

**An analysis of overweight and obesity in South Africa: the case of women of
childbearing age**

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ABSTRACT

This thesis used nationally representative data from the 2008 - 2017 National Income Dynamics Study, 1998 and 2016 South African Demographic and Health Surveys and 2005/06 and 2010/11 Income and Expenditure Surveys to examine prevalence, socioeconomic inequality, and determinants of overweight and obesity among non-pregnant women of childbearing age (15 to 49 years) (WCBA) in South Africa over time. It also assessed socioeconomic inequality in the intergenerational transmission of overweight and obesity from mothers to their offsprings among 10,735 mother-offspring pairs and decomposed socioeconomic inequality in household ultra-processed food (UPF) product spending in samples of 16,209 households in 2005/06 and 17,217 households in 2010/11.

Overweight and obesity in WCBA in South Africa increased between 1998 and 2017 with factors including increased age, self-identifying with the Black African population group, higher educational attainment, residing in an urban area, and wealth contributing to the rise. Smoking had a protective effect on being overweight and obese. Overweight and obesity were also increasingly prevalent among wealthier than poorer WCBA in South Africa between 1998 and 2016. It was found that UPF expenditure increased between 2005/6 and 2010/11, accounting for a substantial share of poorer households' expenditures than their wealthier counterparts over time. Although factors explaining socioeconomic inequality in the intergenerational transmission of overweight and obesity differed by offspring sex, intergenerational overweight and obesity occur more frequently among wealthier mother-offspring pairs than their poorer counterparts. Key factors explaining inequalities in intergenerational overweight and obesity include the mother's socioeconomic status, education and exercise habits.

This study improves the empirical understanding of the burgeoning overweight and obesity challenges among women, especially in South Africa, who are likely to transmit them to their offspring. Policy to address these issues should not only be about health services but also focus on the social determinants of health inequalities.

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LIST OF ABBREVIATIONS

ART	Antiretroviral therapy
AOR	Adjusted odds ratio
BMI	Body mass index
CI	Confidence Interval
CSDH	Commission on Social Determinants of Health
CSM	Community sample member
COVID-19	Coronavirus Disease 2019
DALYs	Disability Adjusted Life Years
EQUAL	The World Health Organization equity analysis of the linkages between health and other sectors
FAOSTAT	Food and Agriculture Organization Corporate Statistical Dataset
GEAR	Growth, employment and redistribution policy
HEMF	Health equity measurement framework
HFOII	Healthy Food Option Industry Initiative
HIV	Human immunodeficiency virus
HREC	Human Research Ethics Committee
IES	Income and Expenditure Survey
LMICs	Low- and middle- income countries
NCDs	Non-communicable diseases
NDoH	National Department of Health
NFNS	National Food and Nutrition Security
NIDS	National Income Expenditure Survey
OLS	Ordinary Least Squares
PSUs	Primary sampling units
RR	Rate ratio
SA	South Africa
SADC	Southern African Development Community
SADHS	South African Demographic and Health Survey
SANHANES	South African Nutrition and Health Examination Survey
SD	Standard deviation
SDGs	Sustainable Development Goals
SDH	Social Determinants of Health
SES	Socioeconomic status
SSA	sub-Saharan Africa
Stats SA	Statistics South Africa
TDA	Total differential approach

UPF	Ultra-processed food
USA	United States of America
WCBA	Women of childbearing age
WHO	World Health Organization
YLDs	Years of life lived with disability

GLOSSARY OF TERMS

Body mass index

BMI, calculated as an individual's weight (kg) divided by height squared (m^2), is a way of determining an individual's body fat content (Finucane et al., 2011). It is the most simple and widely used anthropometric indicator to measure overweight and obesity in adults (James et al., 2015, World Health Organisation, 1995).

Concentration index

The concentration index (C) is used to assess socioeconomic inequality in health and health risk factors. It varies from -1 to +1. A positive concentration index ($C > 0$) means that the health variable of interest is more concentrated among the rich (pro-rich) while a negative index ($C < 0$) signifies the opposite (pro-poor).

Double burden of undernutrition and obesity

This refers to the coexistence of undernutrition and obesity within the same individuals, households, populations, and across the life course (Popkin et al., 2020).

Gini index

The Gini index (G) is used to assess consumption expenditure inequality. The index value ranges from 0 (perfect equality in the distribution of consumption expenditure) to 1 (perfect inequality in the distribution of consumption expenditure).

Health inequality

This refers to differences in health status or the distribution of health determinants such as power, money, and resources between different population groups (World Health Organization, 2017a, World Health Organization, 2020c).

Health inequity

Health inequity is the systematic unfairness in the distribution of social determinants of health that leads to avoidable health inequalities (World Health Organization, 2020b, World Health Organization, 2020c).

Kakwani index

The Kakwani index (K) denotes the difference between the Gini index (G) of consumption expenditure and the concentration index (C) of spending on the particular NOVA food group (i.e., $K = C - G$). It is used in this thesis to assess progressivity in spending on food.

Malnutrition

The different forms of malnutrition include undernutrition, overweight and obesity (as defined below), and micronutrient deficiencies (Popkin et al., 2020).

Non-communicable disease

Non-communicable diseases are chronic in nature. They include but are not limited to cardiovascular disease, diabetes, cancers, and chronic lung disease (Shekar & Popkin, 2020). They represent diseases that cannot be easily transmitted from one individual to another and contribute to a substantial proportion (70%) of deaths globally (Non-Communicable Disease Countdown 2030 Collaborators, 2020, World Health Organization, 2018a). In this thesis, it refers mainly to diet-related non-communicable diseases, which include cardiovascular disease, diabetes, and some cancers.

No inequality

No inequality refers to a situation where the concentration index (as defined above) takes on a zero value.

NOVA food classification system

While NOVA is not an acronym, it is one of the classification systems for food processing widely used in public health nutrition research and policy (Moubarac et al., 2014). The NOVA system classifies food into four groups: unprocessed or minimally processed food; processed culinary ingredients; processed food products, and ultra-processed food products (Monteiro et al., 2012, Moubarac, J. C. et al., 2013). In this thesis, the NOVA classification was adapted as follows: —i) Unprocessed or minimally processed foods include fruits, vegetables, grains or cereals, potatoes and tubers, pulses (dried beans, peas and lentils), meat (beef, pork, mutton and other meat products) and fish, dairy, eggs, unsalted nuts and seeds, dried herbs, coffee and tea. ii) Processed culinary ingredients include fats and oils, table sugar, flours, pasta, honey and table salt. iii) Processed food products include tinned vegetables, legumes or fruits, salted nuts or seeds, processed meat or fish, tinned fish, cheese, and bread. iv) UPF products include confectionary (ice-cream, chocolate and sweets), sugar-sweetened beverages, snacks, breakfast cereals and baked goods.

Nutrition transition

The concept of nutrition transition, developed by Barry Popkin in 1993, is described as the change in diet patterns causing a shift from traditional foods to more processed high energy-dense of low nutritional value (Popkin, 1993, Popkin, 2002a, Popkin, 2002b).

Obesity

In adults, obesity is classified as a BMI of $\geq 30 \text{ kg/m}^2$ (World Health Organization, 2017b). Whereas in children, those under five years with a weight-for-height z-score of three or more standard deviations above the WHO Child Growth Standards median are categorised as obese (World Health Organization, 2017b). Children aged 5-14 years with a BMI-for-age z-score of two or more standard deviations above the WHO Growth Reference median are considered obese (World Health Organization, 2017b).

Overweight

In adults, overweight is classified as a BMI of $\geq 25 \text{ kg/m}^2$ (World Health Organization, 2017b). However, children under five years with a weight-for-height z-score of two or more standard deviations above the WHO Child Growth Standards median are considered overweight (World Health Organization, 2017b). Children aged 5-14 years with a BMI-for-age z-score of one or more standard deviations above the WHO Growth Reference median are categorised as overweight (World Health Organization, 2017b). In this thesis, obese children and adults are included as overweight.

Pro-poor inequality

Pro-poor inequality refers to a case where the concentration index (as defined above) takes on a negative value.

Pro-rich inequality

Pro-rich inequality refers to a case where the concentration index (as defined above) takes on a positive value.

Social determinants of health

The social determinants of health include the "*structural determinants and conditions of daily life responsible for a major part of health inequalities between and within countries. They include the distribution of power, income, goods and services, and the circumstances of people's lives, such as their access to health care, schools and education; their conditions of work and leisure; and the state of their housing and environment*" (World Health Organization, 2009:1).

Socioeconomic gradient in overweight or obesity

This term is also known as ‘social gradient in overweight or obesity.’ It means a higher proportion of individuals who are overweight or obese (i.e. the worst affected by overweight or obesity) occur among those with low socioeconomic status compared to their more affluent counterparts. An inverse socioeconomic gradient: the proportion of obese or overweight individuals is higher among the rich than the poor.

Socioeconomic status

Socioeconomic status is a measure of living standards. It is usually assessed directly or indirectly. Direct measures of living standards include income, expenditure, and consumption. The term income is defined as *“the amount of money received during a period of time in exchange for labour or services from the sale of goods or property as a profit from financial investments”* (O’ Donnell et al., 2008:70). The term expenditure refers to *“money payments or the incurrance of a liability to obtain goods and services”* (O’ Donnell et al., 2008:70). The term consumption denotes *“the final use of goods and services, excluding the immediate use of some goods and services in the production of others”* (O’ Donnell et al., 2008:70). Indirect measures of living standards include the wealth index. The wealth index is based on assets and housing conditions that can be observed during an interview for a survey (O’ Donnell et al., 2008). The aforementioned measures of living standards have some advantages and disadvantages. According to O’ Donnell et al. (2008), consumption, if available, is the preferred measure of living standards instead of income. This is because income can be saved or financed from borrowing and many surveys exclude home production. However, consumption data can be expensive and challenging to collect and is more prone to measurement error. Given the challenges of collecting consumption data, some surveys measure living standards using a wealth index. The wealth index made popular by the Demographic and Health Surveys, is a more permanent measure of living standards than income or consumption. This is because income or consumption can fluctuate over time in most households (O’ Donnell et al., 2008). Moreover, income data are often unreliable in developing countries (Deaton & Grosh, 2000). In this thesis, an individual or household’s socioeconomic status is assessed using a wealth index or household expenditure depending

on the dataset (i.e., National Income Dynamics Study (NIDS) using household expenditure as the socioeconomic status variable, the Income and Expenditure Survey (IES) and the South African Demographic and Health Survey (SADHS) using the wealth index).

The SES variable used for each dataset has been specified in the substantive chapters. For example, household expenditure from the NIDS and the wealth index from the SADHS was used for analysis in chapter three, while the wealth index from the IES was used for analysis in chapter four. The wealth index from SADHS was used for analysis in chapter five, while household expenditure from the NIDS was used for analysis in chapter six.

Women of childbearing age

The term 'women of childbearing age' is defined as "*the active reproductive years in women starting with menarche around 12-14 years and ending with menopause around 45-49 years. For demographic purposes, reproductive age group is usually defined as 15-49 years or 12-49 years*" (Mahapatra & Latha, 2002:1). For this study, the childbearing age group is defined as 15 to 49 years.

CHAPTER ONE: INTRODUCTION

1.1 Overweight and obesity

Overweight and obesity occur when energy intake exceeds energy expenditure creating a state of positive energy balance, and the consequence is an abnormal or excessive accumulation of body fat that adversely affects health (Romieu et al., 2017, World Health Organization, 2017b). Obesity arises from a complex interaction of multiple biological (i.e., genetics), environmental (i.e., exposure of the individual to the food and built environment), and behavioural factors (i.e., food consumption patterns, sedentary behaviour, lack of physical activity), which in turn are influenced by culture, socio-economic factors and policies (e.g., government and private-sector policies), among others (Romieu et al., 2017, Swinburn et al., 2015). Obesity-related behaviours are attributed to the obesogenic environment where there is easy accessibility, affordability and availability of high energy-dense foods, preference for the consumption of these foods, in addition to reduced opportunities for physical activity at work, community or leisure (Lake & Townshend, 2006, World Health Organization, 2016).

Globally, obesity prevalence has nearly tripled since 1975 (World Health Organization, 2017b). The World Health Organization estimated that by 2016, about 1.9 billion adults worldwide were overweight, and more than 650 million adults were obese; these represent about 39% and 13% of the world's adult population, respectively (World Health Organization, 2017b). Women bear a disproportionately higher burden of obesity. In 2016, it was estimated that 15% of women compared to 11% of men were obese worldwide (World Health Organization, 2017b). Overweight and obesity, in turn, are implicated in several transitions, including the demographic transition¹, the epidemiologic transition², and the nutrition

¹ This is described as the change in population dynamics associated with economic growth that gradually causes a decline from high to low rates of fertility and mortality (Kirk, 1996).

² This is described as the shift in the population burden of disease from acute infectious diseases to chronic degenerative diseases as leading causes of death and disability (Omran, 1971).

transition³. The pace of change of these transitions has increased substantially, accompanied by rapid social and economic development during the past four decades, leading to a rise in non-communicable diseases (NCDs) worldwide (Swinburn et al., 2011). Currently, overweight and obesity contribute substantially to global deaths and disability from several high-burden conditions, such as cardiovascular diseases, diabetes, and some cancers (Global Burden of Disease 2016 Risk Factors Collaborators, 2017, Institute for Health Metrics and Evaluation, 2017a). They also contribute significantly to healthcare expenditure in many countries (Swinburn et al., 2011). In fact, addressing the global challenge of overweight/obesity and their related NCDs is a key focus of the 2030 Agenda for Sustainable Development. One of the targets of the Sustainable Development Goals is to reduce premature deaths from NCDs by one-third by 2030, including through prevention of obesity (Target 3.4); another is to end all forms of malnutrition by 2030, including overweight and obesity (Target 2.2) (United Nations Department of Economic and Social Affairs, 2017).

Sub-Saharan Africa has also experienced a rise in overweight and obesity, from an estimated age-standardised prevalence among adults at 18% in 1980 to 30% in 2015 (Institute for Health Metrics and Evaluation, 2017b). In this region, overweight and obesity were estimated to cause over 251,500 deaths, 2.11% of total years of life lived with disability (YLDs) and 1.73% of total disability-adjusted life years (DALYs) in 2016 (Institute for Health Metrics and Evaluation, 2017a). A recent study by the Non-communicable Diseases Risk Factor Collaboration in Africa demonstrated a rise in adult mean body mass index (BMI) from 21.0 kg/m² in 1980 to 23.0 kg/m² in 2014 for men, and from 21.9 kg/m² in 1980 to 24.9 kg/m² in 2014 for women. Average BMI estimates in Northern and Southern African regions were higher than global averages, especially among women (Non-Communicable Diseases Risk Factor Collaboration – Africa Working Group, 2017). The evidence suggests that socioeconomic status, age, parity, marital status, physical inactivity, body weight perceptions, and increased energy are determinants of overweight and obesity among adults in this region (Agyemang et al., 2015). Moreover, there is evidence of a dual burden of adult

³ This is described as the change in diet patterns causing a shift from traditional foods to more processed high energy-dense foods of low nutritional value (Popkin, 2002a, Popkin, 2002b).

overweight/obesity and child malnutrition in low-income sub-Saharan African countries (Garrett & Ruel, 2005, Micklesfield et al., 2013, Wojcicki, 2014).

South Africa, too, has experienced a rise in the prevalence of overweight and obesity and their associated NCDs (Institute for Health Metrics and Evaluation, 2017a, Institute for Health Metrics and Evaluation, 2017b). According to the Global Burden of Disease 2015 estimates, 44.6% of South African women were obese (Institute for Health Metrics and Evaluation, 2017b). The most recent South African Demographic and Health Survey published in 2017 reported that 35.9% of non-pregnant women of childbearing age in South Africa were obese (National Department of Health et al., 2017). While this figure follows the estimate in Egypt (39.2%) (Amugsi et al., 2017), the prevalence is higher than estimates reported for the United States (23.0%) (Vahratian, 2009), Ghana (22.0%), Kenya (15.0%), Zambia (11.5%) (Amugsi et al., 2017) and Morocco (10.1%) (Belahsen et al., 2004). In South Africa, while obesity is high among adults, children of overweight and obese mothers are also likely to be overweight (Steyn et al., 2011a). This phenomenon differs from what occurs in many low-income countries in sub-Saharan Africa, where children of overweight or obese mothers are likely to be malnourished or underweight (Garrett & Ruel, 2005, Micklesfield et al., 2013, Wojcicki, 2014). As expected, low-income households in South Africa suffer from food insecurity (Dinour et al., 2007, Misselhorn & Hendriks, 2017). Food insecurity is paradoxically associated with adult obesity in South Africa. This may be explained by the consumption of affordable and preferred energy-dense foods of low nutritional value available to low-income households, which tend to cause weight gain (Dinour et al., 2007, Micklesfield et al., 2013, Misselhorn & Hendriks, 2017).

The high prevalence of obesity among non-pregnant women of childbearing age in South Africa is a major concern for this research. Obese women of childbearing age are at increased risk of infertility, miscarriage, babies having congenital abnormalities and other adverse obstetric outcomes (Chu et al., 2008, Cresswell et al., 2012, Leary et al., 2015, Lynch et al., 2008, Ojiegbe, 2016, Ramsay et al., 2006). Also, overweight and obesity constitute significant economic burden and strain on social protection systems (Ng et al., 2014, Republic of South Africa, 2015a, Swinburn et al., 2011). With the observed intergenerational transfer of overweight and obesity between parents and offspring (Cardozo et al., 2011, Drake &

Reynolds, 2010, Jungheim et al., 2010, Li et al., 2011, Smith et al., 2009, Whitaker, 2004), there could be an increased chance of perpetuating socio-economic inequality in overweight and obesity between generations in the same way as there is intergenerational transmission of overweight and obesity.

The South African government has recognised the magnitude of the problem of obesity and obesity-related NCDs. In August 2013, the South African National Department of Health (NDoH) set out national targets to reduce NCDs in its National Strategic Plan for the prevention and control of NCDs 2013 – 2017 (Republic of South Africa, 2013a, Republic of South Africa, 2015a). The targets set out included: a) a 10% decrease in the prevalence of overweight and obesity by 2020; b) an increase by 10% in the prevalence of physical activity by 2020 (Republic of South Africa, 2013a). In 2015, the NDoH outlined a promising strategy that will help it to reach its target of reducing the prevalence of obesity and overweight by 10% by 2020 (Republic of South Africa, 2015a). The National Strategy for the Prevention and Control of Obesity in South Africa 2015-2020, sets out six broad goals: creating an institutional framework for effective inter-sectoral engagement; creating an enabling environment that improves the availability of and accessibility to healthy food choices in different settings; increasing physical activity levels among the South African population; supporting prevention in early childhood (in-utero to 12 years); communicating with, educating and mobilising communities; establishing a surveillance system and strengthening monitoring, evaluation and research (Republic of South Africa, 2015a). The targets and goals set out in these promising locally developed plans have yet to be evaluated. Achieving these targets and goals requires action to address the social determinants of health in partnership with other sectors. This will improve population health and reduce health inequalities between different population groups and develop a health-in-all policy⁴ strategy, among others (Republic of South Africa, 2013a).

⁴ The term health in all policies refers to ‘an approach to public policies across sectors that systematically takes into account the health implications of decisions, seeks synergies and avoids harmful health impacts in order to improve population health and health equity’ (World Health Organization, 2014a:2).

1.2 Food consumption patterns

Along with the increase in overweight and obesity, there has been increased consumption of unhealthy food (i.e., processed foods and foods high in fat, salt and sugar) globally, including sub-Saharan Africa (Kearney, 2010). By 2015 the food consumption based on the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) Food Balance data measured in kilocalories (kcal) per capita per day was 2950 globally and 2420 in sub-Saharan Africa (Kearney, 2010, World Health Organization, 2003). Globalisation, liberalised trade, urbanisation, social and economic development, income, food pricing, individual preferences, religious and cultural beliefs, marketing of food, geography and seasons have all resulted in changes in food consumption patterns over time, both globally and in sub-Saharan Africa (Kearney, 2010, World Health Organization, 2003). In South Africa, a study using national data from the FAOSTAT Balance sheets and Euromonitor International Passport that examined shifts in food consumptions between 1994 and 2012 demonstrated a shift to a diet with more sugar-sweetened beverages, more processed and packaged foods, including edible vegetable oils, increased intake of animal source foods, more added caloric sweeteners, and fewer vegetables (Ronquest-Ross et al., 2015). A substantive shift in food consumption was observed for soft drinks, sauces, dressings and condiments, sweet and savoury snacks, meat, and fats and oils (Ronquest-Ross et al., 2015). However, national FAOSTAT food balance sheets and Euromonitor International Passport data represent food available for consumption and thus do not correspond to actual food consumed and may result in an overestimation of food consumption (Kearney, 2010, Ronquest-Ross et al., 2015, World Health Organization, 2003). To note, the study by Ronquest-Ross *et al.* (2015) was done at macro-level (i.e., country-level) rather than at micro-level (i.e. household level) (Ronquest-Ross et al., 2015). However, inequalities in food consumption at micro-level are important to understand because they are a key contributor to inequalities in overweight or obesity as well as overall health (Lake & Townshend, 2006, Tiffin & Salois, 2012). To better understand how inequalities in food consumption contribute to inequalities in overweight or obesity at micro-level, it is crucial to use the information on actual food consumption patterns and trends in

households based on surveys (i.e., food consumption surveys) (Kearney, 2010, Ronquest-Ross et al., 2015, World Health Organization, 2003).

1.3 Socio-economic inequality in overweight and obesity

Inequality in health⁵, especially with reference to the poor among whom ill-health tends to be concentrated, is a topic that has attracted much interest from researchers across disciplines in South Africa and elsewhere (Ataguba et al., 2011, Gwatkin, 2000). In most of the world, the link between poverty and health remains strong (World Health Organization, 2001). In addition, the poor are often trapped in a vicious circle of poverty (World Health Organization, 2001). Consequently, the poor tend to be undernourished and sick, have poor living conditions, are susceptible to illnesses, have limited access to public health services and have a low life expectancy (World Health Organization, 2001). In addition, modernisation brings about diseases associated with civilisations, such as obesity, of which the poor are also affected (World Health Organization, 2000).

Socio-economic inequality in overweight or obesity is related to the social determinants of health (World Health Organization, 2014b). The social determinants of health include the *“structural determinants and conditions of daily life responsible for a major part of health inequalities between and within countries. They include the distribution of power, income, goods and services, and the circumstances of people’s lives, such as their access to health care, schools and education; their conditions of work and leisure; and the state of their housing and environment”* (World Health Organization, 2009:1). According to the World Health Organization, many factors at multiple levels lead to inequities in obesity, such as factors in the broader socio-economic context, different exposures, different experiences within the health system and different consequences of obesity (World Health Organization, 2014b). Evidence from European countries suggests that socially disadvantaged groups are often most vulnerable to developing obesity and that obesity inequities accumulate over the life course (World Health Organization, 2014b). A comprehensive approach to tackling inequities in obesity needs to address both the symptoms and the root cause of social determinants of

⁵ Differences in health status or the distribution of health determinants between different population groups (World Health Organization, 2017a).

health targeting all age groups, including vulnerable groups and the socially disadvantaged groups (World Health Organization, 2014b).

Developing countries are also vulnerable to developing an elevated obesity burden. Comparing low-, middle-, and high-income countries, a review by McLaren found that the association between socioeconomic status⁶ (SES) and obesity was typically positive (higher SES is associated with obesity) for adults in low- and middle-income countries, and predominantly the inverse (lower SES associated with obesity) for adults in high-income countries (McLaren, 2007). Another review comparing SES and obesity in low- and middle-income countries found a positive association between SES and obesity for both men and women in low-income countries but mixed for men and largely negative for women in middle-income countries (Dinsa et al., 2012). The latter associations suggest that obesity was no longer solely a problem of higher SES groups in low- and middle-income countries (Dinsa et al., 2012).

While there is overwhelming evidence that socioeconomic inequality in overweight and obesity is to the advantage of the rich across most stages of the life-course in high-income countries (McLaren, 2007, Shrewsbury & Wardle, 2008, Sobal & Stunkard, 1989), studies from South Africa (Alaba & Chola, 2014, Cois & Day, 2015, Sartorius et al., 2015) and other sub-Saharan countries (Abrha et al., 2016, Dake et al., 2011, Letamo, 2011, Olatunbosun et al., 2011, Steyn et al., 2011b) find that socioeconomic inequality in overweight and obesity is to the disadvantage of the rich for adults. However, some studies from South Africa (Kirsten et al., 2013, Meko et al., 2015, Pradeilles et al., 2015, Reddy et al., 2012) and other African countries (Jackson et al., 2003, Tadesse et al., 2017) show mixed findings for socioeconomic inequality in overweight and obesity in children. In some studies, SES was positively associated with overweight/obesity (Jackson et al., 2003, Pradeilles et al., 2015, Reddy et al., 2012, Tadesse et al., 2017) and in others, there was no association between SES and

⁶ The term socioeconomic status is used interchangeably with socioeconomic position (Krieger et al., 1997). The term refers to ‘to the social and economic factors that influence what positions individuals or groups hold within the structure of a society, and encompasses concepts with different historical and disciplinary origins’ (Galobardes et al., 2006:7). Socioeconomic indicators include income, educational attainment, social class, housing tenure, housing conditions, household amenities and occupation (Galobardes et al., 2006).

overweight/obesity (Kirsten et al., 2013, Meko et al., 2015) in children. Socio-economic inequalities in overweight and obesity likely reflect the social patterning of a positive energy balance-related behaviour relating to unhealthy food consumption (Olstad et al., 2016). Indeed, evidence from developed countries demonstrates that adults and children in lower SES groups consume more energy-dense foods of low nutrient value and fewer fruits and vegetables (Darmon & Drewnowski, 2008, Giskes et al., 2010, Rasmussen et al., 2006). Moreover, evidence suggests that the unaffordability of healthy food has led to social inequalities in overweight and obesity (Darmon & Drewnowski, 2015).

1.4 Obesity poses a threat to the health system and the realisation of universal health coverage

South Africa's health system is an ecosystem that comprises both public and private sector actors. The public sector dominates and provides care to most of the population (Mahlathi & Dlamini, 2015). The private sector is operated by a network of private companies and individual health care providers. Service providers in the public sector are organised into three levels: primary, secondary and tertiary (Mahlathi & Dlamini, 2015). The levels of the public sector comprise health facilities that are situated in and managed by the provincial department of health (Mahlathi & Dlamini, 2015).

The rise in NCDs like obesity poses a threat to a health system already under strain from the enormous burdens of infectious diseases. Efforts supporting lifestyle modification and screening are therefore essential for the prevention and control of obesity and its associated NCDs, this, however, can be costly to the health systems if such interventions fail (Hunter et al., 2017).

Universal health coverage means that everyone enjoys good health and has equitable access to affordable promotive, preventive, curative, rehabilitative and palliative health services (World Health Organization, 2020a). In South Africa, there is a strong policy direction towards universal health care coverage through the yet-to-be fully implemented National Health Insurance (NHI) (National Health Act, 2003). Obesity poses a threat to the realisation of

universal health coverage if obesity prevalence continues to increase and obesity inequality worsens. Therefore, monitoring inequality in health, like overweight/obesity inequality, is one of the aspects essential to the realisation of universal health coverage (World Obesity Federation, 2019a, World Obesity Federation, 2019b).

1.5 Efforts to manage overweight and obesity in South Africa

1.5.1 Government efforts

The government has made significant efforts to manage overweight and obesity in South Africa.

1.5.1.1 Fiscal policies

The government implemented a tax on sugar-sweetened beverages based on sugar content, applying a fixed 2.1-cent tax rate for every gram of sugar (both intrinsic and added) above a 4 g/100 ml threshold (Essman et al., 2021, Republic of South Africa, 2016). The tax on sugar-sweetened beverages was legislated through the Rates and Monetary Amounts and Amendment of Revenue Laws Act, Act No. 14 of 2017, with effect from 1 April 2018 (Rates and Monetary Amounts and Amendment of Revenue Laws Act, No. 14 2017:46). The goal is to reduce the consumption of unhealthy beverage options, prevent disease and increase revenue (Republic of South Africa, 2016). The tax on sugar-sweetened beverages directly impacts purchases, consumption and obesity (Republic of South Africa, 2016).

Zero-rating (including tax-exempt) healthier food items, such as brown bread, samp, dried mielies (corn), dried beans, lentils, tinned sardines, rice, fresh fruit and vegetables, vegetable oil, milk, eggs and edible legumes and legume seeds, aims to promote equity of value-added tax and poverty reduction (Jansen & Calitz, 2017, Value-added Tax Act, No. 89 of 1991, 1991).

The fiscal policies are just some of the ways to manage overweight and obesity. The National Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 introduced in section 1.1, discussed other government interventions to manage overweight and obesity: creating an institutional framework for effective inter-sectoral engagement; creating an enabling environment that improves the availability and accessibility of healthy food choices in different settings; increasing physical activity levels among the South African population;

supporting prevention in early childhood (in-utero to 12 years); communicating with, educating and mobilising communities; establishing a surveillance system and strengthening monitoring, evaluation and research (Republic of South Africa, 2015a).

Progress in implementing the National Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 includes the following:

1.5.1.2 Nutrient and ingredient limits

Mandatory legislation that lowers the limits of salt and trans-fats in processed foods has been enacted to reduce peoples' dietary intake of these potentially harmful ingredients and improve public health. These legislations are discussed further below.

1.5.1.2.1 Reducing salt content in processed foods

In South Africa, there has been ongoing reduction of the salt content in a wide array of processed foods such as bread, cereals, all fat spreads and butter cereals, ready-to-eat savoury snacks and potato crisps, processed meats, savoury powders, gravy powders and stock cubes, through mandatory legislation enacted by the government in 2016 (Foodstuffs, Cosmetics and Disinfectants Act, No. 54 of 197, as amended, 2019). The aim of enacting mandatory legislation reducing the salt content in processed foods is to discourage the consumption of high salt products that are not beneficial for health – high salt intake is associated with increased risk of obesity (Fanzo & McLaren, 2020, Ma et al., 2015). Continuously monitoring salt content limits in processed foods can assist in ensuring that the country is on track in achieving significant reductions in obesity. The government has faced challenges, however, in the monitoring and enforcing of manufacturers and retailers' adherence to the reduction of salt content in processed foods due to inadequate capacity (Vandevijvere & Vanderlee, 2019).

1.5.1.2.2 Reducing the content of trans-fats in processed foods

Another legislation enacted has been the ongoing reduction of the trans-fat content in processed foods to below 2 grams per 100 grams of oil and fat (Foodstuffs, Cosmetics and Disinfectants Act, no. 54 of 1972, as amended, 2011). Evidence has shown that dietary intake of trans-fats increases the incidence of obesity among consumers (Dorfman et al., 2009). Imposing a law lowering the limit of the trans-fat content of processed food leads to discouraging consumers' consumption of dietary trans-fats and promotes positive attitudes of the food industry towards reformulation to reduce trans-fat content in processed food (Fanzo & McLaren, 2020). There has been no evidence of the impact of reducing trans-fat content in processed food on consumer behaviour and the food industry available in South Africa (Goryakin et al., 2019). Regularly monitoring compliance of manufacturers and retailers to the reduced trans-fat content limits in processed foods can assist in ensuring that the country is on track in achieving the targets on obesity set out in the National Strategy for the Prevention and Control of Obesity 2015-2020.

1.5.1.3 Restricting the marketing and advertisement of unhealthy food and monitoring food labelling

While there are government efforts to prevent and control obesity which involve subjecting the food and beverage industry to enforced regulatory control by imposing taxes on added sugars and lowering the limits of nutrients and ingredients in processed foods, there are also draft regulations related to food labelling and the marketing and advertising of unhealthy food especially those aimed at children and adolescents that were published and opened for comment (Foodstuffs,, Cosmetics and Disinfectants Act, No. 54 of 1972, as amended, 2014). This draft legislation relating to food labelling and advertisement of food is awaiting legal and ministerial approvals (Sulcas, 2022). Enforcing restrictions on the marketing and advertisement of unhealthy food to children and adolescents and monitoring the correct and transparent food labelling will ensure that the country is on track to meet the targets on obesity set out in the National Strategy for the Prevention and Control of Obesity 2015-2020.

1.5.1.4 Policies influencing the provision of healthy food and beverages in government worksites

Peoples' eating behaviour is influenced by their food environments. The government can be an important influence on these food environments through their policies to promote health at the workplace. Government worksites are important settings to guide people to make healthier food and beverage choices. In South Africa, the National guide for healthy meal provisioning in the workplace was developed and published in 2016 (National Department of Health, 2016). The scope of the guide:

- serves as a guide in selecting foods and beverages for various workplace events, meetings, conferences, workshops, outdoor/off-site events;
- highlights the standard criteria for quality to be met for foods and beverages purchased, provided, or sold at events;
- gives examples of menu options that can be provided;
- gives the requirements for food safety and hygiene and their application to ensure food that is safe and suitable for consumption;
- covers standards and requirements for food transportation, food premises, and responsibility of food handlers and persons in charge of food premises;
- does not cover the provisioning of food and beverages brought from home for special occasions (e.g., birthday parties). It also excludes provisioning of Early Childhood Development Centers within the workplace (National Department of Health, 2016).

As of November 2018, capacity building workshops were held in government departments targeting all staff, particularly those responsible for planning, purchasing and preparing food and beverages for workplace functions and meetings to guide selecting healthy food and beverage options (Ntsie, 2018). At least 41 National, 87 provincial government departments and 6 parastatals were trained (Ntsie, 2018).

Training was held for catering companies that make food and beverages available for staff, visitors and the general public on workplace premises such as canteens and coffee shops; as

well as vending machines and kiosks service providers (Ntsie, 2018). At least 28 catering companies on the central suppliers' database were trained (Ntsie, 2018).

These capacity-building workshops influenced changes in food and beverages purchased, provided and sold in various government departments (Ntsie, 2018).

1.5.1.5 Increasing physical activity levels among the South African population

Programmes such as National Recreation Day increase awareness of physical activity among the South African population (South African Government, 2021a). Since December 2014, the Cabinet of South Africa declared 1 October as the National Recreation Day (South African Government, 2021a).

There are also policies such as the 1998 National Sports and Recreation Act (National Sports and Recreation Act, No. 110, 1998). Continuously monitoring the sports and recreation policy can assist in ensuring that the country is on track in achieving significant reductions in obesity.

The government is responsible for creating and enabling physical activity environment through promoting safe walking and cycling lanes alongside roads and public parks and recreation facilities (Department of Transport, 2003). However, interventions geared to enabling environments are not widespread countrywide.

1.5.1.6 Supporting prevention in early childhood

Also, the development of the Nutrition Guidelines for Early Childhood Development programmes was published in 2015 (Republic of South Africa, 2015b). These guidelines encourage optimal breastfeeding, good complementary feeding practices, good quality complementary diet that promotes health (includes reducing obesity), growth and development during infancy and childhood (Republic of South Africa, 2015b). In collaboration with the Department of Social Development (DSD) and Statistics South Africa (Stats SA), the department of health conducted capacity-building workshops in seven provinces and their districts (Ntsie, 2018).

1.5.1.7 Communicating with and educating different stakeholders

The Department of Agriculture, Forestry and Fisheries published the National Food and Nutrition Security (NFNS) Plan in 2013 (Republic of South Africa, 2013b). NFNS Plan is aligned to the Strategy for the Prevention and Control of Obesity in South Africa 2015 – 2020. The strategic objective within the NFSP focuses on influencing people across the life-cycle to make informed healthy food choices through the integrated communication strategy (Republic of South Africa, 2013b, The Department of Planning, 2020). The communication strategy for the country was developed in 2020 which includes messages sent across social media, television, radio and print about; 1) overweight and obesity and its consequences, 2) health risks of processed foods, 3) how to find, purchase or grow and prepare healthy food, and 4) the prevention and control of overweight and obesity (The Department of Planning, 2020). The messages are targeted towards a variety of stakeholders, namely: policymakers, the food industry, community leaders, parents and caregivers of children under five years, children 5 – 10 years, adolescents 10 – 19 years and households (The Department of Planning, 2020).

There are also programmes such as the National Nutrition and Obesity Weeks awareness campaigns targeting all South Africans during October to improve knowledge on nutrition and obesity (South African Government, 2021b).

The government scaling up communication with and education of communities to reduce consumption of cheap, ultra-processed, calorie-dense, nutrient-poor foods and increase consumption of fruits, vegetables, whole grains, nuts and seeds, unsaturated fats and fibre-rich foods will ensure that the country is on track in achieving significant reductions in overweight and obesity (Ntsie, 2018).

1.5.2 Role of the food industry

Given the regular engagement between the government (i.e., National Department of Health), the food industry and the Consumer Goods Council of South Africa (CGCSA), the food industry supports the government's efforts to manage overweight and obesity (de Hoop, 2019). The food industry, as coordinated by the CGCSA, embarked on the Health Food Option Industry Initiative (HFOII) in 2015 to support the production of and facilitate access to healthier food and non-alcoholic beverage options (de Hoop, 2019, Food Safety Initiative,

2021). The food industry achieves this by making healthier food options available and accessible to all consumers; and improving how such products are marketed to consumers, especially children and adolescents (de Hoop, 2019, Food Safety Initiative, 2021). Monitoring the compliance to responsible marketing, revised food labelling and formation of physical activity also forms part of the initiative (de Hoop, 2019, Food Safety Initiative, 2021).

