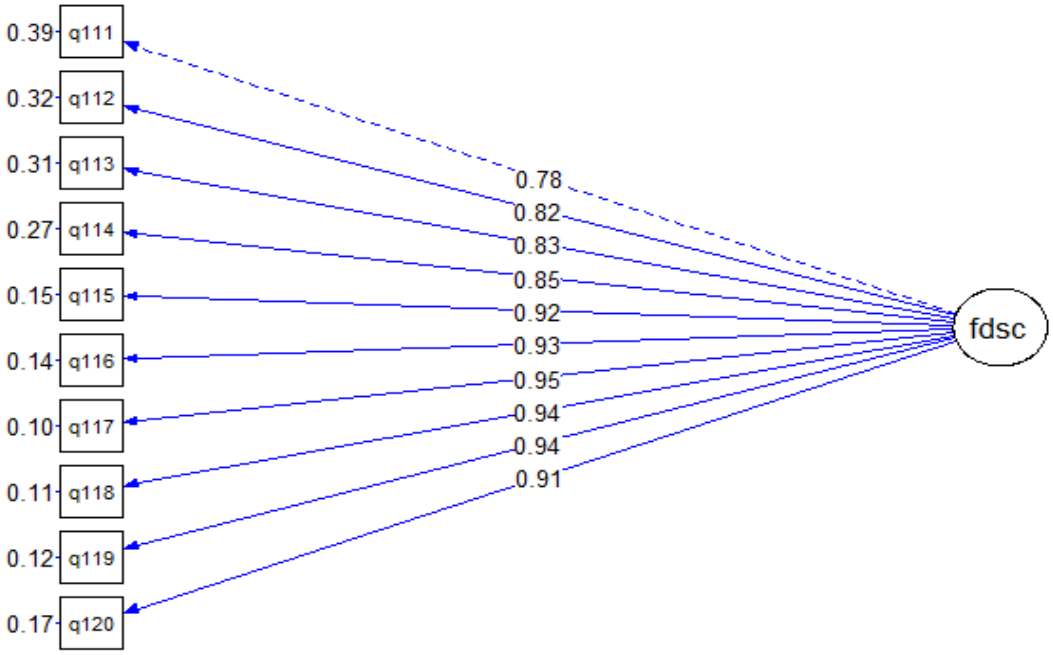
Z-value are based on the Wald test and a corresponding two-sided,
***$p < 0.001$, =~' means is measured by, factor1 (food insecurity)

Table 19 Measures of food insecurity

Construct items and scale reliability	Standardised factor loadings	R-Squared
Factor 1 (Food Insecurity) (***α***=0.97) **(N=393)**		
q111	0.78	0.62
q112	0.82	0.68
q113	0.83	0.69
q114	0.85	0.73
q115	0.92	0.85
q116	0.93	0.86
q117	0.95	0.90
q118	0.94	0.89
q119	0.94	0.88
q120	0.91	0.83

Table 19 shows the results of reliability test and the standardised factor loadings of the manifest variables and the latent variable. The fitted model shows a Cronbach's alpha of 0.97, indicating that the model had an excellent internal validity. Table 19 further showed that manifest variables had higher positive loadings on the latent variable ranging from 0.78 to 0.95. The factor loadings results are summarised in Figure 12 below. In addition, Table 19 shows that about 62% variation in food insecurity was explained by whether households had worry that they will not have enough food. In the same way, the results showed that 86% variation in food insecurity was explained by whether household members had to eat fewer meals in a day because there was no enough food. The study results also supported that 90%

variation in food insecurity was explained by whether there was no food to eat of any kind in their households because of lack of resources to get food.



Food insecurity (fdsc), factor loadings (middle) and errors (end)

Figure 12 Food insecurity factor model structure.

Testing of hypothesis:

H_0: There is no significant difference between manifest variables contributing to food insecurity in Windhoek informal settlements.

From Figure 12, we deduce that all manifest variables contributing to food insecurity in Windhoek informal settlements were found to have a best fit, and have a significant positive relationship ($p< 0.01$). Hence, the fitted model from the viewpoint of respondents, suggested that all manifest variables are significantly

associated and have a positive impact on respondents' overall perception of food insecurity in Windhoek informal settlements.

5.2.2. Application to WHOQOL-BREF

Based on the data driven approach using EFA, the study hypothesised that individuals' quality of life in Windhoek informal settlements is determined by four factors, namely social health, environmental health, physical health, and psychological health. Given the underlying latent model identified using EFA. In this section, the study used CFA to test if the identified model fit the data well. Variables used in this section are attached in Appendix B.

Table 20 Baseline model and fit indices of WHOQOL-BREF

	N=331
Estimator	ML
Minimum Function Test Statistic	488.85
Degrees of freedom	183
P-value	<0.001***
User model versus baseline model	
Comparative Fit Index (CFI)	0.81
Tucker-Lewis Index (TLI)	0.79
Loglikelihood and Information Criteria	
Loglikelihood user model (H0)	-10378.34
Loglikelihood unrestricted model (H1)	-10133.92
Number of free parameters	48
Akaike (AIC)	20852.68
Root Mean Square Error of Approximation	
RMSEA	0.07
90 Percent Confidence Interval	0.06 ; 0.08
P-value RMSEA <= 0.05	<0.001***
Standardized Root Mean Square Residual	
SRMR	0.07

****p < 0.001*

Table 21 Model fit of WHOQOL-BREF

Indicator	model magnitude	Ideal Magnitude	
Chi.sq	488.85	> 200	Yes
RMSEA	0.07	≤ 0.05	No
SRMR	0.07	< 0.1	Yes
GFI	0.88	> 0.9	No

Based on Table 20 and Table 21, the study findings supported that the overall goodness fit of the four-factor model was sufficient with $\chi^2(183) = 488.85$, $p <$ *0.001*, larger than the required $\chi^2 =$ 200. The results of the absolute fit also suggested that we have a good fit with a SRMR = 0.07 and a RMSEA = 0.07 (90% CI 0.06; 0.08). However, the model yields a TLI = 0.79 and a CFI = 0.81 that were below the suggested cut-of points. This indicates that there was low correlation in the data, since the two indexes measures comparability between the proposed and the null model (Prudon, 2014). Hence, we conclude that this is the best model for qualify of life in Windhoek informal settlements. However, there was a need to modify the model, due nonsignificant parameters in the model identified by inspecting Table 22.

Table 22 shows the results of the estimated model parameters. Estimates, standard errors and z-values were computed to determine if the distribution assumptions were met. The estimates are found to be significant when they have a z-value greater than 1.96 (p=0.05). The findings supported that manifest variables on the first three-factors were significant (*p=0.01)*. However, manifest variables on factor4 (psychological) were statistically insignificant (p<0.05). Furthermore, the covariance results support that the psychological factor was not significant with any

of the other three factors. Hence, the model needed to be modified by removing psychological factor from model.

Table 22 Model estimates of WHOQOL-BREF

Parameter Estimates (N=331)				
Information		Expected		
Standard Errors		Standard		
Latent variables	**Estimate**	**Std.Err**	**z-value**	**P(>|z|)**
factor1=~				
q51	1.00			
q50	1.09	0.10	11.32	<0.001***
q49	1.06	0.09	11.66	<0.001***
q48	0.94	0.09	10.82	<0.001***
q47	1.02	0.10	10.49	<0.001***
q52	0.85	0.10	8.72	<0.001***
factor2=~				
q54	1.00			
q41	0.62	0.13	4.99	<0.001***
q55	1.09	0.15	7.40	<0.001***
q53	0.83	0.14	6.13	<0.001***
q56	0.90	0.13	6.73	<0.001***
q42	0.70	0.12	5.70	<0.001***
q44	1.15	0.16	7.06	<0.001***
factor3=~				
q36	1.00			
q38	0.73	0.09	7.93	<0.001***
q40	1.02	0.11	9.59	<0.001***
q43	0.54	0.11	5.01	<0.001***
factor4=~				
q59	1.00			
q45	-3.76	1.98	-1.90	0.057
q37	1.15	0.74	1.56	0.120
q46	-3.79	1.99	-1.90	0.057
Covariances				
factor1~~				
factor2	0.30	0.05	5.91	<0.001***
factor3	0.32	0.05	6.17	<0.001***
factor4	-0.07	0.04	-1.86	0.063
factor2~~				
factor3	0.16	0.05	3.42	<0.001***
factor4	-0.10	0.05	-1.87	0.061
factor3~~				
factor4	-0.08	0.04	-1.83	0.067

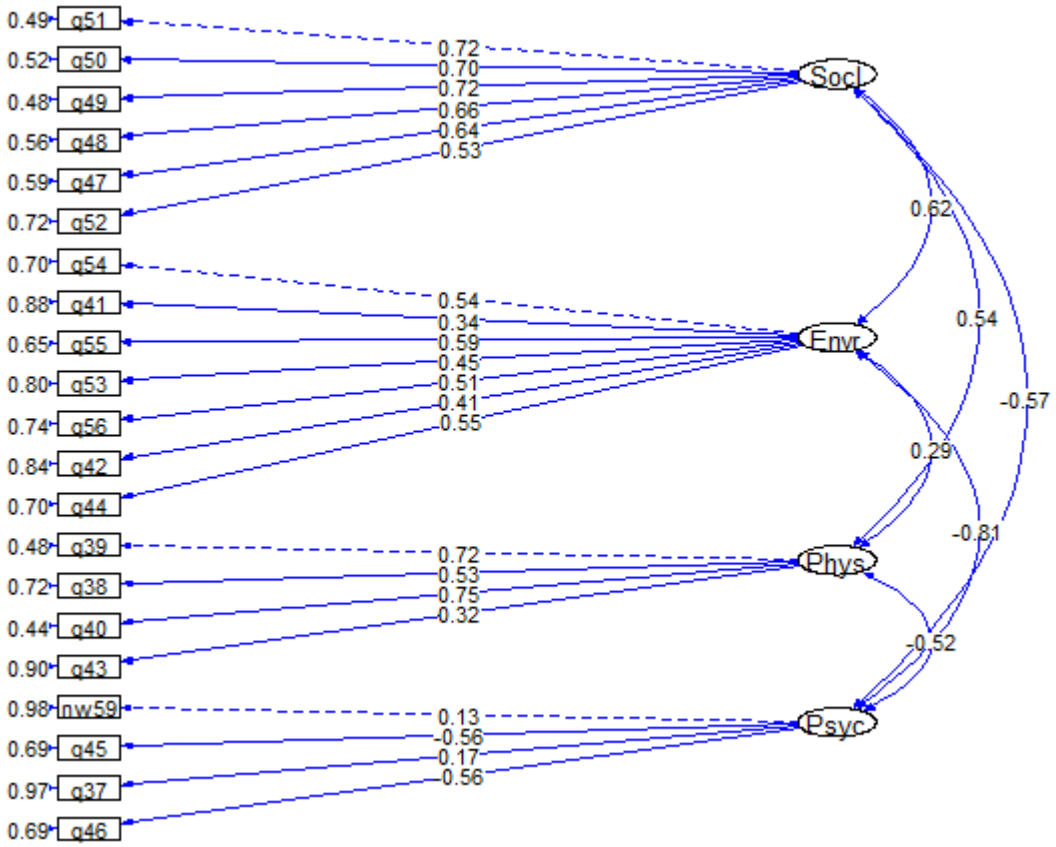
Z-value are based on the Wald test and a corresponding two-sided,
***$p < 0.001$, '=~' means is measured by, factor1 (social health), factor2 (environmental health), factor3 (physical health), factor4 (psychological health).

Table 23 Measures of WHOQOL-BREF

Construct items and scale reliability	Standardised factor loadings	R-Squared
Factor 1 (Social Health) (**α**=0.82)		
q51	0.72	0.51
q50	0.70	0.48
q49	0.72	0.52
q48	0.66	0.44
q47	0.64	0.41
q52	0.53	0.28
Factor 2 (Environmental Health) (**α**=0.69)		
q54	0.55	0.30
q41	0.35	0.12
q55	0.60	0.35
q53	0.45	0.20
q56	0.51	0.26
q42	0.41	0.17
q44	0.55	0.30
Factor 3 (Physical Health) (**α**=0.64)		
q39	0.72	0.52
q38	0.53	0.28
q40	0.75	0.56
q43	0.32	0.10
Factor 4 (Psychological Health) (**α**= - 0.18)		
q59	0.13	0.02
q45	-0.56	0.31
q37	0.17	0.03
q46	-0.56	0.31
Overall scale reliability	**α**=0.80	

Table 23 shows the reliability test results and standardised factor loadings of manifest and latent variables. The fitted model shows a Cronbach's alpha of 0.80, indicating that the model had an acceptable internal validity. However, factor 4 yielded a Cronbach's Alpha of -0.18, which indicated that the factor has

unacceptable internal validity. Based on these findings, the study concluded that psychological factor should be removed from the model. This means that psychological health factor was under-estimating the observed relationship between the pair of quality of life indicators. The structural relationship is summarised in Figure 13. From Figure 13, we clearly observed a negative correlation between psychological health and the other three factors.



Socl (social health), Envr (environmental health), Phys (physical health), Psyc (physiological health), factor loadings (middle) and errors (end)

Figure 13 WHOQOL-BREF model structure (unmodified)

At the beginning of this section, the study fitted a four-factor model of WHOQOL-BREF identified using EFA. However, the results of CFA suggested that

psychological health was not a significant predictor of quality of life in Windhoek informal settlements. Hence, psychological health factor was removed from the model. The study observed the resulting outcome of the three-factor model and compared its results to that of the four-factor model, and inspects which model fits the data well.

Table 24 Four-factor model vs. three-factor (modified) model (WHOQOL-BREF)

Indicator	**four-factor model**		**three-factor model**	**Fitness evaluation**
ECVI	1.77	>	1.07	Not ideal
AIC	20852.68	>	16680.48	Not ideal

Table 24 presents the comparison findings of the two models. The results supported that the three-factor model appeared to be the best model compared to the four-factor model. Based on the study results, the three-factor model had lower absolute fit index compared to the four-factor model. According to the rule of thumb, we select the model that has the lowest values of the expected cross-validation index (ECVI) and Akaike Information Criterion (AIC) (Byrne, 2013).

Below, we present the results of the modified three-factor model of quality of life in Windhoek informal settlements.

The results presented in Table 25 and Table 26 shows that the overall goodness of fit of the modified three-factor model was sufficient with $\chi^2(116) = 282.60$, $p < 0.001$, greater than the required $\chi^2 = 200$. The results of the absolute fit further suggested that the study has a best fit with a SRMR = 0.07 and a RMSEA = 0.07 (90% CI=0.06; 0.08) indicating that we have an acceptable fit.

Moreover, the results of the baseline model fit yielded a TLI = 0.86 and a CFI = 0.88, that were not far from the suggested cut-off point of 0.95 or greater (with a value of one indicating a perfect fit). Since these two fit indexes measures comparability between the proposed and the null model, their resulting low values could be due to low correlation in the data (Prudon, 2014). Based on Table 26 the study concluded that we found the best-fit model for quality of life in Windhoek informal settlements.

Table 25 Baseline model and fit indices of WHOQOL-BREF (modified model)

	N=333
Estimator	ML
Minimum Function Test Statistic	282.60
Degrees of freedom	116
P-value	<0.001***
User model versus baseline model	
Comparative Fit Index (CFI)	0.88
Tucker-Lewis Index (TLI)	0.86
Loglikelihood and Information Criteria	
Loglikelihood user model (H0)	-8303.24
Loglikelihood unrestricted model (H1)	-8161.94
Number of free parameters	37
Akaike (AIC)	16680.48
Root Mean Square Error of Approximation	
RMSEA	0.07
90 Percent Confidence Interval	0.06; 0.08
P-value RMSEA <= 0.05	<0.001***
Standardized Root Mean Square Residual	
SRMR	0.07

****p < 0.001*

Table 26 Model fit of WHOQOL-BREF (modified model)

Indicator	**model magnitude**	**Ideal Magnitude**	
Chi.sq	282.60	> 200	Yes
RMSEA	0.07	≤0.05	No
SRMR	0.07	<0.1	Yes
GFI	0.91	> 0.9	Yes

Table 27 Model estimates of WHOQOL-BREF (modified model)

Parameter Estimates (N=333)				
Information		Expected		
Standard Errors		Standard		
Latent variables	**Estimate**	**Std.Err**	**z-value**	**P(>|z|)**
factor1=~				
q51	1.00			
q50	1.09	0.10	11.42	<0.001***
q49	1.06	0.09	11.77	<0.001***
q48	0.93	0.09	10.81	<0.001***
q47	1.00	0.10	10.44	<0.001***
q52	0.85	0.10	8.78	<0.001***
factor2=~				
q54	1.00			
q41	0.64	0.13	4.86	<0.001***
q55	1.13	0.16	7.10	<0.001***
q53	0.89	0.15	6.09	<0.001***
q56	0.98	0.15	6.67	<0.001***
q42	0.73	0.13	5.60	<0.001***
q44	1.08	0.17	6.40	<0.001***
factor3=~				
q36	1.00			
q38	0.73	0.09	8.10	<0.001***
q40	0.70	0.10	9.47	<0.001***
q43	0.49	0.10	4.75	<0.001***
Covariances				
factor1~~				
factor2	0.29	0.05	5.89	<0.001***
factor3	0.32	0.05	6.16	<0.001***
factor2~~				
factor3	0.15	0.05	3.25	0.001**

Z-value are based on the Wald test and a corresponding two-sided,
****p < 0.001*, ***p* < 0.05 '=~' means is measured by, factor1 (social health), factor2 (environmental health), factor3 (physical health).

Table 27 shows the result of the model estimates. The model calculated the estimate, standard error, and z-values to assess if the distribution assumptions were met. The results showed that all estimates had z-values that were greater than 1.96,

meaning all estimate values were significantly different ($p=0.05$). Furthermore, the study results supported that there is a significance covariance between dimensions of quality of life. The results further showed a significant covariance between social relationships and environmental health aspects in Windhoek informal settlements ($p < 0.05$). Additionally, the findings presented a significant covariance between social relationship and physical health ($p < 0.001$). The study also found a significant covariance between environmental health and physical health ($p < 0.05$).