While progress in reducing sugar and salt content has been made and healthier food options are being made available and accessible by companies across all sectors, some companies per sector have made slower progress than others (de Hoop, 2019).

The food industry, therefore, should scale up the Healthy Food Option Industry initiative (HFOII (2015 – to date) by;

- Reducing the fat, sugar and salt content in foods, including complementary foods for infants and young children;
- Ensuring that healthy and nutritious choices are available and affordable to all consumers;
- Practising responsible marketing especially those aimed at children and adolescents (de Hoop, 2019).

1.5.3 Private sector efforts

There are several private sector efforts to manage overweight and obesity. Discovery Health Vitality, for instance, is an incentivized health promotion programme for insured persons run by South Africa's leading private health insurance company (Discovery, 2021c). The Vitality programme has 1.8 million members (Discovery, 2021c). Beneficiaries earn points through participation in wellness services and programmes, such as health-risk assessments, vitality age assessment, fitness activities and health checks that objectively measure serum cholesterol, blood glucose, blood pressure and assessment of body weight (i.e., height, weight and waist circumference) (Lambert & Kolbe-Alexander, 2013). In addition, insured persons accumulate points for quitting smoking, dietician and fitness specialist visits, online or in-person risk assessments and, online and print materials that aim to change or reinforce good health behaviours (Lambert 2013). Members are rewarded through discounts on a range of

store purchases and services such as airline flights, subsidised gym membership and money paid back on healthy food spending (Lambert & Kolbe-Alexander, 2013).

There are several components of the Vitality programme targeting overweight and obesity management directly—namely, fitness points and the Vitality Healthy Food initiative.

1.5.3.1 Discovery Vitality Fitness Points (Physical Activity Points)

Members accumulate Vitality fitness points through regular physical activity such as, workouts at partner gym facilities, cycling, walking or running, swimming and major race events. They get rewarded for being active (Discovery, 2021b).

1.5.3.2 Discovery vitality HealthyFood Initiative

There is a comprehensive list of HealthyFood items that were selected by a scientific advisory panel and are in line with the national and international dietary guidelines (Lambert & Kolbe-Alexander, 2013). For the purposes of the initiative, the HealthyFood items are broadly defined as those with reduced sugar, salt, trans-fats and saturated fats (Lambert & Kolbe-Alexander, 2013). Additionally, the foods are rich in nutrients, fibre and vitamins as well as low in calories. Examples of foods on the list include fruits, vegetables, whole grains, nuts and seeds, and fat-free dairy products (Lambert & Kolbe-Alexander, 2013).

Members are issued with a HealthyFood card upon activation online or via telephone. Members can swipe their card when purchasing HealthyFood items from partner retail stores and get cash back on their monthly HealthyFood spend, as a reward for eating healthier (Discovery, 2021a).

Despite the benefit of a healthy lifestyle, a large proportion of the members of the Vitality programme fail to participate in a meaningful way, with low levels of engagement in healthy behaviours. The carrot versus the stick approach may not be enough to overcome the barriers to participation (Kolbe-Alexander et al., 2013). Nonetheless, policymakers can learn from the private sector led incentivised health promotion programmes. Such incentivised programmes

can make the choice of living a healthier lifestyle easier for people, reducing obesity and its associated NCDs.

1.6 Research aims, objectives and hypotheses

1.6.1 Research aim

This thesis aims to gather, assess, analyse and interpret national data on the pattern, prevalence and socioeconomic inequality in overweight and/or obesity in South African non-pregnant women aged 15 to 49 years old.

1.6.2 Research objectives

1. To assess the pattern and trends in the prevalence of overweight and obesity for the period 1998 – 2017 in South African non-pregnant women aged 15 to 49 years.
2. To identify the determinants of overweight and obesity in South African non-pregnant women aged 15 to 49 years.
3. To examine the changing pattern in socioeconomic inequalities in food consumption patterns over the period 2005 - 2011 in South African households with women aged 15 to 49 years.
4. To determine the changing patterns in socioeconomic inequality in overweight and obesity over the period 1998 – 2016 among South African non-pregnant women of childbearing age.
5. To assess the socioeconomic inequality in inter-generational overweight and obesity in South Africa.

1.7 Outline of chapters

Chapter one introduces the study and highlights the contextualisation and rationale of the study.

Chapter two provides the theoretical and conceptual framework of the study. The theories of health inequalities and the concepts of the social determinants of health and the nutrition transition are discussed. The literature review is contained in each substantive chapter, which addresses the research objectives to avoid duplication and overlap.

Chapters' three to six address the research objectives including a review of the literature, analytical methods, findings and discussion. Chapter three focuses on the prevalence and determinants of overweight and obesity. Chapter four addresses the socioeconomic inequality in food consumption. Chapter five focuses on socioeconomic inequality in overweight and obesity. Chapter six examines the socioeconomic inequality in the intergenerational transmission of overweight and obesity from mothers to offsprings. The substantive chapters have been formatted differently depending on the journal outlet where they are being reviewed.

Chapter seven is the conclusion section of this thesis. It ties up all the findings from each substantive chapter and provides recommendations for research and policy. It also highlights the study's major limitations and discusses the thesis' contributions to the body of knowledge.

The schema showing the structure of the thesis is depicted in **Figure 1-1**.

Figure 1-1 Outline of the chapters and subtopics of this thesis



Author's illustration

CHAPTER TWO: THEORETICAL AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This section provides the relevant theories and the conceptual framework that underpins this study. It is crucial to understand the role of a theoretical framework within a study because it acts as a blueprint to guide the researcher and helps them stay on track and not stray from the existing theories in the literature when making their scholarly and academic contribution (Adom et al., 2018). A conceptual framework is also important within a study, given that it helps researchers to identify and construct a model that helps them understand the phenomenon under investigation (Adom et al., 2018).

In this section, the theories of health inequalities are examined. Rather than choosing one theory over another, a priori, this thesis seeks to understand each theory on its own. As such, the thesis provides an overview of the key theories of health inequalities. It also discusses and explains the capabilities approach, fundamental cause theory, cumulative inequality theory and weathering hypothesis. These theories are compared, contrasted and critiqued, where possible. Then, it discusses how the relevant theories will be explored in the thesis.

2.2 Theories of health inequalities

Creswell writes that "*a theory is an interrelated set of constructs (or variables) formed into propositions, or hypotheses, that specify the relationship among variables (typically in terms of magnitude or direction*" (Creswell, 2008:51). Many theories explain health inequalities between and within countries.

2.2.1 The Black Report's explanations

The Black report was published in Britain in 1980 (Townsend et al., 1986). This seminal report was produced by the Department of Health and Social Security Working Group on Inequalities in Health, chaired by Sir Douglas Black (Townsend et al., 1986). The report identified a social

patterning in ill-health, life expectancy and infant mortality in Britain (Townsend et al., 1986). The report put forward four types of explanations for health inequality: artefact, selection, cultural/behavioural and materialist (Townsend et al., 1986). These theories will be discussed in more detail, specifically explaining how they influence health inequality.

2.2.1.1 Artefact

Artefact explanations see the relationship between social class and health as not causal, emphasising how social class is measured (Blane, 1985, Townsend et al., 1986). It suggests that the social patterning of mortality in Britain reflects how the Registrar General classified occupations than a causal relationship between social class and health (Townsend et al., 1986). By the early 2000s, the artefact explanation was debunked because of the growing body of contrary evidence (Bartley, 2017).

Inadequacy of the artefact explanation is that it fails to 'explain away' the association between social class and health (Blane, 1985).

2.2.1.2 Selection

The social selection model views the link between social class and health as causal and sees social class as the dependent variable (Blane, 1985). The selection explanation suggests that poor health contributes to downward social mobility, while good health contributes to upward social mobility (Townsend et al., 1986). There are two versions of the selection explanation: direct and indirect selection (Blane et al., 1993). Direct selection, argues that social class is not causally (directly) related to health (Blane et al., 1993). Adults in low paying and manual labour or blue-collar jobs were already more likely to be ill because they have always been ill in early life (Bartley, 2017). In contrast, indirect selection accepts a causal link between health and social class and the direction of causality can be seen as running from health to social class (Blane et al., 1993). Indirect selection factors in early life such as education, height and childhood deprivation (Blane et al., 1993) affect an adult's social class. They also influence health-related behaviours and in turn, health behaviours indirectly

influence adult health. Inadequacy of the selection explanation of health inequality is that its contribution to social differences in health is small, and limited to specific age groups and movements between particular bands of the social hierarchy (Blane, 1985).

2.2.1.3 Cultural and /or behavioural

Cultural/behavioural explanations accept a causal connection between social class and health but are different from the health inequalities explanations above (Blane, 1985). What is unique about it is that this type of explanation sees health as a dependent variable (Blane, 1985). It suggests differences between social classes in behaviours such as the various types of consumption (smoking, alcohol, processed foods and foods high in fat, salt and sugar) and leisure-time physical activity (Townsend et al., 1986). The cultural/behavioural explanation argues that health inequalities result from the clustering of health-damaging behaviours in socially disadvantaged groups. Behaviours such as eating processed foods, foods high in sugar and foods prepared outside the home, among others, are associated with an increased risk of obesity and its associated non-communicable diseases (Lee et al., 2016, Te Morenga et al., 2012).

There are several criticisms of the cultural/behavioural explanation for health inequality. First, risky behaviours are not autonomous but, instead, are tied to a disadvantaged position in the social structure and low income (Blane, 1985). For example, the Black Report shows that those in the Registrar General Social Class IV and V had less frequent contraceptive use than other social classes. It argued that what is taken as variation in knowledge and access to contraception between social groups tends to be, instead, different social classes capacities of self-control or mastery in a material world. Second, culture and/or behavioural factors act as indicators of other social class differences in health. For example, Blane (1985) noted that behaviours such as smoking and eating diets high in saturated fat are related to social class, and those individuals engaging in these risky behaviours are also more likely to be exposed to other factors which differ with social class. Blane (1985) illustrated that cigarette smokers were also more likely to be exposed to air pollution in the home and workplace.

2.2.1.4 Behaviour as a consequence of culture

The work of Pierre Bourdieu (1930 – 2002) is relevant to this type of explanation. Bourdieu's work sheds light on the relationship between culture and health behaviour (Bartley, 2017). Bourdieu pointed out that habitus comprises of an individual's thoughts, tastes and interests, and understanding of the world around them, and it can be created through primary socialisation into the world through culture (Bourdieu, 1984). According to Bourdieu (1984), various tastes such as the choice of leisure-time activities and diet form part of the strategies by which individuals show or use to position themselves into higher status groups and socially distance themselves from groups of lower status. Thus, the concept of habitus can be used to explain how shared culture and lifestyles can be an influence on social differences in health. For example, food choice may be seen as a symbol of social position—people with high socioeconomic status can purchase more expensive food but not necessarily healthy products than those with low socioeconomic status (Grajek et al., 2015).

2.2.1.4.1 Individualised behavioural explanations

The individualised behavioural explanation is described as a subset of cultural/behavioural explanations by Bartley (Bartley, 2017). It suggests that individuals with low socioeconomic status are more likely to have low personal attributes such as intelligence, coping skills and resilience. Thus, people possessing these characteristics tend to achieve low educational attainment and cannot secure better jobs that carry advantages with them (Bartley, 2017, Goldberg, 2012). In this model, the association between social class and behaviour is due to adverse personal characteristics of individuals, which also influences their social class (Bartley, 2017). Thus, these adverse attributes bring about other disadvantages such as poor working conditions, living in inadequate housing and over a life course, the compounding disadvantages make it challenging to end up in a favourable social position (Bartley, 2017, Goldberg, 2012).

2.2.1.4.2 Cultural shift

Cultural shift explanation is a subset of cultural/behavioural explanations by Bartley (Bartley, 2017). It focuses on the distribution of prevalence and certain health-damaging risk behaviours across countries (Bartley, 2017). It argues that certain Southern European countries, which are characterised by large income inequalities and overall good health, have small differences in health between high and low socioeconomic groups due to their healthy Mediterranean diets (Bartley, 2017).

The cultural shift theory can be used to explain certain findings from a comparative study of health inequality in six selected countries from the Southern African Development Community (SADC) - Malawi, Mauritius, South Africa, Swaziland, Zambia and Zimbabwe. (Umuhoza and Ataguba 2018). Income inequalities were highest in South Africa with a Gini index estimated at 0.63. Zambia (0.58) and Swaziland (0.52) also had high-income inequalities. Umuhoza and Ataguba (2018) found that the smoking prevalence was highest in South Africa than the other SADC countries (Malawi, Mauritius, Swaziland, Zambia and Zimbabwe). Smoking inequality shows that smoking was concentrated among the poor in all selected countries (Umuhoza and Ataguba 2018). This suggests that going by the cultural shift idea, adopting a lifestyle of no smoking as a signal of wealth or status has penetrated society in Malawi, Mauritius, South Africa, Swaziland, Zambia and Zimbabwe.

2.2.1.5 Materialist

The materialist explanation is preferred by the authors of the Black Report (Blane, 1985). This type of explanation is similar to the cultural/behavioural explanation because it accepts a causal connection between social class and health, and views health as the dependent variable (Blane, 1985). Materialist explanation is concerned with how material/structural conditions impact health (Bartley, 2017, Blane, 1985). It argues that poor health in lower social groups may be linked to poverty, inadequate or crowded housing, insecure employment, poor working conditions, lack of access to education and inadequate diet (Townsend et al., 1986). Thus, differences in the material/structural conditions can influence

the social patterning of health (Bartley, 2017, Blane, 1985). For example, people belonging to high socioeconomic status groups relative to low socioeconomic status groups tend to have better health knowledge, access to resources to be healthy via income and social capital (Darmon & Drewnowski, 2008, Pampel et al., 2010, Turrell & Vandevijvere, 2015).

2.2.1.5.1 Commodification

Bartley (2017) describes the concept of commodification as a subset of the materialist explanations. Social differences in health result in part due to commodification. According to Bartley (2017), commodification is transforming people and their ability to work into a commodity. Bartley (2017) explained that the commodification of people leads to individuals who are without work having inadequate income to secure goods and services that are needed for a healthy life. Some societies have policies (i.e., provision of benefits) that make it less likely for this situation to happen and thus to some extent people are de-commodified (Bartley, 2017).

The materialist explanation of health inequalities has several inadequacies. First, the materialist explanation of health inequalities focuses on material conditions affecting health and not on psycho-social characters or macro-social/political economy. Second, it fails to examine important aetiological factors, summation/interaction of factors resulting in social differences in health (Blane, 1985).

2.2.2 Recent developments in explanations used to understand health inequalities

New developments seek to explain health inequalities (i.e., psycho-social, life-course perspective, macro-social or political economy). The recent explanations stem from the inadequacies of the explanations of inequalities in health suggested by the Black report (i.e., artefact, selection, behavioural/cultural and materialist) (Bartley, 2017). The four types of explanations of health inequalities put forward in the Black Report focus attention on individual-level, behavioural/cultural and material factors (Blane, 1985). Most of the recent explanations have a common focus to shift attention from individual-level, behavioural/cultural or material factors and instead take a psycho-social, life-course and

multi-level approach (Bartley, 2017). In this section, the thesis outlines the recent explanations of health inequalities – psycho-social, life-course perspective and macro-social or political economy. It also discusses and explains the capabilities approach, fundamental cause theory, cumulative inequality theory and weathering hypothesis.

2.2.2.1 Psycho-social

In addition to cultural/behavioural and materialist explanations, psycho-social explanations are also important in explaining social differences in health. The psycho-social explanation focuses on how social inequality makes people feel and the effects of these feelings on health. Bartley (2017) described how feelings of inequality, domination or subordination stimulate stress responses in the body which have health implications. Social differences in health result from the unequal distribution of psychological risk factors. Psychological risk factors include social support, neighbourhood cohesion, control and autonomy at work, job demands, job strain, work-family life balance, the imbalance between efforts exerted and rewards received (Hemingway & Marmot, 1999). For example, people's food choices may result from their desire to achieve pleasure and manifestation of self-control (Grajek et al., 2015). Individuals in high socioeconomic groups tend to be better able to defer gratification to keep a healthy body weight than those in low socioeconomic groups (Offer, 1998).

2.2.2.2 Life-course perspective

The previous explanations for health inequalities are concerned with exposures occurring and having an effect at a single point in time. The life course perspective, however, argues that socioeconomic inequalities in health result from physical and social exposures, which vary across different stages of the life course such as gestation, childhood, adolescence, young adulthood, adulthood and old age (Ben-Shlomo & Kuh, 2002). The life-course perspective helps to examine the long-term health risks of developing a chronic illness because factors such as social and material circumstances which happened earlier in the life-course affect health later in life (Ben-Shlomo & Kuh, 2002). Also, to examine not only how the causal

mechanisms behind health problems (biological, behavioural, and psycho-social, for example) operate across one's lifetime but also across generations in shaping the development of chronic disease (Ben-Shlomo & Kuh, 2002). Within the broad category of life-course explanations, there are different operating pathways, Ben-Shlomo and Kuh (2002) explained these operating pathways:

- The “critical periods” model: This is when an exposure occurring during a particular period has long-term effects on the bodily wear and tear leading to poor health outcomes later in life, but this mechanism is not influenced dramatically by later life effect modifiers;
- The “sensitive periods” model: This is when there are certain times in the life-course when the adverse health effects experienced later in life from an exposure which happened earlier are much stronger than other times; and
- The “accumulation of risk” model: when health risks (adverse or protective) accumulate gradually over an individual's life course, but the long-term health effects of such exposures may be greater during developmental periods than at other times. These exposures may cause a decline in health separately and independently, chains of risk or a cluster in a socially patterned manner (Ben-Shlomo & Kuh, 2002).

2.2.2.3 Macro-social or political economy

Bartley (2017) points out that, in addition to explaining how health inequalities between social groups exist in a single society, explaining the relationship between income inequality and health across different geopolitical units within which individuals reside (i.e., countries, provinces, states in the United States of America (USA), United Kingdom counties etc.), is also of great importance to understanding social inequalities in health. There have been a number of authors investigating the link between income inequality (the distribution of income) across geopolitical units and health, including Wilkinson and Pickett (2009), Lynch et al. (1998), and Wolfson et al. (1999), among others. There has been considerable debate in the literature about whether there is, and what is causing the relationship between income inequality and

health (if it does exist). Bartley discussed several causal explanations in the literature for the relationship between income inequality and health.

- **Psycho-social explanations**

The psycho-social explanations argue that income inequality affects health due to status insecurity (Kawachi & Kennedy, 1997, Wilkinson & Pickett, 2009). The argument is that unequal income distribution in society is harmful because it places people in a social hierarchy based on a relative position which heightens status competition and as a consequence is detrimental to health. Such insecurities produce negative emotions in individuals such as shame, envy and distrust in others and stress, which, in turn, affects the body and induces behaviours such as smoking, overeating and less exercise (Lynch et al., 2000). Status insecurities and the negative emotions they produce not only result in adverse biological and behavioural effects in individuals but also lead to negative social consequences such as weak civic participation, low social capital and low social cohesion (Lynch et al., 2000).

- **Neo materialist explanations**

The neo-materialist explanations (Lynch, 2000, Lynch et al., 2004) argue that health differences in geopolitical units are brought about by different social policies addressing problems, such as issues with education and health care access and provision, rather than simply people's perceived position in a social hierarchy. This is consistent with findings in a study of health differences in Canada and the USA, where Ross et al. (2000) found that there were variations in life expectancy by income inequality across states in the USA but not across Canadian provinces. They argue that the reason for this may be that Canada had better health care provision compared to the USA (Ross et al., 2000).

- **The effect of welfare regimes on population health**

The role that welfare provision might play is important in explaining the link between income inequality and health. A welfare state is defined as involving government provision per citizen of some basic benefits such as education, healthcare and money (Esping-Andersen, 1990). Esping-Andersen's seminal work on de-commodification has sparked research efforts on how welfare provision might impact health-related inequalities (Esping-Andersen, 1990). The concept of de-commodification is the degree to which people in a society can have enough income to uphold the cost of a healthy life even if they cannot work for any reason (Esping-Andersen, 1990). Therefore, health inequalities should be lower in societies with higher levels of de-commodification. Esping-Andersen (1990) looked at the degree of de-commodification in three types of welfare regimes. According to Esping-Andersen (1990), there are three welfare-regime types: liberal, conservative or corporatist and social democratic regimes. The liberal regime is characterised by low and very restricted welfare provision from the government. In this type of welfare regime, people receive the same welfare benefits (Esping-Andersen, 1990). The USA, post-1980 Great Britain, Australia and New Zealand are typical nations in this category. The conservative or corporatist is one in which people receive benefits from social insurance and the amounts of benefit depend on how much they contributed to the social insurance scheme (Esping-Andersen, 1990). Germany and France are nations in this category. In the social democratic regimes, people receive generous welfare benefits from the government (Esping-Andersen, 1990). There are higher levels of de-commodification according to the scale developed by Esping-Andersen (1990) research and should have lower health inequality. Scandinavian countries such as Norway and Sweden are examples of nations in this category.

Following the fundamental work of Esping-Andersen (1990), a discussion also developed about a fourth welfare regime type called the Southern European regime (Martin, 2015). Nations in this category include Spain, Italy, Portugal and Greece.

Citizens residing in these nations rely more on family-based welfare arrangements than the provision of welfare from the government. Some research work conducted by Mackenbach et al. (2015), Vis and Rylands (2013) and Offer et al. (2010), among others, point to the welfare regime as influencers of either health or health inequalities. Through welfare regime analysis, Mackenbach *et al.* (2015) found that the inequality in mortality was lowest in the 1990s in the Southern European or Mediterranean countries of Italy and Spain and again in the 2000s. There was a greater increase in health inequality over the same period in the social-democratic countries than in the Southern European or Mediterranean nations. While in liberal countries such as Wales and England, health inequality was low in the 1990s but decreased in the 2000s. Mackenbach *et al.* (2015) explained that the paradox of the lower levels of inequalities in mortality in Southern European countries than the social-democratic regimes is due, in part, to the Mediterranean diet.

Vis and Rylands (2013) investigated the extent that welfare regimes influenced the changes in obesity prevalence in 15 European nations between 1980 and 2005. They found that obesity prevalence increased over the period across all welfare regime types. There were higher rates of obesity growth over the same period in the liberal regimes than in the social democratic and conservative regimes (Vis & Rylands, 2013). This study finding suggested that a nation with low and restrictive welfare provision for its citizens promotes an increase in obesity prevalence. Another comparative welfare study conducted by Offer *et al.* (2010) found that market-liberal regimes have a higher obesity prevalence and upward increase over time than non-market-liberal regimes. Offer *et al.* (2010) propose possible reasons: Fast food prices are lower in market-liberal economies. As such fast food is cheap and readily accessible, and people residing in market-liberal economies may feel greater amounts of stress because of competition, uncertainty and inequality. This stress induces behaviours such as overeating and less exercise (Offer et al., 2010).

South Africa has been described by Sithole and Mmakola (2018) to have features of the 'welfare state' in that it can meet some of the basic welfare needs of its citizens. South Africa's welfare state is relatively small compared to the Scandinavian countries

(Sithole & Mmakola, 2018). Not all citizens have access to the benefits, but only those who qualify and are approved get the benefits (Sithole & Mmakola, 2018). Compared to other welfare states, South Africa's welfare state relies more on social assistance than broader social insurance (Sithole & Mmakola, 2018). In the South African context, the largest social assistance recipients do not have an income and largely depend on the state to meet their needs (Sithole & Mmakola, 2018).

It is unclear how South Africa's welfare state affects health. In a qualitative study, however, Hunter-Adams et al. (2019) pointed out that grant recipients in South Africa's urban spaces tend to complain of hunger before receiving their monthly government cash transfers. Their diets shifted to processed foods, given the increased access and availability of these cheap poor quality foods in urban spaces (Hunter-Adams et al., 2019). One of the reasons why they complained of hunger before they receive their grant money at the month-end was because they experienced challenges finding a job to buy food (Hunter-Adams et al., 2019). Other reasons are that grant recipients misuse some of their money to buy alcohol, and the grant money is not enough after they spend it on food and other non-food items like school fees and uniforms, health and transport (Sithole & Mmakola, 2018).

- **Life-course perspective**

Lastly, Bartley (2017) also argued that a life-course approach is necessary to understand the social differences in health. At certain critical periods in the life course, social policies are essential because they protect an individual against health risks over the long term. Examples of such critical periods include moving from primary school to secondary school, the time of school examinations, starting the first job, changing or losing a job, and retirement. Consistently, several scholars' work has pointed to the detrimental effect of deficits in income during these critical periods on long-term health. Bartley et al. (1997) noted that babies might be born with neural tube deficiency due to inadequate vitamin intake in mothers from low-income households. Giving the families welfare benefits to buy food items of good quality would have protected these babies from developing neural tube defects. Brown and Harris (1978)

found that having close relationships with a spouse protects low- income women from developing depression. Maternal depression is associated with the health and school progress of their children. Therefore, the effect of families' low-income affects not only the mothers' health but also their children. Again, welfare provision during this critical period will prevent the triggering of a sequence of adverse events that may influence the health of mothers and their children.

2.2.2.4 Capabilities Approach

An alternative explanation for health inequalities is the capabilities approach developed by the economist Amartya Sen. The capabilities approach proposes that social arrangements should be looked at according to the extent of the social and economic freedoms people have to achieve social functionings that they value (Sen, 1992). Sen (1992) argued that in rich countries, the desire for equality is not just limited to income, but rather that people in low-income groups may need more income to purchase commodities to achieve the same social functioning as others which they value. This redirecting of social participation resources also depletes the finances that could be potentially used for health and nutrition (Sen, 1992).

2.2.2.5 Fundamental cause theory

The fundamental cause theory is relevant in the explanation of health inequalities (Bartley, 2017). Fundamental cause theory helps to explain the persistent relationship between socioeconomic status and health even though there have been changes to the intervening mechanisms that are presumed to explain it. This theory argues that socioeconomic status is likely to be a fundamental cause of disease. A fundamental cause involves access to resources, such as *"knowledge, money, power, prestige and social connectedness,"* used to help individuals protect their health through multiple intervening mechanisms (Link & Phelan, 1995:87). Consequently, the effect of socioeconomic status on health remains even after taking out the intervening mechanisms (Link & Phelan, 1995).

2.2.2.6 Cumulative inequality theory

Cumulative inequality is a middle-range theory-integrating micro and macro analyses (Ferraro et al., 2009). Cumulative inequality theory includes some aspects of what fundamental cause theories discuss, but it discusses how inequality accumulates over the life course (Ferraro et al., 2009). According to Ferraro *et al.* (2009), inequality is found in every society. It is difficult to eliminate because it does not arise primarily from an individual's agency but is systematically generated. For example, inequality causing health problems later in life may accumulate in part because of choices individuals make and in part due to structured determinants, such as social institutions and culture, which influence people's choices around their consumptions and behaviours associated with health or otherwise. While many scholars recognise the social antecedents of inequality, *"what cumulative inequality theory adds is the greater articulation of how inequalities are manifested over a life-course through demographic and developmental processes. Demographic processes refer to cohort-linked stimuli, events and experiences. Developmental processes refer to age-linked stimuli, events and experiences"* (Ferraro et al., 2009:415). Cumulative inequality theory recognises that childhood experiences are important in adult well-being (Ferraro et al., 2009). Further, cumulative inequality theory notes the reproductive period as a critical period, leading to nonlinearities in accumulation processes (Ferraro et al., 2009). In addition, cumulative inequality theory highlights gender differences in the accumulation of inequality by noting the distinct processes for men and women that lead to inequality (Ferraro et al., 2009). Inequality exists in both men and women, in part, because of biology, but with each gender, the accumulation process is distinct (Ferraro et al., 2009). Cumulative inequality theory gives special attention to the intergenerational transmission of inequality. Family lineage is a key source of inequality. Ferraro *et al.* (2009) identified four underlying mechanisms that lead to the understanding of how family lineage may influence the accumulation of inequality: biological, social-psychological, economic and ecological. *"Biological processes are manifested via genetic and nutritional factors, social-psychological via modelling and norms, economic via finances and wealth, and ecological via environmental and spatial arrangements. Any one of these mechanisms may be used to identify the influence of family lineage, but they frequently combine together"* (Ferraro et al., 2009:417).

2.2.2.7 Weathering hypothesis

Combining the tenets of fundamental cause and cumulative inequality theories (Ferraro et al., 2009, Link & Phelan, 1995), the weathering hypothesis helps explain differences in pregnancy outcomes (e.g., high neonatal mortality rates) between African Americans, other minorities and Whites in America (Geronimus, 1992).

Social stress adversely affects the health of African-American women and other minorities (Geronimus, 1992). These stressors include child-rearing, caregiving for the elderly, working/bread-winning, material deprivation, and discrimination (Geronimus, 1992). Specifically, the stressors cause bodily wear and tear (referred to as “weathering”) because of increased stress exposure. This social stress negatively affects minority women’s health and the children’s health if they become pregnant (Geronimus, 1992). This is what is meant by the term inequality gets under the skin (Ferraro & Shippee, 2009).

2.2.3 Theories used in this study

In this thesis, different sets of explanatory factors are selected to decompose health inequalities. Due to data availability, the research focuses on several factors, namely, cultural/behavioural and material factors. We also recognise Bourdieu’s concept of habitus (Bourdieu, 1984). Therefore, in formulating a theoretical framework, the present study will draw from several theories, namely, cultural/behavioural, materialist and Bourdieu’s concept of habitus. In the thesis, a deductive approach will be used to test and verify the theories.

2.2.4 Application of theories

In applying and adapting the various theories to the study, the following variables are identified or operationalised and subsequently selected among variables to decompose (i.e., explain) health inequalities:

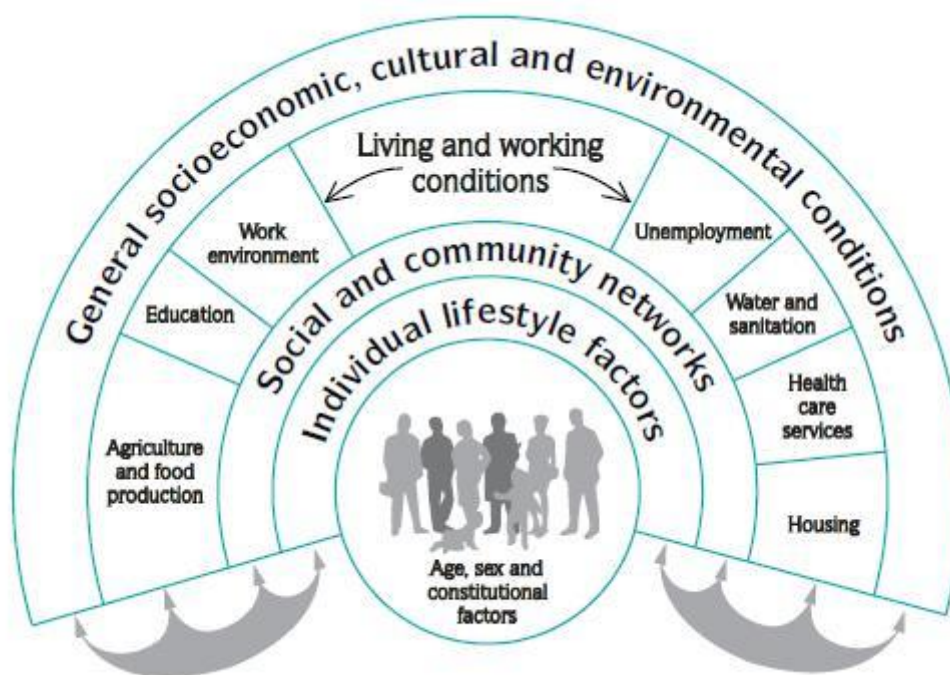
- Cultural/behavioural factors include, but are not limited to, population group, smoking and physical exercise.
- Materialist factors include socioeconomic status (wealth index or expenditure per capita depending on the dataset used) and education.

2.3 Social Determinants of Health

2.3.1 Description of the social determinants of health concept

The social determinants of health (SDH) include the: *“structural determinants and conditions of daily life responsible for a major part of health inequalities between and within countries. They include the distribution of power, income, goods and services, and the circumstances of people’s lives, such as their access to health care, schools and education; their conditions of work and leisure; and the state of their housing and environment”* (World Health Organization, 2009:1). An example of the social determinants of health model is depicted in **Figure 2-1**.

Figure 2-1 Dahlgren and Whitehead model of the social determinants of health



Source: Dahlgren and Whitehead (1991:11)

Figure 2-1 illustrates the main SDH, including access to essential goods and services (specifically water and sanitation, and food); housing and the living environment; ‘lifestyle’ factors; access to health care; unemployment and social security; working conditions; and transport. SDH are important factors that affect people’s health and health inequalities between and within countries. For example, poor diets are a key determinant of ill-health. More mortality burden is attributable to unhealthy diets than any other risk factor in many countries worldwide (Global Burden of Disease 2019 Risk Factors Collaborators, 2020). The obesogenic environment constrains access to healthy food: geographic localities where there is difficulty in access to and affordability of fruit and vegetables, preference for the consumption of cheaper and widely available high energy-dense foods, in addition to reduced opportunities for physical activity (Lake & Townshend, 2006, World Health Organization, 2016). Also, the wider living environment may act as a barrier to physical activity. High crime levels in communities can lead to safety concerns that prevent people from being physically active (Micklesfield et al., 2013). In addition to poor diets and the wider living environment,

lifestyle factors such as smoking, alcohol and physical activity are essential SDH. There are differences between socioeconomic groups in behaviours such as these (Townsend et al., 1986). In high-income countries, risky behaviours such as smoking, alcohol, consumption of processed foods and foods high in fat, salt and sugar and physical inactivity are more prevalent among people with low socioeconomic status (Townsend et al., 1986). Moreover, people in low-income countries and low-income groups are less likely to access health care for obesity-related NCDs than those in high-income countries or high-income groups (Di Cesare et al., 2013). People with low socioeconomic status also have disproportionately high unemployment levels than those with high socioeconomic status and unemployment is an important contributing factor to the socioeconomic gradient in health (Popham & Bambra, 2010). Working conditions are also major SDH. Job stress is linked with increased prevalence of coronary heart disease, depression and absenteeism (Marmot et al., 2006), and it is a key contributing factor to health inequalities (Marmot et al., 1991). Factors such as food advertising, promotion and information (i.e., food environment) as well as commercial interests adversely affect people's health and contribute to the burden of obesity and health inequalities (Herbert-Magee, 2019, Kickbusch et al., 2016).

By establishing interventions and policies promoting actions on the SDH, the government can improve people's health and reduce health inequalities. The SDH framework means that such policies or interventions must be multidimensional and intersectoral.

2.3.2 Development of the social determinants of health concept

SDH is related to the primary health care approach. To understand the historical trajectory of the SDH, one needs to go as far back as the adoption of the 1978 Alma-Ata Declaration of Primary Health Care. The 1978 Alma-Ata Declaration of Primary Health Care and the subsequent Health for All movement asserted the need to strengthen health equity by addressing SDH through intersectoral action (World Health Organization, 2010). However, the neoliberal economic models prevailing during the 1980s and 1990s led to impeding the translation of these ideas into effective policies in many countries because they emphasise the free market rather than the right to health (World Health Organization, 2010). Due to the

accumulating evidence on the impact of the SDH on health inequalities during the late 1990s and early 2000s, the World Health Organization established the Commission on the SDH in 2005 (World Health Organization, 2010). The Commission on the SDH subsequently published the “Closing the Gap in a Generation” report in 2008 aimed at understanding how health inequity could be improved, and what actions could be taken to tackle factors that influence health inequities (World Health Organization, 2008). The report provides three main recommendations for better health and reducing health equity: “1) *improve daily living conditions*; 2) *tackle the inequitable distribution of power, money, and resources*; and 3) *measure and understand the problem and assess the impact of the action*” (World Health Organization, 2008:2). The work of the Commission of the SDH has led to the subject of equity in health gaining tremendous attention (Schmidt & Barnhill, 2015). In 2011, the World Conference on the SDH was held, and the Rio Declaration on SDH was adopted by delegates (World Health Organization, 2020e). The declaration provided a global platform for discussing how the recommendations of the World Health Organization’s Commission on the SDH could be taken forward across the world to combat health inequalities (World Health Organization, 2020e). In May 2012, the Sixty-fifth World Health Assembly was held, in which member states endorsed the Rio Political Declaration on SDH (World Health Organization, 2020d). The member states expressed their political commitment to remedy health inequities through actions on the SDH (World Health Organization, 2020d).

This increasing focus on health equity at global level has ultimately led to the SDH being integrated into the sustainable development goals (SDGs) (World Health Organization, 2019b). The SDGs linked health and SDH to develop and strengthen policies to improve health and reduce health inequities within and between countries (World Health Organization, 2019b). The overarching SDGs linked to SDH and health equity include Goal 1: No poverty; Goal 3: Good health and well-being; Goal 4: Quality education; Goal 5: Gender equality; Goal 8: Decent work and economic growth; Goal 10: Reduced inequalities; Goal 11: Sustainable cities and communities; and Goal 17: Partnership for the goals (World Health Organization, 2019b).