Table 28 Measures of WHOQOL-BREF (modified model)

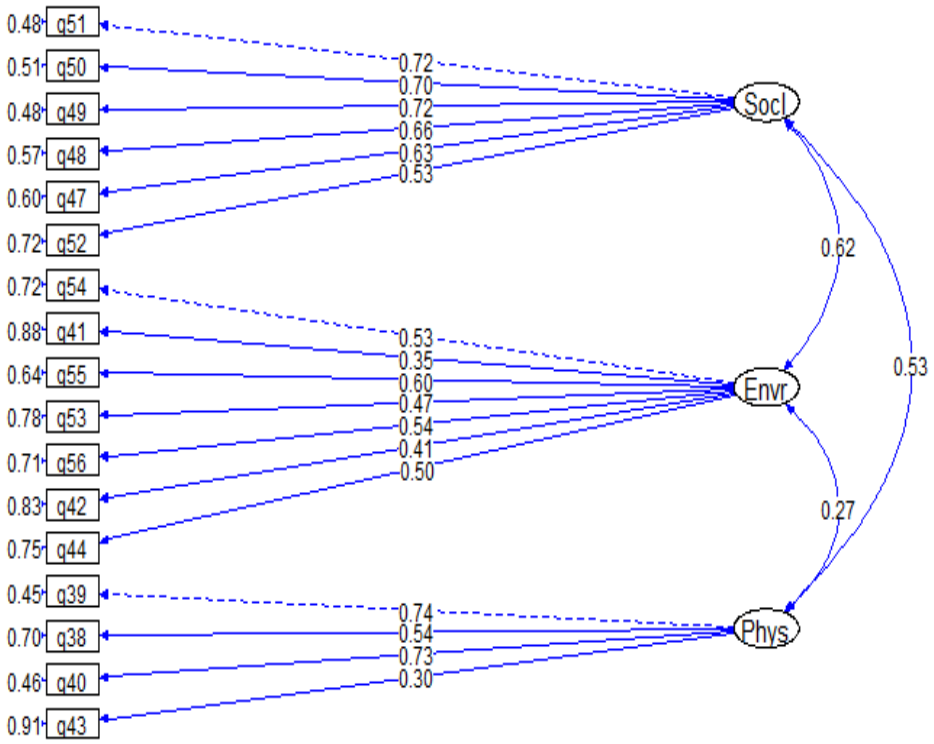
Construct items and scale reliability	**Standardised factor loadings**	**R-Squared**
Factor 1 (Social Health) (**α**=0.82)		
q51	0.72	0.52
q50	0.70	0.49
q49	0.72	0.52
q48	0.66	0.43
q47	0.63	0.40
q52	0.53	0.28
Factor 2 (Environmental Health) (**α**=0.69)		
q54	0.53	0.28
q41	0.35	0.12
q55	0.60	0.36
q53	0.47	0.22
q56	0.54	0.29
q42	0.41	0.17
q44	0.50	0.25
Factor 3 (Physical Health) (**α**=0.64)		
q39	0.74	0.55
q38	0.54	0.30
q40	0.73	0.54
q43	0.30	0.09
Overall scale reliability	**α**=0.83	

Table 28 shows the results of the reliability test and the standardised factor loadings of manifest and latent variables. Refer to Appendix B for variables names used in this section. The overall fitted model shows a Cronbach's alpha = 0.83, which suggest that the model had a good internal validity. The study results further showed that social relationship had a Cronbach's alpha = 0.82, indicating a good internal validity between manifest variables and the latent variable. Variable q51 (*"How satisfied are you with your personal relationships"*) contributed the most on social health construct with factor loadings 0.72 and it explained 52.0% variation in social well-being. The lowest contributing manifest variable q52 (*"How respondents were satisfied with their sex life"*) contributed 0.53 and it explained about 28.0% variation in social well-being.

Likewise, environmental health had a Cronbach's alpha = 0.69, indicating a questionable internal validity among the construct and manifest variables. The study results revealed that the manifest variable q55 (*"How satisfied are you with your access to health services"*) contributed more on environmental health than any other manifest variable with factor loadings of 0.60, and it explained about 36.0% variation in environmental well-being. In addition, the results showed that the manifest variable q41 (*"Do you have enough money to meet your daily needs"*) contributed least on environmental health with factor loading of 0.35, and it explained about 12.0% variation in environmental well-being.

Additionally, the study results found a questionable internal validity (Cronbach's alpha = 0.64) between physical health and manifest variables. The result pointed out that physical health was highly loaded by variable q39 (*"Do you have enough*

energy for everyday life"), with factor loadings of 0.74 and it explained 55.0% variation in physical well-being. Variable q43 (*"To what extend do you have the opportunities for leisure activities"*) contributed less to physical health with factor loadings of 0.30 and it explained 9.0% variation in physical well-being. The results of the overall modified model are displayed in Figure 14.



Socl (social health), Envr (environmental health), Phys (physical health), factor loadings (middle) and errors (end)

Figure 14 WHOQOL-BREF model structure (modified)

Testing of hypothesis:

H_0: There is no significant difference between factors contributing to quality of life in Windhoek informal settlements.

Based on the results in Figure 14, manifest variables based on factors contributing towards quality of life were found to have a best fit, and had a significant positive relationship ($p < 0.01$). Hence, the fitted model from the viewpoint of respondents, suggested that all manifest variables are significantly associated and they have positive impact on respondents' overall perception of quality of life in Windhoek informal settlements.

5.2.3. Application to EQ-5D

Based on the data driven approach-using EFA, the study hypothesised that individuals' quality of life in Windhoek informal settlements had four factors: pain/discomfort, anxiety/depression, self-care, and usual activities. Given the underlying latent model identified using EFA, this section used CFA to test if the identified model fit the data well. Variables used in this section are attached in Appendix C.

Table 29 Baseline model and fit indices of EQ-5D

	N=364
Estimator	ML
Minimum Function Test Statistic	2693.736
Degrees of freedom	588
P-value	<0.001***
User model versus baseline model	
Comparative Fit Index (CFI)	0.75
Tucker-Lewis Index (TLI)	0.44
Loglikelihood and Information Criteria	
Loglikelihood user model (H0)	-15869.97
Loglikelihood unrestricted model (H1)	-14523.10
Number of free parameters	78
Akaike (AIC)	31895.94
Root Mean Square Error of Approximation	
RMSEA	0.09
90 Percent Confidence Interval	0.09 ; 0.10
P-value RMSEA <= 0.05	<0.001***
Standardized Root Mean Square Residual	
SRMR	0.07

****p < 0.001*

Table 30 Model fit of EQ-5D

Indicator	**model magnitude**	**Ideal Magnitude**	
Chi.sq	2693.74	> 200	Yes
RMSEA	0.09	≤ 0.05	No
SRMR	0.07	< 0.1	Yes
GFI	0.69	> 0.9	No

The findings in

Table 29 and Table 30 show that the overall goodness of fit of the model was sufficient with $\chi^2(588) = 2693.74$, $p < 0.001$, that is greater than the required χ^2 value = 200. The results of the absolute fit also suggested that the study has a good fit with a SRMR = 0.07 and a RMSEA = 0.09 (90% CI 0.09; 0.10). However, study results found that the model had comparative fit indexes that were below the cut-off point, with a TLI = 0.44 and a CFI = 0.75. Indicating a low correlation in the data (Prudon, 2014). Thus, we conclude that the study has identified the best model for quality of life in Windhoek informal settlements. However, after inspecting Table 31, we identified a need to modify the model due to nonsignificant parameters in the model.

Table 31 shows the results of the estimated model parameters. Estimates, standard errors and z-values were computed to determine if the distribution assumptions were met. The estimates are found to be statistically significant if they have z-values greater than 1.96 ($p < 0.05$). The results suggested that there were two manifest variables that had z-values less than 1.96 (*"how much of a problem did you have with feeling sad, low or depressed (q78)"* and *"how much difficulty did you have with work or household activities (q60)"*). Hence, the two nonsignificant manifest variables need to be removed to improve the model performance.

Table 31 Model estimates of EQ-5D

Parameter Estimates (N=364)				
Information		Expected		
Standard Errors		Standard		
Latent variables	**Estimate**	**Std.Err**	**z-value**	**P(>|z|)**
factor1=~				
q94	1.00			
q96	1.03	0.08	13.18	<0.001***
q89	1.60	0.12	13.49	<0.001***
q90	1.34	0.10	13.24	<0.001***
q95	1.38	0.11	12.93	<0.001***
q91	1.09	0.08	13.00	<0.001***
q93	1.19	0.09	11.92	<0.001***
q87	1.29	0.09	13.88	<0.001***
q86	1.30	0.09	13.96	<0.001***
q88	1.43	0.10	13.73	<0.001***
q98	1.33	0.10	12.86	<0.001***
q92	1.25	0.10	12.62	<0.001***
q85	0.88	0.09	10.17	<0.001***
q97	0.97	0.10	9.42	<0.001***
q83	1.56	0.28	5.60	<0.001***
factor2=~				
q79	1.00			
q78	-1.05	0.09	-11.70	<0.001***
q68	1.17	0.08	14.16	<0.001***
q77	0.97	0.08	12.65	<0.001***
q66	1.16	0.08	14.06	<0.001***
q67	1.05	0.09	12.18	<0.001***
q76	1.03	0.08	12.26	<0.001***
q69	0.95	0.08	11.97	<0.001***
q73	0.92	0.08	12.18	<0.001***
q71	0.93	0.07	13.65	<0.001***
q72	0.77	0.06	12.36	<0.001***
q70	0.77	0.06	12.35	<0.001***
factor3=~				
q63	1.00			
q64	1.07	0.07	16.46	<0.001***
q61	0.10	0.07	13.90	<0.001***
q62	1.05	0.08	13.34	<0.001***
q60	-1.01	0.07	-13.69	<0.001***

q65	0.86	0.08	11.38	<0.001***
factor4=~				
q74	1.00			
q75	1.05	0.09	11.32	<0.001***
q84	0.55	0.08	6.62	<0.001***
Covariances				
factor1~~				
factor2	0.28	0.04	7.84	<0.001***
factor3	0.27	0.03	8.23	<0.001***
factor4	0.20	0.03	6.61	<0.001***
factor2~~				
factor3	0.36	0.05	7.92	<0.001***
factor4	0.41	0.05	8.28	<0.001***
factor3~~				
factor4	0.26	0.04	6.66	<0.001***

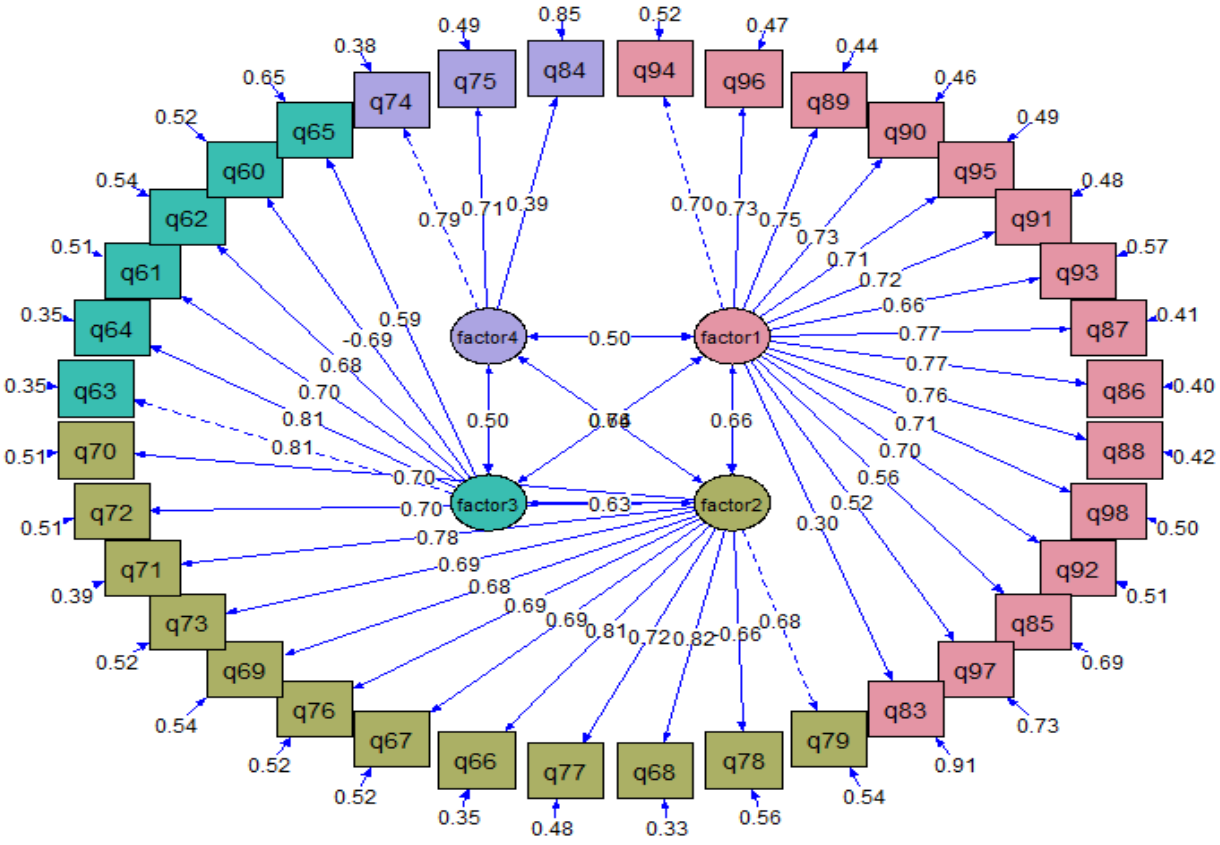
Z-value are based on the Wald test and a corresponding two-sided,
***$p < 0.001$, '=~' means is measured by, factor1 (pain/discomfort), factor2 (anxiety/depression), factor3 (self-care), factor4 (usual activities).

Table 32 shows reliability test results and the standardised factor loadings of manifest and latent variables. Refer to Appendix C for variables names used in this section. The results supported that fitted model had an excellent internal validity, with an overall Cronbach's alpha of 0.98. However, the results suggested that the study needed to adjust the two nonsignificant manifest variables on factor2 (anxiety/depression) and factor3 (self-care) and observe if it improves the internal validity between manifest variables and the factors. The structural relationship of this model is summarised in Figure 15. From this figure, we clearly observed a negative correlation between the two manifest variables and their respective factors.

Table 32 Measures of EQ-5D

Construct items and scale reliability	Standardised factor loadings	R-Squared
Factor 1 (Pain/Discomfort) (**α**=0.88)		
q94	0.70	0.48
q96	0.73	0.53
q89	0.75	0.56
q90	0.73	0.54
q95	0.71	0.51
q91	0.72	0.52
q93	0.66	0.43
q87	0.77	0.59
q86	0.77	0.60
q88	0.76	0.58
q98	0.71	0.50
q92	0.70	0.49
q85	0.56	0.31
q97	0.52	0.27
q83	0.30	0.09
Factor 2 (Anxiety/Depression) (**α**=0.85)		
q79	0.68	0.458
q78	-0.66	0.436
q68	0.82	0.67
q77	0.72	0.52
q66	0.81	0.65
q67	0.69	0.48
q76	0.69	0.48
q69	0.68	0.46
q73	0.69	0.48
q71	0.78	0.61
q72	0.70	0.49
q70	0.70	0.49
Factor 3 (Self-Care) (**α**=0.52)		
q63	0.81	0.65
q64	0.81	0.65
q61	0.70	0.49
q62	0.68	0.46
q60	-0.69	0.48
q65	0.59	0.35

Factor 4 (Usual Activities) (**α**=0.61)		
q74	0.79	0.62
q75	0.71	0.51
q84	0.39	0.15
Overall scale reliability	α=0.98	



factor1 (pain/discomfort), factor2 (anxiety/depression), factor3 (self-care), factor4 (usual activities), factor loadings (middle) and errors (end)

Figure 15 EQ-5D model structure (unmodified)

At the beginning of this section, we performed CFA on EQ-5D module identified using EFA. The results of CFA supported that the following manifest variables were not significant in the factor model q78 (*"How much of a problem did you have with feeling sad, low or depressed"*) and q60 (*"how much difficulty did you have with work or household activities"*). The two variables were removed from the

model and we observed the resulting outcome of the modified model, and compared its results to the unmodified model and inspect which model fits the data well.

Table 33 Unmodified model vs. Modified model EQ-5D

Indicator	Unmodified		Modified	Fitness evaluation
ECVI	7.83	>	6.55	Not ideal
AIC	31895.94	>	30613.24	Not ideal

Unmodified (full model), Modified (q78 and q60 deleted)

Table 33 presents the comparison results of the two factor models. The results showed that the modified model appears to be the best model compared to the unmodified factor model. Based on the comparison, the modified factor model had a lower ECVI and AIC compared to the unmodified factor model. Table 34 show that the overall goodness of fit of the modified factor model was significant with $\chi^2(521) = 2283.54$, $p < 0.001$, that is greater than the required $\chi^2 = 200$. The results further showed that the study had a good fit with a SRMR = 0.06 and a RMSEA = 0.09 (90% CI = 0.09: 0.10), indicating that the study has an acceptable fit. Furthermore, the results shows a TLI = 0.78 and the CFI = 0.76. Even though the values of the comparative were lesser than the cut-off point of 0.95 or greater, based on Table 35 the study concluded that this is the best-fit model for quality of life in Windhoek informal settlements.

Table 34 Baseline model and fit indices of EQ-5D (modified model)

	N=371
Estimator	ML
Minimum Function Test Statistic	2283.54
Degrees of freedom	521
P-value	<0.001***
User model versus baseline model	
Comparative Fit Index (CFI)	0.78
Tucker-Lewis Index (TLI)	0.76
Loglikelihood and Information Criteria	
Loglikelihood user model (H0)	-15232.62
Loglikelihood unrestricted model (H1)	-14090.85
Number of free parameters	74
Akaike (AIC)	30613.24
Root Mean Square Error of Approximation	
RMSEA	0.09
90 Percent Confidence Interval	0.09 ; 0.10
P-value RMSEA <= 0.05	<0.001***
Standardized Root Mean Square Residual	
SRMR	0.06

****p < 0.001*

Table 35 Model fit of EQ-5D (modified model)

Indicator	**model magnitude**	**Ideal Magnitude**	
Chi.sq	2283.54	> 200	Yes
RMSEA	0.095	≤ 0.05	No
SRMR	0.075	< 0.1	Yes
GFI	0.711	> 0.9	No

Table 36 shows the results of the model estimates. Estimates, standard errors and z-values computed to determine if the distributions assumptions are met. The results suggested that all estimates had significant z-values greater than 1.96 (*p < 0.05*).

Table 36 Model estimates of EQ-5D (modified)

Parameter Estimates (N=371)				
Information		Expected		
Standard Errors		Standard		
Latent variables	**Estimate**	**Std.Err**	**z-value**	**P(>|z|)**
factor1=~				
q94	1.00			
q96	1.03	0.08	13.24	<0.001***
q89	1.60	0.12	13.49	<0.001***
q90	1.34	0.10	13.29	<0.001***
q95	1.39	0.11	12.96	<0.001***
q91	1.09	0.08	13.09	<0.001***
q93	1.12	0.09	11.98	<0.001***
q87	1.29	0.09	13.90	<0.001***
q86	1.29	0.09	13.96	<0.001***
q88	1.44	0.11	13.78	<0.001***
q98	1.34	0.10	12.88	<0.001***
q92	1.25	0.100	12.48	<0.001***
q85	0.89	0.09	10.27	<0.001***
q97	0.97	0.10	9.50	<0.001***
q83	1.57	0.28	5.68	<0.001***
factor2=~				
q79	1.00			
q68	1.25	0.09	13.37	<0.001***
q77	0.99	0.08	11.78	<0.001***
q66	1.24	0.09	13.31	<0.001***
q67	1.14	0.10	11.86	<0.001***
q76	1.06	0.09	11.49	<0.001***
q69	1.00	0.09	11.45	<0.001***
q73	0.98	0.08	11.71	<0.001***
q71	1.01	0.08	13.09	<0.001***
q72	0.83	0.07	11.91	<0.001***
q70	0.84	0.07	12.03	<0.001***
factor3=~				
q63	1.00			
q64	1.01	0.06	17.86	<0.001***
q61	0.89	0.07	13.50	<0.001***
q62	0.98	0.07	13.67	<0.001***
q65	0.77	0.07	11.31	<0.001***
factor4=~				

q74	1.00			
q75	1.04	0.09	11.69	<0.001***
q84	0.52	0.08	6.54	<0.001***
Covariances				
factor1~~				
factor2	0.27	0.03	7.72	<0.001***
factor3	0.28	0.03	8.24	<0.001***
factor4	0.20	0.03	6.64	<0.001***
factor2~~				
factor3	0.35	0.05	7.74	<0.001***
factor4	0.40	0.05	8.24	<0.001***
factor3~~				
factor4	0.29	0.04	6.84	<0.001***

Z-value are based on the Wald test and a corresponding two-sided,
****p < 0.001*, '=~' means is measured by, factor1 (pain/discomfort), factor2 (anxiety/depression), factor3 (self-care), factor4 (usual activities).

Table 37 shows reliability test results and the standardised factor loadings of manifest and latent variables. Refer to Appendix C for variables names used in this section. The results indicated excellent internal validity in the overall fitted model, with Cronbach's alpha of 0.94. In addition, the results found a good internal validity between the manifest variables and pain/discomfort (Cronbach's alpha of 0.88). The results presented that pain/discomfort was highly loaded by variable q96 ("*how much difficulty did you have in bathing/washing whole body"*), that contributed 0.78, and explained about 62% variation in pain/discomfort. Whereas, variable q92 (*"how much difficulty did you have in taking care of your household's responsibilities"*) contributed 0.68, and explained about 47% variation in pain/discomfort. The least contributing manifest variable to pain/discomfort was q83 (*"how much difficulty did you have in seeing and recognising an object or a person you know across the road"*) contributed 0.04, and it explained 1% variation in pain/discomfort.

The second factor anxiety/depression had a Cronbach's Alpha of 0.92, indicating an excellent internal validity between the manifest variables and the latent variable. This factor was highly loaded by variable q68 (*"how much difficulty did you have in your daily life because of your pain"*) that contributed 0.82 and explained about 67% variation in being anxious/depressed. Variable q76 (*"how of a problem did you have with sleeping, waking up frequently during the night or waking up too early in the morning"*) contributed least 0.68 and it explained about 46% variation in anxiety/depression.

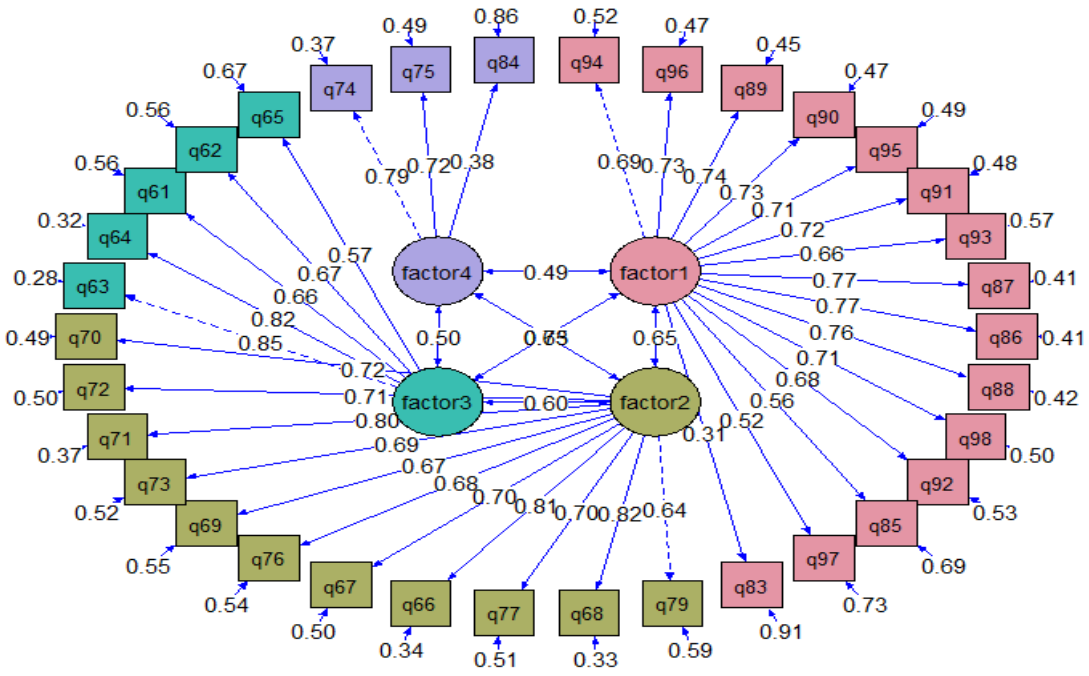
Whereas the third factor self-care, had a Cronbach's alpha of 0.83, indicating a good internal validity between manifest variables and the latent variable. Self-care factor was highly loaded by variable q63 (*"how much difficulty did you have with self-care, such as, bathing/washing or dressing yourself"*) that contributed 0.85 and explained about 72% variation in self-care. The results further showed that variable q65 (*"how much difficulty did you have in staying by yourself for a few days (3 to 7 days)"*) contributed least on self-care 0.57 and it explained about 33% variation in self-care.

The results showed that the fourth factor usual activities had a questionable internal validity (Cronbach's alpha of 0.61). Usual activities was highly loaded by the variable q74 (*"how much difficulty did you have with making new friends or maintaining current friendships"*) that contributed 0.79 and explained about 63% of the variation in usual activities. Whereas variable q84 (*"how much difficulty did you have in seeing and recognising an object very close (reading)"*) contributed least to

usual activities, with factor loadings 0.38 and it explained about 15% variation in usual activities. The results of the overall model are presented in Figure 16 below.

Table 37 Measures of EQ-5D (modified)

Construct items and scale reliability	Standardised factor loadings	R-Squared
Factor 1 (Pain/Discomfort) (**α**=0.88)		
q94	0.69	0.48
q96	0.78	0.61
q89	0.74	0.55
q90	0.73	0.53
q95	0.71	0.51
q91	0.72	0.52
q93	0.66	0.43
q87	0.77	0.59
q86	0.77	0.59
q88	0.76	0.58
q98	0.71	0.50
q92	0.68	0.47
q85	0.56	0.31
q97	0.52	0.27
q83	0.04	0.001
Factor 2 (Anxiety/Depression) (**α**=0.92)		
q79	0.64	0.41
q68	0.82	0.67
q77	0.70	0.49
q66	0.81	0.66
q67	0.70	0.50
q76	0.68	0.46
q69	0.67	0.45
q73	0.69	0.48
q71	0.80	0.63
q72	0.71	0.50
q70	0.72	0.51
Factor 3 (Self-Care) (**α**=0.83)		
q63	0.85	0.72
q64	0.82	0.68
q61	0.66	0.44
q62	0.67	0.44
q65	0.57	0.33
Factor 4 (Usual Activities) (**α**=0.61)		
q74	0.79	0.63
q75	0.72	0.51
q84	0.38	0.15
Overall scale reliability	α=0.94	



factor1 (pain/discomfort), factor2 (anxiety/depression), factor3 (self-care), factor4 (usual activities), factor loadings (middle) and errors (end)

Figure 16 EQ-5D four-factor model structure (modified)

Testing of hypothesis:

H_0: There is no significant difference between factors contributing to quality of life in Windhoek informal settlements.

From Figure 16, manifest variables based on factors contributing towards quality of life were found to have a best fit, and had a significant positive relationship ($p<0.01$). Hence, the fitted model from the viewpoint of respondents, suggested that all manifest variables are significantly associated and have positive impact on respondents' overall perception of quality of life in Windhoek informal settlements.

5.3. Structural Equation modelling

To complete SEM technique, we need to incorporate the regression equations that are linking latent variables estimated using equation (**5.1**) into the model using path diagrams. Path diagrams illustrate how any two factors are related through graphical visualisation. Illustration of these complex relationships concludes SEM.

This section focuses on linking constructs of quality of life to food insecurity (access) using structural equation model, based on the results obtained from CFA and captures their level of relation. The main objective of this section was to quantify the relationship between food insecurity (access) and quality of life in Windhoek informal settlements.

Table 38 and Table 39 shows the results of goodness of fit of the model, the results indicated that the model was significant with $\chi^2(1741) = 4527.90$, $p < 0.001$, that is greater than the required $\chi^2 = 200$. The results of the absolute fit also suggested that we have a best fit with a SRMR = 0.07 and a RMSEA = 0.07 (90% CI=0.07; 0.08), indicating that the study had identified an acceptable model for food insecurity and quality of life in Windhoek informal settlements.

Additionally, the results of the base line model found a TLI = 0.76 and the CFI = 0.78, that were below the suggested cut-off point of 0.95 or greater, with a value of one indicating a perfect fit. Even though the comparative indexes were below the suggested cut-off point, this does not imply that the model is a bad fit, this is an indication of low correlation in the data. Furthermore, Prudon (2014) argued that the value of the two measures are likely to approach one, when there is high

correlation in the data. Thus, the study concluded that the identified model is a good fit.

Table 38 Structural equation model fit indices

	N=292
Estimator	ML
Minimum Function Test Statistic	4527.90
Degrees of freedom	1741
P-value	<0.001***
User model versus baseline model	
Comparative Fit Index (CFI)	0.78
Tucker-Lewis Index (TLI)	0.76
Loglikelihood and Information Criteria	
Loglikelihood user model (H0)	-21649.22
Loglikelihood unrestricted model (H1)	-19385.27
Number of free parameters	150
Akaike (AIC)	43598.43
Root Mean Square Error of Approximation	
RMSEA	0.07
90 Percent Confidence Interval	0.07 : 0.08
P-value RMSEA <= 0.05	<0.001***
Standardized Root Mean Square Residual	
SRMR	0.07

****p < 0.001*

Table 39 Structural equation model summary

Indicator	**model magnitude**	**Ideal Magnitude**	
Chi.sq	4527.90	> 200	Yes
RMSEA	0.07	≤ 0.05	No
SRMR	0.07	< 0.1	Yes
GFI	0.65	> 0.9	No

Table 40 Structural equation model

Parameter Estimates (N=292)						
Information		Expected				
Standard Errors		Standard				
Latent variables	**Estimate**	**Std.Err**	**z-value**	**P(>|z|)**	**Standardised factor loadings**	**R-Squared**
Cronbach's alpha = 0.86						
Social ~ food insecurity	-0.28	0.05	-5.37	<0.001***	-0.35	0.13
Environmental ~food insecurity	-0.37	0.06	-6.20	<0.001***	-0.51	0.26
Physical ~ food insecurity	-0.25	0.06	-4.05	<0.001***	-0.28	0.08
Pain/Discomfort ~ food insecurity	0.17	0.03	5.17	<0.001***	0.33	0.11
Anxiety/Depression ~ food insecurity	0.30	0.05	5.97	<0.001***	0.39	0.16
Self-care ~ food insecurity	0.27	0.05	5.42	<0.001***	0.35	0.12
Usual Activities ~ food insecurity	0.18	0.05	3.42	0.001**	0.24	0.06

'~'Regress on, *** $p < 0.001$, ** p <0.05

Table 40 shows the regression coefficient of the latent variables. The results supported that the model has a good internal validity with a Cronbach's alpha of 0.86. Considering the linkages in the structural model, the results indicated that all seven measures were statistically significant. The results show that the first six (social, environmental, physical, pain/discomfort, anxiety/depression, and self-care) factors were statistically significant at $p < 0.001$, and for these factors, we tested the null hypothesis that the estimated coefficient values are not zero at 1% level of significance. On the other hand, the factor usual-activities was statistically significant at $p < 0.05$, and we tested the null hypothesis that the estimated coefficient value is not zero at 5% level of significance.

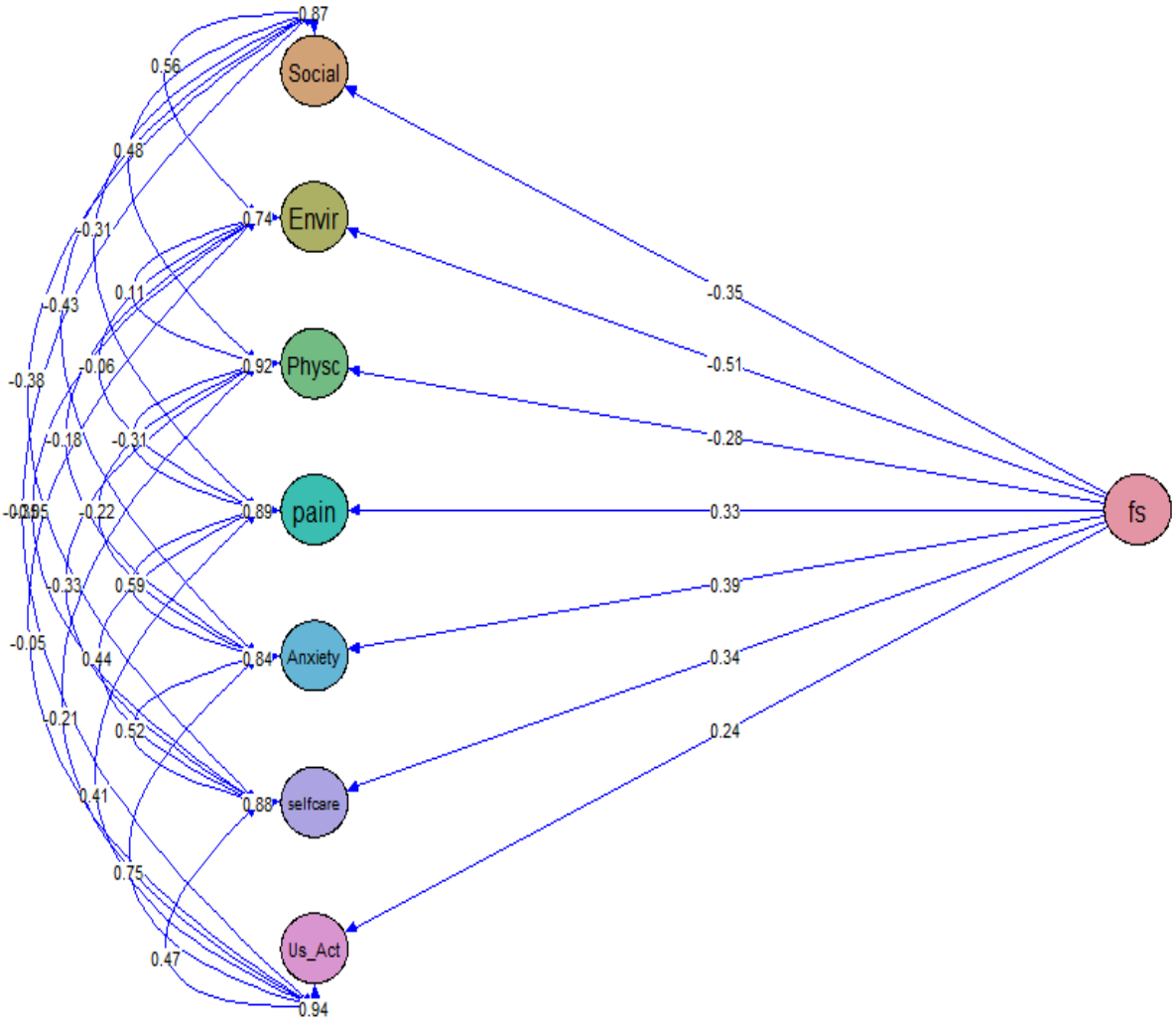
The results further showed that the factors social, environmental, and physical health had estimated coefficients with negative signs, implying a negative relationship with food insecurity. Conversely, the factors pain/discomfort, anxiety/depression, self-care, and usual activities had estimated coefficients with positive signs, denoting a positive relationship with food insecurity. Based on the regression-estimated coefficients the study concluded that, a unit increase in a households' food insecurity decreases social health by 0.28 units. The same was said about environmental health, with a unit increase in food insecurity, decreasing environmental health by 0.37 units. The results further disclosed that, when food insecurity increases by one unit, the physical health of an individual in an informal settlement in Windhoek decreases by 0.25 units.