2.3.3 Evolution of the social determinants of health models

There are many different types of social determinants of health models which have evolved over time. Hosseini Shokouh et al. (2017) explained that models created before 1995 have emphasised identifying the determinants of health and how they relate to each other. In contrast, models created between 1995 and 2005 have emphasised classifying the determinants of health and their relationships in the form of general or universal models (Hosseini Shokouh et al., 2017). In addition, models created after establishing the World Health Organization's Commission on the SDH in 2005, have focussed on the importance of the indicator of socioeconomic status and how health inequalities can be reduced through improving socioeconomic status (Hosseini Shokouh et al., 2017). Recently, the World Health Organization Equity-oriented analysis of the linkages between health and other sectors (EQUAL) framework was developed for monitoring SDH and improving equity in health (Pedrana et al., 2016). The EQUAL framework also emphasises the role of socioeconomic status and comprises three domains related to socioeconomic status—equality, accountability and inclusion, and livelihoods and skills (Pedrana et al., 2016). Lastly, the Health Equity Measurement Framework (HEMF) was developed for monitoring SDH, improving health equity and informing policy-making (Dover & Belon, 2019). Drawing from theoretical components from existing SDH and health system utilisation framework, this comprehensive framework includes a focus on a variety of SDH domains (socioeconomic, cultural, political context, health policy context, social stratification, social location, material and social circumstances, environment, biological factors, health-related behaviours and beliefs, stress, quality of care, and healthcare utilisation) and their interrelationships (Dover & Belon, 2019).

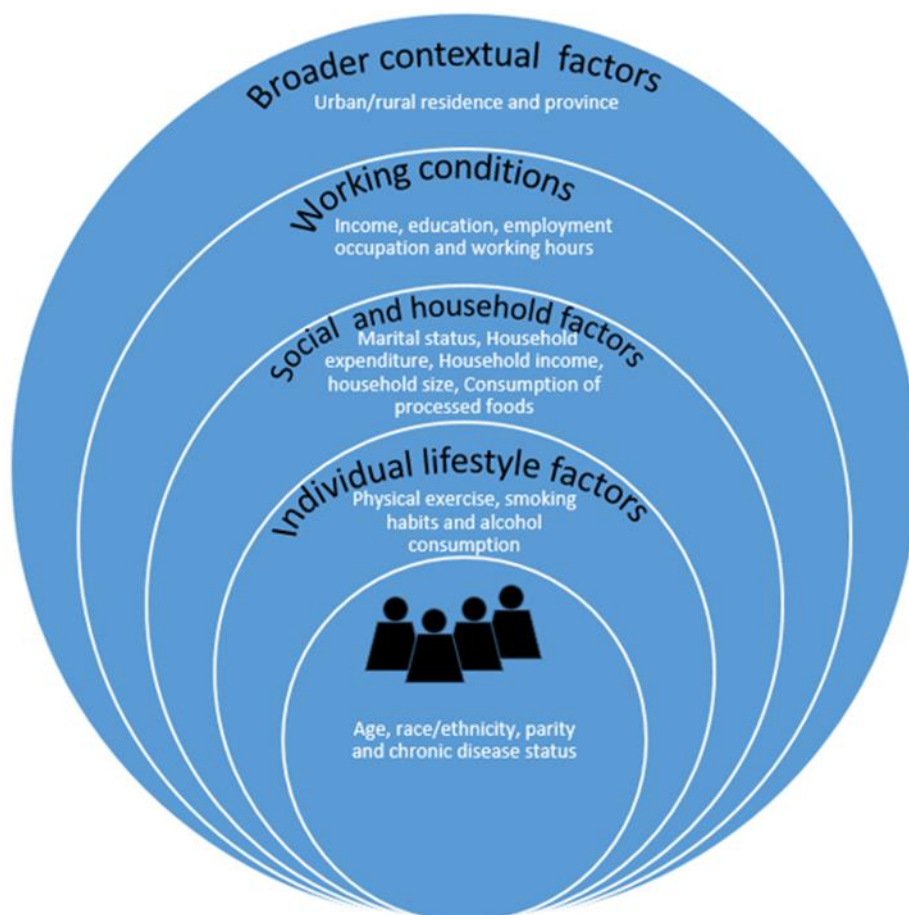
2.3.4 Application of the social determinants of health concept in the thesis

The thesis uses the SDH model adapted from Dahlgren and Whitehead (1991) illustrated in **Figure 2-2**. Here, the SDH are considered to be individual (including biological, demographic and lifestyle factors), social and household factors, working conditions and broader contextual factors (Dahlgren & Whitehead, 1991). Inequalities in health are caused by the uneven distribution of these determinants of health, including income, goods and services,

and the differences in the detrimental health behaviours that the broader determinants produce (World Health Organization, 2014b).

Individual and lifestyle factors include age, sex, ethnicity, socioeconomic status as well as the actions taken by individuals such as physical exercise, smoking habits, and alcohol consumption; social and household factors include marriage, household size, expenditure, income and consumption of processed foods; working conditions include occupation, education, employment and increased working hours; and the broader contextual factors include the location of the residence (urban/rural) and province.

Figure 2-2 Determinants of health



Adapted from: Dahlgren and Whitehead (1991)

Figure 2-2 adequately depicts the determinants in the different domains but does not depict interactions and relationships between the different determinants explicitly (Dahlgren & Whitehead, 2021). For example, single mothers are likely to work long hours to take care of their children with implications on their health and their children's. So, some level of interaction is implicitly assumed because of the nesting of various factors and groups.

Individual factors

Individual factors such as age and population group/ethnicity are important SDH. For example, for each population/ ethnic group there are a set of rules that society has adopted and applied to those that are part of the group and those that are not. In some societies, access to certain opportunities, resources, goods and services depends on the group individuals self-identify with.

Lifestyle factors

Factors such as consuming processed food, smoking, alcohol and physical inactivity are detrimental to health. Individuals, to some extent, choose to participate in these health-damaging behaviours, but this choice may be constrained or limited by other social determinants.

Socioeconomic status

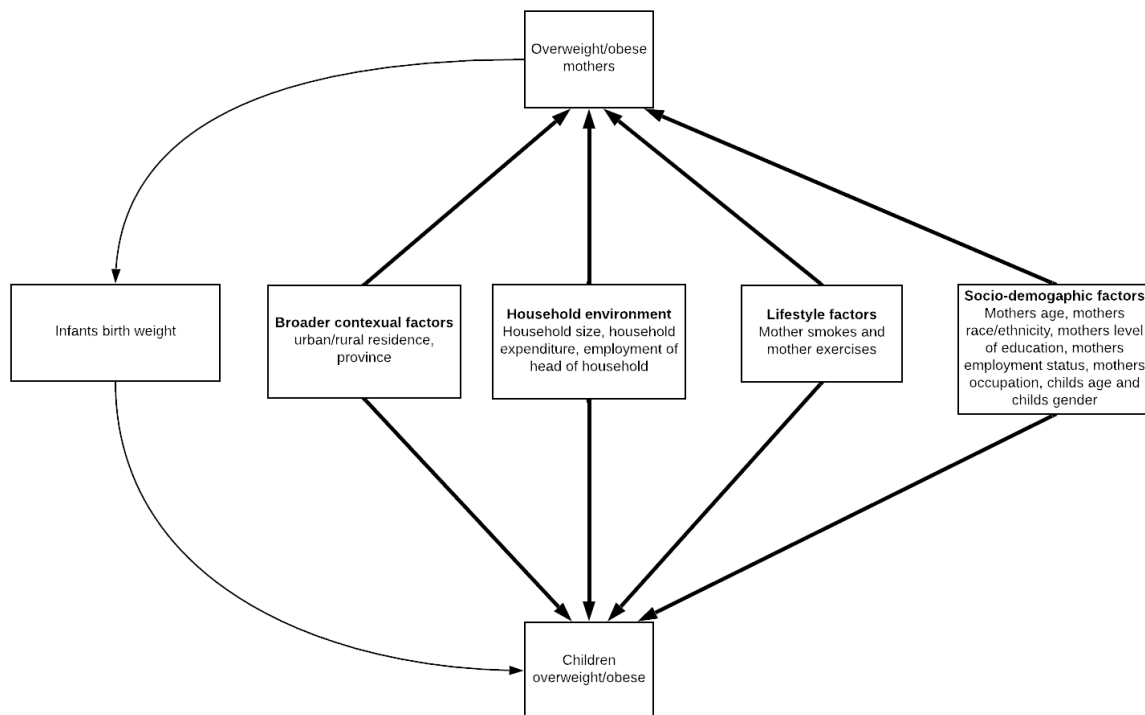
Socioeconomic status is another important SDH. The distribution of income or wealth sets the parameters within which people make food choices (Blane et al., 1997). Other factors, such as education and occupation, are related to socioeconomic status. For example, compared to people with little or no education, those who are more educated get better-paying jobs and they have more money to spend, which in turn influences their dietary choices.

Broader contextual factors

This is the broader milieu, socioeconomic, political and cultural setting in which individuals live, and these factors influence health. For example, culture also influences the choice of diet and leisure-time activities. These choices form part of how individuals show or use to position themselves into higher socioeconomic groups and socially distance themselves from lower-status groups (Bourdieu, 1984). Urbanisation has transformed the way we live, work and travel; as such, urbanisation has led to a rise in obesity prevalence due to people adopting urban dietary patterns such as consuming processed food to reduce the time for consuming ready-to-eat meals (Popkin, 1993).

In this thesis, the modified framework of the SDH (Dahlgren & Whitehead, 1991) is used to guide the choice of variables to describe the influence of the determinants of health on female overweight and obesity inequalities, intergenerational transmission of overweight and obesity inequalities, and food consumption inequalities in women's households. This takes into account the contribution of each factor to inequality through a decomposition analysis approach. Specifically, a decomposition analysis is used in various ways. First, to understand the drivers (i.e., contributions of determinants) that explain the overweight and obesity inequalities at different points in time, and identify and explore factors that explain the change in inequality between years. Second, to identify and explore the factors that explain the socioeconomic inequalities in the intergenerational transmission of overweight and obesity from mothers to their offspring (**Figure 2-3**). Third, to understand the drivers (i.e., contributions of determinants) that explain the household food consumption inequalities at different points in time, and identify and explore factors that explain the change in inequality between years. Moreover, the determinants of the health framework (Dahlgren & Whitehead, 1991) guide the selection of variables used to explore the extent to which the determinants are associated with overweight and obesity prevalence.

Figure 2-3 The intergenerational transmission of overweight and obesity



Adapted from: World Health Organisation (2007)

Figure 2-3 shows the intergenerational transmission of overweight and obesity. Overweight and/or obesity transfers from mothers to their children because once they fall pregnant, heavier mothers tend to give birth to bigger babies that, in turn, have the propensity to be heavier children (World Health Organization, 2007). Determinants of health such as socio-demographic characteristics, lifestyle, the household environment and broader contextual factors also play a part in the intergenerational cycle of overweight and obesity (World Health Organization, 2007). Their unequal distribution is likely to lead to inequality in the intergenerational transmission of overweight/obesity.

2.4 Nutrition transition

2.4.1 Description of the nutrition transition

The concept of *nutrition transition*, developed by Barry Popkin in 1993, is described as the change in diet patterns causing a shift from traditional foods to more processed high energy-dense foods of low nutritional value (Popkin, 1993, Popkin, 2002a, Popkin, 2002b). Driven by urbanisation and rapid social and economic development, the nutrition landscape of many countries worldwide, particularly low- and middle-income countries, has changed rapidly during the past four decades because of the nutrition transition (Popkin et al., 2012, Swinburn et al., 2011). In addition, this unfavourable change in diet patterns has led to a rise in overweight and obesity and diet-related NCDs worldwide (Swinburn et al., 2011).

According to Popkin (1993), the nutrition transition has the following five patterns of diet and lifestyle: hunter-gatherer lifestyles; early labour-intensive agriculture with periods of famine; receding famine as agriculture becomes more industrialised and incomes rise; Westernized diets high in calories, sugar, animal fat and processed foods, and sedentary lifestyles; and healthier diets and more active lifestyles (Popkin, 1993).

Two processes of change in demographic and disease profiles occur concurrently with the nutrition transition. First, *the demographic transition* described as the change in population dynamics associated with economic growth that gradually causes a decline from high to low rates of fertility and mortality (Kirk, 1996). Second, *the epidemiologic transition* described as the change in disease pattern and cause of death of the population as mortality declines during the demographic transition causing a shift from acute infectious diseases to chronic degenerative diseases leading to death and disability (Omran, 1971).

2.4.2 Analysis of the nutrition transition concept

Since its formulation, the concept of nutrition transition has gained prominence in research and policy thinking on obesity in developing countries and the World Health Organization (Lang & Rayner, 2007). The nutrition transition is crucial in understanding the rise in obesity and obesity-related NCDs around the world. Lang and Rayner (2007) are critical of the concept of the nutrition transition. Lang and Rayner (2007) pointed out that the nutrition transition should not be seen as one process but three transitions of diet, physical environment and culture. All of these three transitions need to be addressed for the obesity policy to be effective.

Another challenge to the concept of nutrition transition comes from Hawkes (2006), who argued that the nutrition transition model should not be viewed as a convergence to a homogenous diet high in calories, sugar, animal fat and processed foods. Hawkes pointed out the divergent and convergent nature of dietary outcomes of globalisation. In other words, globalisation not only converges diets to one type but is also divergent in that it brings more dietary diversity. Therefore, the nutrition transition model should consider both the divergent and convergent nature of global dietary change.

An additional critique of the concept of the nutrition transition comes from Walls (2018), who argued that the surveys for assessing diets in their current form are inappropriate for reflecting the nutrition transition because these surveys more often tend to ask about broad food categories (e.g., bread and cereals; meat; fish; milk, cheese and eggs, oils and fats; fruits; and vegetables) rather than on the processed food types associated with the nutrition transition. Walls (2018) also pointed out that research uses proxies such as food availability and anthropometric data like body mass index to reflect the nutrition transition.

Finally, the concept of nutrition transition fails to consider some of the complex aspects of the shift to agriculture. Mummert et al. (2011) point out that both the content of the

agriculture diet and the rise in infectious disease would have produced shorter stature in societies undergoing shifts to agriculture.

2.4.3 Application of the nutrition transition concept in this study

The nutrition transition concept is important in understanding the changes in overweight and obesity prevalence among women of childbearing age over time. Further, to understand the changes in food consumption in these women's households over time.

2.5 Summary

This section identified and discussed the theoretical and conceptual frameworks related to the thesis. The relevant theories included the cultural/behavioural and materialist explanations of health inequalities. The key concepts included the SDH and nutrition transition. Key variables to be used in analyses were identified, and theories and key concepts were identified based on their suitability to address the research objective. The subsequent chapters address the research objectives including a review of the literature, analytical methods, findings and discussion. Chapter three focuses on the prevalence and determinants of overweight and obesity. Chapter four addresses the socioeconomic inequality in food consumption. Chapter five focuses on socioeconomic inequality in overweight and obesity. Chapter six examines the socioeconomic inequality in the intergenerational transmission of overweight and obesity from mothers to offsprings. The substantive chapters have been formatted differently depending on the journal outlet where they are being reviewed.

CHAPTER THREE: OVERWEIGHT AND OBESITY IN NON-PREGNANT WOMEN OF CHILD BEARING AGE IN SOUTH AFRICA: SUBGROUP REGRESSION ANALYSES OF SURVEY DATA FROM 1998 TO 2017

Role of the candidate

The candidate contributed significantly to conceptualisation, design, data analysis and interpretation. The candidate drafted the manuscript, incorporated the supervisor's inputs and submitted the manuscript's final version to the journal.

Publication status

Nglazi, M.D. & Ataguba, J.E. Overweight and obesity in non-pregnant women of childbearing age in South Africa: an analysis of survey data from 1998 to 2017. *Under Review*.

3.1 Abstract

Background

Overweight and obesity in adults are increasing globally, contributing substantially to deaths and disability from non-communicable diseases and the growing burden of disease in South Africa (SA). Compared to men, women suffer a disproportionate burden of obesity, which adversely affects their health and that of their offspring. This study assessed the patterns and trends in prevalence and determinants of overweight and obesity among non-pregnant women in SA aged 15 to 49 years (WCBA) over two decades. It also assesses the factors associated with obesity and overweight in WCBA in South Africa.

Methods

This paper conducts secondary data analysis of seven consecutive nationally representative household surveys—the 1998 and 2016 SA Demographic and Health Surveys, 2008, 2010–2011, 2012, 2014–2015 and 2017 waves of the National Income Dynamics Survey, containing

anthropometric and sociodemographic data. The changing patterns of the overweight and obesity prevalence were assessed across key variables. The inferential assessment was based on overlaps in the 95% confidence intervals. Logistic regression models were used to examine the factors associated with overweight and obesity.

Results

Overweight and obesity prevalence among WCBA in SA increased from 51.3% to 60.0% and 24.7% to 35.2%, respectively, between 1998 and 2017. The urban-rural disparities in overweight and obesity decreased steadily between 1998 and 2017. The prevalence of overweight and obesity among WCBA varies by age, population group, location and socioeconomic status of women. For most women (e.g., by age groups, population groups, education, rural/urban location and socioeconomic quintiles), the prevalence of overweight and/or obesity in 2017 was significantly higher than in 1998. Factors that are significantly associated with being overweight and obese included increased age, self-identifying with the Black African population group, higher educational attainment, residing in an urban area, and wealthier socioeconomic quintiles. Smoking had a protective effect on being overweight and obesity.

Conclusion

The increasing trend in overweight and obesity in WCBA in SA demands urgent public health attention. Increased public awareness is needed about obesity and its health consequences in this vulnerable population. The government has National Nutrition and Obesity Weeks awareness campaigns. However, the government needs to scale up the intervention by communicating and educating communities about obesity and nutrition. In addition, policymakers should use a population-wide approach as opposed to an approach targeting specific groups of women. Given the fact that womens' experiences of the determinants are dynamic, efforts should address both management and prevention of overweight and obesity concurrently.

Keywords

Overweight, obesity, non-communicable diseases, non-pregnant women, South Africa

3.2 Introduction

Overweight and obesity contribute substantially to deaths and disability from many non-communicable diseases, including cardiovascular diseases, diabetes and cancers (Flegal et al., 2013, Forouzanfar et al., 2015, Institute for Health Metrics and Evaluation, 2019, Ng et al., 2014, World Health Organization, 2019a), and remain a significant public health concern. Overweight and obesity occur when energy intake exceeds energy expenditure creating a state of positive energy balance that leads to an abnormal or excessive accumulation of body fat that adversely affects health (Romieu et al., 2017, World Health Organization, 2017b). Obesity arises from a complex interaction of multiple biological (i.e., genetics), environmental (i.e. exposure of the individual to the food and built environment) and behavioural factors (i.e., food consumption patterns, sedentary behaviour, lack of physical activity), which in turn are influenced by culture, socio-economic factors and policies (e.g., government and private-sector policies), among others (Romieu et al., 2017, Swinburn et al., 2015).

Overweight and obesity among adults are increasing globally, with obesity prevalence almost tripling since 1975 (World Health Organization, 2017b). The World Health Organization (WHO) estimated that by 2016, over 2 billion adults worldwide were overweight or obese (World Health Organization, 2017b) and over 70% of overweight or obese adults reside in low- and middle- income countries (LMICs) (Shekar & Popkin, 2020). Many LMICs facing undernutrition now face the double burden of undernutrition and obesity (Popkin et al., 2020). In Africa (Shekar & Popkin, 2020) and South Africa (Institute for Health Metrics and Evaluation, 2017a, National Department of Health et al., 2007, Ng et al., 2014, Puoane et al., 2002), adult overweight and obesity prevalence has increased over time. The rising prevalence of overweight and obesity poses many challenges to countries, the effects of which are evident in maternal and neonatal health among others. Hence, it is worth understanding the evolution of overweight and obesity prevalence over time and their

associated determinants among women in a country like South Africa, where the burden remains high.

Women bear a disproportionately higher burden of obesity, which adversely affects their health. In 2016, about 15% of women compared to 11% of men were obese worldwide (World Health Organization, 2017b). In particular, women of childbearing age (i.e., 15 to 49 years old) (WCBA) tend to accumulate weight faster during this life stage (Adamson et al., 2007, Dutton et al., 2016, Gordon-Larsen et al., 2010, Norman et al., 2003). Obesity during a woman's childbearing years is associated with an increased risk of infertility, miscarriage, stillbirths and births with congenital disabilities, shoulder dystocia and other adverse obstetric outcomes (Chu et al., 2008, Cresswell et al., 2012, Leary et al., 2015, Lynch et al., 2008, Ojiegbe, 2016, Ramsay et al., 2006).

Considering the importance of the health status of WCBA, further examination of the change in prevalence and related determinants of overweight and obesity in this population over the last decades is warranted, including its socioeconomic correlates. In the United States (Vahratian, 2009), Morocco (Belahsen et al., 2004) and sub-Saharan Africa (Amugsi et al., 2017, National Department of Health et al., 2017), obesity prevalence among WCBA ranges between 10% and 39%, with rates over 30% in urban Egypt (Amugsi et al., 2017) and South Africa (National Department of Health et al., 2017). Recent studies have shown an increasing trend in overweight and obesity among WCBA in sub-Saharan Africa (Amugsi et al., 2017, Dake et al., 2011, Mukabutera et al., 2016, Mukora-Mutseyekwa et al., 2019, Tuoyire et al., 2016, Yaya & Ghose, 2019) and Bangladesh (Biswas et al., 2017). Research also shows that the prevalence varies by subgroups (age groups, educational attainment, socioeconomic status, parity and race/ethnicity) (Dake et al., 2011, He et al., 2016, Mukora-Mutseyekwa et al., 2019, Vahratian, 2009, Yaya & Ghose, 2019), although patterns might differ between high-income countries and LMICs. For example, in high-income countries, obesity prevalence is higher among women with low education and among the poor (Vahratian, 2009), while the reverse pattern is seen in LMICs (Bwalya et al., 2017, Dake et al., 2011, Mukora-Mutseyekwa et al., 2019, Yaya & Ghose, 2019). In sub-Saharan Africa and elsewhere, factors such as increased age (Mia et al., 2018, Vahratian, 2009), increased parity (Okoh, 2013), being rich (Bwalya et al., 2017, Mia et al., 2018, Mukabutera et al., 2016), higher education (Bwalya et

al., 2017, Mia et al., 2018, Okoh, 2013, Vahratian, 2009), urban residence (Mia et al., 2018), race/ethnic differences (Okoh, 2013, Vahratian, 2009) and increased television watching or a sedentary lifestyle (Chowdhury et al., 2018, Okoh, 2013) are associated with a higher probability of overweight and obesity in WCBA. In South Africa, apart from an earlier study (a report) showing the prevalence of overweight and obesity at one single point in time (National Department of Health et al., 2017), there is a dearth of studies looking at trend data on overweight and obesity prevalence among WCBA, including their socioeconomic correlates or determinants.

There are several reasons why understanding the evolution in prevalence and related determinants of overweight and obesity over the last decades in the South African setting is critical. South Africa faces a dual burden of overweight and obesity among adult women aged at least 15 years (National Department of Health et al., 2019a). The increased uptake of antiretroviral therapy (ART) has also led to ART-induced lipodystrophy in HIV-positive women (Goedecke et al., 2017, Goedecke et al., 2013). The country also faces a burgeoning threat of non-communicable diseases (Hamid et al., 2019, Nojilana et al., 2016). In addition, the country has poor maternal health outcomes, including a high maternal mortality ratio. There is a rising number of maternal deaths in South Africa due to bleeding associated with caesarean section and deaths due to medical and surgical complications (National Committee on the Confidential Enquiries into Maternal Deaths, 2015). Overweight and obesity were noted in 18% and 57% of mothers who died from pulmonary embolism deaths, respectively. Compared to morbidly obese women, super-obese women experience more pregnancy complications – hypertensive, pre-eclamptic and surgical complications – at Tygerberg Hospital in Cape Town (Nieuwoudt et al., 2014). Another study at Tygerberg Hospital found that super-obese women had lower quality of life scores in the physical function, public distress and work domains than their morbidly obese counterparts (Tisane et al., 2017). In South Africa, the maternal mortality ratio was estimated at 119 maternal deaths per 100,000 live births in 2017 (World Health Organization et al., 2019), which is far higher than the target set for the sustainable development goal (i.e., reducing maternal mortality ratio to fewer than 70 maternal death per 100,000 live births) (United Nations Department of Economic and Social Affairs, 2017). With these health challenges coexisting with obesity and already high obesity prevalence in women, South Africa faces the difficult challenge of not achieving

national targets and those outlined in the Sustainable Development Goals. The national targets include reducing the prevalence of overweight and obesity by 10% by 2020 from 1998 (Republic of South Africa, 2013a). The relevant Sustainable Development Goals are reducing premature deaths from NCDs by one-third by 2030, including through the prevention of obesity (Target 3.4); another is to end all forms of malnutrition by 2030, including overweight and obesity (Target 2.1) (United Nations Department of Economic and Social Affairs, 2017). Understanding the change in prevalence and factors associated with overweight and obesity among WCBA will help to improve their lives and contribute to informing policy interventions. This study, therefore, assesses, for the first time in South Africa, the change in the prevalence of overweight and obesity among non-pregnant WCBA between 1998 and 2017. It also identifies the determinants of overweight and obesity in this population.

3.3 Methods

3.3.1 Data sources

This paper was based on a secondary analysis of de-identified data from several national household surveys that received ethics approval. These anonymised datasets are publicly available and hosted on the DataFirst portal at the University of Cape Town (www.datafirst.uct.ac.za). The nationally representative datasets used in this paper, detailed below, include the 1998 and 2016 South Africa Demographic and Health Surveys (SADHS), and the 2008–2017 National Income Dynamics Study (NIDS). These data are comparable because they are nationally representative and used a similar sampling strategy.

South Africa Demographic and Health Surveys

The 1998 and 2016 SADHS are nationally representative cross-sectional surveys. The fieldwork for the 1998 SADHS was between January and September 1998, with a total sample size of 11,735 women (i.e., a 95% response rate among women) (National Department of Health & Macro International, 2002). The 2016 SADHS was undertaken between July and September 2016 yielding a total sample size of 8,514 women (i.e., an 86% response rate) (National Department of Health et al., 2019b). The sampling procedures for the SADHS are detailed elsewhere (National Department of Health & Macro International, 2002, National

Department of Health et al., 2019b). Briefly, the 1998 and the 2016 SADHS used a two-stage sampling strategy with the 1996 and 2011 Census Enumeration Areas (EAs) as sampling frames, respectively. The EAs were stratified into the nine provinces and by urban, farm and traditional areas. The first stage consisted of selecting EAs with probability proportional to the size. The second stage consisted of systematically sampling residential dwelling units. The SADHS collect information from a household questionnaire, biomarker questionnaire, woman's questionnaire and a man's questionnaire. The SADHS data are stored in several dataset files: household recode, individual recode, birth's recode, kid's recode, men's recode and couples' recode. This paper used data from the women and household files.

National Income Dynamics Study

The NIDS is a nationally representative longitudinal panel survey repeated every two years since 2008 by the Southern African Labour and Development Research Unit, funded by the South African Presidency. Fieldwork for the first NIDS wave (2008) was carried out between February and December 2008. The second wave (2010–2011) between May 2010 and September 2011. The third wave (2012) was between May and December 2012. The fourth wave (2014–2015) was between September 2014 and August 2015, and the latest wave (2017) was between February and December 2017 (Brophy et al., 2018). The overall survey response rates for the 2008, 2010–2011, 2012, 2014–2015 and 2017 waves were 51.2%, 45.3%, 49.9%, 53.9% and 53.3%, respectively. Details of the sampling procedure, including calculating the different sampling weights, are described elsewhere (Brophy et al., 2018, Leibbrandt & Woolard, 2016, Leibbrandt et al., 2009, Wittenberg, 2009). Briefly, the NIDS uses a stratified two-stage cluster sampling strategy to sample households at baseline. A total of 400 primary sampling units (PSUs) were selected in the first stage from Statistics South Africa's 3000 PSUs in the 2003 Master sample. In 2008, a total of 7,305 households were interviewed in the 400 PSUs. All household members became a Continuing Sample Member (CSM) to be interviewed every two years. Children born to CSM women after Wave 1 are 'born into' the sample. Everyone currently living with a CSM (i.e., individuals referred to as Temporary Sampling Members [TSMs]) are also interviewed. As CSMs move out and start their households, the number of interviewees also grows. Trained fieldworkers collected the data through standardised questionnaires across the waves; household questionnaire, adult

questionnaire for adults aged 15 years and older, proxy questionnaire for non-available adults, and child questionnaires for children aged between 0 and 14 years. This paper uses data from the 2008-2017 NIDS waves based on the adults (containing WCBA) and household questionnaires.

3.3.2 Participants

The analysis included adult non-pregnant women aged between 15 and 49 years (i.e., WCBA).

3.3.3 Definitions of key variables

Table 3-1 contains a description of the key variables used in this paper.

Table 3-1 A description of key variables used in the analysis

Variable	Definition
Overweight	A body mass index (BMI) ≥ 25 kg/m ² (World Health Organization, 2018b)
Obesity	A body mass index (BMI) ≥ 30 kg/m ² (World Health Organization, 2018b)
Age	Age category 1 (15-24 years) = 0 if a woman aged between 15 years and 24 years
	Age category 2 (25-34 years) = 1 if a woman aged between 25 years and 34 years
	Age category 3 (35-49 years) = 2 if a woman aged between 35 years and 49 years
Population group	Non-black African = 0 if woman self-identified as white, coloured and Asian race
	Black African ¹ = 1 if women self-identified as black African race
Education	No schooling/primary education ² = 0 for a woman with no education or only primary education
	Secondary education = 1 for a woman with secondary education
	Tertiary education ³ = 2 for a woman with tertiary education
Area of residence	Rural = 0 if a woman residing in a rural location

Variable	Definition
	Urban = 1 if a woman residing in an urban location
Quintiles of socioeconomic status (Quintiles 1-5) ⁴	Quintile 1 = 1 if a woman is in the poorest socioeconomic group; 0 otherwise
	Quintile 2 = 1 if a woman is in the second poorest socioeconomic group; 0 otherwise
	Quintile 3 = 1 if a woman is in the middle socioeconomic group; 0 otherwise Quintile 4 = 1 if a woman is in the second richest socioeconomic group; 0 otherwise
	Quintile 5 = 1 if a woman is in the richest socioeconomic group; 0 otherwise
Smoking status	No = 0 if a woman does not currently smoke tobacco, including cigarettes Yes = 1 if a woman currently smokes tobacco, including cigarettes

Notes: ¹The self-identified black race group dominates in South Africa with previous studies reporting the existence of racial disparities for obesity and overweight (Averett et al., 2014); ²No schooling and primary education are combined due to small numbers; ³ Tertiary education refers to education attained post-secondary school. This includes certificates, diplomas, bachelors, masters and doctoral degrees; ⁴Quintiles of socioeconomic status are based on household expenditure per capita for the NIDS datasets and household wealth index for the SADHS datasets.

3.3.4 Dependent variable

According to the WHO, and as used in the present study, overweight and obesity in adulthood are classified as a body mass index (BMI) of $\geq 25 \text{ kg/m}^2$ and $\geq 30 \text{ kg/m}^2$, respectively (**Table 3-1**).

3.3.5 Independent variables

Guided by the social determinants of the health concept (Dahlgren & Whitehead, 1991), several predictors of overweight and obesity were selected. Previous literature, the availability of the variables in the datasets, and comparability of variables across datasets also guided the selection of predictors. Independent variables include age group (15 – 24 years, 25-34 years and 35-49 years), population group (Black African or non-Black African),

education (no schooling/primary, secondary or tertiary), area of residence (rural or urban), smoking status (yes or no) and socioeconomic quintile (poorest, second poorest, middle, second richest or richest).

3.3.6 Statistical analysis

There was a nationally representative sample of 5,403 WCBA in the 1998 SADHS, 7,298 women in the 2008 NIDS, 7,713 women in the 2010–2011 NIDS, 8,683 in the 2012 NIDS, 9,703 in the 2014–2015 NIDS and 8,210 in the 2016 SADHS and 10,267 in the 2017 NIDS. The prevalence of overweight and obesity for WCBA across the key variables in **Table 3-1** (except for smoking status) and the corresponding 95% confidence intervals were estimated in each survey year. The patterns of the prevalence of overweight and obesity were assessed between periods. Also, inferential interpretation of overlaps in the confidence intervals was used to assess if the prevalence of overweight or obesity across the key variables (except for smoking status) was statistically different between periods (Cumming & Finch, 2005).

The effect of each independent variable on BMI status was examined using logistic regression models. The significance of each independent variable in predicting overweight or obesity was determined using the likelihood ratio test, which gives p-values for each predictor in the model. The outputs of the models were presented using adjusted odds ratios (AOR) and 95% confidence intervals. The level of significance was set at $p < 0.05$.

All analyses were adjusted for the sample design (cluster and sample weight) and performed in Stata version 15 (StataCorp, 2017).

3.4 Results

3.4.1 Descriptive summary

The average age of women was approximately 30 years between 1998 and 2017, with Black Africans forming the predominant population group (**Table 3-1**). Over half of the women had attained secondary education, and most women resided in urban areas.

Table 3-2 Descriptive statistics of the sample of women of childbearing age between 15 and 49 years by time period, South Africa

Variables	Survey year						
	1998	2008	2010/2011	2012	2014/2015	2016	2017
Sample	5403	7298	7713	8683	9703	8210	10267
Age, mean (SD)	29.8 (9.71)	29.7 (9.87)	29.6 (9.88)	29.8 (9.75)	30.0 (9.79)	30.4 (9.80)	30.3 (9.48)
Population group							
Black African	78.4	79.5	80.1	80.9	81.7	86.7	82.1
	75.9 – 80.7	74.3 – 83.8	74.8 – 84.6	75.5 – 85.4	76.9 – 85.6	84.4 – 88.7	77.8 – 85.7
non-Black African	21.6	20.5	19.9	19.1	18.3	13.3	17.9
	19.3 – 24.1	16.2 – 25.7	15.4 – 25.2	14.6 – 24.5	14.4 – 23.1	11.3 – 15.4	14.3 – 22.2
Education							
No school/primary	41.9	18.7	15.6	13.6	10.7	11.0	7.8
	39.9 – 43.9	16.9 – 20.7	14.0 – 17.4	12.0 – 15.3	9.6 – 12.0	9.9 – 12.2	6.9 – 8.8
Secondary	51.1	67.9	69.9	69.9	71.6	77.2	71.4
	49.2 – 53.0	65.9 – 69.8	67.9 – 71.8	67.9 – 71.9	7.0 – 73.4	7.6 – 7.9	6.9 – 73.3
Tertiary	7.0	13.4	14.5	16.5	17.6	11.8	20.8
	6.1 – 8.1	11.4 – 15.7	12.7 – 16.5	14.5 – 18.6	15.9 – 19.6	10.4 – 13.4	18.8 – 22.9
Area of residence							
Rural	36.4	37.2	39.8	39.9	39.0	32.8	34.8
	34.9 – 38.1	32.4 – 42.3	34.3 – 45.6	34.6 – 45.4	34.1 – 44.1	30.6 – 35.2	30.4 – 39.5
Urban	63.6	62.8	60.2	60.1	61.0	67.2	65.2
	61.9 – 65.1	57.7 – 67.6	54.4 – 65.7	54.6 – 65.4	55.9 – 65.9	64.8 – 69.4	60.5 – 69.6
Socioeconomic status quintile							
1 (poorest)	14.9	20.1	20.0	19.9	20.0	19.3	20.1
	13.1 – 16.8	17.7 – 22.7	17.6 – 22.7	17.4 – 22.8	17.6 – 22.7	16.7 – 22.2	17.7 – 22.8
2 (poor)	18.4	19.9	20.0	20.0	19.9	19.9	20.0
	16.6 – 20.5	17.9 – 22.1	17.9 – 22.2	18.0 – 22.1	18.0 – 22.0	18.0 – 21.9	18.1 – 22.0
3 (middle)	20.5	20.0	20.1	20.0	20.1	21.1	20.0
	18.6 – 22.6	17.8 – 22.4	18.2 – 22.1	17.9 – 22.3	18.3 – 22.0	19.2 – 23.2	18.3 – 21.9
4 (rich)	23.7	20.0	20.0	20.0	19.9	20.8	20.2
	21.4 – 26.1	17.8 – 22.4	17.7 – 22.4	18.0 – 22.2	18.0 – 22.0	18.7 – 23.2	18.4 – 22.1
5 (richest)	22.5	20.0	20.0	20.0	20.0	18.8	19.7
	20.3 – 24.9	16.3 – 24.2	16.4 – 24.2	16.5 – 24.1	17.3 – 23.1	16.2 – 21.8	16.9 – 22.7

SD, standard deviation; %, percent; 95% CI, 95% confidence interval

3.4.2 Changes in prevalence of overweight and obesity over time

The overweight prevalence for WCBA increased from 51.3% (95% confidence interval 49.6 - 53.0) in 1998 to 62.3% (95% confidence interval 60.0 – 64.6) in 2016, but fell to 60.0% (95% confidence interval 58.1 - 61.9) in 2017. However, the confidence intervals were non-overlapping between 1998 and 2017 (**Figure 3-1**). Similarly, obesity prevalence increased from 24.7% (95% confidence interval 23.3% - 26.2%) in 1998 to 35.7% (95% confidence interval 33.4% - 38.0%) in 2016, but fell slightly to 35.2% (95% confidence interval 33.3% - 37.1%) in 2017. Here also, the confidence intervals indicated statistical significance as they were non-overlapping between 1998 and 2017.