On the other hand, the results further indicated that as the household food insecurity increases by one unit, it increases pain/discomfort by 0.17 units. Similarly, a unit increase in food insecurity at household level increases the level of anxiety/depression among individuals living in Windhoek informal settlements by 0.30 units. In the same way, the results revealed that as the household food insecurity increases by one unit, individuals' level of self-care increases by 0.27 units. Furthermore, the results supported that as the household food insecurity rises by one unit, individuals in these particular households in Windhoek informal settlements increase their level of engagement in their usual activities by 0.18 units.

With regard to relative contribution of food insecurity to quality of life constructs or measures, the results showed that food insecurity had a strong negative influence on environmental health (-0.51), followed by a moderate influence on

anxiety/depression (0.39) and negative moderate influence on social health (-0.35). Additionally, food insecurity also had a moderate influence on self-care (0.35), followed by moderate influence on pain/discomfort (0.33), a negative week influence on physical health (-0.28), and a weak influence on usual activities (0.24). The results of food insecurity relative contribution to quality of life are summarised in figure 17 (see Appendix D for high-resolution figure).

Considering coefficient of determination, which is simply the standardised loading squared. The results revealed that 26% variation in environmental health was explained by food insecurity, followed by 16% variation in anxiety/depression. Furthermore, Table 40 also showed that 6% variation in usual activities was explained by food insecurity.



fs *(food insecurity),* ***social*** *(social health),* ***Envir*** *(environmental health),* ***Physc*** *(physical health),* ***pain*** *(pain/discomfort),* ***anxiety*** *(anxiety/depression),* ***selfcare*** *(self-care),* ***Us-Act*** *(usual activities), factor loadings (middle), correlation between latent variables (end)*

Figure 17 Structural model for food insecurity and quality of life

5.3.1. Testing SEM hypotheses

Based on the structural model in Figure 17, we identified seven important relationships between food insecurity and quality of life in Windhoek informal settlements. These seven relationships were examined in the form of the following seven hypotheses:

Hypothesis 1 (H1): Food insecurity has a significant impact on social health.

Hypothesis 2 (H2): Food insecurity has a significant impact on environmental health.

Hypothesis 3 (H3): Food insecurity has a significant impact on physical health.

Hypothesis 4 (H4): Food insecurity has a significant impact on pain/discomfort.

Hypothesis 5 (H5): Food insecurity has a significant impact on anxiety/depression.

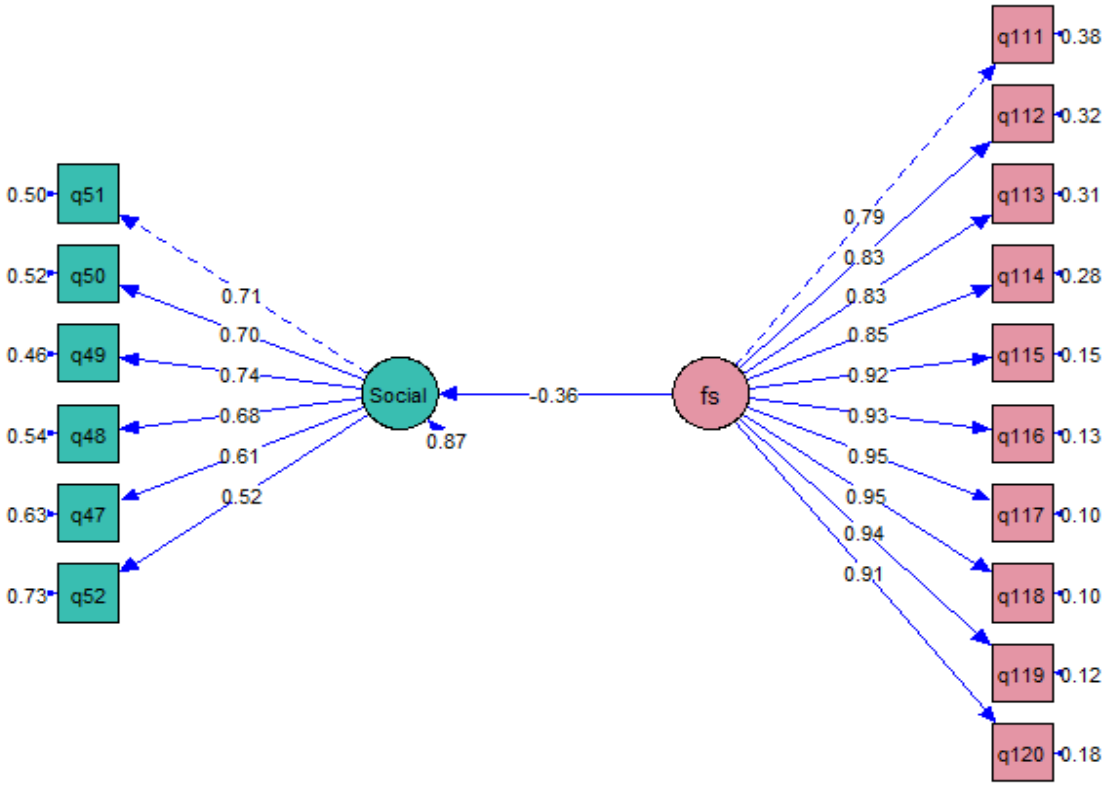
Hypothesis 6 (H6): Food insecurity has a significant impact on self-care.

Hypothesis 7 (H7): Food insecurity has a significant impact on usual activities.

To test for these hypotheses, structural modelling was applied to identify the hypothesised linkages between the constructs and the assumed model concept.

5.3.1.1. Hypothesis 1 (H1): Food insecurity has a significant impact on social health.

The first hypothesis was tested to examine if social health as a dependent latent variable is related to food insecurity. This relation presented an acceptable model fit of the data ([SRMR] =0.06, [CFI] =0.90, [TLI] =0.88). From Figure 18, we deduce that food insecurity had a significant negative impact on social health in Windhoek informal settlements ($\beta = -0.36, p < 0.001$).

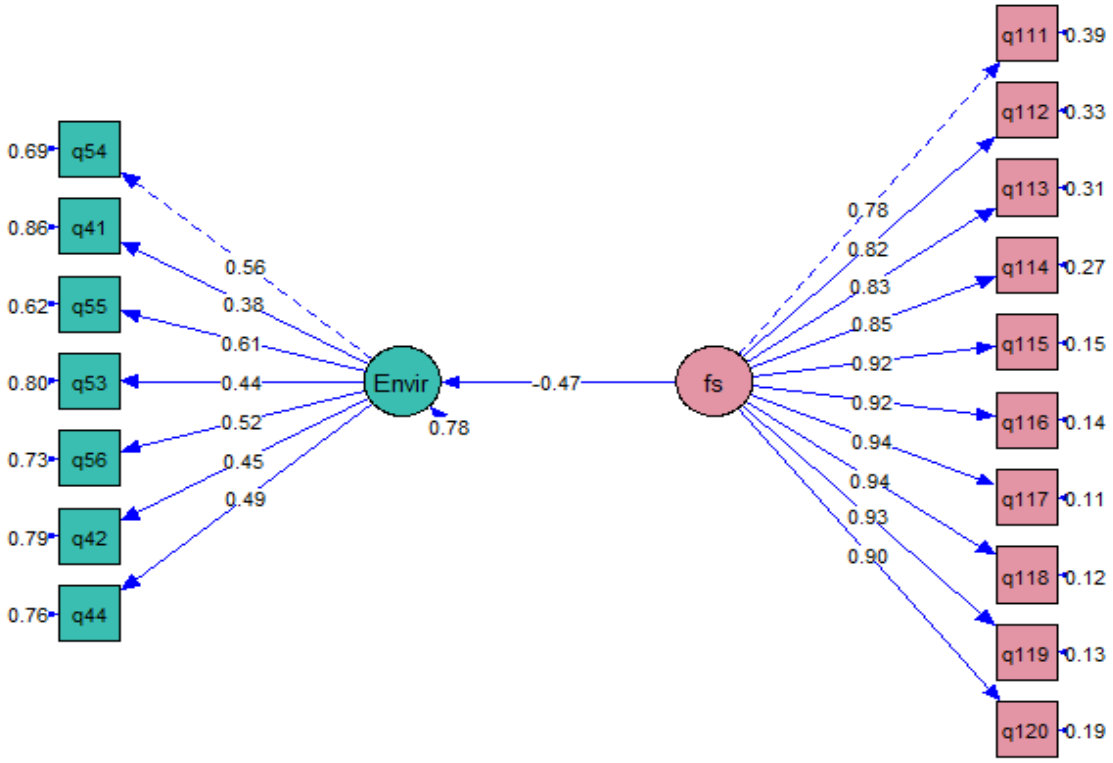


fs (food insecurity), social (Social health), factor loadings (middle) and errors (end)

Figure 18 Impact of food insecurity on social health

5.3.1.2. Hypothesis 2 (H2): Food insecurity has a significant impact on environmental health.

The second hypothesis was tested to examine the relationship between food insecurity and environmental health. This relation presented an acceptable model fit of the data ([SRMR] =0.05, [CFI] =0.88, [TLI] =0.86). The results on Figure 19 signified that food insecurity had a significant negative impact on environmental health in Windhoek informal settlements ($\beta = -0.47$, $p < 0.001$).

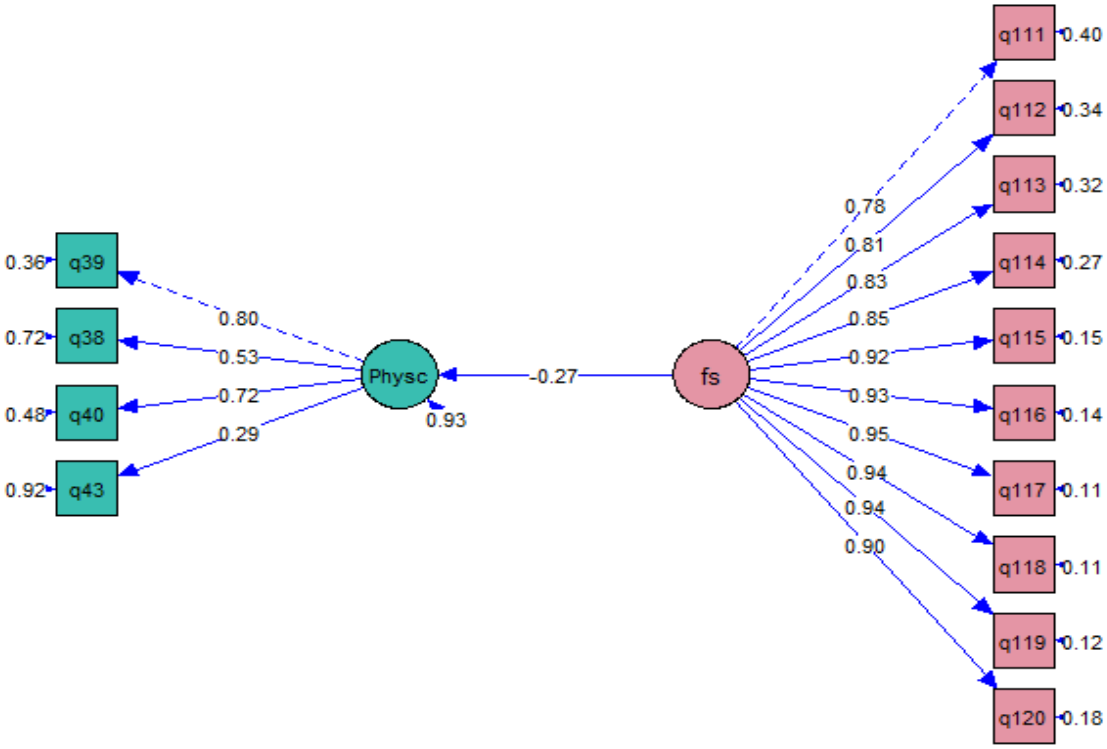


fs (food insecurity), Envir (environmental health), factor loadings (middle) and errors (end)

Figure 19 Impact of food insecurity on environmental health

5.3.1.3. Hypothesis 3 (H3): Food insecurity has a significant impact on physical health.

The third hypothesis was tested to examine if physical health as a dependant latent variable is related to food insecurity. Their relation presented an acceptable model fit for the data ([SRMR] =0.06, [CFI] =0.89, [TLI] =0.87). Figure 20 indicated that food insecurity has a significant negative impact on physical health in Windhoek informal settlements ($\beta = -0.27$, $p < 0.001$).

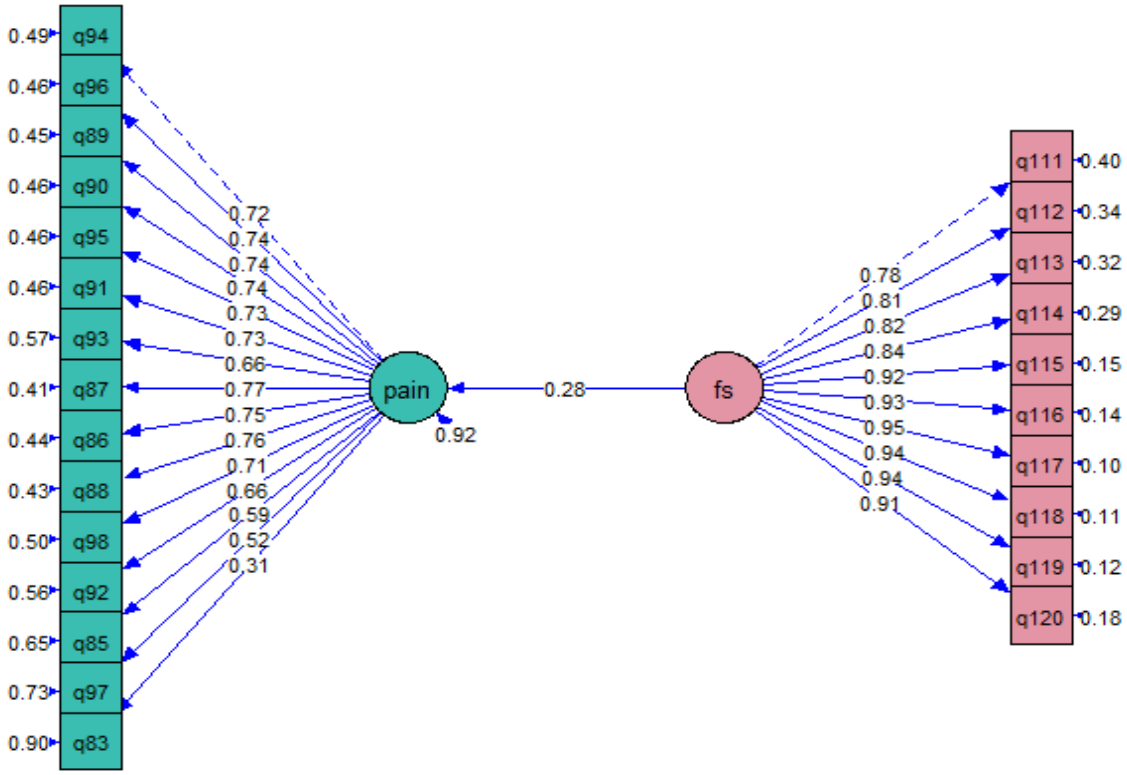


fs (food insecurity), Physc (physical health), factor loadings (middle) and errors (end)

Figure 20 Impact of food insecurity on physical health

5.3.1.4. Hypothesis 4 (H4): Food insecurity has a significant impact on pain/discomfort.

The fourth hypothesis was tested to examine the relationship between food insecurity and pain/discomfort. The relation presented an acceptable model fit for the data ([SRMR] =0.06, [CFI] =0.85, [TLI] =0.83). Based on the results on Figure 21, we concluded that food insecurity has a significant positive impact on pain/discomfort in Windhoek informal settlements ($\beta = 0.28$, $p < 0.001$).

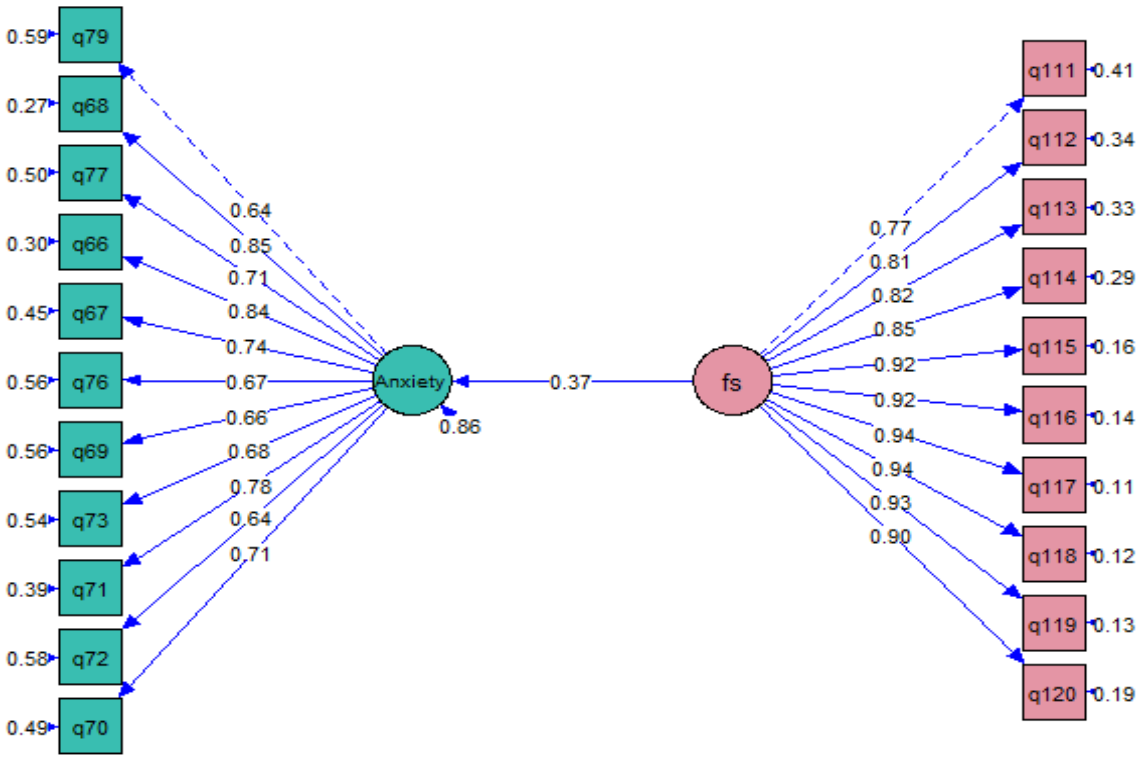


fs (food insecurity), pain (pain/discomfort), factor loadings (middle) and errors (end).

Figure 21 Impact of food insecurity on pain/discomfort

5.3.1.5. Hypothesis 5 (H5): Food insecurity has a significant impact on anxiety/depression.

The fifth hypothesis was tested to examine if anxiety/depression as a dependant latent construct is related to food insecurity. Their relation presented an acceptable model fit for the data ([SRMR] =0.06, [CFI] =0.852, [TLI] =0.84). Based on Figure 22, we concluded that food insecurity has a significant positive impact on anxiety/depression in Windhoek informal settlements ($\beta = 0.37$, $p < 0.001$).

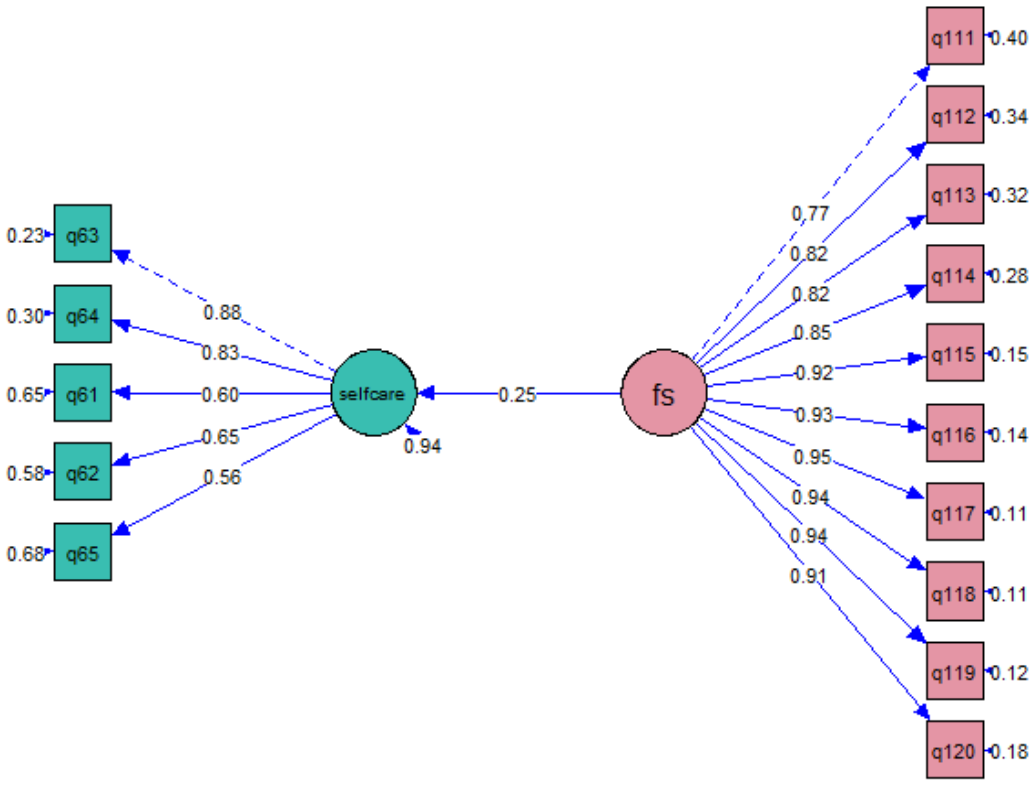


fs (food insecurity), anxiety (anxiety/depression), factor loadings (middle) and errors (end).

Figure 22 Impact of food insecurity on individual's anxiety/depression

5.3.1.6. Hypothesis 6 (H6): Food insecurity has a significant impact on self-care.

The sixth hypothesis was tested to examine the relationship between food insecurity and self-care. The relation presented a good model fit for the data ([SRMR] =0.06, [CFI] =0.89, [TLI] =0.87). The results on Figure 23 illustrated that that food insecurity has a positive impact on self-care in Windhoek informal settlements ($\beta = 0.25$, $p < 0.001$).

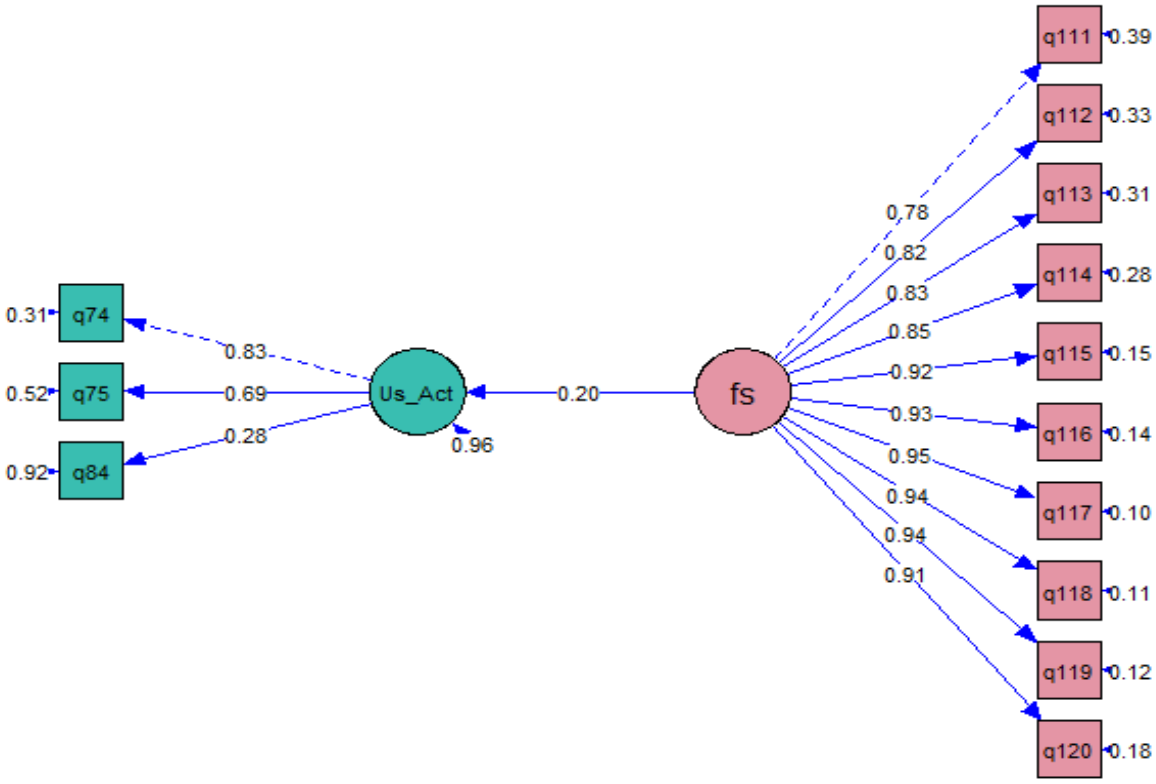


fs (food insecurity), selfcare (self-care), factor loadings (middle) and errors (end).

Figure 23 Impact of food insecurity on self-care

5.3.1.7. Hypothesis 7 (H7): Food insecurity has a significant impact on usual activities.

The seventh hypothesis was tested to examine if usual activities as a dependent latent construct is related to food insecurity. The relation of food insecurity and usual activities presented an acceptable model fit ([SRMR] =0.07, [CFI] =0.89, [TLI] =0.86). Figure 24 signified that food insecurity has a significant positive impact on usual activities ($\beta = 0.20$, $p < 0.001$).



fs (food insecurity), Us-Act (usual activities), factor loadings (middle) and errors (end).

Figure 24 Impact of food insecurity on usual activities

5.4. Conclusion

In this chapter, the study validated the constructs of quality of life and food insecurity using CFA. The chapter concluded that food insecurity is a significant predictor of quality of life in the informal settlements of Windhoek. At the end of this chapter, I wish to mention that, even though psychological health aspect was excluded from the final model, this does not imply that psychological health is not a predictor of quality of life outcomes in the informal settlements of Windhoek.

CHAPTER 6: DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

The purpose of this study was to model the relationship between food insecurity and quality of life in Windhoek informal settlements using SEM approach. The study used a data driven method to construct latent models for food insecurity and quality of life respectively, using EFA. The identified latent models were validated using CFA and the study analyses was concluded by linking the construct food insecurity to the constructs of quality of life through SEM and their relationship were summarised using path diagrams.

The first section of this chapter discusses the results of study in relation to existing literature. The second section of the chapter dwells on the study limitations, conclusions and recommendations for further research.

6.2. Discussions of Results

The study results presented that food insecurity in Windhoek informal settlement had only one component "food insecurity (access)", even though FANTA (2004) and Coates (2004) (cited in Coates et al., 2007) proposed that food insecurity can be grouped into three domains. However, when cluster analysis was applied to determine household groupings, the study findings grouped households into three main groups; anxiety and uncertainty about the household food supply, insufficient quality (which includes variety and preference of the type of food), and insufficient food intake and its physical consequences. As a result, these groupings matched the

existing domains of FANTA. The results found a slight strength of agreement ($\kappa = 0.76$) between the existing FANTA method and the data driven method. The results suggest that the derived food insecurity component matched the existing FANTA method and it can be used to study the impact of food insecurity in Windhoek informal settlements.

The study further explored how to derive the constructs of quality of life based on the question of WHOQOL-BREF module. The results found that quality of life in Windhoek informal settlements was mainly explained by four components, based on the highest contributing variable, namely social health, environmental health, physical, and psychological health. However, some variables in the study were not well distinguished between their respective domains and they contributed highly on other domains, variables such as q47 *"how satisfied with your sleep"* (contributed to social health, but belonged to physical health domain), q45 "*how healthy is your physical environment"* (contributed to psychological health, but belonged to environmental health domain), and q50 "*how satisfied are you with yourself"* (contributed to social health, but belonged to psychological health domain). The issue of misclassification resulted in the psychological factor to have negative covariances with the other three factors, which infer a negative correlation between psychological health and social, environmental, and physical health. In other words, the psychological factor under-estimated the observed relationship between the set of quality of life indicators, and it was excluded from the final model.

The study findings were similar to those of Skevington, Lotfy, and O'Connell (2004) who encountered misspecification errors in the domains. They argued that

such errors of misclassification arise from theoretical concepts of the domains. The dissimilarity in our study could be due the fact that the study only included 21 questions from WHOQOL-BREF module, other than using all 26 questions. Further, the WHOQOL-BREF sample included data from hospitals, rehabilitation centres and primary health care centres (WHO, 1996), whereas the study only sampled from the general population. Given these limitations, the model derived in this study may only be applicable to study self-reported quality of life of the general population, and it might not correctly quantify that of individuals from other special population sub-groups such as hospitals and rehabilitation centres.

Additionally, the study also generated constructs of EQ-5D. Even though there was a slight difference in the questions used in the study and those of EQ-5D, the dimensions were similar. The EQ-5D consist only of five dimensions that has five levels of severity (i.e. no problems, slight problems, moderate problems, severe problems and extreme problems), whereas the study had several questions on each dimension that had five level of severity. The study results found that only four dimensions explained much of the variation in the data (i.e. pain/discomfort, anxiety/depression, self-care, and usual activities). However, the results differed from those of the EuroQol technical group that specified that the EQ-5D should have five dimension and five levels of severity (van Reenen & Janssen, 2015). Their resulting difference is due to the dissimilarities in methodologies used to derive the dimensions of the current study. The EuroQol approach was based on document review and qualitative judgements, whereas the current study used the data driven approach. Further, there was also a variation in the set of questions used

to collect information from respondents. The current study used a questionnaire that allowed respondents to give multiple responses on each domain, whereas the EQ-5D instrument only permits a single response per dimension.

More importantly, the study tested the validity of the identified constructs of food insecurity and quality of life using CFA. The results revealed that, the latent model of food insecurity was found to be a best fit one-factor model (SRMR=0.05, which satisfy the goodness of fit and all estimates were significantly different from zero at $p < 0.05$). Moreover, the model had an excellent internal reliability with a Cronbach's alpha of 0.97, which prove its applicability to food insecurity in the informal settlements of Windhoek. The study concluded that all manifest variables included in the model had a significant impact on food insecurity.

The study further examined validity of WHOQOL-BREF four-factor latent model. The initial results of CFA indicated that the model was the best fit (SMRS=0.07), however, the results of the parameter estimates suggested that the model needed to be modified, because psychological health factor had non-significant manifest variables. Hence, psychological health was not a significant predictor of quality of life in Windhoek's informal settlements. A study by Martinez-Martin et al. (2012) also made a similar discovery, when they found that psychological factor was not statistically significant to health related quality of life outcomes in Spain. They emphasised that this could be because of the other three constructs social, physical, and environment health were accounting for much variation in the model, resulting to the contribution of psychological factor to be displaced.

The model modification was accomplished by completely removing psychological health. The results of the two models (four-factor and three-factor) were then compared to observe which model would perform better. The study results provide most support for the three-factor model (SRMR=0.07, AIC=16,680.48) compared to the four-factor model (SRMR=0.07, AIC=20,852.68). The results of measure of internal reliability, revealed that the three-factor model (Overall Cronbach's alpha=0.83, social health α=0.82, environmental α=0.69 and physical α=0.64) performed better than the four-factor model (Overall Cronbach's alpha=0.80, social health α=0.82, environmental α=0.69, physical α=0.64, psychological α=-0.18). This implies that the three-factor model was sufficient to model quality of life in Windhoek informal settlements. Even though the psychological health factor was removed from the model, this does not suggest that psychological health is not a predictor of quality of life outcomes in Windhoek informal settlements. The study concluded that all manifest variables included in the modified model had a significant impact WHOQOL-BREF. Meaning all questions included in the model had a positive impact on respondents' overall perception of quality of life.

The validation results of EQ-5D constructs based on the four-factor latent model, yielded a best fit (SRMR=0.07). However, the model needed to be modified due to two nonsignificant manifest variables contributing to anxiety/depression and self-care respectively. As a result, the model was modified by deleting the two manifest variables from their respective constructs, and compared the results of the models. The results found that the modified model (SRMR=0.08, AIC=30,613.24) performed better compared to the baseline model (AIC=31,895.94). Similarly, the

results of measure of internal reliability showed that the modified model (Overall Cronbach's alpha=0.94, pain/discomfort α=0.88, anxiety/depression α=0.92, self-care α=0.83, usual activities α=0.61) performed better compared to the baseline model (Overall Cronbach's alpha=98, pain/discomfort α=0.88, anxiety/depression α=0.85, self-care α=05, usual activities α=0.61). This proves that the modified four-factor model can be applied to EQ-5D. The study concluded that, all manifest variables included on the modified model had a significant impact on quality of life. Suggesting that all set of questions included on the final model to study quality of life based on EQ-5D had a substantial influence on individuals' overall perception of quality of life.

The study's main objective was answered by relating quality of life constructs to food insecurity in Windhoek informal settlements using SEM approach. The study results found a good model fit with SRMR values of 0.07 and RMSEA value of 0.07, with a value of zero indicating a best model fit. The study results revealed that all quality of life constructs were statistically significant in the model. More importantly, the study results amplified that food insecurity was a significant predictor of quality of life in Windhoek informal settlement. The quality measures of the study constructs were assessed by inspecting their validity. Further, the results supported that the study constructs had a good internal validity with a Cronbach's alpha of 0.86; indicating that the model can be applied to study the relationship between food insecurity and quality of life.

Based on the structural relationship identified by SEM, the study examined seven hypotheses to appreciate the relationship between food insecurity and quality of life.

The hypotheses were tested using standardised coefficients between quality of life constructs and the construct of food insecurity. The study fully supported all seven hypotheses, discussed below.

Based on the study results, food insecurity had a significant negative impact on social health. This implies that, as households in Windhoek informal settlements food insecurity increases, their social well-being also worsen. This could be because most people do not like disclosing their households' food shortage, because they fear to be judged and questioned about their capability to supply for their households. As a result, people tend to isolate themselves from their neighbours and other close relatives. However, a study by Pendleton et al. (2012) in Windhoek pointed out food insecure households resort to using social protection methods in times of food shortage such as, sharing meals with neighbours and borrowing food. Even though the study by Pendleton et al. (2012) found social protection to be practiced by food insecure households in Windhoek, the findings of the current study dictate otherwise. The study findings were also similar to those of Nanama and Frongillo (2012); Jones (2017) who found that borrowing and sharing of meals with neighbours is regarded as a socially unacceptable way of acquiring food and it often lead to the feeling of alienation, shame, powerless, feeling guilty and social deprivation.

Furthermore, the study results also supported the hypothesis that, food insecurity had a significant impact on environmental health. From the study findings, it was concluded that environmental health was negatively related to food insecurity. Implying that, as households become more food insecure, their environmental or

living conditions are likely to deteriorate, given the high level of poverty in informal settlements. Hence, as households tend to spend more on food, their ability to spend on other items decreases due to limited resources that they possess. Not having enough money to meet their daily need affects the living conditions of the poor. The study findings were similar to those in a study of Tarasuk, Mitchell, McLaren, and McIntyre (2013), who found that resources constrained households put more effort in reducing their food insecurity by using labour intensive strategies to acquire food at low cost and carefully portion it. They further identified that due to limited resources, these households at times tend to delay payments of other bills and seek assistance from friends or relative to source food.

As a result of the existing high poverty level in Windhoek informal settlements, individuals in these areas often have limited or no access to services such electricity, tarred roads, clean water, hospitals, ablution facilities, and supermarkets among others. Lack of access to basic amenities in informal settlements often pushes individuals to be dissatisfied with their surrounding environments, which often result in unsustainable land use. Therefore, lack of access to services and poverty might have influenced the current study relationship.