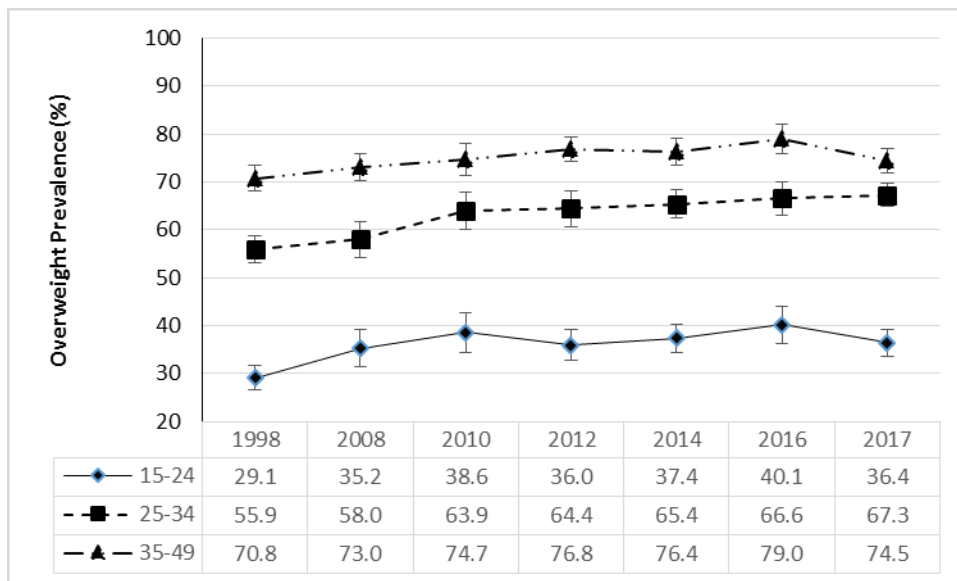
Figure 3-1 Overweight and obesity prevalence for women aged 15 – 49 years from 1998 to 2017, South Africa. Error bars represent 95% confidence intervals



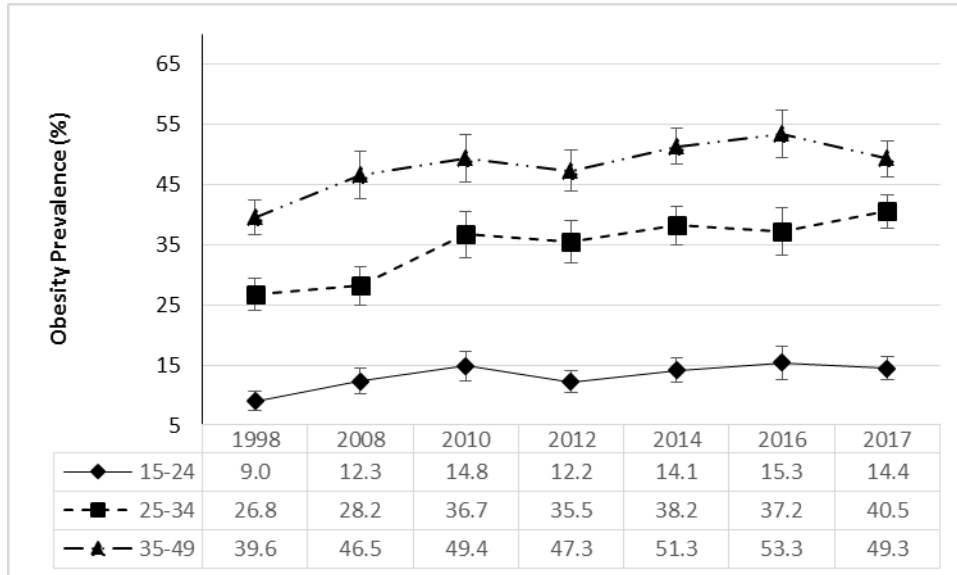
After stratifying by age group, the overweight prevalence remained higher among older than younger women between 1998 and 2017 (**Figure 3-2**). In 1998, the overweight prevalence was higher among women aged 35–49 years (70.8%) compared to those aged 25–34 years (55.9%) or those aged 15–24 years (29.1%). In 2017, the pattern remained similar with the estimate higher among women aged 35–49 years (74.5%) compared to those aged 25–34 years (67.3%) or aged 15–24 years (36.4%). An increasing prevalence of overweight was seen in women aged 15–24 years (29.1% in 1998 to 36.4% in 2017), 25–34 years (55.9% in 1998 to 67.3% in 2017) and 35–49 years (70.8% in 1998 to 74.5% in 2017), although the confidence intervals were overlapping for some of the periods. Similarly, obesity prevalence remained higher among older than younger women between 1998 and 2017 (**Figure 3-2**). In 1998, the obesity prevalence was higher among women aged 35–49 years (39.6%) compared to those aged 25–34 years (26.8%) or 15–24 years (9.0%). In 2017, the estimate was also higher among women aged 35–49 years (49.3%) compared to those aged 25–34 years (40.5%) or 15–24 years (14.4%). Obesity prevalence also increased for women aged 15–24 years (9.0% in 1998 to 14.4% in 2017), 25–34 years (26.8% in 1998 to 40.5% in 2017) and 35–49 years (39.6% in 1998 to 49.3% in 2017). However, the confidence intervals were overlapping for some periods.

Figure 3-2 Overweight and obesity prevalence according to age group for women aged 15 – 49 years from 1998 to 2017. Error bars represent 95% confidence intervals

A

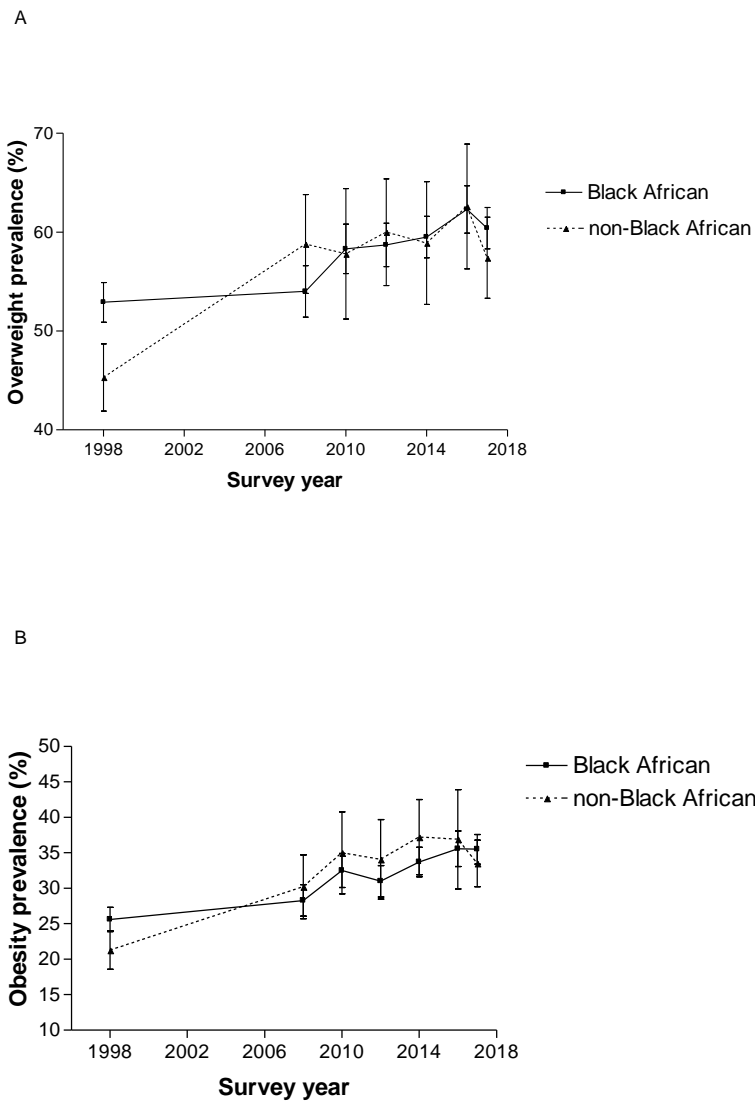


B



The results, after stratifying overweight and obesity prevalence by population group, were different in pattern. In 1998, overweight and obesity occurred more in the self-identified Black African population group than the self-identified non-Black African population group. The gap in overweight and obesity prevalence between the self-identified Black African population and the non-Black African population reduced significantly since 2008 (**Figure 3-3**). In some cases, overweight and obesity prevalence was higher among the non-Black African than Black African population groups. Generally, except for a few years, the overweight and obesity prevalence among the self-identified Black African and the non-Black African population groups increased between 1998 and 2017, though with overlapping confidence intervals for adjacent periods. For example, between 1998 and 2017, the obesity prevalence among the self-identified non-Black African population rose from 21.3% to 33.5% and from 25.6% to 35.5% among the self-identified Black African population group. Even though the confidence intervals for the prevalence of obesity and overweight among the self-identified Black African and the non-Black African population groups overlapped for the adjacent years, they did not overlap when the prevalence in 2008 was compared to that in 2017 (**Figure 3-3**).

Figure 3-3 Overweight and obesity prevalence according to population group for women aged 15 – 49 years from 1998 to 2017. Error bars represent 95% confidence intervals

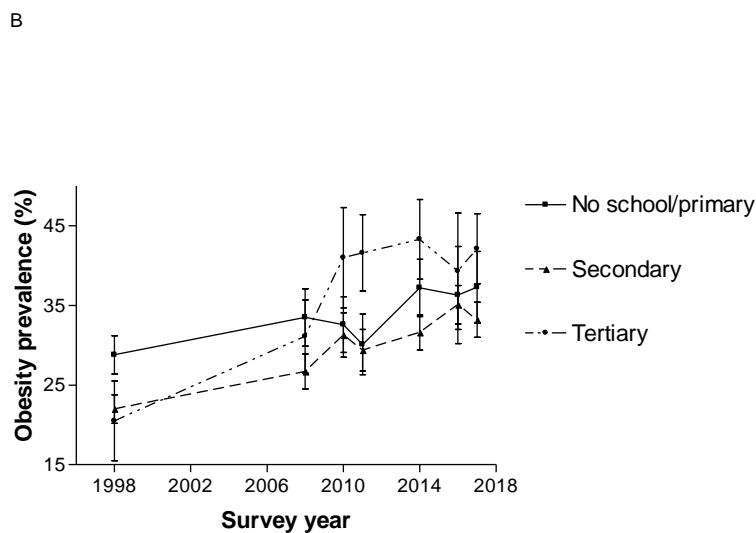
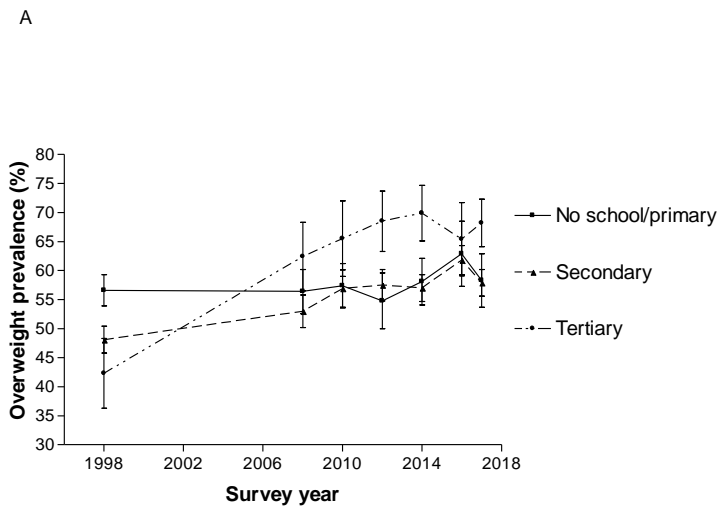


In 1998, women who had no schooling/primary education and those with secondary education had a higher overweight prevalence than those with tertiary education (**Figure 3-4**). By contrast, since 2008, women with tertiary education had a higher overweight prevalence than those with no schooling/primary/secondary education. The overweight prevalence among those with no schooling/primary education has not changed between 1998 and 2017 (**Figure 3-4**). In 1998, the overweight prevalence among those with no schooling/ primary education was 56.6% (95% confidence interval of 53.9% to 59.3%). In 2017, the prevalence

has increased to 58.3% (95% confidence interval of 53.7% to 62.8%). Similarly, the overweight prevalence among women who had a secondary education rose from 48.1% to 57.9%, between 1998 and 2017, with the 95% confidence interval in 1998 not overlapping with that in 2017. Also, overweight prevalence among women who had tertiary education has increased from 42.3% in 1998 to 68.2% in 2017. Again, the 1998 and 2017 confidence intervals were non-overlapping.

Like the overweight results, women who had no schooling/primary education and those with secondary education had a higher obesity prevalence than those with tertiary education in 1998 (**Figure 3-4**). However, the pattern changed since 2010 as women with tertiary education had a higher obesity prevalence than those with secondary, primary or no formal education. The trend for obesity was marginally different from that of overweight, where prevalence estimates among women with no schooling/ primary education appeared to have risen between 1998 (28.8%) and 2017 (37.3%). **Figure 3-4** showed that the 95% confidence intervals for the two extreme years (i.e., 1998 (26.4 – 31.3) and 2017 (32.8 – 41.9)) were non-overlapping even though there were overlapping confidence intervals for adjacent years.

Figure 3-4 Overweight and obesity prevalence according to education level for women aged 15 – 49 years from 1998 to 2017. Error bars represent 95% confidence intervals



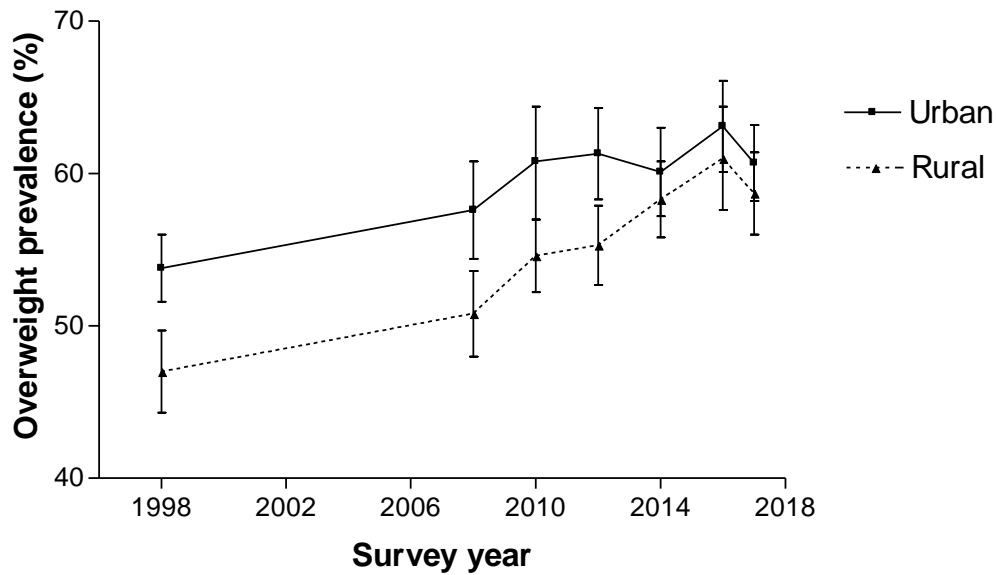
The urban-rural disparity in overweight and obesity prevalence decreased steadily between 1998 and 2017. As shown in **Figure 3-5**, the overweight prevalence among urban residents steadily increased between 1998 and 2016 (from 53.8% to 63.1%) but fell slightly to 60.7% in 2017. However, the 1998 and 2017 confidence intervals were non-overlapping. While overweight prevalence among rural residents also steadily increased between 1998 and 2016 (from 47.0% to 61.0%), it had fallen to 58.7% in 2017, with non-overlapping confidence intervals between 1998 and 2017. The obesity prevalence among urban residents steadily increased between 1998 and 2016 (from 27.4% to 36.7%), but dropped to 37.3% in 2017,

again with non-overlapping confidence intervals between 1998 and 2017 (**Figure 3-5**). The obesity prevalence among rural residents also steadily increased between 1998 and 2016 (from 20.0% to 34.0%) but fell to 31.7% in 2017. Again, the confidence intervals between 1998 and 2017 were non-overlapping.

The difference in the prevalence of overweight and obesity was more pronounced between the lowest and highest socioeconomic quintiles than between the middle and highest socioeconomic quintiles. As shown in **Figure 3-6**, the overweight prevalence among women in the lowest socioeconomic quintile increased from 46.6% in 1998 to 54.5% in 2016. The prevalence dropped in 2017 to a level lower than it was in 2016, although with overlapping confidence intervals over the entire period. Also, overweight prevalence among women in the highest socioeconomic quintile increased from 50.8% in 1998 to 65.9% in 2016 but decreased in 2017 to a level lower than it was in 2016. A similar pattern existed for obesity prevalence across the socioeconomic quintiles. For example, among women in the lowest socioeconomic quintile, obesity prevalence appeared to be on an upward trend between 1998 and 2016 (18.6% in 1998 to 26.9% in 2016). The obesity prevalence had since decreased to a level lower than it was in 2016. Across all the socioeconomic quintiles, the obesity prevalence in 2017 was significantly higher than the estimates in 1998 as the 95% confidence intervals in 1998 do not overlap with those in 2017, for each quintile.

Figure 3-5 Overweight and obesity prevalence according to urban and rural residence for women aged 15 – 49 years from 1998 to 2017, South Africa. Error bars represent 95% confidence intervals

A



B

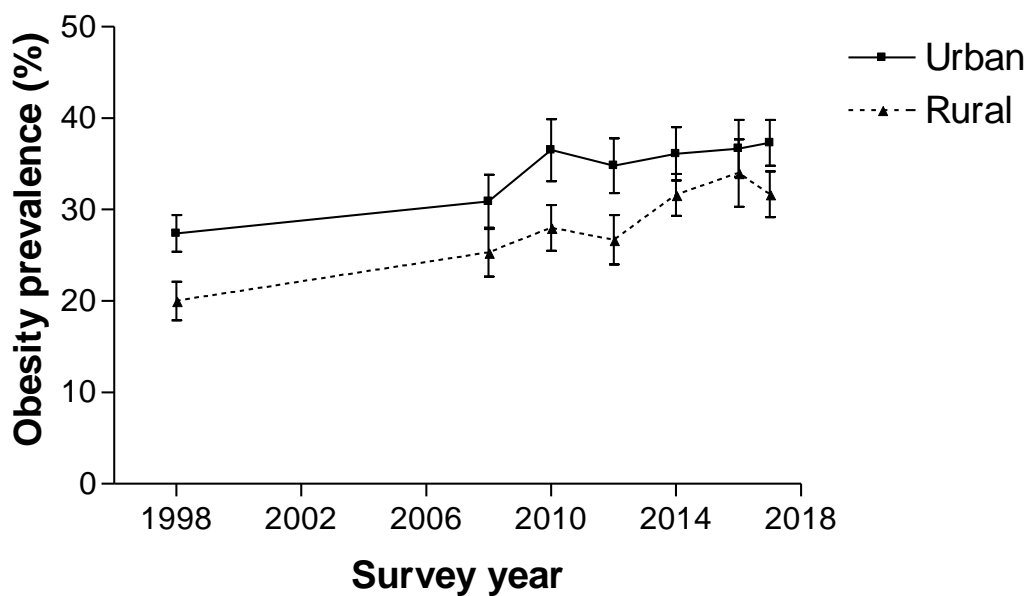
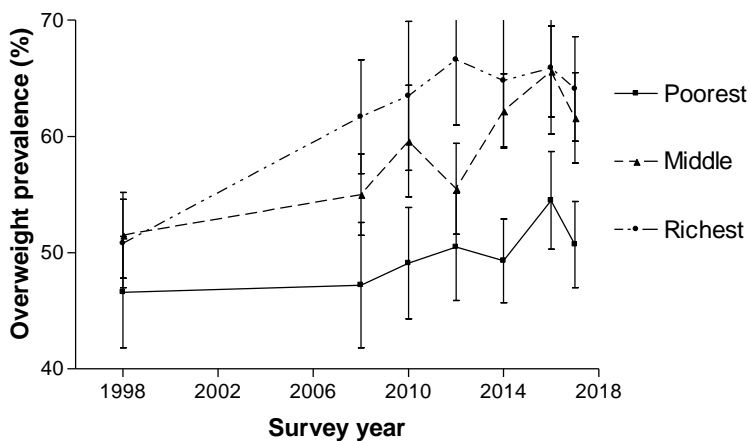
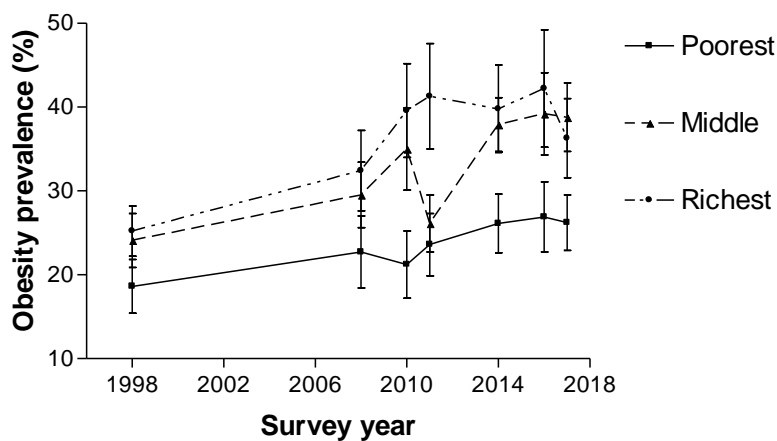


Figure 3-6 Overweight and obesity prevalence according to socioeconomic status quintile for women aged 15 – 49 years from 1998 to 2017, South Africa. Error bars represent 95% confidence intervals

A



B



3.4.3 Determinants of overweight and obesity

The odds of being overweight and obese were significantly higher with increasing age (Tables 3-3 and 3-4). For example, in 1998, women in all the older age groups (25-34 years and 35-49 years age groups), compared to those in the 15-24 years age group, had higher odds of being overweight (25-34 years versus 15-24 years, AOR 3.11, 95% CI 2.60 - 3.72; 35-49 years versus 15-24 years, AOR 6.60, 95% CI 5.39 - 8.09) (Table 3-3). Similarly, the odds of being obese are higher in all the older age groups compared to the 15-24 years age group (25-34 years versus 15-24 years, AOR .71, 95% CI 2.91 - 4.71; 35-49 years versus 15-24 years, AOR 6.87, 95% CI 5.40 - 8.73) (Table 3-4). In 1998 and 2016, women who self-identified as Black African had higher odds of being overweight and obese than those who self-identified as non-Black African (Tables 3-3 and 3-4).

In most years (except for 1998 and 2016), the odds of being overweight and/or obese were higher in women having a secondary education than the reference category (no schooling/primary school education) (Tables 3-3 and 3-4). In 1998, the odds of being overweight and obese were lower in women having a tertiary education compared to those having no schooling/primary school education. Whereas, in 2012 and 2014/2015, women having tertiary education, compared to no schooling/primary school education, had higher odds of being overweight and/or obese. The odds of being overweight and obese increased with wealth as women living in wealthier households had greater odds of being overweight or obese than those living in poorer households (Tables 3-3 and 3-4).

In general, smoking had a protective effect on overweight and obesity. Smoking reduced the odds of being overweight and/or obese (Tables 3-3 and 3-4). Compared to women residing in rural areas, those residing in urban areas had significantly greater odds of being overweight (AOR 1.25, 95% CI 1.02 - 1.53) and obese (AOR 1.32, 95% CI 1.03 - 1.70) in 1998. In 2017, women residing in rural areas compared with those residing in urban areas had significantly greater odds of being obese (AOR 1.23, 95% CI 1.00 - 1.52). The effect of urbanicity on overweight and obesity was not statistically significant for the other years.

Table 3-3 Determinants of overweight among women of childbearing age in South Africa

Determinants	Survey year AOR (95% CI)						
	1998	2008	2010/2011	2012	2014/2015	2016	2017
Age							
15-24	1	1	1	1	1	1	1
25-34	3.11*** (2.60 - 3.72)	2.54*** (2.02 - 3.18)	2.83*** (2.27 - 3.54)	3.19*** (2.67 - 3.82)	3.08*** (2.59 - 3.65)	2.99*** (2.39 - 3.73)	3.51*** (3.00 - 4.11)
35-49	6.60*** (5.39 - 8.09)	5.35*** (4.32 - 6.63)	5.24*** (4.14 - 6.63)	6.64*** (5.44 - 8.11)	5.65*** (4.72 - 6.75)	5.98*** (4.54 - 7.87)	5.28*** (4.52 - 6.17)
Population group							
Non-Black African	1	1	1	1	1	1	1
Black African	1.69*** (1.35 - 2.11)	1.04 (0.73 - 1.48)	1.39 (0.95 - 2.04)	1.34 (0.98 - 1.83)	1.25 (0.94 - 1.67)	1.42* (1.01 - 2.00)	1.12 (0.89 - 1.41)
Education							
No schooling/Primary	1	1	1	1	1	1	1
Secondary	0.97 (0.82 - 1.15)	1.30* (1.05 - 1.62)	1.43** (1.14 - 1.79)	1.78*** (1.36 - 2.32)	1.36** (1.11 - 1.66)	1.25 (0.91 - 1.72)	1.30* (1.03 - 1.64)
Tertiary	0.56*** (0.41 - 0.76)	1.33 (0.93 - 1.88)	1.39 (0.99 - 1.96)	1.71** (1.21 - 2.42)	1.70*** (1.24 - 2.33)	1.10 (0.70 - 1.73)	1.28 (0.95 - 1.73)
Place of residence							
Rural	1	1	1	1	1	1	1
urban	1.25* (1.02 - 1.53)	1.15 (0.90 - 1.45)	1.16 (0.92 - 1.47)	1.10 (0.91 - 1.34)	0.92 (0.76 - 1.11)	0.92 (0.73 - 1.16)	0.98 (0.81 - 1.19)
Smoking	0.61*** (0.48 - 0.79)	0.63** (0.45 - 0.88)	0.81 (0.48 - 1.39)	0.86 (0.49 - 1.52)	0.73 (0.50 - 1.07)	0.92 (0.60 - 1.42)	0.62** (0.47 - 0.84)
Socioeconomic quintiles							
1 (poorest)	1	1	1	1	1	1	1
2 (poor)	1.12 (0.84 - 1.49)	1.07 (0.82 - 1.39)	1.47** (1.13 - 1.91)	1.24 (0.99 - 1.55)	1.16 (0.93 - 1.44)	1.32 (0.99 - 1.77)	1.19 (0.98 - 1.43)
3 (middle)	1.15 (0.87 - 1.53)	1.16 (0.87 - 1.54)	1.35 (0.99 - 1.83)	0.96 (0.74 - 1.24)	1.54*** (1.24 - 1.91)	1.59** (1.18 - 2.13)	1.30* (1.03 - 1.63)
4 (rich)	1.27 (0.92 - 1.75)	1.36 (0.99 - 1.87)	1.26 (0.91 - 1.75)	1.32 (0.99 - 1.76)	1.65*** (1.26 - 2.18)	1.56* (1.09 - 2.22)	1.66*** (1.30 - 2.12)
5 (richest)	1.35 (0.95 - 1.94)	1.24 (0.79 - 1.96)	1.38 (0.92 - 2.07)	1.40 (0.98 - 2.02)	1.39* (1.00 - 1.92)	1.62* (1.06 - 2.46)	1.39* (1.04 - 1.87)
Constant	0.21*** (0.15 - 0.30)	0.35*** (0.22 - 0.54)	0.25*** (0.15 - 0.41)	0.21*** (0.14 - 0.33)	0.29*** (0.20 - 0.43)	0.30*** (0.19 - 0.50)	0.34*** (0.24 - 0.48)
Observations	4,993	5,785	6,286	7,594	9,034	3,262	9,342

AOR, Adjusted odds ratio; 95% CI, 95% confidence intervals in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Table 3-4 Determinants of obesity among women of childbearing age in South Africa

Determinants	Survey year AOR (95% CI)						
	1998	2008	2010/2011	2012	2014/2015	2016	2017
Age							
15-24	1	1	1	1	1	1	1
25-34	3.71*** (2.91 - 4.71)	2.79*** (2.17 - 3.59)	3.24*** (2.55 - 4.12)	3.74*** (3.01 - 4.65)	3.65*** (3.01 - 4.42)	3.24*** (2.42 - 4.33)	3.95*** (3.28 - 4.75)
35-49	6.87*** (5.40 - 8.73)	6.46*** (5.05 - 8.28)	5.88*** (4.70 - 7.37)	6.53*** (5.28 - 8.06)	6.34*** (5.17 - 7.77)	6.61*** (5.10 - 8.57)	5.86*** (4.89 - 7.02)
Population group							
Non-Black African	1	1	1	1	1	1	1
Black African	1.71*** (1.33 - 2.19)	1.21 (0.86 - 1.70)	1.31 (0.91 - 1.91)	1.46* (1.01 - 2.11)	0.98 (0.73 - 1.31)	1.52* (1.01 - 2.29)	1.03 (0.82 - 1.30)
Education							
No schooling/Primary	1	1	1	1	1	1	1
Secondary	0.90 (0.73 - 1.10)	1.11 (0.91 - 1.35)	1.29* (1.04 - 1.60)	1.34* (1.07 - 1.67)	1.06 (0.86 - 1.30)	1.19 (0.87 - 1.63)	1.03 (0.82 - 1.30)
Tertiary	0.59** (0.40 - 0.85)	0.93 (0.67 - 1.27)	1.29 (0.94 - 1.78)	1.38* (1.01 - 1.88)	1.24 (0.92 - 1.66)	1.00 (0.65 - 1.55)	1.07 (0.80 - 1.41)
Place of residence							
Rural	1	1	1	1	1	1	1
urban	1.32* (1.03 - 1.70)	1.23 (0.95 - 1.59)	1.29* (1.03 - 1.63)	1.24 (0.99 - 1.54)	1.09 (0.88 - 1.35)	0.88 (0.69 - 1.13)	1.23* (1.00 - 1.52)
Smoking	0.68* (0.50 - 0.93)	0.73 (0.50 - 1.07)	0.87 (0.51 - 1.50)	1.21 (0.74 - 1.97)	0.65* (0.44 - 0.96)	1.12 (0.70 - 1.78)	0.57*** (0.43 - 0.74)
Socioeconomic quintiles							
1 (poorest)	1	1	1	1	1	1	1
2 (poor)	1.24 (0.89 - 1.72)	1.13 (0.82 - 1.56)	1.85*** (1.36 - 2.52)	1.23 (0.96 - 1.56)	1.09 (0.86 - 1.38)	1.40 (1.00 - 1.96)	1.28* (1.03 - 1.58)
3 (middle)	1.47* (1.04 - 2.07)	1.23 (0.90 - 1.68)	1.77** (1.26 - 2.48)	0.89 (0.67 - 1.18)	1.49** (1.16 - 1.93)	1.84*** (1.29 - 2.63)	1.45** (1.10 - 1.91)
4 (rich)	1.76** (1.22 - 2.53)	1.37 (0.94 - 1.99)	1.70** (1.16 - 2.50)	1.47* (1.07 - 2.01)	1.34 (0.96 - 1.87)	1.79** (1.22 - 2.61)	1.60*** (1.24 - 2.06)
5 (richest)	1.74** (1.18 - 2.56)	1.27 (0.80 - 2.04)	1.78** (1.17 - 2.70)	1.63* (1.09 - 2.45)	1.26 (0.87 - 1.82)	2.19** (1.33 - 3.59)	1.15 (0.84 - 1.57)
Constant	0.042*** (0.027 - 0.063)	0.085*** (0.053 - 0.14)	0.060*** (0.037 - 0.097)	0.057*** (0.036 - 0.089)	0.12*** (0.084 - 0.19)	0.073*** (0.041 - 0.13)	0.11*** (0.076 - 0.16)
Observations	4,993	5,785	6,286	7,594	9,034	3,262	9,342

AOR, Adjusted odds ratio; 95% CI, 95% confidence intervals in parentheses

*** p<0.001, ** p<0.01, * p<0.05

3.5 Discussion

This study assessed the changes in the prevalence of overweight and obesity from 1998 to 2017 for non-pregnant women aged 15 to 49 years in South Africa. It also examined the determinants of overweight and obesity in these women. The paper found that overweight prevalence increased from 51.3% to 60.0% and obesity from 24.7% to 35.2% over the period. Overweight and obesity prevalence remained higher for older than younger women. In 1998, women who had no schooling/primary education and those with secondary education had a higher overweight and obesity prevalence than those with tertiary education. This pattern was reversed in 2017. Also, the prevalence of overweight and obesity has tended to be higher among the rich than the poor. For most women, the prevalence of overweight and/or obesity in 2017 was significantly higher than the estimate in 1998. Significant predictors of overweight and obesity included increased age, self-identifying with the Black African population group, higher educational attainment, residing in an urban area, and wealth. Smoking had a protective effect on being overweight and obese, which may explain its ability to increase energy expenditure and suppress appetite (Chiolero et al., 2008, Peer et al., 2014).

The finding that overweight and obesity increased over time was consistent with previous studies (Amugsi et al., 2017, Biswas et al., 2017, Dake et al., 2011, Mukora-Mutseyekwa et al., 2019, Yaya & Ghose, 2019) citing the nutrition transition to be responsible for the pattern and trend. Many factors could account for this rise in prevalence over time in South Africa, including rapid economic development since the new democracy in 1994, urbanisation and increased female labour force participation (i.e., working outside the home) (World Bank, 2020). The Growth, Employment and Redistribution (GEAR) Policy in 1996 liberalised the South African economy, leading to the rapidly changing food environment. This significantly increased the number of large transnational food and beverage industries, supermarket and fast-food chains in the country (Igumbor et al., 2012, Puoane et al., 2012, Weatherspoon & Reardon, 2003). These contributed to the widespread availability and acceptability of cheap processed foods; people changed diets from traditional to Western lifestyle diets with more processed high energy-dense foods of poor quality and low nutritional value coupled with increased sedentary lifestyles (Popkin, 2002a, Popkin, 2002b).

Consistent with previous studies, overweight and obesity prevalence varies by age groups, educational attainment, urban/rural residence, socioeconomic status, race/ethnicity (Dake et al., 2011, Mukora-Mutseyekwa et al., 2019, Yaya & Ghose, 2019). In keeping with other studies (National Department of Health et al., 2017, Vahratian, 2009), this paper found that the odds of being overweight and obese were significantly higher with increasing age. This relationship was consistent over time and could be due, in part, to the increased physical inactivity as women get older and increased weight gain during this life stage (Bwalya et al., 2017, Little et al., 2016, Sidik & Rampal, 2009). Also, increased consumption of unhealthy and convenient foods (i.e., food prepared outside the home, takeaways, and readymade meals) as discussed above may increase overweight and obesity in women in South Africa during this life stage (Ronquest-Ross et al., 2015, 2014). Moreover, the finding that the odds of overweight and obesity were higher among older women compared to young women, supports the argument of “accumulation of risk” that health risks (adverse or protective) accumulate gradually over an individual’s life-course (Ben-Shlomo & Kuh, 2002).

This study finds that in 1998 and 2016, the odds of being overweight and obese were greater among women self-identified as the Black African population group than the non-Black African population group. This observed relationship may be partly due to not only nutrition transition (Popkin, 2002a, Popkin, 2002b) but to other factors including changes in the food environment (Hunter-Adams et al., 2019) for the different population groups, residing in neighbourhoods perceived to be unsafe (which limits the ability and willingness to engage in physical activities), culture, socioeconomic status and the built environment (which constitute obstacles to physical activity) (Micklesfield et al., 2013).

This study finds that, in 2012 and 2014/2015, women having tertiary education, compared to no schooling/primary school education, had higher odds of being overweight and/or obese. In addition, in most years (except for 1998 and 2016), the odds of being overweight and/or obese were higher in women having secondary education compared to those with no schooling/primary school education. This corroborates other studies from sub-Saharan Africa (Abrha et al., 2016, Adeboye et al., 2012, Dalal et al., 2011, Letamo, 2011, Mfenyana et al., 2006). Those with higher education tend to have less energy-demanding jobs, are more

physically inactive and have sedentary lifestyles (National Department of Health et al., 2007). By contrast, this study finds that in 1998, the odds of being overweight and obese were lower in women having a tertiary education compared to those having no schooling/primary school education. This is consistent with the findings of Puoane *et al.* (2002) that women with tertiary education had a lower BMI than those with some schooling, maybe because they are more aware of the health benefits of physical activity. Micklesfield *et al.* (2013) suggested that this finding may be due to the wide distributions of education and socioeconomic status among the South African population just after the country became a democracy in 1994.

In keeping with previous studies (Mukora-Mutseyekwa et al., 2019, Yaya & Ghose, 2019), this paper finds that in 1998 and 2017, women residing in urban areas had higher odds of being overweight or obese than those who resided in rural areas. The finding of higher odds of overweight and obesity in urban areas is due to the westernised diets, processed food consumption and lifestyles, including increased physical inactivity and sedentary behaviour characteristic of the urban populations (Pisa & Pisa, 2017). Consistent with studies from South Africa (Alaba & Chola, 2014, Cois & Day, 2015, Sartorius et al., 2015) and other sub-Saharan African countries (Abrha et al., 2016, Bwalya et al., 2017, Dake et al., 2011, Letamo, 2011, Mukora-Mutseyekwa et al., 2019, Olatunbosun et al., 2011, Steyn et al., 2011b, Yaya & Ghose, 2019), women living in wealthier households had higher odds of being overweight and obese compared to those in poorer socioeconomic groups. The relationship between socioeconomic status and overweight or obesity was consistent over time, suggesting an inverse socioeconomic gradient in overweight and obesity occurring in the context of the nutrition transition (Popkin, 2002a, Popkin, 2002b).