The study findings further supported the claim, that food insecurity had a significant negative impact on physical health. This suggests that as the household food insecurity increases, individual's physical health is also likely to decrease. This is an indication that insufficient food intake can results in poor health outcomes (Nanama & Frongillo, 2012). A study by Weigel et al. (2016) found that food insecurity is related to chronic diseases that affect physical well-being. Similarly,

Black et al. (2008) also found that undernutrition pose a significant threat on well-being. They also argued that over-time lack of nutrition can cause the body to weaken, and thus distressing the functioning of the body organs. This findings were also similar to those of Friel and Ford (2015) who found that food insecurity was associated with poor mental development among most children in the US and it was also linked to lower participations in jobs requiring physical strength among adults. The study findings suggest that food insecurity has a negative effect on individual's physical growth, and if it not controlled it can results in a human to body to lose energy, strength and its ability to function well. Loss of physical energy has consequences of individuals to lose their economic productivity because of vulnerability to health problems, and therefore resulting in loss of income (Atuoye & Luginaah, 2017).

Further, the study also tested the hypothesis if whether; food insecurity had a significant impact on individual's pain/discomfort. The study findings suggest that, food insecurity had a significant positive impact on pain/discomfort. This implies that as households' food insecurity increases, individuals in these households are likely to experience pain/discomfort triggered by stress caused by food shortage. Likewise, Weigel et al. (2016) also found that individuals from food insecure households are reported to have had experienced pain/discomfort/tiredness and chest pain. As a result of food shortages, individuals from food insecure household experience pain/discomfort caused by prolonged periods without or with limited food. The chronic pain caused by hunger can have devastating effect individual's

physical and psychological well-being, which might have outcomes of loss of economic resources if an individual fell ill.

The study also found that food insecurity had a significant impact on anxiety/depression. This suggests that as households' food insecurity increases, individuals in these households are likely to be anxious or depressed. The findings concurred with those of Leung et al. (2014), who found that adult from food insecure households were likely to experience troubles in sleeping, feeling, and hopeless. Other studies by Weigel et al. (2016); Atuoye and Luginaah (2017) also made similar discovery, when they found that food insecurity was the main cause of depression and mental distress. The findings imply that food insecurity causes stress that increases individuals' susceptibility to anxiety/depression. Food related stress is mostly common among women and children, since they spend more time compared to in the household and they are deprived of economic resources (Weigel et al., 2016). Further, stress caused by food insecurity is reported have various non-nutritional health outcomes in both adults and children such as poor educational attainment, behavioural problems, poor mental health and poor parenting problems (Nanama & Frongillo, 2012).

Other studies have also found that, depression induced by food insecurity among household heads mostly occur when they fail to source food in socially acceptable manners, and therefore resorting to socially unacceptable ways (e.g. begging, stealing, engaging sexual acts for money) (Jones, 2017). This has implications of social deprivation, feeling guilty, ashamed, powerless, humiliation, and acquiring infectious diseases.

Furthermore, the study findings also supported the claim that, food insecurity had a significant positive impact on self-care. This implies that as food insecurity rises, individuals in the informal settlements continue to take care of themselves (i.e. bathing, maintaining your general appearance, staying by yourself) despite their household's food insecurity status. Heerman et al. (2016) made a similar discovery when they reported that food insecurity was significantly associated with self-care. However, Weigel et al. (2016) claimed that food insecurity impede individuals' ability to take care of themselves, and they found it to be very common in women. They pointed out that in times of food shortage; women spend a lot of their time searching for good quality food at cheaper prices from one place to another. On top of that, they also spend much of their time preparing food and caring for other affected household members, other than taking care of themselves.

The study also supported that food insecurity had a significant impact on usual activities. This implies that, as households become food insecure in Windhoek informal settlements, individuals living in these households are more likely to continue engaging in their usual activities, such as fetching water and fire woods, doing household chores, selling items alongside the road for profit. The resulting positive impact between food insecurity and usual activities can be explained by the reality that most individuals in Windhoek informal settlements depend on the informal economy for a living (income). Even if their food insecurity worsen, they continue to carry out their usual daily activities in order earn an income and be able to purchase food. The current study contrasted the findings of To et al. (2014) who

found that food insecure individuals were less likely to engage in usual physical activities, than their counter parts from food secure households.

6.3. Limitations of the Study

Even though I outlined some strength in the study design and methods, I also wish acknowledge that the study had some limitations. Firstly, SEMs are valid when certain assumptions are met and model identification solely depends on model fit indices. However, there are no standard grounds to infer that the fitted model is in fact a true model. Although the study has identified models that fitted the data well, there might have been insignificant factors that were included in the models.

Secondly, the study encountered issue of specification errors. Some latent variables in the path models contributed to other constructs other than on their intended constructs. This has also resulted in some manifest and latent variables to be excluded from the final model. Thirdly, the study used exploratory data analysis method to identify models other than the theoretical approach, and model modifications were not theoretically motivated. Due to misspecification, the models suffered to prove causality in between constructs, even though they were interpreted as casual model.

Lastly, the issue of missing values and omitted variables in the data resulted in the loss of statistical power due to a reduced sample size. Hence, the study only included some variables, there might have been other multilevel community, and household or individual factors that may have influence the relationship between food insecurity and quality of life and were excluded from the models.

6.4. Conclusions and Recommendations

In conclusion, the study found that food insecurity was a significant predictor of quality of life outcomes in Windhoek informal settlements. The study further supported that food insecurity plays a predominant role in determining individuals' well-being. Equally important, the study discovered that the high level of urban poverty in Windhoek's informal settlements has affected households' food insecurity and this has resulted in poor quality life outcomes of individuals living in these areas.

The study recommends that, there is an immediate need to re-evaluate food insecurity prevalence in these informal settlements to assess if the situation has changed after the government had introduced the food bank programme in these areas in the second half of 2016. The programme was introduced with the aim to provide food for the needy and reduce youth unemployment in informal settlements. Study recommends the government to give priority to policies addressing poverty and inequality, in order to end poverty. The study further recommends the Ministry of Poverty Eradication and Social Welfare, Ministry of Economic Planning and other line ministries to explore other new ways to alleviate poverty. In addition, the study also recommend the Ministry of Poverty Eradication and Social Welfare to extend the current social grants received by the elderly to the poor resident of informal settlements as an immediate solution to help lessen lack of household income.

.Further, the government also need to create partnerships with non-governmental organisations to formulate and implement projects that are aimed to improve the

livelihoods of people living in informal settlements around Windhoek by increasing employment opportunities and empowering women in order to eradicate poverty, end hunger, and maintain good health for all by 2030.

The study also recommends the City of Windhoek Municipality to accelerate the implementation of activities geared towards development and improving the well-being of people living informal settlements of Katutura.

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APPENDIX A: FOOD INSECURITY (ACCESS) QUESTIONS

SECTION I: FOOD INSECURITY			
HOUSEHOLD FOOD INSECURITY ACCESS SCALE (HFIAS) FOR THE LAST FOUR WEEKS (**READ** the list and categories and circle only ONE answer for each question)			
Q111	a. In the past four weeks did you worry that your household would not have enough food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q112	b. In the past four weeks were you or any member of your household not able to eat the kind of foods you preferred because of a lack of resources?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q113	c. In the past four weeks did you or any household member have to eat a limited variety of foods due to a lack of resources?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q114	d. In the past four weeks did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q115	e. In the past four weeks did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q116	f. In the past four weeks did you or any household member have to eat fewer meals in a day because there was not enough food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q117	g. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q118	h. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q119	i. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3
Q120	j. In the past four weeks, did you or any household member eat a cooked meal less than once a day?	No Rarely (Once or twice) Sometimes (3 to 10 times) Often (more than 1o times)	0 1 2 3

APPENDIX B: WHOQOL-BREF QUESTIONS

SECTION D: QUALITY OF LIFE			
The following questions ask how you feel about your quality of life, health, or other areas of your life. I will read out each question to you, along with the response options. Please answer the answer that is most appropriate. Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in the last four weeks.			
Q36	How much do you enjoy your life	Not at all A little A moderate amount Very much An extreme amount	1 2 3 4 5
Q37	To what extend do you feel your life is to be meaningful	Not at all A little A moderate amount Very much An extreme amount	1 2 3 4 5
Q38	How well are you able to concentrate	Not at all A little A moderate amount Very much Extremely	1 2 3 4 5
Q39	Do you have enough energy for everyday life?	Not at all A little Moderately Mostly Completely	1 2 3 4 5
Q40	Are you able to accept your bodily appearance?	Not at all A little Moderately Mostly Completely	1 2 3 4 5
Q41	Do you have enough money to meet your daily needs?	Not at all A little Moderately Mostly Completely	1 2 3 4 5
Q42	How available to you is the information that you need in your day-to-day life?	Not at all A little Moderately Mostly Completely	1 2 3 4 5
Q43	To what extend do you have the opportunity for leisure activities?	Not at all A little Moderately Mostly Completely	1 2 3 4 5
Q44	How safe do you feel in your daily life?	Not at all A little Moderately	1 2 3

		Mostly	4
		Completely	5
Q45	How healthy is your physical environment?	Not at all	1
		A little	2
		Moderately	3
		Mostly	4
		Completely	5
Q46	How well are you able to get around	Very poor	1
		Poor	2
		Neither poor nor good	3
		Good	4
		Very good	5
Q47	How satisfied are you with your sleep?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q48	How satisfied are you with your ability to perform your daily living activities?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q49	How satisfied are you with your capacity for work?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q50	How satisfied are you with yourself?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q51	How satisfied are you with your personal relationships?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q52	How satisfied are you with your sex life?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q53	How satisfied are you with the support you get from friends?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q54	How satisfied are you with the conditions of your living place?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4

		Very Satisfied	5
Q55	How satisfied are you with your access to health services?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q56	How satisfied are you with your transport?	Very dissatisfied	1
		Dissatisfied	2
		Neither satisfied nor dissatisfied	3
		Satisfied	4
		Very Satisfied	5
Q57	How would you rate your quality of life	Very poor	1
		Poor	2
		Neither good nor poor	3
		Good	4
		Very good	5
Q59	How often do you need any medical treatment to function in your daily life?	Not at all	5
		A little	4
		A moderate amount	3
		Very much	2
		An extreme amount	1

APPENDIX C: EQ-5D QUESTIONS

SECTION E: GENERAL HEALTH, MOBILITY, SELF-CARE, PAIN AND DISCOMFORT, COGNITION, INTERPERSONAL, SLEEP AND ENERGY, AFFECT, VISION			
Q58	**HEALTH** In general, how do you rate your health?	Very good Good Moderate Bad Very bad	1 2 3 4 5
Q59	How often do you need any medical treatment to function in your daily life?	Not at all A little A moderate amount Very much An extreme amount	5 4 3 2 1
Q60	Overall, in the last 30 days, how much difficulty did you have with work or household activities?	None Mild Moderate Severe Extreme/could not do work	1 2 3 4 5
Q61	**MOBILITY** In the last 30 days, how much difficulty did you have with moving around?	None Mild Moderate Severe Extreme/could not move	1 2 3 4 5
Q62	In the last 30 days, how much difficulty did you have in vigorous activities (activities that require hard physical effort and cause large increases in breathing or heart rate)?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q63	**SELF CARE** In the last 30 days, how much difficulty did you have with self-care, such as, bathing/washing or dressing yourself?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q64	In the last 30 days, how much difficulty did you have in taking care of and maintaining your general appearance (e.g. grooming, looking neat and tidy)?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q65	In the last 30 days, how much difficulty did you have in staying by yourself for a few days (3 to 7 days)?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q66	**PAIN AND DISCOMFORT** In the last 30 days, how much of bodily aches or pains did you have?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5

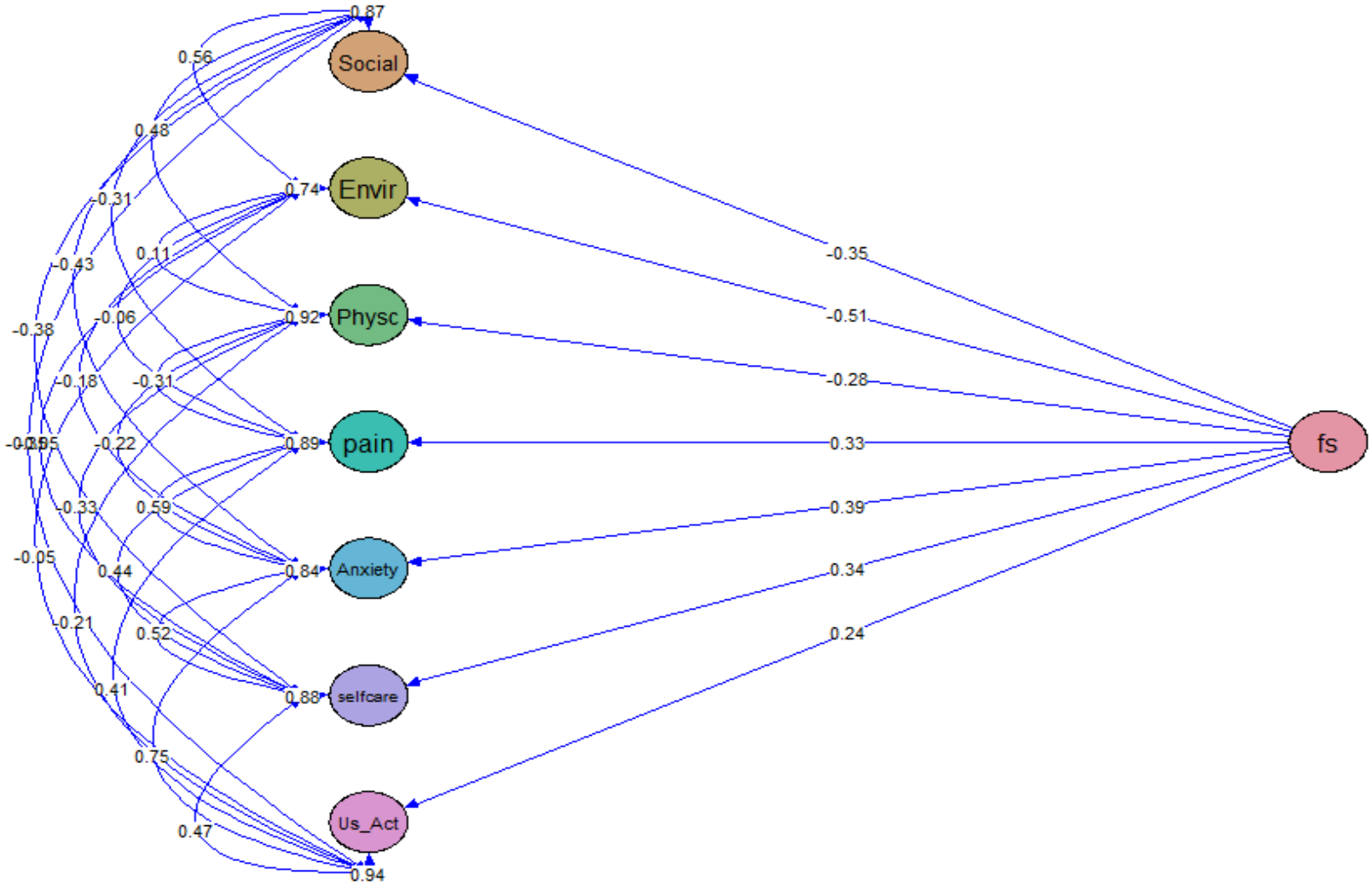
Q67	In the last 30 days, how much bodily discomfort did you have?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q68	In the last 30 days, how much difficulty did you have in your daily life because of your pain?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q69	**COGNITION** In the last 30 days, how much difficulty did you have with concentrating or remembering things	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q70	In the last 30 days, how much difficulty did you have in learning a new task (e.g. how to get to a new place, learning a new game, learning a new recipe, etc.)?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q71	In the last 30 days, how much difficulty did you have concentrating on doing something?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q72	**INTERPERSONAL ACTIVITIES** In the last 30 days, how much difficulty did you have with personal relationships or participation in the community?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q73	In the last 30 days, how much difficulty did you have in dealing with conflicts and tensions with others?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q74	In the last 30 days, how much difficulty did you have with making new friendships or maintaining current friendships?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q75	In the last 30 days, how much difficulty did you have with dealing with strangers?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q76	**SLEEP AND ENERGY** In the last 30 days, how much of a problem did you have with sleeping, waking up frequently during the night or waking up too early in the morning?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q77	In the last 30 days, how much of a problem did you have due to not feeling rested and	None	1

	refreshed during the day (e.g. feeling tired, not having energy)?	Mild Moderate Severe Extreme/cannot do	2 3 4 5
Q78	**AFFECT** In the last 30 days, how much of a problem did you have with feeling sad, low or depressed?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q79	In the last 30 days, how much of a problem did you have with worry or anxiety?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q80	**VISION** When was the last time you had your eyes examined by a medical professional?		1……Months ago 2 ……..Years ago 3 Never 4 Don't know
Q81	Do you use eyeglasses or contact lenses to see far away?	Yes No	1 2
Q82	Do you use eyeglasses or contact lenses to see up close (when reading)?	Yes No	1 2
Q83	In the last 30 days, how much difficulty did you have in seeing and recognizing an object or a person you know across the road?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q84	In the last 30 days, how much difficulty did you have in seeing and recognizing an object very close (reading)?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q85	**FUNCTIONING ASSESSMENT** In the last 30 days, how much difficulty did you have in sitting for long periods?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q86	In the last 30 days, how much difficulty did you have in walking up to 100 meters (e.g. sports field)?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q87	In the last 30 days, how much difficulty did you have in standing up from sitting down?	None Mild Moderate Severe Extreme/cannot do	1 2 3 4 5
Q88	In the last 30 days, how much difficulty did you have in standing for long periods?	None Mild	1 2

		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q89	In the last 30 days, how much difficulty did you have with climbing on stairs or going up hill?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q90	In the last 30 days how much difficulty did you have with stooping, kneeling or crouching?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q91	In the last 30 days how much difficulty did you have with picking up things with your fingers (such as picking up a coin from a table)?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q92	In the last 30 days how much difficulty did you have in taking care of your household responsibilities?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q93	In the last 30 days, how much difficulty did you have in joining community activities (festivities, religious) in the same way as anyone else?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q94	In the last 30 days, how much difficulty did you have in extending your arms above shoulder level?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q95	In the last 30 days, how much difficulty did you have in walking a long distance such as one kilometre (many soccer fields)?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q96	In the last 30 days, how much difficulty did you have in bathing/washing your whole body?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q97	In the last 30 days, how much difficulty did you have with getting where you want to go, using private or public transport if needed?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q98	In the last 30 days how much have you been emotionally affected by your health conditions?	None	1
		Mild	2
		Moderate	3

		Severe	4
		Extreme/cannot do	5
Q99	Overall, how much did these difficulties interfere with your life?	None	1
		Mild	2
		Moderate	3
		Severe	4
		Extreme/cannot do	5
Q100	Besides any vision aids, do you use any other assistive devices (cane, walker or other) for any difficulties you experience?	Yes	1
		No	2

APPENDIX D: STRUCTURAL MODEL FOR FOOD INSECURITY AND QUALITY OF LIFE



fs *(food insecurity),* ***social*** *(social health),* ***Envir*** *(environmental health),* ***Physc*** *(physical health),* ***pain*** *(pain/discomfort),* ***anxiety*** *(anxiety/depression),* ***selfcare*** *(self-care),* ***Us-Act*** *(usual activities),* ***factor loadings*** *(middle),* ***correlation between latent variables*** *(end)*

APPENDIX E: SPSS SYNTAX

EXPLORATORY FACTOR ANALYSIS AND PRINCIPAL COMPONENT ANALYSIS

Food Security

```
FACTOR
  /VARIABLES q111 q112 q113 q114 q115 q116 q117 q118 q119 q120
  /MISSING LISTWISE
  /ANALYSIS q111 q112 q113 q114 q115 q116 q117 q118 q119 q120
  /PRINT INITIAL CORRELATION KMO REPR AIC EXTRACTION ROTATION
  /FORMAT SORT BLANK(.30)
  /PLOT EIGEN ROTATION
  /CRITERIA MINEIGEN(1) ITERATE(25)
  /EXTRACTION PC
  /CRITERIA ITERATE(25)
  /ROTATION VARIMAX
  /SAVE REG(ALL)
  /METHOD=CORRELATION.

* Visual Binning.
*FAC1_1.
RECODE  FAC1_1 (MISSING=COPY) (LO THRU -0.279=1) (LO THRU HI=2)
(ELSE=SYSMIS) INTO Food_cat.
VARIABLE LABELS  Food_cat 'Food Security (access) (Binned)'.
FORMATS  Food_cat (F5.0).
VALUE LABELS  Food_cat 1 '= -.28' 2 '-.27+'.
VARIABLE LEVEL  Food_cat (ORDINAL).
EXECUTE.

CROSSTABS
  /TABLES=Insecurity BY Food_cat
  /FORMAT=AVALUE TABLES
  /STATISTICS=KAPPA
  /CELLS=COUNT
  /COUNT ROUND CELL.


RELIABILITY
  /VARIABLES=q111 q112 q113 q114 q115 q116 q117 q118 q119 q120
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=DESCRIPTIVE SCALE
  /SUMMARY=TOTAL.
```

WHOQOL-BREF

Reshaping q59 (negatively phrased question)

```
RECODE q59 (SYSMIS=SYSMIS) (Lowest thru 5=1) (Lowest thru 4=2) (Lowest
thru 3=3) (Lowest thru 2=4) (Lowest thru 1=5) INTO newq59.
VARIABLE LABELS  newq59 'reversedq59'.
EXECUTE.
```

```
FACTOR
  /VARIABLES q37 q38 q39 q40 q41 q42 q43 q44 q45 q46 q47 q48 q49 q50 q51
q52 q53 q54 q55 q56 newq59
  /MISSING LISTWISE
  /ANALYSIS q37 q38 q39 q40 q41 q42 q43 q44 q45 q46 q47 q48 q49 q50 q51
q52 q53 q54 q55 q56 newq59
  /PRINT INITIAL KMO REPR AIC EXTRACTION ROTATION
  /FORMAT SORT BLANK(.30)
  /PLOT EIGEN ROTATION
  /CRITERIA FACTORS(4) ITERATE(25)
  /EXTRACTION PC
  /CRITERIA ITERATE(25)
  /ROTATION VARIMAX
  /SAVE REG(ALL)
  /METHOD=CORRELATION.

* Visual Binning.
*FAC1_2.
RECODE  FAC1_2 (MISSING=COPY) (LO THRU -0.249=1) (LO THRU 0.491=2) (LO
THRU HI=3) (ELSE=SYSMIS) INTO Social_cat.
VARIABLE LABELS  Social_cat 'Social relationships (Binned)'.
FORMATS  Social_cat (F5.0).
VALUE LABELS  Social_cat 1 '= -.25' 2 '-.24 - .49' 3 '.50+'.
VARIABLE LEVEL  Social_cat (ORDINAL).
EXECUTE.


CROSSTABS
  /TABLES=Domain3Compt BY Social_cat
  /FORMAT=AVALUE TABLES
  /STATISTICS=KAPPA
  /CELLS=COUNT
  /COUNT ROUND CELL.


* Visual Binning.
*FAC2_2.
RECODE  FAC2_2 (MISSING=COPY) (LO THRU -0.4218=1) (LO THRU 0.525=2) (LO
THRU HI=3) (ELSE=SYSMIS) INTO Enviro_cat.
VARIABLE LABELS  Enviro_cat 'Environmental (Binned)'.
FORMATS  Enviro_cat (F5.0).
VALUE LABELS  Enviro_cat 1 '= -.42' 2 '-.41 - .53' 3 '.54+'.
VARIABLE LEVEL  Enviro_cat (ORDINAL).
EXECUTE.


CROSSTABS
  /TABLES=Domain3Computd BY Enviro_cat
  /FORMAT=AVALUE TABLES
  /STATISTICS=KAPPA
  /CELLS=COUNT
  /COUNT ROUND CELL.
```

```
* Visual Binning.
*FAC3_2.
RECODE  FAC3_2 (MISSING=COPY) (LO THRU -0.284=1) (LO THRU 0.478=2) (LO
THRU HI=3) (ELSE=SYSMIS) INTO Physical_cat.
VARIABLE LABELS  Physical_cat 'Physical health (Binned)'.
FORMATS  Physical_cat (F5.0).
VALUE LABELS  Physical_cat 1 '= -.28' 2 '-.27 - .48' 3 '.49+'.
VARIABLE LEVEL  Physical_cat (ORDINAL).
EXECUTE.


CROSSTABS
  /TABLES=Domain1comp BY Physical_cat
  /FORMAT=AVALUE TABLES
  /STATISTICS=KAPPA
  /CELLS=COUNT
  /COUNT ROUND CELL.


* Visual Binning.
*FAC4_2.
RECODE  FAC4_2 (MISSING=COPY) (LO THRU -0.573=1) (LO THRU 0.414=2) (LO
THRU HI=3) (ELSE=SYSMIS) INTO Psychol_cat.
VARIABLE LABELS  Psychol_cat 'Psychological (Binned)'.
FORMATS  Psychol_cat (F5.0).
VALUE LABELS  Psychol_cat 1 '= -.57' 2 '-.56 - .41' 3 '.42+'.
VARIABLE LEVEL  Psychol_cat (ORDINAL).
EXECUTE.


CROSSTABS
  /TABLES=Domain2Comp BY Psychol_cat
  /FORMAT=AVALUE TABLES
  /STATISTICS=KAPPA
  /CELLS=COUNT
  /COUNT ROUND CELL.

RELIABILITY
  /VARIABLES=q37 q38 q39 q40 q41 q42 q43 q44 q45 q46 q47 q48 q49 q50 q51
q52 q53 q54 q55 q56 newq59
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=DESCRIPTIVE SCALE
  /SUMMARY=TOTAL.
```

EQ-5D

```
FACTOR
  /VARIABLES q60 q61 q62 q63 q64 q65 q66 q67 q68 q69 q70 q71 q72 q73 q74
q75 q76 q77 q78 q79 q83 q84 q85 q86 q87 q88 q89 q90 q91 q92 q93 q94 q95
q96 q97 q98
  /MISSING LISTWISE
  /ANALYSIS q60 q61 q62 q63 q64 q65 q66 q67 q68 q69 q70 q71 q72 q73 q74
q75 q76 q77 q78 q79 q83 q84 q85 q86 q87 q88 q89 q90 q91 q92 q93 q94 q95
q96 q97 q98
  /PRINT INITIAL KMO REPR AIC EXTRACTION ROTATION
```

```
  /FORMAT SORT BLANK(.30)
  /PLOT EIGEN ROTATION
  /CRITERIA FACTORS(4) ITERATE(25)
  /EXTRACTION PC
  /CRITERIA ITERATE(30)
  /ROTATION VARIMAX
  /SAVE REG(ALL)
  /METHOD=CORRELATION.


RELIABILITY
  /VARIABLES=q60 q61 q62 q63 q64 q65 q66 q67 q68 q69 q70 q71 q72 q73 q74
q75 q76 q77 q78 q79 q83 q84 q85 q86 q87 q88 q89 q90 q91 q92 q93 q94 q95
q96 q97 q98
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA
  /STATISTICS=DESCRIPTIVE SCALE CORR
  /SUMMARY=TOTAL.
```

HIERARCHICAL CLUSTER ANALYSIS

Food Security

```
CLUSTER   FAC1_1
  /METHOD SINGLE
  /MEASURE=EUCLID
  /PRINT SCHEDULE CLUSTER(3)
  /PLOT DENDROGRAM VICICLE
  /SAVE CLUSTER(3).
```

WHOQOL-BREF

```
CLUSTER   FAC1_2 FAC2_2 FAC3_2 FAC4_2
  /METHOD WARD
  /MEASURE=SEUCLID
  /PRINT SCHEDULE CLUSTER(4)
  /PLOT DENDROGRAM VICICLE
  /SAVE CLUSTER(4).
```

EQ-5D

```
CLUSTER   FAC1_5 FAC2_5 FAC3_5 FAC4_5
  /METHOD WARD
  /MEASURE=SEUCLID
  /PRINT SCHEDULE CLUSTER(5)
  /PLOT DENDROGRAM VICICLE
  /SAVE CLUSTER(5).


SAVE OUTFILE=
'C:\Users\tshinyemba\Documents\Academics\Thesis\Thesis_QoL_FS_Tobias_27_S
ept_17_With_Factors.sav'

  /COMPRESSED.
```

APPENDIX F: R CODES

```
sessionInfo()

setwd("C:\\Users\\tshinyemba\\Documents\\Academics\\Thesis\\Analysis")
```

Study site map

```
install.packages(c("dismo","ggplot2","rgbig","ggmap","maptools","GISTools","mapdata","ggsn"))

library(foreign); library(dismo); library(ggplot2); library(rgbif)

library(ggmap);library(maptools);library(GISTools);library(mapdata);library(ggsn)

link <- "http://biogeo.ucdavis.edu/data/gadm2.8/rds/NAM_adm1.rds"

download.file(url=link, destfile="file.rda", mode="wb")

gadmNab <- readRDS("file.rda")

plot(gadmNab)

# plot with colour filled in, title and label.

plot(gadmNab, col = 'lightblue', border = 'darkgrey')

points(17.0658, -22.5609,col=2,pch=18)

text(17, -22, "Windhoek")

geo<-read.csv("C:\\Users\\tshinyemba\\Documents\\Academics\\Thesis\\Analysis\\Geo
points.csv",header=T)

mymap<-qmap(location="Namibia,Wanaheda",zoom = 13,maptype="toner",source =
c("stamen"),title="Study Site")

mymap

mymap+geom_jitter(data=geo,aes(geo$lon,geo$lat),alpha=0.6, size = 2, color = "red")

north2(mymap+geom_jitter(data=geo,aes(geo$lon,geo$lat),alpha=0.6, size = 2, color =
"red"),0.06,0.15,scale = 0.2, symbol = 1)
```

EXPLORATORY FACTOR ANALYSIS AND PRINCIPAL COMPONENT ANALYSIS

FOOD INSECURITY

```
file.choose()
```

```
mydata<-
read.csv("C:\\Users\\tshinyemba\\Documents\\Academics\\Thesis\\UrLife_4THAPRIL2017_FS.
csv",header=T,sep=",")
```

Inspecting for data completeness

```
head(mydata) ; is.na(mydata);str(mydata)

summary(mydata,na.rm=T)  # to see if there is any missing data

newdata<-na.omit(mydata) # Reduces the data from 416 obs to 393 obs

summary(newdata);head(newdata)

install.packages("psych")

library(psych)

# Varimax Rotated Principal Components

fit <- principal(newdata, nfactors=1,rotate="varimax", sort=TRUE)

summary(fit)

fit$loadings

# Maximum Likelihood Factor Analysis

fit1<- factanal(newdata, 1, rotate="varimax")

print(fit1, digits=3, cutoff=.3, sort=TRUE)

fit1$loadings

# Determine Number of Factors to Extract

install.packages("nFactors")

library(nFactors)

ev <- eigen(cor(newdata))

ap <- parallel(subject=nrow(newdata),var=ncol(newdata),rep=100,cent=.05)

nS <- nScree(x=ev$values, aparallel=ap$eigen$qevpea)

plotnScree(nS,main="Number of factors to retain on Food security")
```

/ Food insecurity END/

WHOQOL-BREF

```
mydataQoL<-
read.csv("C:\\Users\\tshinyemba\\Documents\\Academics\\Thesis\\UrLife_4THAPRIL2017_Qo
L1.csv",header=T,sep=",")

head(mydataQoL);is.na(mydataQoL)
```

```
str(mydataQoL);summary(mydataQoL,na.rm=T)  # to see if there is any missing data

newdataQoL<-na.omit(mydataQoL) # Reduces the data from 416 obs to 327 obs

summary(newdataQoL);head(newdataQoL)

#Varimax Rotated Principal Components

fitWHOQoL <- principal(newdataQoL, nfactors=6,rotate="varimax")

summary(fitWHOQoL)

fitWHOQoL$loadings


# Maximum Likelihood Factor Analysis

fitWHOQoL1<- factanal(newdataQoL, 6, rotation ="varimax")

print(fitWHOQoL1, digits=3, cutoff=.3, sort=TRUE)

fitWHOQoL1$loadings

load <- fitWHOQoL1$loadings[,1:2]

plot(load,type="n")

text(load,labels=names(newdataQoL),cex=.7)

# Determine Number of Factors to Extract

ev <- eigen(cor(newdataQoL))

ap <- parallel(subject=nrow(newdataQoL),var=ncol(newdataQoL),rep=100,cent=.05)

nS <- nScree(x=ev$values, aparallel=ap$eigen$qevpea)

plotnScree(nS, main="Number of factors to retain on WHOQol-Bref")
```

/ WHOQOL-BREF END/

EQ-5D

```
mydataE5QoL<-
read.csv("C:\\Users\\tshinyemba\\Documents\\Academics\\Thesis\\UrLife_4THAPRIL2017_E5
QoL.csv",header=T,sep=",")

head(mydataE5QoL);is.na(mydataE5QoL)

str(mydataE5QoL)

summary(mydataE5QoL,na.rm=T)  # to see if there is any missing data

newdataE5QoL<-na.omit(mydataE5QoL) # Reduces the data from 416 obs to 362 obs
```

```
summary(newdataE5QoL);head(newdataE5QoL)


# Varimax Rotated Principal Components
fitEQ5Qol <- principal(newdataE5QoL, nfactors=7,rotate="varimax")
summary(fitEQ5Qol)
fitEQ5Qol$loadings

# Maximum Likelihood Factor Analysis
fitEQ5Qol1<- factanal(newdataE5QoL, 7, rotation ="varimax")
print(fitEQ5Qol1, digits=3, cutoff=.3, sort=TRUE)
fitEQ5Qol1$loadings

# Determine Number of Factors to Extract
ev <- eigen(cor(newdataE5QoL))
ap <- parallel(subject=nrow(newdataE5QoL),var=ncol(newdataE5QoL),rep=100,cent=.05)
nS <- nScree(x=ev$values, aparallel=ap$eigen$qevpea)
plotnScree(nS,main="Number of factors to retain on European EQ-5D")
```

/ EQ-5D END/

HIERARCHICAL CLUSTER ANALYSIS

```
library(pvclust)
```

Food insecurity

```
resulta <- pvclust(newdata, method.dist="euclidean", method.hclust="ward.D2", nboot=10000)
plot(resulta)
abline(h=18, col="red", lty=2.5)
pvrect(resulta, alpha=0.95)
```

WHOQOL-BREF

```
resul <- pvclust(newdataQoL, method.dist="euclidean", method.hclust="ward.D2", nboot=10000)
plot(resul)
```

abline(h=37, col="red", lty=2.5)

pvrect(resul, alpha=0.95)

EQ-5D

res <- pvclust(newdataE5QoL, method.dist="euclidean", method.hclust="ward.D2", nboot=10000)

plot(res)

abline(h=69, col="red", lty=2.5)

pvrect(res, alpha=0.95) **/ EQ-5D END/**

CONFIRMATORY FACTOR ANALYSIS

#install.packages(c("lavaan","semPlot","semTools","nonnest2","MVN","GPArotation","gridExtra","knitr",

"dplyr","tidyr",dependencies =T))

library(lavaan);library(semPlot);library(semTools);library(nonnest2);library(MVN);library(lattice)

library(GPArotation);library(gridExtra);library(qgraph);library(knitr);library(dplyr);library(tidyr)

thesisdata<-read.csv("C:\\Users\\tshinyemba\\Documents\\Academics\\Thesis\\

Thesis_QoL_FS_Tobias_27_Sept_17_With_Factors.csv",header=T,sep=",")

Food insecurity

#fitting a one-factor CFA model

#Specifying the three-factor model

FS.model1<-'food security=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120'

#Performing the regression and storing the regression model

fit1f<-cfa(FS.model1,data=thesisdata)

#obtaining the regression coefficients

summary(fit1f,fit.measures=TRUE,standardized=TRUE)