This study has some policy implications. The current tax on sugar-sweetened beverages (Republic of South Africa, 2016) highlights an example of the government's commitment to fighting non-communicable diseases, including obesity and overweight in South Africa. However, the high prevalence and pattern of overweight and obesity among WCBA reported in this paper means the government needs to complement the sugar-sweetened beverage tax with other policies to address overweight and obesity. Although many essential food items, including "healthy" food items, are exempted from value-added tax in South Africa (Roos et al., 2020), they could be subsidised further to increase accessibility and availability

(Shekar & Popkin, 2020). There is also a need for awareness-raising campaigns promoting healthy eating and lifestyles among WCBA (Ojiegbe, 2016). Regular anthropometric measurement is crucial for confirming overweight or obesity status and for timely interventions (Hambidge et al., 2018). Based on the study findings, we advocate for routine monitoring of weight in WCBA. These women should regularly check their weight at home or during health visits (Ojiegbe, 2016). Self-weight checking and planned clinic visits to check weight were not common practices, especially among those who self-identify as Black African (Okop et al., 2016). In addition, moderate to vigorous physical exercise is recommended for at least 150 minutes a week to maintain good health (Ojiegbe, 2016). However, having a safe physical environment for exercise is an issue in South Africa (Kolbe-Alexander et al., 2015). In addition to advocating for increased physical activities among WCBA, the government should secure the physical environment to enhance physical exercise, given the relatively high burden of overweight and obesity reported in this paper. There is also a need for action on the broader social determinants of health reported in this paper to reduce the burden of obesity and overweight among WCBA in South Africa.

This study has some strengths and limitations. The use of comparable nationally representative secondary data, covering two decades, allowed for applying sampling weights and generalising the results. Also, an objective measure of BMI was used to categorise women as overweight and obese. This study uses only non-pregnant women because BMI measures can be conflated by pregnancy. Research is, also, needed to assess changes over time in socioeconomic inequality in overweight and obesity among WCBA and to decompose this inequality into determinants to identify their contribution to inequality. Furthermore, research is needed to investigate whether changes in the processed food consumption pattern, a likely determinant of overweight and obesity, occurred in households and explore how that affects socioeconomic inequality in overweight and obesity.

3.6 Conclusion

In South Africa, overweight and obesity prevalence is increasing among non-pregnant WCBA. The pattern and trend vary by different stratifiers. The increasing overweight and obesity

prevalence requires urgent action and attention to improve the health of WCBA. There is an urgent need for the government to increase public awareness on obesity and its health consequences, especially among WCBA. The government has National Nutrition and Obesity Weeks awareness campaigns (South African Government, 2021b). However, the government needs to scale up this intervention. Specifically, the government needs to communicate with and educate communities to reduce consumption of cheap ultra-processed foods, and increase the consumption of healthy foods such as fruit and vegetables, whole grains, nuts and seeds, unsaturated fats and fibre rich foods. In addition, policymakers should use a population-wide approach as opposed to an approach targeting specific groups of women. Given the fact that women's experience of the determinants is dynamic, efforts should address both management and prevention of overweight and obesity concurrently. This is important for South Africa to meet the national targets and those set in the sustainable development goals.

CHAPTER FOUR: FIGHTING OVERWEIGHT AND OBESITY IN SOUTH AFRICA: EXPLAINING SOCIOECONOMIC INEQUALITY IN FOOD CONSUMPTION IN HOUSEHOLDS WITH WOMEN OF CHILDBEARING AGE BETWEEN 2005 AND 2011

Role of the candidate

The candidate contributed significantly to conceptualisation, design, data analysis and interpretation. The candidate drafted the manuscript, incorporated the supervisor's inputs and submitted the manuscript's final version to the journal.

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4.1 Abstract

The changing food environment impacts consumers' eating behaviour toward unhealthy food leading to detrimental health outcomes like overweight and obesity. This study examines changes in socioeconomic inequalities in food consumption between 2005/06 and 2010/11 in South African households with women aged 15 to 49 years (WCBA). Data came from the 2005/06 and 2010/11 Income and Expenditure Surveys. Distribution of spending according to the NOVA food classification system groupings (unprocessed or minimally processed foods, processed culinary ingredients, processed and ultra-processed food (UPF) products) was analysed using standard methodologies. Changes in spending on UPF products between 2005/06 and 2010/11 were assessed using the concentration index (C), while the *factors explaining these changes were identified using the Oaxaca decomposition approach*. A positive C means that the rich spend more on food than the poor in absolute terms. The Kakwani index (K) used to assess progressivity is positive for progressive spending and

negative for regressive spending. Results show that average spending on unprocessed or minimally processed foods, processed culinary ingredients, processed and UPF products increased between 2005/06 and 2010/11 in South African households with WCBA. Socioeconomic inequality in UPF product consumption decreased between 2005/06 ($C=0.498$, 0.248 for UPF and processed foods, respectively) and 2010/11 ($C=0.432$, 0.209 for UPF and processed foods, respectively). The decomposition analysis suggests that socioeconomic status and race and urban location were chief contributors to socioeconomic inequality in UPF consumption, including changes in socioeconomic inequality in UPF spending between 2005/06 and 2010/11. Spending on each NOVA food group was regressive for 2005/06 ($K = -0.173$, -0.425 for UPF and processed foods, respectively) and 2010/11 ($K = -0.192$, -0.418 for UPF and processed foods, respectively). The government needs to recognise the critical contributors to inequality in addressing the risks of overweight and obesity caused by UPF product consumption.

4.2 Introduction

The World Health Organization estimated about 1.9 billion overweight and 677.6 million obese adults globally in 2016 (World Health Organization, 2017b), with a significant proportion in Africa. Sub-Saharan Africa (SSA) had 58.4 million overweight and 19.3 million obese adults in 2015 (Institute for Health Metrics and Evaluation, 2017b), with 12.0 million overweight and 6.3 million obese adults in South Africa (SA). This means that SA, with less than 6% of the SSA population (World Bank, 2021), accounts for more than 20% and 32% of SSA's overweight and obese adults, respectively (Institute for Health Metrics and Evaluation, 2017b). Women bear a disproportionate burden of obesity. Globally, 393.5 million (13%) women and 284.1 million (11%) men were obese in 2016 (Micha et al., 2020, World Health Organization, 2017b). In 2016, about 15% of women and 6% of men were obese in Africa (World Health Organization, 2019a), compared to 41% of women and 11% of men in South Africa (National Department of Health et al., 2019a).

The changing food environments, diets and nutrition transition, among others, are critical drivers of overweight and obesity (Igumbor et al., 2012, Morland & Evenson, 2009, Wilson et

al., 2010). The food environment is *“the physical, economic, political and socio-cultural context in which consumers engage with the food system to make their decisions about acquiring, preparing and consuming food”* (HLPE, 2017:28). Having easy accessibility, affordability and availability of processed foods allows people to make unhealthy food choices (Lake & Townshend, 2006). Changes from traditional diets to diets consisting of more processed high energy-dense foods of low nutritional value, especially in Africa, occur alongside urbanisation and rapid socioeconomic development (Popkin, 2002a, Popkin, 2002b). As the food environment changes, so do inequalities in food consumption (Miura et al., 2009) caused by people’s everyday cultural/behavioural, psychosocial and material circumstances interacting with their wider environments. These environments, often referred to as the social determinants of health, include access to adequate, affordable, quality and safe food; food promotion, advertising and information (i.e., food environment); living and working environments; broader political, socioeconomic, and cultural surroundings; policies; commercial interests; and climate change, among others (Dahlgren & Whitehead, 1991, HLPE, 2017, World Health Organization, 2010). Unequal distribution in these social determinants results in differences in food consumption and eating behaviour and ultimately overweight/obesity inequality (World Health Organization, 2010).

In many developing countries, including South Africa, research in the general adult population shows that the purchase and consumption of healthy food vary by socioeconomic status, with lower socioeconomic groups purchasing or eating fewer fruits and vegetables but more oils and fats than wealthier groups (Appelhans et al., 2012, Boylan et al., 2011, Dubowitz et al., 2008, Giskes et al., 2010, Groth et al., 2001, Hulshof et al., 2003, Kamphuis et al., 2007, Mayen et al., 2016, McCartney et al., 2013, Metcalf et al., 2006, Pechey et al., 2013, Shohaimi et al., 2004, Wandel, 1995). Relatively poorer socioeconomic groups also purchase or eat fewer ready-made meals, less healthy takeaways or food prepared outside the home (Bai et al., 2010, Gould & Villarreal, 2006, Groth et al., 2001, Hulshof et al., 2003, Langellier, 2015, Miura et al., 2012, Prochaska & Schrimper, 1973, Yen, 1993) compared to their richer counterparts. They also eat more sugar-sweetened foods and beverages (Bhargava & Amialchuk, 2007, Gray & Leyland, 2009), fewer meat products but more maize meals as reported in Tanzania (Njelekela et al., 2011), and more traditional diets comprised of fish and rice as found in Seychelles (Mayen et al., 2016), than their wealthier counterparts.

Socioeconomic patterning also exists in the consumption of specific food items in developed countries. For example, fruit and vegetable consumption is positively correlated with socioeconomic status indicators in Korea and Finland, with this correlation increasing over time (Hong et al., 2012, Roos et al., 2008). In the United States, weak associations existed between meat consumption and socioeconomic status but with a U-shaped trend for meat consumption between 1988 and 2004 (Wang et al., 2010). In the Netherlands, however, meat and visible fat consumption among the adult population was inversely associated with socioeconomic status with a stable trend between 1987 and 1998 (Hulshof et al., 2003).

Other factors are associated with ultra-processed food (UPF) consumption apart from socioeconomic variables such as education and income. Significant UPF consumption was associated with younger age (Baraldi et al., 2018, Cediel et al., 2018, Marrón-Ponce et al., 2018b), living in urban areas (Cediel et al., 2018, Marrón-Ponce et al., 2018a, Marrón-Ponce et al., 2018b), households with women working outside the home (Marrón-Ponce et al., 2018a), time constraints, having a high number of children in the household, and overweight/obese individuals (Djupegot et al., 2017).

Generally, consuming UPF, which usually contains artificial colourants, flavours and preservatives and has added sugar, salt and fats (Monteiro et al., 2016), contributes significantly to the growing non-communicable disease burden, including socioeconomic inequality in overweight and obesity (Elizabeth et al., 2020, Srour et al., 2019, Te Morenga et al., 2012). Although differences in the affordability of UPF between high- and low- and middle-income countries (Moubarac, J. C. et al., 2013) may affect results, a negative association existed between socioeconomic status and UPF consumption in Norway, France and the United States (Baraldi et al., 2018, Djupegot et al., 2017, Schnabel et al., 2019). However, in Brazil and Chile, a positive association was reported (Cediel et al., 2018, Martins et al., 2013, Monteiro et al., 2010, Simões et al., 2018). There were no significant differences in consuming UPF between income groups in Canada (Moubarac, Jean-Claude et al., 2013). A recent systematic review investigated the associations between UPF consumption and health outcomes (Elizabeth et al., 2020) and found no studies reporting an association between UPF consumption and favourable health outcomes. The review revealed that UPF consumption

was associated with detrimental health outcomes in thirty-seven of the 43 studies reviewed. In adults, these detrimental outcomes included not only overweight or obesity but a range of conditions such as cardio-metabolic risks, type-2 diabetes, some cancers, cardiovascular diseases, irritable bowel syndrome, depression, frailty condition and all-cause mortality risk (Elizabeth et al., 2020). In children and adolescents, these detrimental health outcomes were cardio-metabolic risks and asthma (Elizabeth et al., 2020).

Data on food available for consumption in South Africa show a shift in consumption patterns, between 1994 and 2015, to a diet with more sugar, sugar-sweetened beverages, more processed and packaged food including edible vegetable oils, increased intake of animal source foods, more added caloric sweeteners, and fewer vegetables (Ronquest-Ross et al., 2015). While these findings are essential, especially at “macro-level”, not using actual food consumed may overestimate food consumption (Kearney, 2010, Ronquest-Ross et al., 2015, World Health Organization, 2003). Further, the analysis (Ronquest-Ross et al., 2015) cannot demonstrate socioeconomic inequalities in food consumption at individual or household level. This paper, therefore, begins by examining the distribution of household spending according to the NOVA (*this is not an acronym*) food classification system groupings (unprocessed or minimally processed foods, processed culinary ingredients, processed and UPF products). It also assesses the changing pattern in socioeconomic inequalities in UPF consumption and the progressivity of these expenditures between 2005/2006 and 2010/2011 in South African households with women aged 15 to 49 years. This paper also assesses the factors that explain the changes in socioeconomic inequality in UPF consumption in South Africa. To the best of our knowledge, this represents the first of such analyses in South Africa and, indeed, Africa, focusing on households with women aged 15 to 49 years, a population with high overweight and obesity prevalence (National Department of Health et al., 2019a).

4.3 Methods

4.3.1 Data sources

Individual-level data about food consumption or expenditure would be ideal for investigating food consumption inequality, but these data are often unavailable at the nationally representative scale. This paper uses consumption per capita from household data, assuming homogeneity in food consumption pattern among individuals within each household. Data came from two rounds (2005/06 and 2010/11) of the nationally representative Income and Expenditure Survey (IES) conducted by Statistics South Africa (Stats SA). Fieldwork for 2005/06 IES was between September 2005 and August 2006. A total of 3000 primary sampling units were selected, with 22,617 households sampled, corresponding to a 93.5% response rate (Statistics South Africa, 2008). Fieldwork for 2010/11 IES was between September 2010 and August 2011, with 27,665 households (91.4% response rate) sampled from 3254 primary sampling units (Statistics South Africa, 2012). A combination of diary and questionnaire recall methods were used in both IES rounds to collect data; households were visited five separate times—one visit for the main questionnaire and four times for the weekly diaries (Statistics South Africa, 2008, Statistics South Africa, 2012). The IES 2005/06 and 2010/11 rounds are comparable, but previous rounds (i.e., IES 1995 and 2000) used face-to-face recall only with a single household visit.

4.3.2 Food classification according to NOVA system

Food and non-alcoholic beverages reported in the IES were classified according to the NOVA food classification system based on the level of industrial food processing (Monteiro et al., 2012, Moubarac, J. C. et al., 2013). The NOVA system is commonly used in public health nutrition research and policy (Moubarac et al., 2014) and has four food groups—i) Unprocessed or minimally processed foods include fruits, vegetables, grains or cereals, potatoes and tubers, pulses (dried beans, peas and lentils), meat (beef, pork, mutton and other meat products) and fish, dairy, eggs, unsalted nuts and seeds, dried herbs, coffee and tea. ii) Processed culinary ingredients include fats and oils, table sugar, flours, pasta, honey

and table salt. iii) Processed food products include tinned vegetables, legumes or fruits, salted nuts or seeds, processed meat or fish, tinned fish, cheese, and bread. iv) UPF products include confectionary (ice-cream, chocolate and sweets), sugar-sweetened beverages, snacks, breakfast cereals and baked goods. Details of the four NOVA groups are contained in Table A4-1.

4.3.3 Key variables

Table 4-1 contains a description of the key variables used in this paper. The variable selection was based on the broader determinants of health (Dahlgren & Whitehead, 1991) and their availability in the IES datasets. Household consumption expenditure was used as a measure of socioeconomic status. Household consumption and spending according to the NOVA food classification system were divided by household size to generate per capita variables. The expenditure data for 2005/06 and 2010/11 were adjusted to 2016 prices using the consumer price index.

Table 4-1 Description of key variables

Expenditure variables	
Unprocessed or minimally processed foods (per capita)	Total household spending on unprocessed or minimally processed foods divided by household size
Processed culinary ingredients (per capita)	Total household spending on processed culinary ingredients divided by household size
Processed food products (per capita)	Total household spending on processed food products divided by household size
Ultra-processed food products (per capita)	Total household spending on ultra-processed food products divided by household size
Total expenditure on food and non-alcoholic beverages (per capita)	Total household spending on food and non-alcoholic beverages divided by household size
Total household consumption expenditure (per capita)	Total household spending on cost of housing, food, non-alcoholic beverages, alcoholic beverages, clothing, footwear, health services, recreation and entertainment and own consumption home grown products divided by household size
Determinants	
Population group	Black African ¹ = 1 for household head self-identified as black African race; 0 otherwise
	Coloured = 1 for household head self-identified as coloured; 0 otherwise
	Indian/Asian = 1 for household head self-identified as Indian/Asian race; 0 otherwise
	White = 1 for household head self-identified as white; 0 otherwise
Area of residence	Urban = 0 if a household in a rural location
	Urban = 1 if a household in an urban location
Quintiles of socioeconomic status (Quintiles 1-5) ²	Quintile 1 = 1 if a household is in the poorest socioeconomic group; 0 otherwise
	Quintile 2 = 1 if a household is in the second poorest socioeconomic group; 0 otherwise
	Quintile 3 = 1 if a household is in the middle socioeconomic group; 0 otherwise
	Quintile 4 = 1 if a household is in the second richest socioeconomic group; 0 otherwise
	Quintile 5 = 1 if a household is in the richest socioeconomic group; 0 otherwise

Notes: ¹The South African population is predominantly black and racial disparities have been reported for obesity and overweight (Averett et al., 2014); ²Quintiles of socioeconomic status are based on household consumption expenditure per capita.

4.3.4 Analytical methods

4.3.4.1 Concentration index

Socioeconomic inequality in food spending by the NOVA groups was assessed using the concentration index, C (Wagstaff et al., 1991). For simplicity, the standard C is computed via the regression Equation 4-1 (Kakwani et al., 1997):

$$2\sigma_r^2 \left(\frac{y_i}{\mu} \right) = \alpha + Cr_i + \epsilon_i \quad \text{Equation 4-1}$$

where μ is the mean of food spending (y_i), σ_r^2 is the variance of the fractional rank (r_i) of the socioeconomic status, α is the intercept, and ϵ_i is the error term (Kakwani et al., 1997, O' Donnell et al., 2008).

The value of the C ranges from -1 to +1. A positive concentration index ($C > 0$) means that food spending in the specific NOVA group is more likely among wealthier than poorer households with women aged 15-49 years, while a negative index ($C < 0$) signifies the opposite.

4.3.4.2 Decomposing the concentration index

The C is decomposed to explain the drivers (i.e., the contributions of the determinants listed in Table 4-1) of socioeconomic inequalities in food spending. Here, only the concentration index in UPF spending is decomposed as this is the major driver of overweight and obesity. Consider the relationship between UPF spending (y) and the determinants (x):

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \epsilon_i \quad \text{Equation 4-2}$$

where α and β are ordinary least squares parameters, and ϵ denotes the error term.

Wagstaff et al.(2003) show that the concentration index for y (i.e., C), can be re-written taking into account the relationship in Equation 4-2 as follows:

$$C = \underbrace{\sum_k \left(\frac{\beta_k \bar{x}_{k_i}}{\mu} \right) C_k}_{\text{explained}} + \underbrace{\frac{GC_\varepsilon}{\mu}}_{\text{unexplained}} \quad \text{Equation 4-3}$$

where μ remains the mean of UPF spending, \bar{x} is the mean of each regressor, β_k is the ordinary least squares coefficient for each of the explanatory factors from Equation 4-2, C_k denotes the concentration index for the k -th contributing factor, while GC_ε is the generalised concentration index for the error term (ε) in Equation 4-2 (Wagstaff et al., 2003). The explained component in Equation 4-3, which represents the contribution of each determinant to the concentration index, is the product of the elasticity of y with respect to each determinant $\left(\frac{\beta_k \bar{x}_{k_i}}{\mu} \right)$ and C_k . With a pro-rich C where $C > 0$, a positive sign on a contributing factor denotes that, ceteris paribus, the socioeconomic inequality in UPF spending would be reduced if that factor was not present (i.e. $\left(\frac{\beta_k \bar{x}_{k_i}}{\mu} \right) = 0$ or $C_k = 0$). The opposite applied for a negative sign on a contributing factor.

4.3.4.3 Decomposing changes in the concentration index

The Oaxaca decomposition method was used to assess and explore factors contributing to changes in socioeconomic inequalities in UPF spending between 2005/06 and 2010/11 (Wagstaff et al., 2003). The decomposition was based on UPF products spending only as these are products linked to obesity.

Oaxaca decomposition approach (Oaxaca, 1973) is performed using the formula below:

$$\Delta C = \sum_k \eta_{kt} (C_{kt} - C_{kt-1}) + \sum_k C_{kt-1} (\eta_{kt} - \eta_{kt-1}) + \Delta \left(\frac{GC_{\varepsilon t}}{\mu_t} \right) \quad \text{Equation 4-4}$$

where t indicates time period with t corresponding to 2010/11 and $t - 1$ corresponding to 2005/06, Δ denotes first differences and η_k is the elasticity of y with respect to \bar{x}_k as in Equation 3. Oaxaca method allows for decomposing the change in socioeconomic inequality in spending on UPF over time into changes in the contributing factors of the concentration index and elasticities of the determinants of spending on UPF. However, one limitation of the method is that it is challenging to disentangle changes within elasticities (O' Donnell et al., 2008).

4.3.4.4 Assessing progressivity in food spending by NOVA classification

Progressivity was assessed using two approaches. The first involved comparing the share of total household expenditure spent on food by quintiles of household consumption expenditure for each NOVA food classification group (Ataguba et al., 2018). If the share increases with quintiles, wealthier households spend a higher share on the NOVA food group, and that spending on the NOVA food category is progressive. The spending is regressive when the share decreases with quintiles. The second approach uses the Kakwani index of progressivity that compares the distribution of household consumption expenditure using the Lorenz curve (or the Gini index) with that of food spending using the concentration curve (or the concentration index).

In this paper, the Kakwani index (K_j) for each NOVA food group (j) was calculated as the difference between the Gini index (G) of consumption expenditure and the concentration index (C_j) of expenditure on the particular NOVA food group:

$$K_j = C_j - G \quad \text{Equation 4-5}$$

Progressive spending on the NOVA food group (j) occurs when $K_j > 0$ or $C_j > G$, whereas regressive spending occurs when $K_j < 0$ or $C_j < G$ and proportional spending occurs when $C_j = G$. The value of K_j ranges from -2 (most regressive) to 1 (most progressive) (O'

Donnell et al., 2008). Also, changes in the progressivity or regressivity of food spending were assessed as outlined in Ataguba (2016).

All analyses were done in Stata (StataCorp, 2017), accounting for the IES sampling structure. The standard errors for the various components of the concentration index decomposition in equation 4 were obtained using a bootstrapping procedure with 250 resamples based on the sampling structure (Doorslaer & Koolman, 2004). This study received ethics approval from the Human Research Ethics Committee at the University of Cape Town (HREC Reference 409/2019).

4.4 Results

The IES data have a nationally representative sample of 21,214 households in 2005/6 and 25,328 households in 2010/11. Out of these samples, 16,209 (76.7%) in 2005/6 and 17,217 (68.0%) in 2010/11 were households with at least one woman aged 15 – 49 years. Among households with at least one woman aged 15 – 49 years, nearly half were female-headed households, the majority of household heads self-identified with the Black African population group, and nearly two-thirds were in urban areas in both 2005/6 and 2010/11 (see Table A4-2).

Per capita spending on food and non-alcoholic beverages increased between 2005/06 and 2010/11, with wealthier households spending more on food and non-alcoholic beverages than poorer households, as expected (Table 4-2). Average annual per capita spending on unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and UPF products increased by US\$61.54, US\$22.26, US\$66.58 and US\$ 37.24, respectively in real terms between 2005/06 and 2010/11 (Table 4-2).

Table 4-2 Average annual per capita consumption on specific NOVA food classification in South African households with women aged 15 - 49 years, 2005/06 - 2010/11

	Survey year	Poorest	2nd Quintile	3rd Quintile	4th Quintile	Richest	Total
Total food and non-alcoholic beverages	2005/06	126.76	183.91	224.31	284.41	575.97	303.66
	2010/11	195.13	289.46	369.84	418.34	693.73	407.30
Unprocessed or minimally processed foods	2005/06	57.01	80.16	97.43	129.03	240.70	131.33
	2010/11	96.13	131.26	163.90	198.69	334.82	192.88
Processed culinary ingredients	2005/06	17.58	19.72	21.28	21.04	28.03	22.06
	2010/11	37.23	41.05	44.26	42.73	53.29	44.32
Processed food products	2005/06	51.63	66.89	74.71	84.75	125.21	84.50
	2010/11	103.06	128.37	146.31	158.00	200.83	151.08
Ultra-processed food products	2005/06	16.57	26.37	35.96	53.68	141.06	62.32
	2010/11	34.54	48.20	71.13	97.18	203.74	99.56

Socioeconomic inequality in food expenditures is shown in Table 4-3 using the concentration index. Based on the results in Table 4-2, and as expected, the concentration indices in Table 4-3 are positive and statistically different from zero (i.e. pro-rich), meaning that wealthier households with at least one woman aged between 15 and 49 years spend more on the various NOVA food categories than poorer households in absolute terms.

Between 2005/06 and 2010/11, the statistically significant pro-rich socioeconomic inequality in UPF consumption decreased from 0.50 to 0.43 (Table 4-3). The decomposition of the concentration index of UPF spending in Figure 4-2 shows that in 2005/06, socioeconomic status (about +30%), race (about +29%) and urban residence (about +8%) contributed positively to socioeconomic inequality in UPF products spending. The residual contributed

approximately 34% of the total socioeconomic inequality in UPF products spending. The 2010/11 results were similar to those for 2005/06 (Figure 4-2), with urban residence becoming less prominent.

The Oaxaca decomposition in Figure 4-2 shows that socioeconomic status (about +37%) is the largest contributor to changes in socioeconomic inequality in UPF spending between 2005/06 and 2010/11. Also, race (approximately +30%) and urban residency (approximately +19%) contributed to the decline in the concentration index of UPF spending from 0.50 to 0.43 (i.e. becoming less pro-rich) between 2005/06 and 2010/11. The detailed results of the contributions of the different factors to socioeconomic inequality in overweight and obesity are presented in Table A4-3.

The preliminary progressivity results in Figure 4-1 indicate that wealthier households (i.e. richer quintiles) with at least a woman aged between 15 and 49 years spend a smaller share of their expenditure on the various NOVA food groups than their poorer counterparts (i.e. poorer quintiles) in both 2005/06 and 2010/11. In other words, NOVA food categories account for a larger share of poorer households' expenditure than for wealthier households. This relationship means that the spending on unprocessed or minimally processed foods, processed culinary ingredients, processed foods and UPF products were regressive in 2005/06 and 2010/11. The same conclusion of regressive spending on the various NOVA food groups is reached using the Kakwani index, as shown in Table 4-3. The Kakwani index results indicate that spending on most NOVA food groups became less regressive between 2005/06 and 2010/11, except for UPF and total food and non-alcoholic beverages spending. There was a slight increase in UPF spending regressivity, with the Kakwani index decreasing from -0.173 to -0.192.

Figure 4-1 Share of total household consumption expenditure spent on specific NOVA food classification groups in South African households with women aged 15 - 49 years, 2005/06 – 2010/11

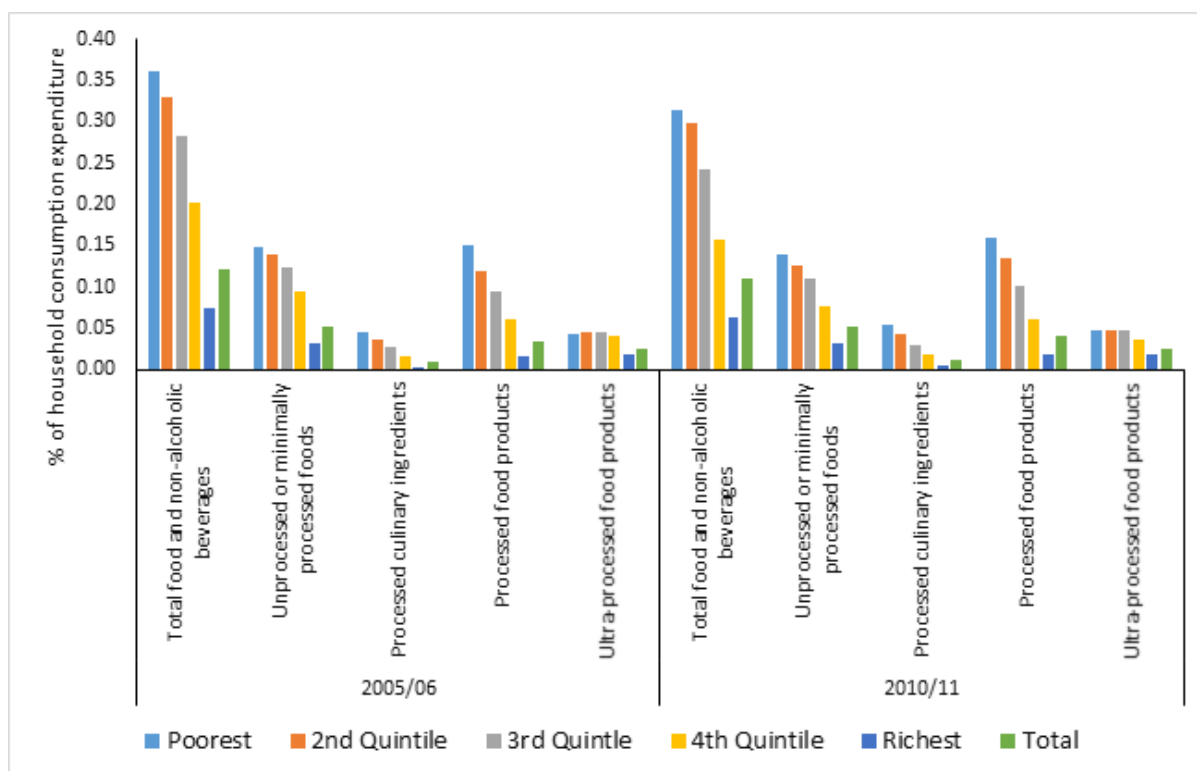


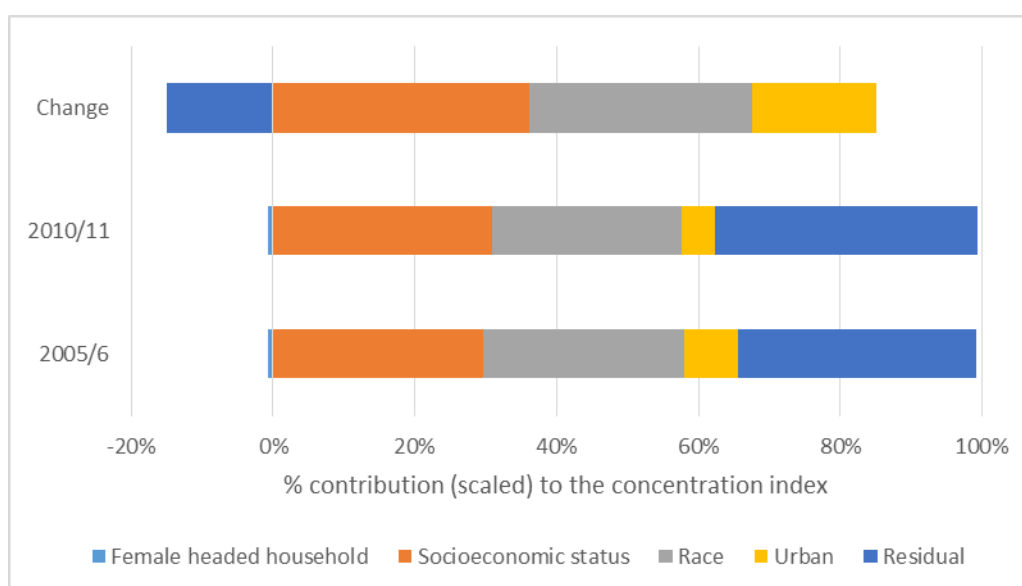
Table 4-3 Progressivity of spending on specific NOVA food classification groups in South African households with women aged 15 - 49 years, 2005/6 - 2010/11

NOVA Food classification	2005/6	2010/11
Gini index		
Total food and non-alcoholic beverages	0.673*** (0.008)	0.629*** (0.008)
Unprocessed or minimally processed foods	0.673*** (0.008)	0.628*** (0.008)
Processed culinary ingredients	0.673*** (0.009)	0.627*** (0.009)
Processed food products	0.673*** (0.009)	0.627*** (0.009)
Ultra-processed food products	0.671*** (0.009)	0.624*** (0.009)
Concentration index		
Total food and non-alcoholic beverages	0.377*** (0.007)	0.319*** (0.006)
Unprocessed or minimally processed foods	0.370***	0.343***

NOVA Food classification	2005/6	2010/11
	(0.006)	(0.005)
Processed culinary ingredients	0.187*** (0.007)	0.169*** (0.006)
Processed food products	0.248*** (0.006)	0.209*** (0.005)
Ultra-processed food products	0.498*** (0.007)	0.432*** (0.007)
Kakwani index		
Total food and non-alcoholic beverages	-0.296*** (0.020)	-0.309*** (-0.309)
Unprocessed or minimally processed foods	-0.303*** (0.020)	-0.285*** (0.019)
Processed culinary ingredients	-0.486*** (0.022)	-0.458*** (0.022)
Processed food products	-0.425*** (0.022)	-0.418*** (0.021)
Ultra-processed food products	-0.173*** (0.020)	-0.192*** (0.022)

Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard error displayed in parentheses.

Figure 4-2 Contributions of determinants on spending on ultra-processed food products in South African households with women aged 15 to 49 years, 2005/6 , 2010/11 and between the years



4.5 Discussion

Average spending on unprocessed or minimally processed foods, processed culinary ingredients, processed food and UPF products were found to have increased in real terms between 2005/06 and 2010/11. Socioeconomic inequality in the consumption of UPF decreased between 2005/06 and 2010/11, albeit with consistently positive concentration indices. The decomposition analyses suggest that socioeconomic status and race were major contributors to socioeconomic inequality in UPF consumption, with socioeconomic status, race and urban residency contributing to reducing the pro-rich socioeconomic inequality in UPF spending between 2005/06 and 2010/11. This paper also found that wealthier households with women aged 15-49 years spend a relatively smaller share of their expenditure on each specific NOVA food group than poorer households, making such spending regressive. Also, spending on most NOVA food groups became less regressive between 2005/06 and 2010/11.

The finding that socioeconomic inequality in UPF product consumption was pro-rich is similar to results from other studies from Brazil and Chile with a positive association between socioeconomic status and UPF consumption (Cediel et al., 2018, Martins et al., 2013, Monteiro et al., 2010, Simões et al., 2018). However, other studies from Norway, France and the United States showed a negative association between socioeconomic status and UPF consumption (Baraldi et al., 2018, Djupegot et al., 2017, Schnabel et al., 2019). In Canada, the differences in UPF products' consumption between income groups were similar (Moubarac, Jean-Claude et al., 2013). While differences in UPF products' affordability may explain the differences in the results across countries, in South Africa, food consumption patterns have changed significantly in the past decades toward western-oriented diets that are readily available and affordable to the rich (Ronquest-Ross et al., 2015). Diet choice forms part of individuals' strategies to position into higher socioeconomic groups and socially distance themselves from lower-status groups (Bourdieu, 1984) and could explain the significant concentration of spending on UPF among the rich in South Africa. For example, those with

higher education have better jobs and tend to purchase more expensive but not always healthier food products since food might be seen as a status symbol (Grajek et al., 2015).

The socioeconomic inequality in UPF spending and decreasing inequalities in UPF spending were substantially attributed to socioeconomic status and self-classified race. In South Africa, apart from the advantage created by income for the rich, the shift to westernised diets (Ronquest-Ross et al., 2015) and lifestyles, especially in Black African communities (Micklesfield et al., 2013), could explain the significant disparities in socioeconomic inequality in UPF spending. For the wealthy, it may well be that purchasing UPF products, especially foreign products, is perceived as a sign of prestige and status (Grajek et al., 2015, Jackson, 2004). Urban residency contributed positively to reducing the pro-rich socioeconomic inequality in UPF product consumption in South Africa. In the absence of disparities in UPF consumption between urban and rural areas, the concentration index of UPF consumption would have been more pro-rich. Studies from elsewhere have shown that UPF product consumption is higher in urban areas (Cediél et al., 2018, Marrón-Ponce et al., 2018a, Marrón-Ponce et al., 2018b), households with women working outside the home (Marrón-Ponce et al., 2018a), households with time constraints, households with a high number of children, and overweight/obese individuals (Djupegot et al., 2017). A substantial portion of the socioeconomic inequality was not explained by the factors included in the model, suggesting that unobserved factors, including individual-level determinants and unquantifiable idiosyncrasies, drive consumption patterns towards UPF. For example, household consumption patterns might differ from individual consumption patterns, depending on autonomy and decision-making abilities. Unfortunately, these factors are not included directly in the model but may be contained in the unexplained component.

This study has strengths and limitations. The study's strength is that comparable nationally representative data (IES 2005/06 and IES 2010/11) are used. A limitation of the study is that the household consumption pattern was assumed to be congruent with the consumption pattern for women aged 15-49 years in the household. While this alignment may not always be the case, there is likely a substantial correlation between individual consumption patterns and household consumption patterns for a large portion of the population. Also, household-level determinants were used for the decomposition analysis mainly because the household,

not all women aged between 15 and 49 years, was assumed as the decision-making unit for consumption and food spending. Further research is needed using nationally representative women-level (or individual) data to assess socioeconomic inequalities in food consumption and to investigate other determinants, including individual-level determinants, which contribute to socioeconomic inequality.

This study has policy implications. One of the chief contributors to socioeconomic inequality in UPF consumption was socioeconomic status. Therefore, the government needs to target households with women aged 15-49 years from different socioeconomic backgrounds, mainly those prone to consuming UPF products and those that bear the disease burden associated with consuming UPF. This approach will substantially reduce socioeconomic inequality in UPF consumption and the burden of non-communicable diseases, including overweight, obesity, cardiovascular disease, diabetes and some cancers. The study authors submit that investment in interventions to tackle overweight and obesity linked to reducing UPF consumption will positively impact South Africa's population health. Currently, UPF consumption accounts for a substantial share of poorer households' expenditure than wealthier households (Figure 4-1), which can be reduced significantly with policy to shift consumption towards healthier alternatives, including fresh fruits, vegetables and less processed food products. Cost-effective interventions for achieving this and tackling overweight and obesity include continuing to zero-rate healthier food items from the country's value-added tax (Jansen & Calitz, 2017) while other commodities maintain the 15% value-added tax rate. Unfortunately, apart from the recent increase in the value-added tax rate from 14% to 15%, it has been over 20 years that the country has changed the value-added tax structure, including adding more items for zero-rating (Jansen & Calitz, 2017). This paper's findings make it imperative for continuous policy reforms, understanding the changing landscape of food consumption, especially those that are less healthy and contribute to the growing burden of non-communicable diseases. Taxing unhealthier food products like using the current sugar-sweetened beverages (Manyema et al., 2014) is another complementary policy, including promoting food labelling and regulating food formulation (Shekar & Popkin, 2020). It is understandable that substantial political will and investment are required in the face of oppositions from the food industry to curb the rise in consuming UPF products, especially among the vulnerable population group, including women aged 15-49 years used in this

study. The interests of the food industry that contribute to the rise in obesity and overweight linked to the abundant supply of UPF products (i.e. the commercial determinants of health) need to be regulated (Kroll et al., 2019). From the individual's perspective, and as noted within the National Strategic Plan for the Prevention of Non-communicable Diseases in South Africa (Republic of South Africa, 2013a, Republic of South Africa, 2015a), continuous education is needed about healthy lifestyles and being physically active through awareness-raising campaigns and programmes aimed at behavioural changes. A combination of actions and interventions will be necessary to reduce the consumption of UPF and the burden of disease associated with UPF consumption in South Africa.

4.6 Conclusion

Although the food environment in South Africa may be changing, socioeconomic status, race, and urban residency remain critical factors to consider in designing, targeting and encouraging healthy eating behaviour. There is a need for continuous sensitisation campaigns about the links between UPF products consumption and the risks of overweight and obesity and how to reduce them. A combination of strategies highlighted in this paper is needed to substantially reduce the burden of obesity, overweight and other non-communicable diseases associated with consuming UPF, among other less healthy food alternatives in South Africa.

4.7 Appendix

Table A4-1 NOVA food classification system* based on the nature, extent and purpose of industrial foods processing

Food groups and definition	Examples
<p>1 Unprocessed or minimally processed foods Unprocessed foods are those obtained directly from plants or animals (such as green leaves and fruits, or eggs and milk) and purchased for consumption without having undergone any alteration following their removal from nature. Minimally processed foods are natural foods that have the cleaning, removal of inedible or unwanted parts, fractioning, grinding, drying, fermentation, pasteurisation, cooling, freezing, or other processes which do not add substances to the original food. Purpose of minimum processes is to preserve foods and make it possible to store them and, sometimes, also to decrease stages of food preparation (cleaning and removing inedible parts) or facilitate their digestion, or render them more palatable (grinding or fermentation).</p>	<p>Fruits; vegetables; grains or cereals; potatoes and tubers; pulses (dried beans, peas and lentils); meat (beef, pork, mutton and other meat products) and fish; dairy; eggs; unsalted nuts and seeds; dried herbs, coffee and tea.</p>
<p>2 Processed culinary ingredients These are substances extracted from natural foods or from nature itself by processes such as pressing, grinding, crushing, pulverising, and refining. The purpose of processing here is to obtain ingredients used in homes and restaurants kitchens to season and cook natural or minimally processed foods and to create with them varied and enjoyable dishes such as soups and broths, salads, rice and beans dishes, grilled or roasted vegetables and meat, and homemade breads, pies, cakes, and desserts.</p>	<p>Fats and oils; table sugar; flours; pasta; honey and table salt.</p>
<p>3 Processed food products These are relatively simple products manufactured essentially with the addition of salt or sugar or other substance of common culinary use, such as oil or vinegar, to natural or minimally processed foods. The purpose here is to prolong the duration of foods and modify their palatability.</p>	<p>Tinned vegetables, legumes or fruits; salted nuts or seeds; processed meat or fish; tinned fish; cheese, and bread.</p>
<p>4 Ultra-processed food products These are food and drink products whose manufacture involves several stages and various processing techniques and ingredients, many of which are used exclusively by the industry. The purpose of processing here is to create durable, accessible, convenient, and highly palatable, ready-to-drink, ready-to-eat, or ready-to-heat products typically consumed as snacks or desserts or as fast meals which replace dishes prepared from scratch.</p>	<p>Confectionary (ice-cream, chocolate, sweets); sugar-sweetened beverages, snacks; breakfast cereals; fast food, ready-to-eat and ready-to-heat meals; and baked goods.</p>

*Adapted from Monteiro et al. (2012) and Moubarac et al. (2013)

Table A4-2 Descriptive Statistics of households with at least one woman aged 15 – 49 years in South Africa, 2005/6 and 2010/11

Variables	2005/6	2010/11
Number of households	21144	25328
Proportion of households with at least one woman aged 15 - 49 years	76.7	68.0
Number of households with at least one woman aged 15 - 49 years	16209	17217
Female headed household	46.7% (45.6 - 47.9)	46.0 (45.1 - 46.9)
Socioeconomic quintile		
1	17.1 (16.3 - 17.9)	18.8% (18.1 - 19.5)
2	17.7 (16.9 - 18.5)	19.0 (18.3 - 19.8)
3	18.9 (18.1 - 19.7)	19.0 (18.3 - 19.7)
4	20.5 (19.6 - 21.4)	19.6 (18.9 - 20.4)
5	25.8 (24.8 - 26.9)	23.5 (22.6 – 24.4)
Population group		
Black African	76.5 (75.4 - 77.5)	77.9 (77.1 - 78.7)
Coloured	8.9 (8.3 - 9.5)	9.6 (9.1 10.1)
Asian/Indian	2.7% (2.3 - 3.1)	2.9 (2.5 - 3.2)
White	11.8 (10.9 - 12.8)	9.7 (9.0 - 10.4)
Area of residence		
Urban	63.6 (62.6 - 64.6)	66.5 (65.7 - 67.3)

Table A4-3 Decomposition of concentration index for spending of ultra-processed food products in South African households with women aged 15 to 49 years, 2005/6 , 2010/11 and between the years

	2005/6			2010/11			Change
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	
Female headed household	-0.127*** (0.008)	0.030 (0.024)	-0.004 (0.003)	-0.132*** (0.008)	0.023 (0.020)	-0.003 (0.003)	0.000 (0.000)
Socioeconomic status	0.676*** (0.006)	0.221*** (0.023)	0.14***9 (0.015)	0.640*** (0.007)	0.211*** (0.047)	0.135*** (0.029)	-0.037** (0.001)
Population group							
Black African	-0.150*** (0.005)	-0.945*** (0.314)	0.141*** (0.047)	-0.142*** (0.005)	-0.947*** (0.270)	0.134*** (0.039)	0.009** (0.003)
Coloured	0.108*** (0.020)	-0.041* (0.023)	-0.004* (0.002)	0.132*** (0.016)	-0.051** (0.022)	-0.007*** (0.003)	-0.004** (0.000)
Asian/Indian	0.469*** (0.038)	-0.009* (0.005)	-0.004* (0.002)	0.545*** (0.029)	-0.019*** (0.005)	-0.010*** (0.002)	-0.007** (0.000)
White	0.808*** (0.007)	0.013 (0.011)	0.011 (0.009)	0.789*** (-)	0.000 (-)	0.000 (-)	-0.030** (0.001)
Area of residence							
Urban	0.184*** (0.005)	0.211*** (0.011)	0.039*** (0.002)	0.154*** (0.005)	0.134*** (0.021)	0.021*** (0.003)	-0.018** (0.000)
Residual			0.170*** (0.036)			0.161*** (0.012)	0.015
Total			0.498*** (0.006)			0.431*** (0.007)	-0.071

Significance levels are denoted as follows: *** p < 0.01, ** p < 0.05, * p < 0.10. Standard error displayed in parentheses

CHAPTER FIVE: CHANGES IN THE SOCIOECONOMIC INEQUALITIES IN OVERWEIGHT AND OBESITY IN SOUTH AFRICAN WOMEN OF CHILDBEARING AGE BETWEEN 1998 AND 2016: A DECOMPOSITION ANALYSIS

Role of the candidate

The candidate contributed significantly to conceptualisation, design, data analysis and interpretation. The candidate drafted the manuscript, incorporated the supervisor's inputs and submitted the manuscript's final version to the journal.

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5.1 Abstract

Background

This study assesses the changing patterns in the socioeconomic inequality in overweight and obesity among South African non-pregnant women of child-bearing age (WCBA) between 1998 and 2016.

Methods

Data came from the 1998 and 2016 South African Demographic and Health Surveys. Socioeconomic inequality in overweight and obesity was assessed using the concentration index (C). The concentration index was decomposed to identify contributing factors to obesity and overweight inequalities among WCBA in each year. Factors contributing to changes in

inequalities between 1998 and 2016 were assessed using the Oaxaca decomposition approach.

Results

Socioeconomic inequalities in overweight and obesity among WCBA in South Africa increased between 1998 (C of 0.01 and 0.06, respectively) and 2016 (C of 0.04 and 0.09, respectively). Socioeconomic status was the biggest contributor to overweight and obesity inequalities for both years. The Oaxaca decomposition showed that race was a major contributor to changes in both overweight and obesity inequalities.

Conclusion

Policy interventions across all socioeconomic groups in South Africa are needed. For example, encouraging the intake of low fat/caloric diets could reduce overweight or obesity among the wealthier and poorer socioeconomic groups. The poor suffer many deprivations and tend to have the worst health outcomes if they fall sick with an illness related to being overweight or obese. Therefore, the proposed interventions will ensure that no one is left behind.

Keywords

Overweight, obesity, socioeconomic inequality, non-pregnant women, South Africa

5.2 Introduction

The increase in the global prevalence of overweight and obesity among adults since 1975 has been substantial, presenting a significant challenge for health and wellbeing worldwide (World Health Organization, 2017b). In 2016, over 2 billion adults worldwide were overweight or obese (World Health Organization, 2017b) and over 70% of these overweight or obese adults live in low- and middle-income countries (LMIC) (Shekar & Popkin, 2020). Overweight and obesity contribute substantially to deaths and disability from non-communicable diseases (NCDs) (Flegal et al., 2013, Forouzanfar et al., 2015, Institute for Health Metrics and

Evaluation, 2019, Ng et al., 2014, World Health Organization, 2019a). Many LMICs facing malnutrition now face the two issues of undernutrition and obesity at once (Popkin et al., 2020). In Africa (Shekar & Popkin, 2020) and South Africa (Institute for Health Metrics and Evaluation, 2017a, National Department of Health et al., 2007, Ng et al., 2014, Puoane et al., 2002) in particular, overweight and obesity prevalence has also increased over time, disproportionately affecting women, including women of childbearing age (WCBA) (Hulshof et al., 2003, World Health Organization, 2019a). Obesity during a woman's childbearing years is associated with an increased risk of infertility, miscarriage, giving birth to stillbirth children and those with congenital disabilities, shoulder dystocia and other adverse obstetric outcomes (Chu et al., 2008, Cresswell et al., 2012, Leary et al., 2015, Lynch et al., 2008, Ojiegbe, 2016, Ramsay et al., 2006). WCBA tend to accumulate weight faster during this life stage (Adamson et al., 2007, Dutton et al., 2016, Gordon-Larsen et al., 2010, Norman et al., 2003). There are several reasons for the overweight and obesity epidemic occurring during this life stage with many related to socioeconomic conditions. For example, there are differences between the poor and the rich in behaviours such as the various types of consumption (smoking, alcohol, processed foods and foods high in fat, salt and sugar) and leisure-time physical activity (Townsend et al., 1986). Differences in the prevalence of overweight and obesity between socioeconomic groups are partly due to a clustering of health-damaging behaviours by socioeconomic groups (Townsend et al., 1986). Behaviours such as eating processed foods, foods high in sugar and foods prepared outside the home, for example, are related to individuals' socioeconomic status and associated with an increased risk of obesity and associated NCDs (Lee et al., 2016, Te Morenga et al., 2012).

The rapid social and economic development experienced globally in the past four decades has seen a parallel nutrition transition (Popkin, 2002a, Popkin, 2002b) with a rise in obesity and NCDs (Swinburn et al., 2011). Many LMICs experienced nutrition transition accompanied by economic growth in the last four decades, contributing to the rise in obesity prevalence (Popkin et al., 2012). The significant growth in South Africa's economy, accompanied by the nutrition transition, has increased adult obesity prevalence for both sexes (Pisa & Pisa, 2017). For example, advancements in food technology in South Africa increased the production and consumption of processed foods, including those with added sugar and salt (Ronquest-Ross et al., 2015, Vorster et al., 2014). Besides, inequalities in health outcomes, including obesity

and its associated social determinants, persist in South Africa (Alaba & Chola, 2014, Ataguba et al., 2011, Ataguba et al., 2015). Understanding the changes in socioeconomic inequality in overweight and obesity as well as the associated determinants among WCBA could potentially be one of the ways to address the obesity problem in South Africa. Doing so, for example, will help with targeting policies to socioeconomic groups that are most affected and have a higher probability of being obese or overweight.

Mixed results have been reported in studies from developed countries that explore determinants and trends in socioeconomic inequalities in overweight and obesity. A study from Canada showed that among the general adult population, there was a reduction in the income-related inequalities in obesity between 2000 to 2010, with the concentration indices remaining consistently negative (pro-poor) over the period (Hajizadeh et al., 2014). Similarly, a study from Sweden found that among the general adult population, income-related inequalities reduced between 1980/1981 and 1996/1997, again with the concentration indices remaining consistently negative (pro-poor) throughout the period (Ljungvall & Gerdtham, 2010). Zhu et al. (2015) examined trends in socioeconomic inequalities in obesity among economically-active adults in Scotland from 1995 to 2011. Using the relative index of inequality, they showed that socioeconomic inequalities in obesity prevalence declined over the study period due to the increase in obesity prevalence in higher socioeconomic groups (Zhu et al., 2015). Zhang and Wang (2004) investigated the absolute and relative differences in obesity prevalence across socioeconomic groups (low-, medium- and high- socioeconomic groups) in the United States' adult population between 1971 and 2000. They demonstrated that the absolute and relative differences in the prevalence between the richest and the poorest groups narrowed over time, and the differences were more pronounced in women than men. Specifically, among women, the difference in obesity prevalence between the richest and the poorest groups reduced in absolute terms from 18% to 8% or in relative difference terms, from 71% to 21%. Among men, the difference in obesity prevalence between the richest and the poorest groups reduced in absolute terms from approximately 5% to 3% or a relative difference from 38% to 12% (Zhang & Wang, 2004).

In contrast, Hoffmann *et al.* (2017) used pooled analyses to examine the trend in education-related inequality in obesity in 15 European countries between 1990 and 2010. Their results

showed an increase in absolute but not relative education-related inequalities in obesity in many European countries between 1990 and 2010 (Hoffmann et al., 2017). For example, the difference in obesity prevalence between the high- and low-educated groups increased over time in absolute terms by 0.11 percentage points per year for men and 0.12 percentage points per year for women. The relative difference in the obesity prevalence between the low- and high-educated groups did not significantly change over time in men (rate ratio (RR) 0.99, 95% confidence interval (CI) 0.99 to 1.00) and women (RR 0.99, 95% CI 0.98 to 1.00). Kriaucioniene (2016) examined the differences in the socioeconomic trend of overweight and obesity prevalence among the adult population in Lithuania between 1994 and 2014. They found that body mass index (BMI) decreased in highly-educated women between 1994 and 2016, increasing the difference in the prevalence of overweight and obesity between high- and low-educated women (Kriaucioniene et al., 2016). A study from England conducted by Wardle and Boniface (2008) investigated the pattern of change in the distribution of adult BMI from 1993/1994 to 2002/2003 between low- and high-socioeconomic groups. They found very little differences in mean BMI between low- and high socioeconomic groups over the period for both men and women (Wardle & Boniface, 2008). Another study from England investigated the pattern of change in adult obesity prevalence from 1993 to 2004 between socioeconomic groups (based on occupation) (Zaninotto et al., 2009). They found that over the study period those belonging in the manual class exhibited a higher adult obesity prevalence compared with those belonging in the non-manual class; and that the differences in obesity prevalence between those belonging to the manual and non-manual classes were significant in 1994 and 2004 for both men and women (Zaninotto et al., 2009). In Belgium, Charafeddine et al. (2009) investigated the trends in socioeconomic inequality in obesity prevalence by educational level. They found significant increases in relative inequality between 1997 and 2004 for men but not women (Charafeddine et al., 2009). The study findings show that obesity prevalence is higher in the lowest educational group than in the highest educational group in 1997 and 2004 for both men and women. While there was an increase in the relative index of inequality by educational level for men, there was no significant change for women between 1997 and 2004 (Charafeddine et al., 2009). There is a dearth of studies assessing trends in socioeconomic inequalities in overweight and obesity in sub-Saharan Africa, including South Africa, where the prevalence of these conditions is also increasing, contributing significantly to disease burden.

Although health inequalities literature in South Africa is growing, there is still limited literature concerning the socioeconomic inequalities in overweight and obesity (Alaba & Chola, 2014, Nakimuli, 2016). Only one study in South Africa has examined socio-economic inequality in obesity among adults and found that obesity occurs more frequently among rich men and all women across the socioeconomic strata (Alaba & Chola, 2014). However, that study considered only a single point in time and did not assess the factors that explain changes in inequality in South Africa. This paper aims to assess, for the first time, the changing patterns in the socioeconomic inequality in overweight and obesity among South African non-pregnant WCBA between 1998 and 2016. It also assesses the factors that explain the changes in socioeconomic inequalities in overweight and obesity.

5.3 Methods

5.3.1 Data sources

Data came from the 1998 and 2016 nationally representative South Africa Demographic and Health Surveys (SADHS) that are publicly available at <https://dhsprogram.com/data/available-datasets.cfm>. This paper did not use the 2003 SADHS data because they are not available in any public data repository (Wandai et al., 2017) and are not available to researchers.

The fieldwork for the 1998 SADHS was between January and September 1998, with a total sample size of 11,735 women (i.e., a 95% response rate among women) (National Department of Health & Macro International, 2002). The 2016 SADHS was undertaken between July and September 2016, yielding a total sample size of 8,514 women (i.e., a 86% response rate) (National Department of Health et al., 2019b). The sampling procedures for the SADHS are detailed elsewhere (National Department of Health & Macro International, 2002, National Department of Health et al., 2019b). Briefly, the 1998 and the 2016 SADHS used a two-stage sampling strategy with the 1996 and 2011 Census Enumeration Areas (EAs) as sampling frames, respectively. The EAs were stratified into the nine South African provinces and by

urban, farm and traditional areas. The first stage consisted of selecting EAs with probability proportional to the size. The second stage consisted of systematically sampling residential dwelling units. The SADHS collects information from a household questionnaire, biomarker questionnaire, woman’s questionnaire and a man’s questionnaire. The SADHS data are stored in several dataset files: household recode, individual recode, birth’s recode, kid’s recode, men’s recode and couples’ recode. This paper used data from the women and household’s data files.

Table 5-1 contains a description of the key variables used in this paper. The variable selection was based on the Dahlgren and Whitehead model of the determinant of health (Dahlgren & Whitehead, 1991) and on availability across all datasets.

Table 5-1. A description of key variables used in the analysis

Variable	Definition
Variables of interest	
Overweight	A body mass index (BMI) ≥ 25 kg/m ² (World Health Organization, 2018b)
Obesity	A BMI ≥ 30 kg/m ² (World Health Organization, 2018b)
Determinants	
Age	A woman's age in years
Population group	Black African ¹ = 1 for women self-identified as black African race; 0 otherwise
	Coloured = 1 for women self-identified as coloured; 0 otherwise
	Indian/Asian = 1 for women self-identified as Indian/Asian race; 0 otherwise
	White = 1 for women self-identified as white; 0 otherwise
Education	No schooling = 1 for a woman with no education; 0 otherwise
	Primary education = 1 for a woman only primary education; 0 otherwise
	Secondary education = 1 for a woman with secondary education; 0 otherwise
	Tertiary education = 1 for a woman with tertiary education; 0 otherwise
Area of residence	Urban = 0 for a woman residing in a rural location
	Urban = 1 for a woman residing in an urban location

Variable	Definition
Smoking	Smoking = 1 for a woman who reported currently smoking; 0 if otherwise
Quintiles of socioeconomic status (Quintiles 1-5) ²	Quintile 1 = 1 if a woman is in the poorest socioeconomic group; 0 otherwise
	Quintile 2 = 1 if a woman is in the second poorest socioeconomic group; 0 otherwise
	Quintile 3 = 1 if a woman is in the middle socioeconomic group; 0 otherwise
	Quintile 4 = 1 if a woman is in the second richest socioeconomic group; 0 otherwise
	Quintile 5 = 1 if a woman is in the richest socioeconomic group; 0 otherwise

Notes: ¹The South African population is predominantly black and racial disparities have been reported for obesity and overweight (Averett et al., 2014); ²Quintiles of socioeconomic status are based on household wealth index for the Demographic and Health Survey data.

5.3.2 Socioeconomic status variable

Socioeconomic status is assessed using the wealth index created within the SADHS data using a method described in Rutstein and Johnson (Rutsein & Johnson, 2004:8-10). The wealth index uses household scores based on data on the number and kind of household assets, ranging from a television to a bicycle or car, and housing characteristics such as the source of drinking water, type of toilet facilities, and flooring materials. Factor scores for each household are derived using the principal component analysis. After these scores are computed, national wealth quintiles, ranked from lowest to highest, are produced by assigning the household score to each usual (de jure) household member.

5.3.3 Statistical analysis

5.3.3.1 Descriptive statistics

Each survey year's data were summarised using descriptive statistics (means for continuous variables and proportions for categorical variables). National estimates are reported after accounting for the sampling design and applying the appropriate sample weights.

5.3.3.2 Analytical methods for estimating health inequality

5.3.3.2.1 Concentration index

Socioeconomic inequality in overweight and obesity in WCBA was assessed using the concentration index (C) (Wagstaff et al., 1991). The standard C is computed via the "convenient regression" Equation 5-1 (Kakwani et al., 1997):

$$2\sigma_r^2 \left(\frac{h_i}{\mu_h} \right) = \alpha + Cr_i + \epsilon_i \quad \text{Equation 5-1}$$

where C is the concentration index for overweight or obesity (h_i), μ_h is the mean of h or the proportion of overweight and obese WCBA, r_i is the fractional rank of a woman in the living standards distribution based on the wealth index, σ_r^2 is the variance of the fractional rank, α is the intercept and ϵ_i is the error term (Kakwani et al., 1997, O' Donnell et al., 2008).

The value of the C ranges from -1 to +1. A positive concentration index ($C > 0$) denotes a pro-rich distribution where obese or overweight women are more likely to be wealthier, while a negative index ($C < 0$) denotes a pro-poor distribution and signifies the opposite.

5.3.3.2.2 Decomposing the concentration index

The C obtained in Equation 1 is decomposed to explain the drivers (i.e., the contributions of the determinants listed in Table 5-1) of socioeconomic inequalities in obesity and overweight among non-pregnant WCBA. Therefore, let the relationship between the indicator of overweight or obesity (h) and the k explanatory variables (x_k) be given in a regression model (Wagstaff et al., 2003) as:

$$h_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \quad \text{Equation 5-2}$$

where α and β are parameters, with β measuring the relationship between each explanatory factor (k) and the indicator of overweight and obesity (h), while ε denotes the error term.

The concentration index, C , obtained from Equation 5-1 can be re-written, taking into account the relationship in Equation 5-2 as (Wagstaff et al., 2003):

$$C = \sum_k (\beta_k \bar{x}_k / \mu_h) C_k + GC_\varepsilon / \mu_h \quad \text{Equation 5-3}$$

where h and μ_h remain as previously described, \bar{x} is the mean of each explanatory factor (k), β_k is the parameter estimated from Equation 5-2 for each explanatory factor, C_k denotes the concentration index for the k -th contributing factor, while GC_ε is the generalised concentration index for the error term (ε) in Equation 5-2.

The contribution of each explanatory factor to the concentration index for inequality in overweight or obesity (i.e., $(\beta_k \bar{x}_k / \mu_h) C_k$) is the product of the concentration index of each factor, C_k , and the elasticity of h with respect to each explanatory factor $(\beta_k \bar{x}_k / \mu_h)$. The last component in Equation 3 (GC_ε / μ_h) is socioeconomic inequality in overweight or obesity that cannot be systematically explained by variations in the explanatory factors across socioeconomic groups.

5.3.3.2.3 Decomposing changes in the concentration index

The Oaxaca decomposition approach was used to assess and explore factors contributing to changes in socioeconomic inequalities in overweight and obesity between 1998 and 2006 (ΔC) (Wagstaff et al., 2003).

Oaxaca decomposition approach (Oaxaca, 1973) is performed using the formula below:

$$\Delta C = \sum_k \eta_{kt} (C_{kt} - C_{kt-1}) + \sum_k C_{kt-1} (\eta_{kt} - \eta_{kt-1}) + \Delta \left(\frac{GC_{\epsilon t}}{\nu_t} \right) \quad \text{Equation 5-4}$$

Where t indicates time, Δ denotes first differences and η_k is the elasticity of γ with respect to \bar{x}_k (i.e., $\eta_k = \frac{\beta_k \bar{x}_{ki}}{\nu}$).

This method allows for decomposing the change in socioeconomic inequality in overweight and obesity over time into changes in the contributing factors of the concentration index and elasticities of the determinants of overweight and obesity. However, one limitation of the method is that it is difficult to disentangle changes within elasticities (Wagstaff et al., 2003), with the total differential approach (TDA) as another alternative. This paper uses the Oaxaca decomposition approach because it has the advantages of being widely used, easy to understand and does not hold only for small changes in inequality (Wagstaff et al., 2003).

All analyses were done in Stata (StataCorp, 2017), accounting for the SADHS sampling structure.

5.3.4 Ethics approval

Although both datasets were publicly available, ethics approval was obtained from the Human Research Ethics Committee at the University of Cape Town (HREC Reference 409/2019).

5.4 Results

5.4.1 Summary statistics

Table 5-2 presents summary statistics for 1998 and 2016. The sample size was 5,403 women of childbearing age in the 1998 SADHS and 8,210 in the 2016 SADHS. Between 1998 and 2016, the prevalence of overweight in women increased from 51.3% to 62.3%. Similarly, between 1998 and 2016, the prevalence of obesity in women increased from 24.7% to 35.7%. In both 1998 and 2016, the average age of women was about 30 years. Both the 1998 and 2016 SADHS had more self-identified Black African women, compared to other race groups. Compared with the 1998 SADHS, the 2016 SADHS had more women having secondary school education and tertiary education, but fewer women having no schooling or primary education. Besides, more women resided in urban areas for both survey years. The prevalence of smoking among WCBA decreased from 11.5% to 6.9% between 1998 and 2016.

Table 5-2 Summary statistics of the sample of women of childbearing age between 15 and 49 years old for 1998 and 2016

Variables	Survey year	
	1998	2016
Sample	5403	8210
Overweight	51.3 (49.7 - 52.9)	62.3 (60.1 – 64.4)
Obesity	24.7 (23.4 - 26.1)	35.7 (33.6 - 37.9)
Age, mean (SD)	29.8 (9.71)	30.4 (9.80)
Black African	77.2 (75.7 - 78.6)	87.5 (86.3 - 88.7)
Coloured	10.1 9.2 – 11.0)	8.0 (7.1 – 9.0)
Asian/Indian	4.2 (3.7 - 4.9)	1.5 (1.1 - 2.1)
White	8.5 (7.5 - 9.6)	3.0 (2.3 - 3.7)
Education		
No schooling	6.5 (5.8 - 7.3)	2.0 1.5 - 2.6)
Primary	33.7 32.2 - 35.2)	9.1 (8.1 - 10.2)

Variables	Survey year	
	1998	2016
Secondary	52.4 (50.8 - 54.1)	77.7 (76.0 - 79.3)
Tertiary	7.3 (6.5 - 8.2)	11.3 (10.0 - 12.7)
Area of residence		
Rural	36.6 (35.1 - 38.2)	33.6 (31.9 - 35.3)
Urban	63.4 (61.8 - 64.9)	66.4 (64.7 - 68.1)
Smoking	11.5 (10.5 - 12.6)	6.9 (6.0 - 8.0)
Socioeconomic status quintile		
1 (poorest)	15.0 (14.0 - 16.1)	20.0 (18.5 - 21.5)
2	18.2 (17.1 - 19.5)	19.8 (18.3 - 21.4)
3	20.0 (18.8 - 21.3)	21.3 (19.7 - 22.9)
4	23.0 (21.7 - 24.5)	20.3 (18.8 - 22.0)
5 (richest)	23.6 (22.2 - 25.2)	18.6 (17.0 - 20.4)

SD, standard deviation; %, percent; 95% CI, 95% confidence interval

Notes: Estimates are weighted to the population using sampling design (cluster and sample weights) Standard deviation or 95% confidence interval are displayed in parenthesis

5.4.2 Concentration indices for 1998 and 2016

Socioeconomic inequality in overweight and obesity among women was pro-rich, with the positive concentration index increasing from 0.01 (in 1998) to 0.04 (in 2016) for overweight, and from 0.06 (in 1998) to 0.09 (in 2016) for obesity. These statistically significant pro-rich distributions indicate that overweight and obesity were more concentrated among wealthier women. Besides, overweight and obesity inequalities became more pro-rich between 1998 and 2016 because the positive concentration indices for 2016 are greater than those for 1998.

5.4.3 Decomposition results

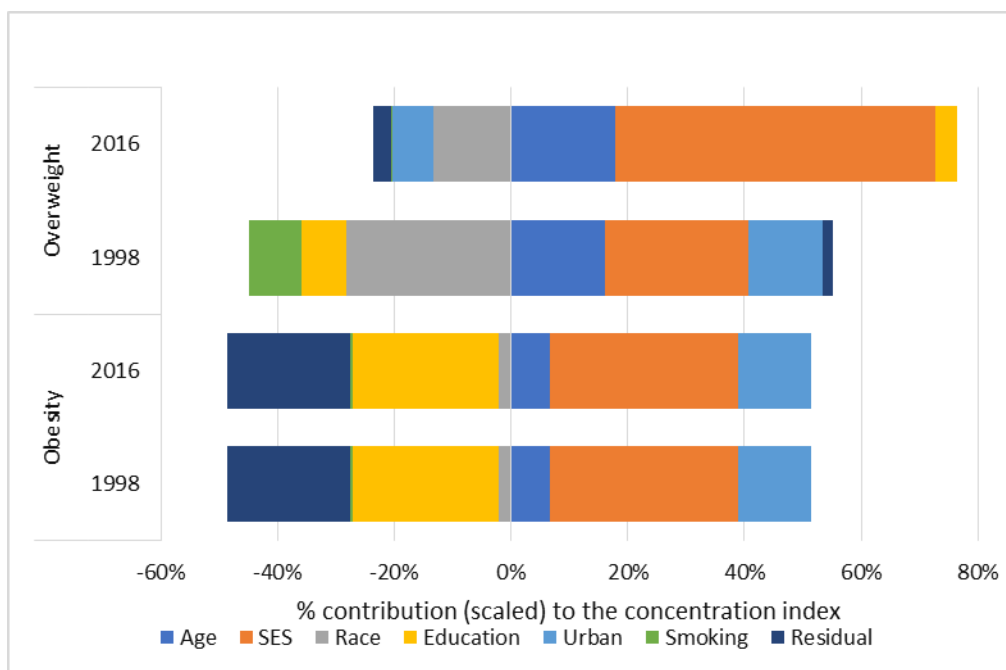
The contributions of different factors to overweight and obesity inequality in 1998 and 2016 are shown in Figure 5-1. A positive sign on a contributing factor denotes that, *ceteris paribus*, the positive inequality in overweight or obesity inequality would be reduced if that factor was not present or has no contribution (*vice-versa*).

In 1998, the pro-rich concentration index of overweight was due in part, to positive contributions of socioeconomic status (approximately +25%), age (approximately +15%) and urban residence (approximately +10%); and the negative contribution of race (approximately -24%). In 2016, most of the socioeconomic inequality in overweight was explained by socioeconomic status (approximately +58%) and age (approximately +18%). In both 1998 and 2016, the concentration indices of obesity were due in part to the positive contributions of socioeconomic status (approximately +25%), urban residence (+10%), age (+5%); and the negative contributions of education (approximately -28%). Also, the contribution of the residual to socioeconomic inequality in obesity is fairly high for both 1998 and 2016 (approximately -20%). The detailed analyses of the contributions of the different factors to socioeconomic inequality in overweight and obesity are presented in Tables A5-1 , A5-2 and A5-3.

The decomposition of changes in the socioeconomic inequality in overweight and obesity among women between 1998 and 2016 (Figure 5-2) shows the percentage contribution of

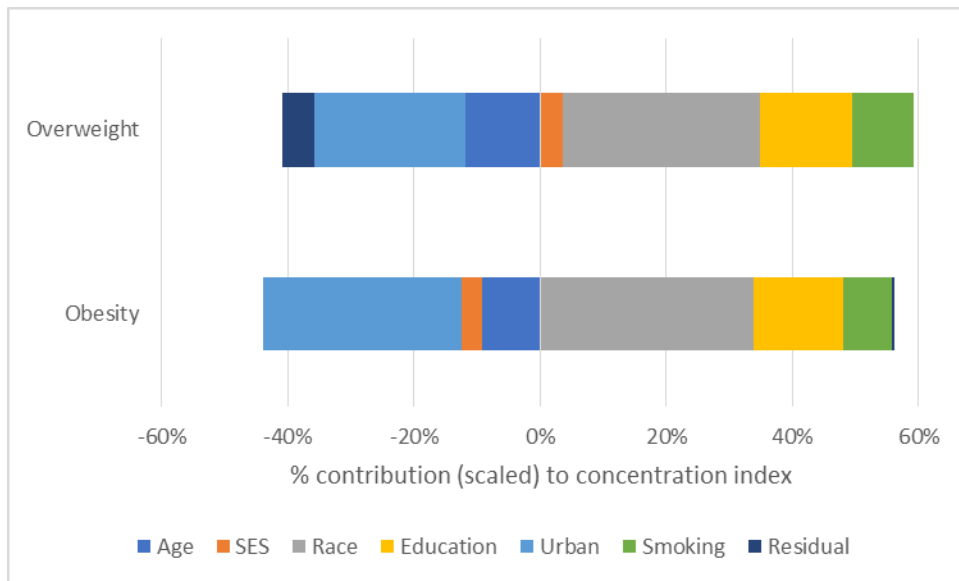
each contributing factor to the observed change in overweight and obesity inequalities. A positive percentage denotes a contribution to an increase in socioeconomic inequality in overweight or obesity among the rich (i.e., inequality is becoming more pro-rich or more concentrated among the rich) between 1998 and 2016, while a negative percentage indicates the contribution to reducing socioeconomic inequality among the rich. The results in Figure 5-2 show that race is the most significant contributor to changes in socioeconomic inequalities in both overweight (around + 33%) and obesity (+33%) between 1998 and 2016. Also, changes in socioeconomic inequalities related to educational attainment contribute to the pro-rich inequalities in overweight (about +15%) and obesity (around +14%).

Figure 5-1 Contribution of determinants to inequality in overweight and obesity among women of childbearing age between 15 and 49 years old for 1998 and 2016, South Africa



SES, socioeconomic status

Figure 5-2 Contribution of determinants to changes in overweight and obesity inequalities among women of childbearing age between 15 and 49 years old for 1998 and 2016, South Africa



SES, socioeconomic status

5.5 Discussion

5.5.1 Main findings of this study

This study investigated the socioeconomic inequality in overweight and obesity among WCBA between 1998 and 2016 in South Africa. Socioeconomic inequalities in overweight and obesity indicate that wealthier women bear a higher burden than poorer women in South Africa, which increased between 1998 and 2016. The main contributors to socioeconomic inequality in overweight and obesity were socioeconomic status, age and urban residence. The contribution of race groups was more prominent for the changes in socioeconomic inequality in overweight than for obesity.