#Obtaining the goodness of fit indicators of the model

fitMeasures(fit1f,c("chisq", "rmsea", "srmr", "gfi", "ecvi"))

reliability(fit1f)

```
inspect(fit1f)

# Obtaining the factor loadings of the three-factor model

parameterEstimates(fit1f, standardized=TRUE,ci=TRUE,level=0.95) %>% filter(op == "=~") %>%

        select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue, Beta=std.all)
%>%

        kable(digits = 3, format="pandoc", caption="Factor Loadings") # Summarises the table

#plotting the one-factor model

semPaths(fit1f, what = "paths", whatLabels="std", style="lisrel", layout = "tree",  intercepts = TRUE,

        residuals = TRUE,edge.label.cex=0.8, thresholds = TRUE,  intStyle = "multi", rotation = 4,

        curve= 2,curvature = 1,nCharNodes = 4, nCharEdges = 3, edge.color="blue",reorder =

        TRUE,structural = FALSE, equalizeManifests =FALSE, optimizeLatRes = TRUE, node.width
=

        1.1,  edge.width = 0.5, shapeMan = "rectangle", shapeLat = "ellipse",  shapeInt = "triangle",
sizeMan

        = 4, sizeInt = 4, sizeLat = 6, node.label.cex = .5,edge.label.color = "black") / Food insecurity
END/
```

WHOQOL-BREF

```
#specifying the Four-factor model (Unmodified model)

model.WHOQoL        <- "Social=~q51+q50+q49+q48+q47+q52

                    Environmental=~q54+q41+q55+q53+q56+q42+q44

                    Physical=~q39+q38+q40+q43

                    Psychological=~newq59+q45+q37+q46"

#Performing the regression and storing the regression model, saturated model

WHOQoL4f<-cfa(model.WHOQoL,data=thesisdata)

#obtaining the regression coefficients

summary(WHOQoL4f,fit.measures=TRUE,standardized=TRUE)

#Obtaining the goodness of fit indicators of the model

fitMeasures(WHOQoL4f,c("chisq", "rmsea", "srmr", "gfi", "ecvi"))

reliability(WHOQoL4f)

inspect(WHOQoL4f)
```

```
# Obtaining the factor loadings of the three-factor model

parameterEstimates(WHOQoL4f, standardized=TRUE,ci=TRUE,level=0.95) %>% filter(op ==
"=~")

        %> % select ('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-
    value'=pvalue,

        Beta=std.all) %> % kable(digits = 3, format="pandoc", caption="Factor Loadings")
        # Summarises the table

#ploting the four-factor model

semPaths(WHOQoL4f, what = "paths", whatLabels="std", style="lisrel", layout = "tree2", intercepts
=

    TRUE, residuals = TRUE,edge.label.cex=0.7, thresholds = TRUE, intStyle = "multi", rotation
= 4,

    curve=2,curvature = 1,nCharNodes = 4, nCharEdges = 3, edge.color="blue",reorder =

    TRUE,structural = FALSE,  equalizeManifests =FALSE, optimizeLatRes = TRUE,
node.width =

    1.1, edge.width = 0.5, shapeMan = "rectangle", shapeLat = "ellipse", shapeInt = "triangle",
sizeMan

    = 4, sizeInt = 4, sizeLat = 5, node.label.cex = .5, edge.label.color = "black")


#Specifying the Three-factor model (modified model)

model.WHOQoL3f      <-"Social=~q51+q50+q49+q48+q47+q52

                    Environmental=~q54+q41+q55+q53+q56+q42+q44

                    Physical=~q39+q38+q40+q43"

#Performing the regression and storing the regression model

WHOQoL3f<-cfa(model.WHOQoL3f,data=thesisdata)

#obtaining the regression coefficients

summary(WHOQoL3f,fit.measures=TRUE,standardized=TRUE)

#Obtaining the goodness of fit indicators of the model

fitMeasures(WHOQoL3f,c("chisq", "rmsea", "srmr", "gfi", "ecvi"))

reliability(WHOQoL3f)

# Obtaining the factor loadings of the three-factor model

parameterEstimates(WHOQoL3f, standardized=TRUE,ci=TRUE,level=0.95) %>% filter(op ==
"=~")
```

```
        %>% select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue,
Beta=std.all)

        %>% kable(digits = 3, format="pandoc", caption="Factor Loadings") # Summarises the table


#ploting the three-factor model

semPaths(WHOQoL3f, what = "paths", whatLabels="std", style="lisrel", layout = "tree2", intercepts
=

        TRUE, residuals = TRUE,edge.label.cex=0.7, thresholds = TRUE, intStyle = "multi", rotation
= 4,

        Curve=2, curvature = 1, nCharNodes = 4, nCharEdges = 3, edge.color="blue",reorder =

        TRUE,structural = FALSE, equalizeManifests =FALSE, optimizeLatRes = TRUE, node.width
=

        1.2, node.height= 0.5, edge.width = 0.5, shapeMan = "rectangle", shapeLat = "ellipse",
shapeInt =

        "triangle", sizeMan = 4, sizeInt = 4, sizeLat = 5, node.label.cex = .5, edge.label.color =
"black")

#Obtaining goodness of fit

fitMeasures(WHOQoL4f,c("ecvi","aic","bic"))

fitMeasures(WHOQoL3f,c("ecvi","aic","bic"))
```

/ WHOQOL-BREF END/

EQ-5D

```
#Specifying the Four-factor model (unmodified)

model.EuroQol<-
"pain=~q94+q96+q89+q90+q95+q91+q93+q87+q86+q88+q98+q92+q85+q97+q83

          anxiety=~q79+q78+q68+q77+q66+q67+q76+q69+q73+q71+q72+q70

          selfcare=~q63+q64+q61+q62+q60+q65

          usualacti=~q74+q75+q84"

#Performing the regression and storing the regression model

EuroQol4f<-cfa(model.EuroQol,data=thesisdata)


#obtaining the regression coefficients

summary(EuroQol4f,fit.measures=TRUE,standardized=TRUE)

#Obtaining the goodness of fit indicators of the model
```

```
fitMeasures(EuroQol4f,c("chisq", "rmsea", "srmr", "gfi", "ecvi"))

reliability(EuroQol4f)

inspect(EuroQol4f)


#obtain modification indices

modificationindices(EuroQol4f)

# Obtaining the factor loadings of the three-factor model

parameterEstimates(EuroQol4f, standardized=TRUE,ci=TRUE,level=0.95) %>% filter(op == "=~")
%>%

        select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue, Beta=std.all)
%>%

        kable(digits = 3, format="pandoc", caption="Factor Loadings") # Summarises the table

#ploting the three-factor model

semPaths(EuroQol4f, what = "paths", whatLabels="std", style="lisrel", layout ="circle3",

      intercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,

      intStyle = "multi", rotation = 3,curve=1,curvature = 2.5,nCharNodes = 0,

      nCharEdges = 0, edge.color="blue",reorder = TRUE,structural = FALSE,

      equalizeManifests =FALSE, optimizeLatRes = TRUE, node.width = 1.2,node.heith=0.1,

      edge.width = 0.5, shapeMan = "rectangle", shapeLat = "ellipse",

      shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 4,

      node.label.cex =.6,edge.label.color = "black",unCol = "#070b8c",groups = "latents", pastel =
TRUE)


# four-factor model with insignificant manifest deleted (modified)

#Specifying the Four-factor model, q78 and q60 deleted

model.EuroQol1f<-
"pain=~q94+q96+q89+q90+q95+q91+q93+q87+q86+q88+q98+q92+q85+q97+q83

                anxiety=~q79+q68+q77+q66+q67+q76+q69+q73+q71+q72+q70

                selfcare=~q63+q64+q61+q62+q65

                usualacti=~q74+q75+q84"

#Performing the regression and storing the regression model
```

```
EuroQol1f<-cfa(model.EuroQol1f,data=thesisdata)

#obtaining the regression coefficients

summary(EuroQol1f,fit.measures=TRUE,standardized=TRUE)

#Obtaining the goodness of fit indicators of the model

fitMeasures(EuroQol1f,c("chisq", "rmsea", "srmr", "gfi", "ecvi"))

reliability(EuroQol1f)

# Obtaining the factor loadings of the three-factor model

parameterEstimates(EuroQol1f, standardized=TRUE,ci=TRUE,level=0.95) %>%

  filter(op == "=~") %>%

  select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue,

        Beta=std.all) %>% kable(digits = 3, format="pandoc", caption="Factor Loadings") #
Summarises the table


#ploting the four-factor modified model

semPaths(EuroQol1f, what = "paths", whatLabels="std", style="lisrel", layout = "circle3",

        intercepts = TRUE, residuals = TRUE,edge.label.cex=0.8, thresholds = TRUE,

        intStyle = "multi", rotation = 3,curve=2,curvature = 1,nCharNodes = 0,

        nCharEdges = 0, edge.color="blue",reorder = TRUE,structural = FALSE,

        equalizeManifests =FALSE, optimizeLatRes = TRUE, node.width = 1.1,

        edge.width = 0.5, shapeMan = "rectangle", shapeLat = "ellipse",

        shapeInt = "triangle", sizeMan = 4, sizeInt = 4, sizeLat = 6,

        node.label.cex = .5,edge.label.color = "black",groups = "latents", pastel = TRUE)

#Obtaining goodness of fit

fitMeasures(EuroQol1f,c("ecvi","aic","bic"))

fitMeasures(EuroQol4f,c("ecvi","aic","bic"))                                    / EQ-5D END/
```

STRUCTURAL EQUATION MODELLING

```
#Specifying the Structural model of food security and quality of life

mySemModel<-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120

                Social=~q51+q50+q49+q48+q47+q52
```

```
                Envir=~q54+q41+q55+q53+q56+q42+q44

                Physc=~q39+q38+q40+q43

                pain=~q94+q96+q89+q90+q95+q91+q93+q87+q86+q88+q98+q92+q85+q97+q8
3

                Anxiety=~q79+q68+q77+q66+q67+q76+q69+q73+q71+q72+q70

                selfcare=~q63+q64+q61+q62+q65

                Us_Act=~q74+q75+q84

                #Regression

                Social~fs

                Envir~fs

                Physc~fs

                pain~fs

                Anxiety~fs

                selfcare~fs

                Us_Act~fs"

#Performing the regression and storing the regression model

mySem<-sem(mySemModel,data=thesisdata)

#obtaining the regression coefficients

summary(mySem,fit.measures=TRUE,standardized=TRUE)

#Obtaining the goodness of fit indicators of the model

fitMeasures(mySem,c("chisq", "rmsea", "srmr", "gfi", "ecvi"))

reliability(mySem)

# Obtaining the factor loadings of the three-factor model

parameterEstimates(mySem, standardized=TRUE, ci=TRUE, level=0.95) %>%

  filter(op == "=~") %>%

  select('Latent Factor'=lhs, Indicator=rhs, B=est, SE=se, Z=z, 'p-value'=pvalue,

         Beta=std.all) %>% kable(digits = 3, format="pandoc", caption="Factor Loadings") #
Summarises the table

#ploting the three-factor model (Completing SEM)

semPaths(mySem, what = "paths", whatLabels="std", style="lisrel", layout ="tree3",
```

intercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,

intStyle = "multi", rotation = 4,curve=-3.4,curvature = 1.3,nCharNodes = 0,

nCharEdges = 0,edge.color="blue",reorder = TRUE,structural = T,

equalizeManifests =FALSE, optimizeLatRes = TRUE, node.width = 1.2,node.heith=0.5,

edge.width = 0.5, shapeMan = "square", shapeLat = "ellipse",

shapeInt = "triangle", sizeMan = 4, sizeInt = 4, sizeLat = 4,

node.label.cex = .5,edge.label.color = "black",groups = "latents", pastel = TRUE,mar=c(2,9,2,1))

/SEM

END/

SEM HYPOTHESES

#Specifying the Structural model of food insecurity vs social health

FSvsSH <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120

Social=~q51+q50+q49+q48+q47+q52

#Regression

Social~fs"

#Performing the regression and storing the regression model

H1<-sem(FSvsSH,data=thesisdata)

#Obtaining the goodness of fit indicators of the model

fitMeasures(H1,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))

reliability(H1)

#plotting the three-factor model

semPaths(H1,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",

ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,

intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,

nCharEdges = 0,edge.color="blue" ,reorder = TRUE,

equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat = "ellipse",

shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,

edge.label.color = "black",groups = "latents", pastel = TRUE)

#specifying the Structural model of food insecurity vs environmental health

```
FSvsEH          <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120
                Envir=~q54+q41+q55+q53+q56+q42+q44
                #Regression
                Envir~fs"
#Performing the regression and storing the regression model
H2<-sem(FSvsEH,data=thesisdata)
#Obtaining the goodness of fit indicators of the model
fitMeasures(H2,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))
reliability(H2)
#plotting the three-factor model
semPaths(H2,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",
      ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,
      intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,
      nCharEdges = 0,edge.color="blue" ,reorder = TRUE,
      equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat =
"ellipse",
      shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,
      edge.label.color = "black",groups = "latents", pastel = TRUE)
```

#specifying the Structural model of food insecurity vs physical health

```
FSvsPH          <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120
                Physc=~q39+q38+q40+q43
                #Regression
                Physc~fs"
#Performing the regression and storing the regression model
H3<-sem(FSvsPH,data=thesisdata)
#Obtaining the goodness of fit indicators of the model
fitMeasures(H3,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))
reliability(H3)
#plotting the three-factor model
```

```
semPaths(H3,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",
        ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,
        intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,
        nCharEdges = 0,edge.color="blue" ,reorder = TRUE,
        equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat =
"ellipse",
        shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,
        edge.label.color = "black",groups = "latents", pastel = TRUE)
```

#Specifying the Structural model of food insecurity vs Pain/Discomfort

```
FSvsPaH          <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120
                   pain=~q94+q96+q89+q90+q95+q91+q93+q87+q86+q88+q98+q92+q85+q97+q8
                   3
                   #Regression
                   pain~fs"
#Performing the regression and storing the regression model
H4<-sem(FSvsPaH,data=thesisdata)
#Obtaining the goodness of fit indicators of the model
fitMeasures(H4,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))
reliability(H4)
#plotting the three-factor model
semPaths(H4,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",
        ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,
        intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,
        nCharEdges = 0,edge.color="blue" ,reorder = TRUE,
        equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat =
"ellipse",
        shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,
        edge.label.color = "black",groups = "latents", pastel = TRUE)
```

#Specifying the Structural model of food insecurity vs Anxiety health

```
FSvsAH           <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120
```

```
                Anxiety=~q79+q68+q77+q66+q67+q76+q69+q73+q71+q72+q70

                #Regression

                Anxiety~fs"

#Performing the regression and storing the regression model

H5<-sem(FSvsAH,data=thesisdata)

#Obtaining the goodness of fit indicators of the model

fitMeasures(H5,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))

reliability(H5)

#plotting the three-factor model

semPaths(H5,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",

      ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,

      intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,

      nCharEdges = 0,edge.color="blue" ,reorder = TRUE,

      equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat =
"ellipse",

      shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,

      edge.label.color = "black",groups = "latents", pastel = TRUE)
```

#Specifying the Structural model of food insecurity vs Self-Care health

```
FSvsSC          <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120

                selfcare=~q63+q64+q61+q62+q65

                #Regression

                selfcare~fs"

#Performing the regression and storing the regression model

H6<-sem(FSvsSC,data=thesisdata)

#Obtaining the goodness of fit indicators of the model

fitMeasures(H6,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))

reliability(H6)

#plotting the three-factor model

semPaths(H6,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",
```

```
        ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,
        intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,
        nCharEdges = 0,edge.color="blue" ,reorder = TRUE,
        equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat =
"ellipse",
        shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,
        edge.label.color = "black",groups = "latents", pastel = TRUE)
```

#Specifying the Structural model of food insecurity vs Usual Activities

```
FSvsUA          <-"fs=~q111+q112+q113+q114+q115+q116+q117+q118+q119+q120
                Us_Act=~q74+q75+q84
                #Regression
                Us_act~fs"
#Performing the regression and storing the regression model
H7<-sem(FSvsUA,data=thesisdata)
#Obtaining the goodness of fit indicators of the model
fitMeasures(H7,c("chisq", "rmsea", "srmr", "gfi", "ecvi","cfi","tli"))
reliability(H7)
#plotting the three-factor model
semPaths(H7,what = "paths", whatLabels="std", style="lisrel", layout ="tree2",
        ntercepts = TRUE, residuals = TRUE,edge.label.cex=0.6, thresholds = TRUE,nDigits=2,
        intStyle = "multi", rotation = 4,curve=-3.5,curvature = 1,nCharNodes = 0,
        nCharEdges = 0,edge.color="blue" ,reorder = TRUE,
        equalizeManifests =FALSE, optimizeLatRes = TRUE,shapeMan = "square", shapeLat =
"ellipse",
        shapeInt = "triangle", sizeMan = 4, sizeInt = 2, sizeLat = 5,node.label.cex = .5,
        edge.label.color = "black",groups = "latents", pastel = TRUE)
```

/END/

APPENDIX G: ETHICAL CLEARANCE CERTIFICATE

UNAM
UNIVERSITY OF NAMIBIA

ETHICAL CLEARANCE CERTIFICATE

Ethical Clearance Reference Number: FOS /364/2018 **Date: 20 February, 2018**

This Ethical Clearance Certificate is issued by the University of Namibia Research Ethics Committee (UREC) in accordance with the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the Research Project outlined below. This Certificate is issued on the recommendations of the ethical evaluation done by the Faculty/Centre/Campus Research & Publications Committee sitting with the Postgraduate Studies Committee.

Title of Project: Food Security And Quality Of Life In Windhoek Informal Settlements: A Structural Equation Modelling Approach

Researcher: Tobias W. Shinyemba

Student Number: 201019035

Supervisor(s) Dr. N.M. Nickanor (Main) Prof. L. Kazembe (Co)

Take note of the following:

(a) Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the UREC. An application to make amendments may be necessary.

(b) Any breaches of ethical undertakings or practices that have an impact on ethical conduct of the research must be reported to the UREC.

(c) The Principal Researcher must report issues of ethical compliance to the UREC (through the Chairperson of the Faculty/Centre/Campus Research & Publications Committee) at the end of the Project or as may be requested by UREC.

(d) The UREC retains the right to:

(i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,

(ii) Request for an ethical compliance report at any point during the course of the research.

UREC wishes you the best in your research.

Prof. P. Odonkor: UREC Chairperson

Ms. P. Claassen: UREC Secretary