5.5.2 What is already known about this topic?

Socioeconomic inequalities in overweight and obesity have been reported in the literature. Overweight and obesity could occur more among the rich (Hajizadeh et al., 2014, Hasan et al., 2020, Ljungvall & Gerdtham, 2010, Najafi et al., 2018, Najafi et al., 2020, Triaca et al., 2020) or the poor (Costa-Font & Gil, 2008, Emamian et al., 2017, Hajizadeh et al., 2014, Hwang et al., 2019, Nikolaou & Nikolaou, 2008). There could also be gender differences in socioeconomic inequalities in overweight and obesity (Hwang et al., 2019). Evidence from Spain (Costa-Font & Gil, 2008), Canada (Hajizadeh et al., 2014), Iran (Emamian et al., 2017) and Brazil (Triaca et al., 2020) shows significant socioeconomic inequality with obesity and/or overweight occurring more among poorer populations, sometimes among poorer women, men or the general adult population. There is also evidence that overweight or obesity could occur more among wealthier population groups as found in Canada and South Africa, where obesity occurred more among richer men (Alaba & Chola, 2014, Hajizadeh et al., 2014) and in Iran, with overweight and obesity occurring more among wealthier adults (Najafi et al., 2018, Najafi et al., 2020). Also, as reported in South Africa, obesity could be evenly spread between poorer and richer women (Alaba & Chola, 2014). Significant factors that explain socioeconomic inequalities in overweight and obesity, especially in the general population, include wealth, alcohol consumption and smoking habits, occupational status, educational attainment, residency status, sedentary lifestyle and physical inactivity, and marital status (Alaba & Chola, 2014, Emamian et al., 2017, Hajizadeh et al., 2014, Hasan et al., 2020, Najafi et al., 2018, Najafi et al., 2020, Triaca et al., 2020). A study in Bangladesh specifically examined socioeconomic inequality in overweight and obesity among non-pregnant WCBA, with overweight and obesity occurring more among wealthier women (Hasan et al., 2020).

Fewer studies, predominantly from high-income countries, estimate and decompose changes in socioeconomic inequality in overweight and obesity over time. For example, changes in socioeconomic inequality in obesity among Swedish adults between 1980 and 1997 show that obesity is increasingly concentrated among richer males and females (Ljungvall & Gerdtham, 2010). However, the study among Korean adults between 1998 and 2015 showed mixed results, with obesity becoming more concentrated among the poor for women, but among

the rich for men (Hwang et al., 2019). In Korea and Sweden, significant factors explaining changes in socioeconomic inequalities in obesity include key sociodemographic factors like age, educational attainment and income (Hwang et al., 2019, Ljungvall & Gerdtham, 2010).

5.5.3 What this study adds to the topic

Nationally representative datasets were used to report the changing patterns in the socioeconomic inequality in overweight and obesity among South African non-pregnant WCBA between 1998 and 2016. Overweight and obesity prevalence among WCBA has increased in South Africa, but associated socioeconomic inequality remains unclear. To the best of our knowledge, this study was the first to report on the changing patterns in the socioeconomic inequality in overweight and obesity among South African non-pregnant WCBA (and indeed in Africa) between 1998 and 2016. This study uses the concentration index and decomposition techniques to estimate the socioeconomic inequality in overweight and obesity, identify the factors that explain the inequality in 1998 and 2016, and determine the factors explaining the change in socioeconomic inequality between 1998 and 2016. This study finds that overweight and obesity occur more among wealthier WCBA in South Africa, consistent with a previous South African study (Alaba & Chola, 2014). In keeping with previous studies (Alaba & Chola, 2014, Hasan et al., 2020), we also find that socioeconomic status is a major contributor to socioeconomic inequality in overweight and obesity among WCBA in 1998 and 2016. Age also plays an important role in explaining the socioeconomic inequality in overweight and obesity among WCBA in 1998 and 2016. In the context of age, the critical reproductive period often leads to nonlinearities in the accumulation of inequality (Ferraro et al., 2009). Also, this study finds that the urbanisation, and likely its accompanying stress (Steyn et al., 1997), is one of the main contributors to obesity inequality. For example, Bartley (2017) describes how feelings of inequality, domination or subordination can stimulate stress responses in the body, adversely affecting health and health outcomes. Social differences in health could result from an unequal distribution of psychological risk factors. Factors such as the stress of urbanisation may increase the incidence of chronic diseases of lifestyle (including female obesity). For instance, Steyn *et al.* (1997) investigated urban exposure among 986 men and women aged 15 to 64 years who self-identified as Black African, living in the Cape

Peninsula, South Africa, concerning unhealthy lifestyle risk factors for chronic diseases. They found that those who spent more extensive portions of their lives in an urban setting tended to have unhealthier lifestyles and higher risk for chronic diseases of lifestyle (including female obesity) than their less urbanised counterparts (Steyn et al., 1997). Besides, this study finds that education is one of the main contributors to socioeconomic inequality in obesity among WCBA in 1998 and 2016. This finding is similar to studies from elsewhere (Hasan et al., 2020).

By examining the changes in socioeconomic inequality in overweight and obesity, this study finds a pro-rich shift between 1998 and 2016 (i.e., overweight and obesity increasingly being concentrated among the rich) for WCBA in South Africa. Oaxaca decomposition results showed that the main contributors to changes in socioeconomic inequality in overweight and obesity between 1998 and 2016 were race and education. These contributions were significant for overweight but not obesity inequality. While it is difficult to explain the role of race in this study, previous research found the self-identified Black African population group perceiving weight gain as a sign of beauty, wealth and being healthy (Micklesfield et al., 2013). Women with no formal educational qualification tend to be more physically inactive (National Department of Health et al., 2007). Also, women with higher education have better-paying jobs and choose more expensive but not always healthier food products since consuming such food items might be a sign of prestige (Grajek et al., 2015).

The study found that the contribution of the residual to socioeconomic inequality in obesity was fairly high for both 1998 and 2016. This study finding was seen because the decomposition analyses did not include some cultural, behavioural, psychosocial and personal factors that were not in the datasets.

5.5.4 Limitations and strengths of this study

One limitation of this study is the assumption of linearity in estimating the determinants of obesity and overweight that are binary indicators. However, as noted elsewhere (Hosseinpoor et al., 2006), this assumption does not change the qualitative results from decomposing socioeconomic inequality in overweight or obesity. The study has some strengths.

Comparable nationally representative data are used to provide a picture of the entire country after accounting for sampling weights. Also, heights and weights are used to compute BMI values that were objectively measured. Because pregnancy can inflate BMI, only non-pregnant women are used in this study.

5.6 Conclusion

Rising socioeconomic inequalities in overweight and obesity among non-pregnant WCBA in South Africa means that government policies need to target women from all socioeconomic backgrounds, including the poor and the rich, recognising the drivers of inequality identified in this paper. While overweight and obesity are prevalent among richer women, the poor are likely to have worse health outcomes related to obesity because richer women may afford better health care. The country can encourage cost-effective interventions to tackle overweight and obesity, including the current taxing of sugar-sweetened beverages (Manyema et al., 2014), reducing taxes or subsidising fruit and vegetables, promoting food labelling and regulate food formulation (Shekar & Popkin, 2020). Although there is no value-added tax on fruits and vegetables in South Africa, their availability and affordability remain a challenge (Miller et al., 2016, Okop et al., 2019). Given that the problem of overweight and obesity in non-pregnant WCBA can potentially impact the next generations, further research is needed to explore socioeconomic inequalities in the intergenerational transmission of overweight and obesity from mothers to their offspring.

5.7 Appendix

Table A5-1 Decomposition of concentration index for overweight among women of childbearing age 15 – 49 years, South Africa, 1998 and 2016

	1998			2016		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Age, years	1.207 (6.726)	0.019*** (0.003)	0.023 (0.135)	0.874*** (0.054)	0.015*** (0.004)	0.014*** (0.004)
Socioeconomic status	0.125 (2.022)	0.274*** (0.003)	0.034 (0.554)	0.190*** (0.059)	0.218*** (0.004)	0.041*** (0.013)
Population group						
Black African	0.239*** (0.067)	-0.176*** (0.007)	-0.042*** (0.012)	0.094 (0.122)	-0.060*** (0.005)	-0.006 (0.007)
Coloured	0.020** (0.010)	0.374*** (0.018)	0.008 (0.004)	-0.003 (0.010)	0.389*** (0.031)	-0.001 (0.004)

Asian/Indian	-0.007 (0.026)	0.665*** (0.018)	-0.005 (0.017)	0.000 (-)	0.816 (-)	-
White	0.000 (-)	0.859 (-)		-0.004 (0.004)	0.883*** (0.020)	-0.003 (0.004)
Education						
No schooling	0.000 (-)	-0.492 (-)	-	-0.007 (0.005)	-0.435*** (0.077)	0.003 (0.002)
Primary	0.014 (0.024)	-0.256*** (0.012)	-0.004 (0.006)	0.000 (0.009)	-0.396*** (0.030)	0.000 (0.003)
Secondary	0.024 (0.223)	0.155*** (0.008)	0.004 (0.035)	0.052 (0.052)	-0.008 (0.008)	0.000 (0.001)
Tertiary	-0.021 (0.061)	0.519*** (0.023)	-0.011 (0.032)	0.000 (-)	0.536 (-)	-
Area of residence						
Urban	0.064 (0.046)	0.278*** (0.008)	0.018 (0.013)	-0.024 (0.026)	0.214*** (0.009)	-0.005 (0.006)
Lifestyle						
Smoking	-0.050	0.250***	-0.013	-0.002	0.154***	0.000

	(3.142)	(0.027)	(0.786)	(0.005)	(0.050)	(0.001)
Residual			0.002 (0.092)			-0.002 (0.002)
Total			0.014 (0.010)			0.040*** (0.010)

Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard error displayed in parentheses.

Table A5-2 Decomposition of concentration index for obesity among women of childbearing age 15 – 49 years, South Africa, 1998 and 2016

	1998			2016		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Age, years	7.253 (114.633)	0.019*** (0.003)	0.136 (2.150)	1.889 (1.825)	0.015*** (0.004)	0.029 (0.031)
Socioeconomic status	2.410 (14.672)	0.274*** (0.003)	0.660 (4.024)	0.556 (0.608)	0.218*** (0.004)	0.121 (0.133)
Population group						
Black African	0.863 (71.796)	-0.176*** (0.007)	-0.152 (12.700)	0.314 (0.502)	-0.060*** (0.005)	-0.019 (0.030)
Coloured	0.059 (1.837)	0.374*** (0.018)	0.022 (0.690)	-0.001 (0.022)	0.389*** (0.031)	-0.001 (0.008)
Asian/Indian	0.128** (0.062)	0.665*** (0.018)	0.085** (0.041)	0.000 (-)	0.816 (-)	0.000 (-)
White	0.000 (-)	0.859 (-)	0.000 (-)	-0.011 (0.213)	0.883*** (0.020)	-0.010 (0.189)

	1998			2016		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Education						
No schooling	0.000 (-)	-0.492 (-)	0.000 (-)	-0.004 (0.101)	-0.435*** (0.077)	0.002 (0.041)
Primary	0.104 (1.637)	-0.256** (0.012)	-0.027 (0.417)	-0.004 (0.122)	-0.396*** (0.030)	0.002 (0.048)
Secondary	0.070 (10.230)	0.155*** (0.008)	0.011 (1.594)	0.142 (0.184)	-0.008*** (0.008)	-0.001 (0.002)
Tertiary	-0.951** (0.394)	0.519*** (0.023)	-0.494 (0.204)	0.000 (-)	0.536 (-)	0.000 (-)
Area of residence						
Urban	0.915 (0.757)	0.278*** (0.008)	0.255 (0.211)	-0.098 (0.145)	0.214*** (0.009)	-0.021 (0.031)
Lifestyle						
Smoking	-0.042 (1.954)	0.250*** (0.027)	-0.010 (0.484)	0.002 (0.010)	0.154*** (0.050)	0.000 (0.002)
Residual			-0.429 (5.086)			-0.018 (0.168)

	1998			2016		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Total			0.057*** (0.016)			0.085*** (0.017)

Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard error displayed in parentheses.

Table A5-3 Decomposition of change in concentration index for overweight and obesity among women of childbearing age 15 – 49 years, South Africa, 1998 – 2016

	Overweight	Obesity
	Contribution	Contribution
Age, years	-0.009 (0.005)	-0.011 (0.028)
Socioeconomic status	0.003 (0.018)	-0.004 (0.158)
Population group		
Black African	0.043** (0.015)	0.060 (0.062)
Coloured	-0.011 (0.007)	-0.011 (0.119)
Asian/Indian	0.000 (0.003)	0.000 (0.014)
White	-0.009 (0.021)	-0.007 (0.080)
Education		

	Overweight	Obesity
	Contribution	Contribution
No schooling	0.006 (0.004)	0.007 (0.005)
Primary	0.009 (0.012)	0.025 (0.140)
Secondary	-0.021 (0.012)	-0.025 (0.030)
Tertiary	0.016** (0.007)	0.011 (0.012)
Area of residence		
Urban	-0.018 (0.013)	-0.039 (0.059)
Lifestyle		
Smoking	0.007 (0.008)	0.009 (0.118)
Residual	-0.004	0.001
Total	0.0135	0.015

Significance levels are denoted as follows: *** p< 0.01, ** p< 0.05, *p< 0.10. Standard error displayed in parentheses.

CHAPTER SIX: THE INTERGENERATIONAL TRANSMISSION OF SOCIOECONOMIC INEQUALITIES IN OVERWEIGHT AND OBESITY FROM MOTHERS TO THEIR OFFSPRING IN SOUTH AFRICA, 2017: A DECOMPOSITION ANALYSIS

Role of the candidate

The candidate contributed significantly to conceptualisation, design, data analysis and interpretation. The candidate drafted the manuscript, incorporated the supervisor's inputs and submitted the manuscript's final version to the journal.

Publication status

Nglazi, M.D. & Ataguba, J.E. Socioeconomic inequalities in intergenerational overweight and obesity transmission from mothers to offsprings in South Africa. *Under Review*.

6.1 Abstract

This study assesses socioeconomic inequality in the intergenerational transmission of overweight and obesity from mothers to offsprings in South Africa, including the factors contributing to inequality. Data were drawn from the 2017 National Income Dynamic Study, which collected anthropometric and socioeconomic information. Non-pregnant mothers aged 15 - 49 years and their offsprings 0 - 14 years were included in the analysis. The dependent variables used in the study were the intergenerational transmission of overweight and obesity. Socioeconomic inequality was assessed using the concentration index. A positive index means that intergenerational overweight and obesity are more likely among the wealthier populations, while a negative index signifies the opposite. The concentration index was decomposed to understand the factors that explain inequalities in the transmission of overweight and obesity from mothers to offsprings. Concentration indices for the intergenerational transmission of overweight and obesity were consistently positive for both sexes (0.16 and 0.24, respectively), meaning that the intergenerational transmission of overweight and obesity occurs more among richer mothers. Mother's socioeconomic status (around +25%) and education (about +20%) were central determinants of intergenerational

overweight inequality while mother's exercise habits (around 38%) and mother's education (about 10%) contributed to intergenerational obesity inequality—factors explaining how socioeconomic inequality in the intergenerational transmission of overweight and obesity differed by offspring sex. Interventions are needed to reduce overweight and obesity burdens and the intergenerational transmission of overweight and obesity in South Africa. In particular, there is a need to target women who bear a significant burden of overweight and obesity in South Africa who are likely to transmit them to their offsprings, recognising the key factors that explain these socioeconomic inequalities. This approach will not only reduce the future burden of diseases associated with overweight and obesity in South Africa but will improve overall health outcomes in the country.

Keywords

Intergenerational transmission, socioeconomic inequality, overweight, obesity, South Africa

6.2 Introduction

Overweight and obesity are associated with elevated risk for certain non-communicable diseases like cardiovascular disease, diabetes, and cancers (Flegal et al., 2013, Forouzanfar et al., 2015, Institute for Health Metrics and Evaluation, 2019, Ng et al., 2014, World Health Organization, 2019a). While negative impacts of overweight and obesity are documented for individuals, there is overwhelming evidence of the intergenerational transmission of body mass index (BMI) and overweight or obesity from parents to offsprings (Anderson et al., 2007, Brown & Roberts, 2013, Classen & Hokayem, 2005, Classen, 2010, Classen & Thompson, 2016, Dolton & Xiao, 2015, Dolton & Xiao, 2017, Martin, 2008, Whitaker, 2004). This transmission is a complex process involving many factors such as genetics, cultural and environmental factors shared by both parents and offsprings (Classen & Thompson, 2016, World Health Organization, 2007). The intergenerational transfer of overweight and obesity impacts health and may pose a substantial economic burden for both generations, reducing economic productivity and putting social protection systems under severe strain (Classen & Thompson, 2016, Ng et al., 2014, Republic of South Africa, 2015a, Swinburn et al., 2011).

Despite evidence from South Africa and elsewhere on the intergenerational transmission of obesity (Anderson et al., 2007, Brown & Roberts, 2013, Classen & Hokayem, 2005, Classen, 2010, Classen & Thompson, 2016, Dolton & Xiao, 2015, Dolton & Xiao, 2017, Martin, 2008, Whitaker, 2004), few studies have examined the relationship between socioeconomic status and overweight/obesity across generations (Balasooriya et al., 2021, Zhang et al., 2011). Using the intergenerational mobility index based on the concentration index, a United States study by Zhang *et al.* (2011) measured the changes in socioeconomic inequality in obesity across generations and performed a decomposition analysis of the intergenerational mobility index to identify the factors that contribute to changing socioeconomic disparity in obesity. The decomposition analysis captured the effects of both changes in income distributions and changes in socioeconomic disparity in obesity at the same time (Zhang et al., 2011). The study found that the intergenerational disparity in obesity across socioeconomic groups between fathers and their adult sons had reduced (Zhang et al., 2011). They also found a similar reduction in intergenerational disparity in obesity across socioeconomic groups between mothers and their adult daughters (Zhang et al., 2011). The decompositions suggested that

changes in income distributions contribute smaller effects to changes in socioeconomic inequality in obesity between mothers and their adult daughters than between fathers and their adult sons (Zhang et al., 2011). Using regression-based decomposition on data from three waves of the Household Income and Labour Dynamics in Australia surveys for 2007 through to 2013, Balasooriya *et al.* (2021) examined the effects of inherited contributing factors on body weight in adult children and found demographic factors such as age, marital status, employment status, and living area to explain 4% of the inequality for BMI and overweight. Other circumstances like parental socioeconomic status accounted for between 20% and 25% for BMI and overweight inequalities (Balasooriya et al., 2021).

Intergenerational transmission of overweight and obesity could perpetuate existing socioeconomic inequalities between generations, making it essential to estimate and understand the factors contributing to the socioeconomic inequality in the intergenerational transmission of overweight and obesity. This is particularly important in countries with a significant proportion of obese adults. In South Africa, 16% of adult men and 41% of adult women were obese in 2016 (NCD-RisC - Africa Working Group, 2017). According to the NCD Risk Factor Collaboration estimates, South Africa had a global ranking (i.e., % obesity by country) of 112 in terms of adult male obesity and 23 in terms of adult female obesity in 2016 (Non-Communicable Disease Risk Factor Collaboration – Africa Working Group, 2017). The prevalence of adult female obesity is among the highest, especially in Africa. Moreover, evidence is lacking concerning the socioeconomic inequality in the intergenerational transmission of overweight and obesity in South Africa. Therefore, this study aims to estimate and decompose the socioeconomic inequality in the intergenerational transmission of overweight and obesity from mothers to offsprings. The evidence from this paper will be useful in South Africa, a country with a relatively high burden of obesity.

6.3 Material and methods

6.3.1 Data source and participants

This paper uses data from the 2017 wave of the National Income Dynamic Study (NIDS). The NIDS is a nationally representative longitudinal panel survey commenced in 2008 and repeated every two years. It is conducted by the Southern African Labour and Development Research Unit at the University of Cape Town and funded by the South African Presidency. Fieldwork for the 2017 wave was between February and December 2017 (Brophy et al., 2018). The overall survey response rate was 53.3%. Details of the sampling procedure, including the sampling weights, are described elsewhere (Brophy et al., 2018). Briefly, the NIDS uses a stratified two-stage cluster sampling strategy to sample households at baseline. A total of 400 primary sampling units (PSUs) were selected in the first stage from Statistics South Africa's 3000 PSUs in the 2003 Master sample. In 2008, 7,305 households were interviewed in 400 PSUs. All household members became a Continuing Sample Member (CSM) to be interviewed every two years. Children born to CSM women after Wave 1 are 'born into' the sample. Everyone currently living with a CSM (i.e., individuals referred to as Temporary Sampling Members [TSMs]) are also interviewed. As CSMs move out and start their households, the number of interviewees also grows. Trained fieldworkers collected the data through standardised questionnaires; household questionnaire, adult questionnaire for adults aged 15 years and older, proxy questionnaire for non-available adults, and child questionnaires for children aged between 0 and 14 years. This paper used data from the adult (containing women of childbearing age), household and child questionnaires. There were 12,157 non-pregnant mothers aged between 15 and 49 years and 15,014 offsprings in the 2017 dataset. The final data set consisted of 10,735 matched mother-offspring pairs.

6.3.2 Definition of key variables

Table 6-1 contains a description of the key variables used in this paper. The variable selection was based on the model shown in Figure 6-1, adapted from the WHO Regional Office for Europe (World Health Organization, 2007). As shown in Figure 6-1, overweight/obesity transfers from mothers to their children because once they fall pregnant, heavier mothers tend to give birth to bigger babies that, in turn, have the propensity to be heavier children (World Health Organization, 2007). Although it is complex (Classen & Thompson, 2016), determinants such as socio-demographic characteristics, lifestyle, the household

environment and broader contextual factors play a part in the intergenerational cycle of overweight and obesity (World Health Organization, 2007).

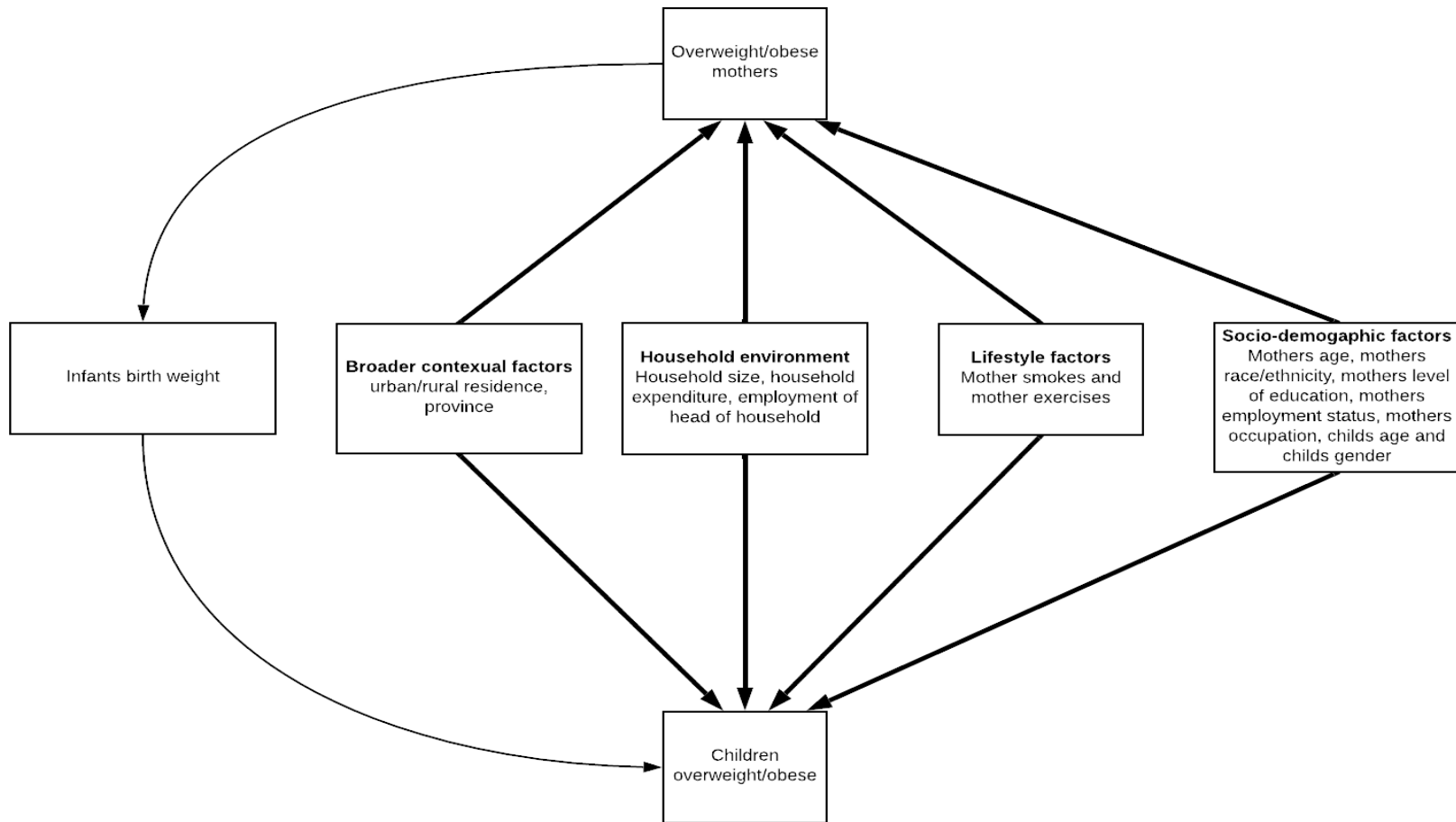
Table 6-1 A description of key variables used in the analysis

Variable	Definition
Child's age	A child's age in years
Child overweight	Children under five years with a weight-for-height z-score of two or more standard deviations above the WHO Child Growth Standards median. Children 5 -14 years with a BMI-for-age z-score of one or more standard deviations above the WHO Growth Reference median (World Health Organization, 2017b).
Child obesity	Children under five years with a weight-for-height z-score of three or more standard deviations above the WHO Child Growth Standards median. Children 5-14 years with a BMI-for-age z-score of two or more standard deviations above the WHO Growth Reference median (World Health Organization, 2017b).
Maternal overweight	A body mass index (BMI) ≥ 25 kg/m ² (2018b)
Maternal obesity	A body mass index (BMI) ≥ 30 kg/m ² (2018b)
Mother's age	A woman's age in years
Population group	Black African ¹ = 1 for women self-identified as black African race; 0 otherwise
	Coloured = 1 for women self-identified as coloured; 0 otherwise
	Indian/Asian = 1 for women self-identified as Indian/Asian race; 0 otherwise
	White = 1 for women self-identified as white
Education	No schooling = 1 for a woman with no education; 0 otherwise
	Primary education = 1 for a woman only primary education; 0 otherwise
	Secondary education = 1 for a woman with secondary education; 0 otherwise
	Tertiary education = 1 for a woman with tertiary education; 0 otherwise
Area of residence	Urban = 0 for a woman residing in a rural location
	Urban = 1 for a woman residing in an urban location
Marital status	Married = 1 for a woman who is married; 0 otherwise
	Living with partner = 1 for a woman who is living with a partner; 0 otherwise
	Widow = 1 for a woman who is a widow; 0 otherwise
	Divorced or separated = 1 for a woman who is divorced or separated; 0 otherwise
	Never married = 1 for a woman who never married; 0 otherwise

Variable	Definition
Smoking	Smoking = 1 for a woman who reported currently smoking; 0 otherwise
Exercise habits	Never = 1 for a woman who never exercises; 0 otherwise
	Less than once time a week = 1 for a woman who exercises less than once a week; 0 otherwise
	Once a week = 1 for a woman who exercises once a week; 0 otherwise
	Twice a week = 1 for a woman who exercises twice a week; 0 otherwise
	Three or more times a week = 1 for a woman exercises three or more times a week; 0 otherwise
Quintiles of socioeconomic status (Quintiles 1-5) ³	Quintile 1 = 1 if a woman is in the poorest socioeconomic group; 0 otherwise; 0 otherwise
	Quintile 2 = 1 if a woman is in the second poorest socioeconomic group; 0 otherwise
	Quintile 3 = 1 if a woman is in the middle socioeconomic group; 0 otherwise
	Quintile 4 = 1 if a woman is in the second richest socioeconomic group; 0 otherwise
	Quintile 5 = 1 if a woman is in the richest socioeconomic group; 0 otherwise
Intergenerational transmission of overweight from mothers to their offspring	1= If both a woman and her offspring are overweight and 0 if this is not the case.
Intergenerational transmission of obesity from mothers to their offspring	1= If both a woman and her offspring are obese and 0 if this is not the case.

Notes: ¹The South African population is predominantly black and racial disparities have been reported for obesity and overweight (Averett et al., 2014); ³Quintiles of socioeconomic status are based on household expenditure per capita.

Figure 6-1 The intergenerational transmission of overweight and obesity



Source: Adapted from World Health Organisation (2007)

6.3.3 Analytical methods of estimating health inequality

Descriptive statistics were used to summarise data, with means for continuous variables and proportions for categorical variables and estimates adjusted for sampling weights. Offspring sex-stratified analyses were performed separately for the data.

6.3.3.1 Concentration index

The concentration index (Kakwani et al., 1997, Wagstaff et al., 1991) was used to assess socioeconomic inequality in the intergenerational transmission of overweight and obesity from mothers to offsprings, with intergenerational transmission assessed using a dummy variable for having both a woman and her offspring overweight or obese (see Table 6-1 for the description).

For simplicity and convenience, the standard concentration index (β) is computed as (Kakwani et al., 1997):

$$2\sigma_r^2 \left(\frac{h_i}{\mu} \right) = \alpha + \beta r_i + \epsilon_i \quad \text{Equation 6-1}$$

where σ_r^2 is the variance of the fractional rank of socioeconomic status measure (r), α is the intercept, μ is the mean of the variable for the intergenerational transmission of overweight or obesity (h_i), and ϵ_i is the error term (Kakwani et al., 1997, O' Donnell et al., 2008). A positive index (i.e., $\beta > 0$) means that intergenerational transmission of overweight and obesity from mothers to offsprings is more likely among richer than poorer women. Stated differently, richer women are more likely to have overweight or obese children than poorer women. A negative concentration index (i.e., $\beta < 0$) signifies the opposite.

6.3.3.2 Decomposing the concentration index

The concentration index in Equation 1 was decomposed using the methods outlined in Wagstaff *et al.* (2003) to understand the drivers (i.e., contributions of the determinants) or factors that explain socioeconomic inequalities in the intergenerational transmission of overweight and obesity from mothers to offsprings.

Consider an ordinary least squares regression model in Equation 2 that links the intergenerational transmission of overweight or obesity (i.e. the outcome denoted h) to a set of k determinants (x_k) where γ is the estimated coefficient on the determining factors.

$$h_i = \alpha + \sum_k \gamma_k x_{ki} + \varepsilon_i \quad \text{Equation 6-2}$$

The concentration index for h , (i.e. C in Equation 3 but defined as β in Equation 1) can be decomposed as:

$$C = \sum_k \underbrace{(\gamma_k \bar{x}_{ki} / \mu) C_k}_{\text{deterministic}} + \underbrace{GC_\varepsilon / \mu}_{\text{unexplained}} \quad \text{Equation 6-3}$$

where, μ is the mean of the outcome, h (i.e., intergenerational transmission of overweight and obesity from mothers to offsprings), \bar{x} is the mean of the determining factor or variable (k), γ_k is the coefficient for each of the determinants in Equation 2, GC_ε is the generalised concentration index for the error term (ε) (Wagstaff *et al.*, 2003).

Equation 3 comprises two parts. The first part, the deterministic component, is the product of the elasticity of h with respect to each determining factor, denoted as $(\gamma_k \bar{x}_{ki} / \mu)$ and the concentration index of the determining factor (C_k). This deterministic component is interpreted as the contribution of the determining factor (x) to socioeconomic inequality in the intergenerational transmission of overweight or obesity. The unexplained component is the generalised concentration index of the error term (ε) and should be close to zero in a well-

specified model where all determining factors have been included in Equation 2 (Wagstaff et al., 2003).

The concentration index proposed by Wagstaff was used to measure socioeconomic inequality in the health variable (intergenerational transmission of overweight and obesity from mothers to their offspring, in this case) (Wagstaff et al., 1991).

For simplicity and convenience, the standard concentration index is computed as:

$$2\sigma_r^2 \left(\frac{h_i}{\mu} \right) = \alpha + \beta_k r_i + \sum_j \varphi_j x_{ij} + \epsilon_i \quad \text{Equation 6-4}$$

Where σ_r^2 is the variance of the rank of socioeconomic status measure, α is the intercept, φ_j are the parameter vectors of the determinants x_j and ϵ_i was the error term (Kakwani et al., 1997, O' Donnell et al., 2008).

A positive index means that intergenerational transmission of overweight and obesity from mothers to their offspring is more likely among the richer while a negative index signifies the opposite.

6.3.3.3 Decomposing the concentration index

The concentration index was decomposed to understand the drivers (i.e. contributions of determinants) of socioeconomic inequalities in intergenerational transmission of overweight and obesity from mothers to their offspring using an ordinary least squares regression model (Wagstaff et al., 2003). Therefore, given an ordinary least squares regression model for an outcome denoted y is expressed as:

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \quad \text{Equation 6-5}$$

the concentration index for y , can be defined as:

$$C = \sum_k (\beta_k \bar{x}_{ki} / \mu) C_k + GC_\varepsilon / \mu \quad \text{Equation 6-6}$$

where, μ is the mean of the outcome (intergenerational transmission of overweight and obesity from mothers to their offspring, in this case), \bar{x} is the mean of each regressor (k), β_k is coefficient for each of the determinants from equation 2, GC_ε is the generalised concentration index for the error term (ε) (Wagstaff et al., 2003).

Equation 3 was used to derive, the elasticity of y with respect to each determinant, the concentration index for each determinant, and the total contribution of each determinant to the concentration index.

6.3.3.4 Ethics approval

Although the data were publicly available, ethics approval was obtained from the Human Research Ethics Committee at the University of Cape Town (HREC Reference 409/2019).

6.4 Results

6.4.1 Description of the sample

As shown in Table 6-2., the mean age for offsprings (boys and girls) was estimated at 6.3 years (standard deviation (SD) 6.3 years), while the mean age for mothers was $32.7 \pm \text{SD } 7.2$ years. Overweight and obesity prevalence was higher for girls than boys. Mothers had an overweight

and obesity prevalence of 61.7% and 38.2%, respectively. Mothers were predominantly Black African, had attained secondary or higher levels of education and never exercised. Just over half of the mothers were never married. Nearly two-thirds lived in urban locations.

Table 6-2 Descriptive statistics for mothers aged 15 - 49 years and their offspring in South Africa, 2017

	Mothers	Sons	Daughters	Both§
Sample	10735	5310	5416	10,726
Child's age years mean (SD)	-	6.3 (4.15)	6.3 (4.21)	6.3 (6.29)
Child overweight	-	13.9 (12.3 – 15.6)	15.3 (13.9 - 16.9)	14.6 (13.5 – 15.7)
Child obesity	-	4.6 (3.6 - 5.8)	4.8 (4.0 - 5.7)	4.7 (4.0 – 5.4)
Mother's age, years mean (SD)	32.7 (7.18)	-	-	
Mother's population group		-	-	
Black African	83.8 (82.5 – 84.9)	-	-	
Coloured	9.0 (8.1 - 9.9)	-	-	
Asian/Indian	2.0 (1.6 - 2.5)	-	-	
White	5.0 (4.3 - 5.7)	-	-	
Missing	0.3 (0.0 - 1.8)	-	-	
Mother's education		-	-	-
No schooling	1.2 (1.0 - 1.4)	-	-	-
Primary	7.0 (6.4 - 7.7)	-	-	-
Secondary	63.7 (62.2 - 65.1)	-	-	-
Tertiary	27.1 (25.7 - 28.5)	-	-	-
Missing	1.1 (0.6 - 1.1)	-	-	-
Mother's marital status		-	-	-

	Mothers	Sons	Daughters	Both§
Sample	10735	5310	5416	10,726
Married	33.0 (31.6 - 34.5)	-	-	-
Living with partner	9.5 (8.6 - 10.4)	-	-	-
Widow	2.2 (1.8 - 2.6)	-	-	-
Divorced or separated	2.8 (2.3 - 3.5)	-	-	-
Never married	51.0 (49.5 - 52.6)	-	-	-
Missing	1.5 (1.2 - 1.8)	-	-	-
Area of residence		-	-	-
Rural	37.0 (35.6 - 38.4)	-	-	-
Urban	62.0 (60.6 - 63.4)	-	-	-
Missing	1.0 (0.7 - 1.3)	-	-	-
Mother smoking		-	-	-
No	85.0 (83.7 - 86.1)	-	-	-
Yes	7.1 (6.3 - 8.0)	-	-	-
Missing	8.0 (7.1 - 9.0)	-	-	-
Exercise Habits		-	-	-
Never	71.0 (69.5 - 72.4)	-	-	-
Less than once a week	6.4 (5.6 - 7.3)	-	-	-
Once a week	3.8 (3.1 - 4.5)	-	-	-
Twice a week	4.0 (3.5 - 4.7)	-	-	-
Three or more times a week	6.6 (5.9 - 7.4)	-	-	-
Missing	8.2 (7.3 - 9.2)	-	-	-
Mother's socioeconomic status quintile		-	-	-
1 (poorest)	20.8	-	-	-

	Mothers	Sons	Daughters	Both§
Sample	10735	5310	5416	10,726
	(19.7 – 22.0)			
2	20.7 (19.5 - 21.9)	-	-	-
3	20.3 (19.1 - 21.6)	-	-	-
4	17.8 (16.6 - 19.1)	-	-	-
5 (richest)	18.8 (17.5 - 20.2)	-	-	-
Missing	1.5 (1.2 - 1.9)	-	-	-
Maternal overweight	61.7 (60.1 - 63.2)	-	-	-
Maternal obesity	38.2 (36.7 - 39.7)	-	-	-

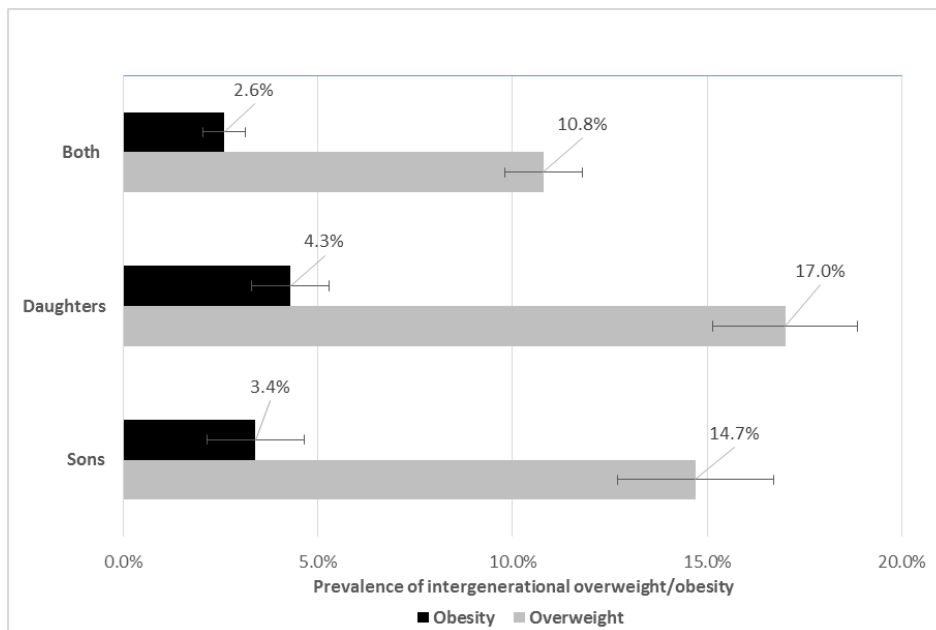
Standard deviation and 95% confidence interval are displayed in parenthesis.

§Both refers to sons and daughters.

6.4.2 Intergenerational transmission of overweight and obesity from mothers to their offspring

The prevalence of intergenerational overweight, as shown in Figure 6-2, was higher for girls (17.0%) than boys (14.7%). Similarly, intergenerational obesity is higher for girls (4.3%) than boys (3.4%). Combined, the prevalence of intergenerational overweight and obesity was 10.8% and 2.6%, respectively (Figure 6-2).

Figure 6-2 Intergenerational transmission of overweight and obesity from mothers to offsprings, 2017



Note: Error bars represent the 95% confidence intervals. Both refers to sons and daughters.

6.4.3 Inequality in intergenerational overweight and obesity using the concentration index

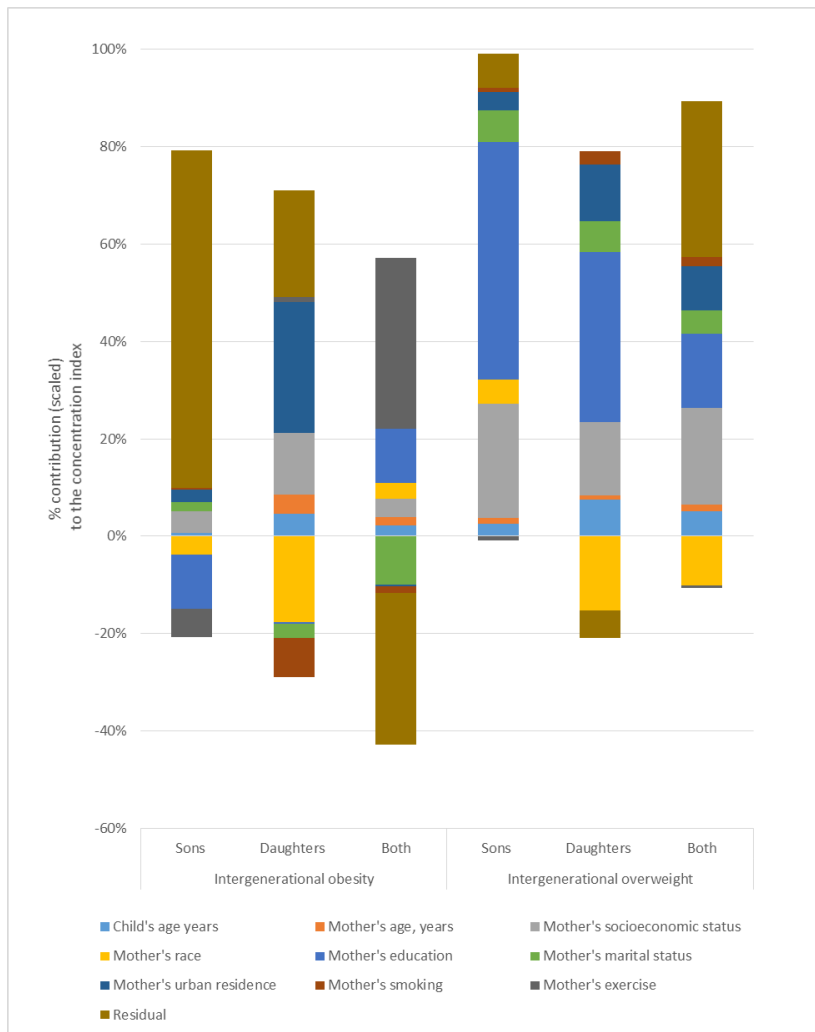
The concentration indices for intergenerational overweight were consistently positive for both sexes (0.15 and 0.18 for boys and girls, respectively). Similarly, the concentration indices for intergenerational obesity were consistently positive for both sexes (0.30 and 0.20, respectively for boys and girls). Overall, the concentration indices for intergenerational overweight and obesity were also consistently positive (0.16 and 0.24, respectively). These results mean that intergenerational transmission of overweight and obesity from mothers to offsprings occurs more often in wealthier than poorer households in South Africa.

6.4.4 Decomposition of socioeconomic inequality in intergenerational overweight and obesity

Socioeconomic inequality in the intergenerational transmission of overweight from mothers to both girls and boys, as shown in Figure 6-3, is attributed mainly to the mother's socioeconomic status (around +25%), education (about +20%) and race (about -10%). For boys: mother's education (approximately +48%) and socioeconomic status (about +24%) contribute positively to the socioeconomic inequalities in intergenerational overweight. For girls: a mother's education (around +36%), socioeconomic status (approximately +12%) and residing in urban areas (about +10%) contribute positively to the socioeconomic inequalities in intergenerational overweight. Other contributing factors to the socioeconomic inequality in the intergenerational transmission of overweight for boys or girls include a child's age, mother's marital status and race groups.

Socioeconomic inequality in the intergenerational transmission of obesity, for boys and girls combined, is attributed mainly to the mother's exercise habits (around 38%), education (about 10%) and marital status (about -10%). Mother's socioeconomic status (around +8%) was a positive contributor while mother's education was a negative contributor (about -10%) to socioeconomic inequality in intergenerational obesity for boys. Most of the inequalities remained unexplained for intergenerational obesity for boys. For girls, mother's residing in urban areas (about +25%), mother's socioeconomic status (around +10%) and the child's age (about +5%) were positive contributors to intergenerational obesity while race (about -20%) was a negative contributor. Although a part of the inequality was unexplained for girls, this was smaller than for boys. Detailed results of the decomposition of socioeconomic inequality in intergenerational overweight and obesity are in Tables A6-1 and A6-2.

Figure 6-3 Contribution of determinants to inequality in the intergenerational transmission of overweight and obesity from mothers to offspring in South Africa, 2017



Note: Both refers to sons and daughters.

6.5 Discussion

This study finds that intergenerational transmission of overweight and obesity occurs more often among the wealthy for boys and girls, meaning that intergenerational overweight and obesity occur less frequently among poorer mother-offspring pairs. The main contributing factors to socioeconomic inequality in intergenerational overweight or obesity differ slightly when the analysis is stratified by offspring sex. For instance, the main contributors to socioeconomic inequality in intergenerational overweight for boys include mother's education and socioeconomic status, while for girls, the factors include mother's education, socioeconomic status, urban residence, marital status, race and the child's age.

It is not surprising that this study demonstrates the presence of intergenerational overweight and obesity, especially among more affluent mother-offspring pairs in South Africa, as there is overwhelming evidence that overweight and obesity, especially in the adult population, is concentrated among the wealthy in low- and middle- income countries (McLaren, 2007, Sobal & Stunkard, 1989), South Africa (Alaba & Chola, 2014, Cois & Day, 2015, Sartorius et al., 2015) and other countries in sub-Saharan Africa (Abrha et al., 2016, Dake et al., 2011, Letamo, 2011, Olatunbosun et al., 2011, Steyn et al., 2011b). This finding means that wealthier overweight or obese mothers are more likely to have overweight or obese offsprings compared to poorer overweight or obese mothers. Simply put, overweight or obesity among the rich in South Africa perpetuates itself, irrespective of the offspring's sex.

Some mothers' sociodemographic factors significantly influence socioeconomic inequality in intergenerational overweight or obesity in South Africa. For example, socioeconomic status is a major contributor to the intergenerational transmission of overweight and obesity for both boys and girls. This finding agrees with Balasooriya *et al.* (2021), finding that parental socioeconomic status significantly contributes to BMI and overweight in adult children, which could result from differences in consumption patterns between the rich and the poor. Studies among adults from sub-Saharan Africa have also shown a positive relationship between educational attainment and obesity (Adeboye et al., 2012, Dalal et al., 2011, Letamo, 2011, Mfenyana et al., 2006). Mothers' education also contributed to the socioeconomic inequality

in intergenerational overweight for boys probably because mothers with higher educational qualification are more likely to have physically active lifestyles (Mlangeni et al., 2018), while those with no formal educational qualification are less likely to engage in physical activity (National Department of Health et al., 2007).

In literature, racial disparities have been reported for obesity and overweight (Averett et al., 2014). Similarly, in this study, the self-reported race was found to contribute negatively to the socioeconomic inequality in the intergenerational transmission of obesity from mothers to girls. An earlier study from South Africa had shown the intergenerational transmission of perceptions towards food and exercise from Black African mothers to their daughters (Phillips et al., 2016). Although not directly linked to race, Classen noted that while the relationship may be complex, culture and family values might influence the intergenerational transmission of BMI and obesity from parents to offsprings (Classen, 2010).

Mother's marital status was a positive contributor to the socioeconomic inequality in intergenerational overweight for girls. Although the explanations for the contribution of marital status to the intergenerational transmission of overweight and obesity are not well understood, it is purported that marriage, a major life transition may alter the eating habits of individuals resulting in excessive weight gain, possibly due to shifts in roles and responsibilities after getting married within the African context (Faber & Kruger, 2005, Okop et al., 2015, Puoane et al., 2002). Moreover, parents and children sharing common environmental factors, including similar food consumption choices, could account in part for the observed intergenerational transmission of obesity from mothers to girls (Classen & Thompson, 2016). There is need for more studies to unpack the causal pathways through which marital status affects intergenerational overweight and obesity.

Living in urban areas contributes to socioeconomic inequality in intergenerational obesity from mothers to girls, which might be due to differences in available diets between urban and rural populations, processed food consumption and lifestyles, including increased physical inactivity and sedentary behaviour characteristic of urban populations (Pisa & Pisa, 2017).

The finding that mother's exercise habit contributes to the socioeconomic inequality in intergenerational obesity for both boys and girls is expected as parents and offsprings share inactive or sedentary lifestyle behaviours (e.g., reduced physical activity and increased sedentary behaviours) (Classen & Thompson, 2016). Sharing inactive lifestyles, including reduced physical activity and increased sedentary life, accounts in part for the observed intergenerational obesity because physically inactive parents will raise physically inactive children (Classen & Thompson, 2016). Factors such as neighbourhood safety influences individuals' physical activity levels (Malambo et al., 2017, Oyeyemi et al., 2012) and could explain why living in urban areas contributes to socioeconomic inequality in intergenerational overweight and obesity in South Africa. Moreover, Lokuruka (2013) argued that the habit of sitting and watching television for prolonged periods and the long time spent by children playing videogames in wealthy and middle-class urban dwellers might contribute to the rise of overweight and obesity in both parents and children in wealthier households in sub-Saharan Africa.

A significant portion of socioeconomic inequality mainly in intergenerational obesity, could not be explained by the factors included in the model. This finding is not surprising as *"the transmission of health outcomes between generations is a complicated process governed by a myriad of factors including genetics, culture, family values and consumption choice"* (Classen, 2010:32), some of which are not quantifiable. Therefore, unobserved and unquantifiable factors such as circumstances, behaviours, genetic factors, family values, and culture (Balasooriya et al., 2021, Classen, 2010) may be responsible for sizeable unexplained factors. The unexplained factors are more pronounced for socioeconomic inequalities in intergenerational obesity than for intergenerational overweight, which may mean that the transition from overweight to obesity can be attributed to significant changes in unexplained or unquantifiable factors. This area of research is, therefore, one that is important for future investigation.

The findings have implications for policy and further research. There is a need for more research assessing the relationship between the intergenerational transmission of overweight/obesity and socioeconomic status. This will help us understand the pathways and mechanisms underlying this transmission to reduce South Africa's health inequalities

(Ataguba et al., 2011). The significant intergenerational transmission of obesity in South Africa requires policy and interventions to focus on reducing excessive weight gain in women of childbearing age as this is crucial for preventing premature death and disease, reducing economic burden and strain on both generations' social protection systems and in attaining the country's national development goals. Specifically, interventions targeting women across all socioeconomic statuses in South Africa, especially those with a higher probability of intergenerational transmission of overweight and obesity, are needed to reduce socioeconomic inequality in intergenerational overweight and obesity for boys and girls. Family-based interventions are cost-effective strategies to reduce obesity with weight loss in children usually accompanied by parental weight loss (Boutelle et al., 2012, Wrotniak et al., 2004).

This study has some limitations. Some of the factors that explain socioeconomic inequalities in intergenerational overweight and obesity were not captured in this study, largely because some may be intangible or are not contained in the NIDS dataset. Consequently, a large part of the findings on socioeconomic inequality in intergenerational transmission of obesity are not explained by observed variables due to the complexities in the factors that contribute to the intergenerational transmission of obesity and overweight to offspring. Also, this paper assumes intergenerational transmission of overweight and obesity as simply observing overweight or obesity in a mother-offspring pair. While this may be so in most cases and will not change our findings qualitatively, an offspring's overweight or obesity status may be unrelated to the mother's. Also, self-reported data for physical exercise used in this paper may be prone to bias. However, most household surveys globally rely on self-reports for physical activity, and our results are consistent with others in the literature as discussed above. These limitations notwithstanding, the study has some strengths, including the use of contemporaneous observations of measured BMI for mothers and BMI-for-age and weight-for-height z-scores for offspring at a single point in time. These measurements were objective for both mothers and offsprings.

6.6 Conclusion

Intergenerational transmission of overweight and obesity has been reported in literature, with a complex pathway. However, there is a dearth of studies assessing socioeconomic inequalities in intergenerational overweight and obesity, especially in South Africa, with one of the highest burdens of obesity in sub-Saharan Africa. The need to secure future generations and reduce the current levels of health inequalities in South Africa demands an understanding of the nature of intergenerational inequalities, including the transmission of overweight and obesity between mothers and offsprings. Besides, policies are needed to address the factors that underlie this transmission, as identified in this study. The study authors argue that the key social determinants of health inequalities identified in this paper for intergenerational overweight and obesity provide policy insights to reduce health inequalities in South Africa's future generations.

6.7 Appendix

Table A6-1 Decomposition of concentration index for intergenerational transmission of overweight from mothers to offspring in South Africa, 2017

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Child's age years	0.307 (0.276)	0.013 (0.010)	0.004 (0.005)	0.657 (1.692)	0.035*** (0.009)	0.023 (0.057)	0.450 (0.312)	0.024*** (0.007)	0.011 (0.008)
Mother's age, years	0.166 (0.573)	0.012*** (0.003)	0.002 (0.007)	0.129 (0.953)	0.019*** (0.004)	0.002 (0.018)	0.171 (2.092)	0.015*** (0.002)	0.003 (0.033)
Mother's socioeconomic status	0.057 (0.066)	0.627*** (0.018)	0.035 (0.041)	0.072 (0.589)	0.630*** (0.015)	0.045 (0.371)	0.065 (0.533)	0.629*** (0.013)	0.041 (0.334)
Mother's population group									
Black African	-0.224 (0.938)	-0.054*** (0.008)	0.012 (0.049)	1.317 (14.033)	-0.064*** (0.007)	-0.084 (0.917)	0.001 (1.075)	-0.059*** (0.005)	0.000 (0.066)
Coloured	-0.020 (0.112)	0.129*** (0.049)	-0.003 (0.013)	0.110 (0.092)	0.205*** (0.045)	0.023 (0.018)	0.010 (0.031)	0.167*** (0.037)	0.002 (0.005)

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Asian/Indian	0.000 (-)	0.591 (-)	0.000 (-)	0.024 (0.368)	0.629*** (0.056)	0.015 (0.230)	0.000 (-)	0.612 (-)	0.000 (-)
White	-0.002 (0.024)	0.812*** (0.050)	-0.002 (0.019)	0.000 (-)	0.858 (-)	0.000 (-)	-0.027 (5.208)	0.836*** (0.030)	-0.022 (4.397)
Mother's education									
No schooling	-0.036 (0.919)	-0.494*** (0.102)	0.018 (0.449)	-0.173 (1.926)	-0.431*** (0.092)	0.075 (0.850)	0.032 (0.324)	-0.462*** (0.063)	-0.015 (0.149)
Primary	-0.137 (2.429)	-0.530*** (0.028)	0.073 (1.274)	-0.052 (0.717)	-0.438*** (0.038)	0.023 (0.312)	-0.086 (1.479)	-0.487*** (0.022)	0.042 (0.726)
Secondary	-0.929 (2.010)	-0.063*** (0.012)	0.058 (0.133)	-0.154 (2.903)	-0.080*** (0.011)	0.012 (0.222)	-0.584 (7.951)	-0.072*** (0.008)	0.042 (0.584)
Tertiary	-0.252 (0.413)	0.298*** (0.021)	-0.075 (0.124)	-0.014 (0.200)	0.343*** (0.020)	-0.005 (0.068)	-0.118 (0.201)	0.320*** (0.015)	-0.038 (0.065)
Mother's marital status									
Married	0.007 (0.121)	0.188*** (0.021)	0.001 (0.023)	0.081 (0.326)	0.220*** (0.020)	0.018 (0.071)	0.066 (1.161)	0.204*** (0.015)	0.013 (0.225)
Living with partner	-0.110 (1.420)	0.021 (0.043)	-0.002 (0.045)	0.046 (1.715)	0.062 (0.044)	0.003 (0.100)	-0.054 (3.858)	0.041 (0.029)	-0.002 (0.138)
Widow	0.000 (-)	-0.166 (-)	0.000 (-)	-0.007 (0.115)	-0.256*** (0.086)	0.002 (0.030)	-0.002 (0.020)	-0.211*** (0.066)	0.000 (0.004)

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Divorced or separated	-0.005 (0.015)	0.362*** (0.074)	-0.002 (0.005)	0.000 (-)	0.477 (-)	0.000 (-)	0.000 (-)	0.430 (-)	0.000 (-)
Never married	-0.100 (0.294)	-0.128*** (0.015)	0.013 (0.038)	0.020 (0.374)	-0.167*** (0.015)	-0.003 (0.062)	0.013 (0.265)	-0.147*** (0.011)	-0.002 (0.004)
Area of residence									
Urban	0.028 (0.128)	0.200*** (0.010)	0.006 (0.025)	0.173 (0.238)	0.201*** (0.012)	0.035 (0.048)	0.093 (0.676)	0.201*** (0.009)	0.019 (0.134)
Mother's lifestyle									
Smoking	0.008 (0.042)	0.169*** (0.057)	0.001 (0.006)	0.025 (0.216)	0.326*** (0.055)	0.008 (0.073)	0.016 (0.035)	0.250*** (0.042)	0.004 (0.009)
Exercise Habits									
Never	-0.486 (1.049)	-0.058*** (0.010)	0.028 (0.061)	0.060 (0.376)	-0.055*** (0.009)	-0.003 (0.020)	-0.232 (3.366)	-0.057*** (0.007)	0.013 (0.190)
Less than once time a week	-0.035 (0.342)	0.113** (0.056)	-0.004 (0.039)	0.010 (0.046)	0.157*** (0.056)	0.002 (0.007)	-0.017 (0.035)	0.136*** (0.043)	-0.002 (0.005)
Once a week	0.000 (-)	0.327 (-)	0.000 (-)	0.001 (0.035)	-0.030 (0.081)	0.000 (0.001)	0.000 (-)	0.185 (-)	0.000 (-)
Twice a week	-0.032 (0.180)	0.108 (0.073)	-0.003 (0.018)	0.000 (-)	0.219 (-)	0.000 (-)	-0.021 (0.114)	0.166*** (0.054)	-0.004 (0.018)

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Three or more times a week	-0.096 (0.820)	0.230*** (0.057)	-0.022 (0.178)	0.006 (0.056)	0.277*** (0.048)	0.002 (0.016)	-0.033 (0.083)	0.255*** (0.039)	-0.008 (0.020)
Residual			0.011 (1.335)			-0.017 (0.909)			0.066 (3.439)
Total			0.149*** (0.044)			0.175*** (0.031)			0.161*** (0.024)

Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard error displayed in parentheses.

§Both refers to sons and daughters.

Table A6-2 Decomposition of concentration index for intergenerational transmission of obesity from mothers to offspring in South Africa, 2017

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Child's age years	0.285 (2.396)	0.013 (0.010)	0.004 (0.032)	0.615 (6.534)	0.035*** (0.009)	0.021 (0.229)	1.591 (8.282)	0.024*** (0.007)	0.038 0.198
Mother's age, years	-0.028 (2.317)	0.012*** (0.003)	0.000 (0.028)	0.989 (28.699)	0.019*** (0.004)	0.018 (0.508)	1.692 (22.303)	0.015*** (0.002)	0.026 0.335
Mother's socioeconomic status	0.036 (2.407)	0.627*** (0.018)	0.022 (1.507)	0.093 (1.523)	0.630*** (0.015)	0.059 (0.961)	0.102 (8.519)	0.629*** (0.013)	0.064 5.350
Mother's population group									
Black African	-0.745 (47.900)	-0.054*** (0.008)	0.040 (2.442)	2.095 (44.654)	-0.064*** (0.007)	-0.133 (2.870)	-2.994 (19.400)	-0.059*** (0.005)	0.176 1.131
Coloured	-0.318 (5.293)	0.129*** (0.049)	-0.041 (0.635)	-0.176 (36.502)	0.205*** (0.045)	-0.036 (7.134)	-0.035 (1.612)	0.167*** (0.037)	-0.006 0.263
Asian/Indian	0.000 (-)	0.591 (-)	0.000 (-)	0.139 (1.617)	0.629*** (0.056)	0.088 (1.021)	0.000 (-)	0.612 (-)	0.000 (-)
White	-0.022 (0.307)	0.812*** (0.050)	-0.018 (0.253)	0.000 (-)	0.858 (-)	0.000 (-)	-0.140 (2.072)	0.836*** (0.030)	-0.117 1.726

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Mother's education									
No schooling	0.004 (0.095)	-0.494*** (0.102)	-0.002 (0.045)	-0.035 (2.644)	-0.431*** (0.092)	0.015 (1.141)	-0.004 (0.914)	-0.462*** (0.063)	0.002 0.418
Primary	-0.015 (0.549)	-0.530*** (0.028)	0.008 (0.293)	0.017 (1.226)	-0.438*** (0.038)	-0.007 (0.533)	-0.260 (4.010)	-0.487*** (0.022)	0.127 (1.947)
Secondary	0.558 (12.170)	-0.063*** (0.012)	-0.035 (0.795)	-0.875 (29.604)	-0.080*** (0.011)	0.070 (2.418)	-1.001 (34.162)	-0.072*** (0.008)	0.072 (2.500)
Tertiary	-0.091 (1.489)	0.298*** (0.021)	-0.027 (0.439)	-0.232 (27.308)	0.343*** (0.020)	-0.079 (9.272)	-0.064 (1.083)	0.320*** (0.015)	-0.021 (0.347)
Mother's marital status									
Married	0.087 (1.290)	0.188*** (0.021)	0.016 (0.244)	0.274 (1.675)	0.220*** (0.020)	0.060 (0.369)	0.210 (1.808)	0.204*** (0.015)	0.043 (0.367)
Living with partner	0.331 (1.601)	0.021 (0.043)	0.007 (0.042)	0.148 (1.677)	0.062*** (0.044)	0.009 (0.119)	0.030 (8.282)	0.041 (0.029)	0.001 (0.255)
Widow	0.000 (-)	-0.166 (-)	0.000 (-)	0.051 (0.143)	-0.256*** (0.086)	-0.013 (0.036)	-0.035 (0.105)	-0.211*** (0.066)	0.007 (0.020)
Divorced or separated	0.000 (0.119)	0.362*** (0.074)	0.000 (0.043)	0.000 (-)	0.477 (-)	0.000 (-)	0.000 (-)	0.430 (-)	0.00 (-)
Never married	0.106 (4.886)	-0.128*** (0.015)	-0.014 (0.595)	0.419 (14.957)	-0.167*** (0.015)	-0.070 (2.418)	1.455 (5.640)	-0.147*** (0.011)	-0.214 (0.825)

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
Area of residence									
Urban	0.062 (1.156)	0.200*** (0.010)	0.012 (0.230)	0.619 (10.228)	0.201*** (0.012)	0.125 (2.055)	-0.031 (31.047)	0.201*** (0.009)	-0.006 (6.291)
Mother's lifestyle									
Smoking	0.014 (1.200)	0.169*** (0.057)	0.002 (0.212)	-0.115 (2.410)	0.326*** (0.055)	-0.037 (0.777)	-0.089 (1.189)	0.250*** (0.042)	-0.022 (0.283)
Exercise Habits									
Never	-0.411 (35.420)	-0.058*** (0.010)	0.024 (2.027)	0.473 (14.255)	-0.055*** (0.009)	-0.026 (0.800)	-5.483 (101.763)	-0.057*** (0.007)	0.311 (5.846)
Less than once time a week	-0.036 (0.213)	0.113** (0.056)	-0.004 (0.025)	0.054 (0.927)	0.157*** (0.056)	0.008 (0.144)	-0.047 (0.429)	0.136*** (0.043)	-0.006 (0.061)
Once a week	0.000 (-)	0.327 (-)	0.000 (-)	0.033 (0.085)	-0.030 (0.081)	-0.001 (0.004)	0.000 (-)	0.185 (-)	0.000 (-)
Twice a week	-0.172 (1.981)	0.108 (0.073)	-0.019 (0.208)	0.000 (-)	0.219 (-)	0.000 (-)	0.029 (4.239)	0.166*** (0.054)	0.005 (0.691)
Three or more times a week	-0.132 (2.447)	0.230*** (0.057)	-0.030 (0.561)	0.084 (3.546)	0.277*** (0.048)	0.023 (0.950)	1.058 (7.153)	0.255*** (0.039)	0.270 (1.856)
Residual			0.350 (4.314)			0.102 (15.600)			-0.512 (20.364)
Total			0.296***			0.195***			0.237***

	Sons			Daughters			Both§		
	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions	Elasticities	Concentration indices	Contributions
			(0.113)			(0.060)			(0.062)

Significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard error displayed in parentheses.

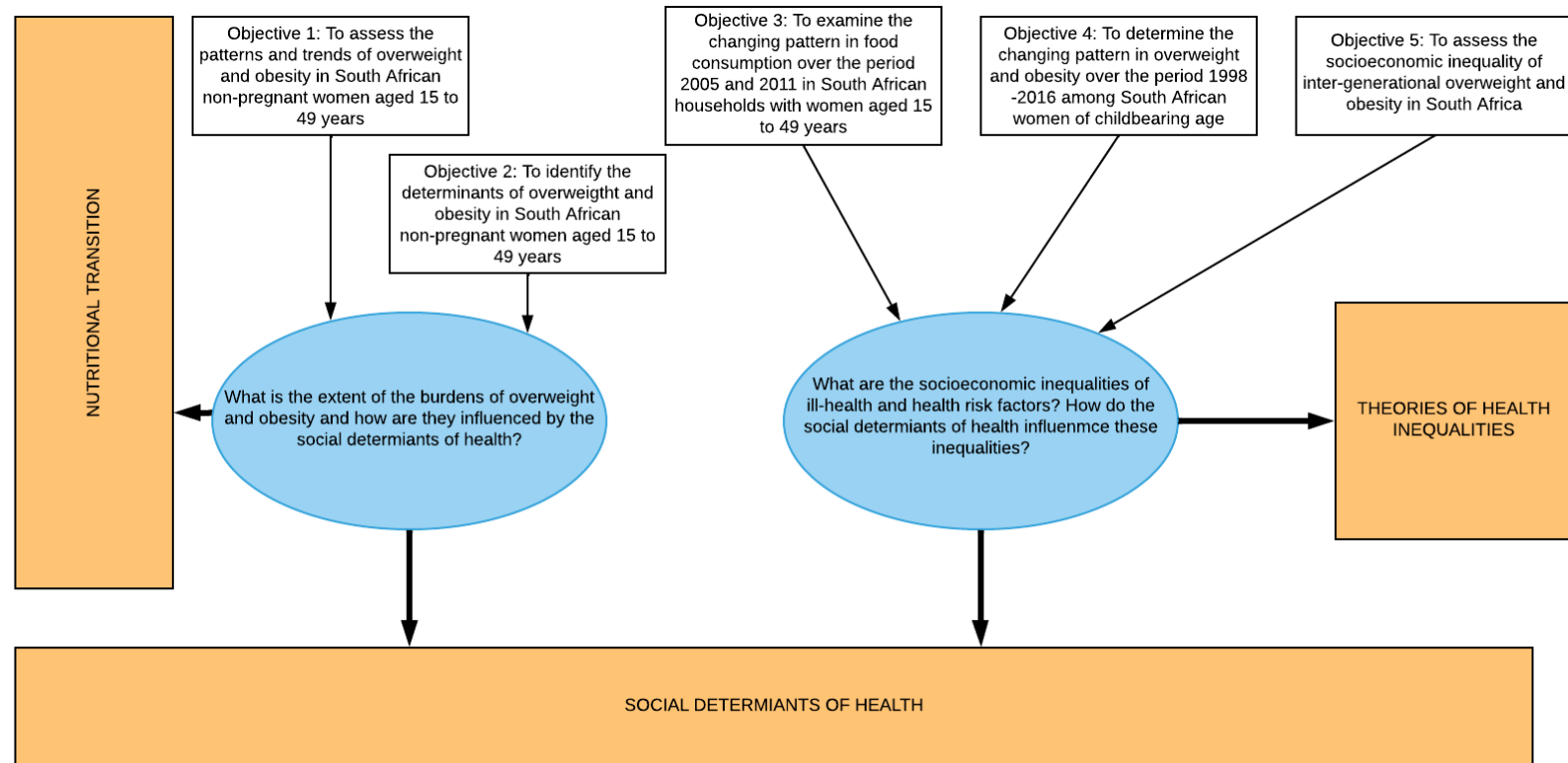
§Both refers to sons and daughters.

CHAPTER SEVEN: RECOMMENDATIONS AND CONCLUSIONS

7.1 Introduction

In this chapter, the summary of findings, the resulting conclusions, and the study limitations will be highlighted. This chapter will discuss recommendations and how the research has contributed to knowledge. **Figure 7-1** presents the different approaches to analyse overweight and obesity in South Africa for the thesis. It analysed overweight and obesity through theories of health inequalities, social determinants of health and nutrition transition lenses. Furthermore, it shows how the research objectives posed in the substantive chapters tie up together in the thesis.

Figure 7-1 Different approaches to the analysis of overweight and obesity in South Africa for the thesis



Author's illustration

7.2 Summary of research findings

The thesis' overall aim was to gather, assess, analyse and interpret national data on the pattern, prevalence and socioeconomic inequality in overweight and/or obesity in South African non-pregnant women aged 15 to 49 years old (WCBA). By analysing the changing prevalence and determinants of overweight and obesity among non-pregnant women in South Africa aged 15 to 49 years over two decades, this thesis has shown that there is a rise in the prevalence of overweight and obesity due to nutrition transition (Chapter three), among other things. Consistent with the literature, the results from chapter three indicate that factors associated with being overweight and obese were increased age, self-identifying with the Black African population group, higher educational attainment, residing in an urban area and belonging to wealthier socioeconomic quintiles. Besides, smoking had a protective effect on being overweight and obese. It can be concluded, therefore, that the increasing trend in overweight and obesity in WCBA in South Africa demands urgent public health attention, including increasing public awareness and interventions that target groups of women that have higher odds of being overweight or obese. These interventions, among others proposed in Chapter three, will reduce the economic burden and loss associated with the increasing prevalence of obesity and overweight in South Africa.

By examining the distribution of household spending according to the NOVA food classification system groupings (unprocessed or minimally processed foods, processed culinary ingredients, processed and ultra-processed food (UPF) products), this thesis has shown an increase in these expenditures (Chapter four). Using methods to measure the progressivity of UPF products spending, the study findings in Chapter four indicate that UPF consumption accounts for a substantial share of poorer households' expenditure than that of wealthier households. Based on the decomposition analysis of the changes in socioeconomic inequalities in UPF consumption between 2005/2006 and 2010/2011, the results from chapter five indicate that the decreasing inequality in UPF products spending was mainly explained by socioeconomic status, race and urban residency. It was concluded that there is a need to target households from all socioeconomic backgrounds, especially those more prone to UPF spending and its associated disease burden. Socioeconomic status, race and

urban residency are important factors to consider in designing and targeting interventions for households with WCBA.

Based on the decomposition analysis of the changes in socioeconomic inequality in overweight and obesity between 1998 and 2016, the results from chapter five indicate that the pro-rich shifts in overweight and obesity between the two-time periods (i.e., where the concentration of obesity and overweight is increasing among the rich) were attributed mainly to race and education. This was statistically significant for overweight but not obesity inequality. It was concluded again that race and education are essential factors to consider when designing interventions to reduce socioeconomic inequalities in overweight and obesity among women of child bearing age in South Africa.

Using a decomposition approach to identify determinants contributing to socioeconomic inequality in the intergenerational transmission of overweight and obesity in 2017 (chapter six), this thesis has shown that mother's socioeconomic status and education were central determinants of intergenerational overweight inequality while mother's exercise habits and education contributed to intergenerational obesity inequality. It was concluded that recognising the key factors that explain these socioeconomic inequalities is again essential when designing interventions targeting women who bear a significant burden of overweight and obesity in South Africa who are likely to transmit them to their offsprings. This has the potential not only to reduce the future burden of diseases associated with overweight and obesity but also to improve the overall health outcomes in the country.

It is worth explaining the study's finding in relation to overweight and obesity prevalence by education – in 1998, women with no schooling/primary education had higher overweight prevalence than those with tertiary education and this changed since 2010 as women with tertiary education had a higher obesity prevalence than those with secondary, primary or no formal education (**Figure 3-4**), despite an observed trend of an overall increase in per capita consumption of unhealthy food (Table 4-2). More WCBA attained higher education since 1998. The Growth, Employment and Redistribution (GEAR) Policy in 1996 liberalised the South African economy, leading to the rapidly changing food environment towards unhealthy food.

It is important to note that statistics in South Africa on unhealthy dietary habits of women by education status are scarce. This is a possible area for future research.

7.3 Limitations of the study

It is important to note that the substantive chapters contain limitations pertaining to each analysis. However, study limitations common to all chapters will be presented here.

- **Self-reported variables:** The thesis used self-reported data, including variables like physical exercise and smoking which are prone to recall bias. Unfortunately, it is difficult to assess the nature of the bias and how it will affect the results.
- **Unmeasured variables:** Given the nature of the secondary data analysis, the available data were not collected initially to answer the particular study objectives. However, most of the variables have been constructed based on literature.
- **Unmeasured confounders:** A confounding variable influences both the dependent and independent variables, thereby causing a potentially misleading association (Oakes & Kaufman, 2017). For example, many factors are associated with wealth (independent/exposure variable) and overweight/obesity (dependent/outcome variable), such as employment or occupation status. It may be that these factors explain part of the observed association.
- **Data users did not collect the data:** Related to the unmeasured variables, secondary data users do not know all data collection challenges because they did not collect the data directly. However, the documentation of each dataset was relied upon to understand nuances or challenges which occurred in the data collection process and how the variables have been collected.
- **Interpretation of the concentration index:** Given that cross-sectional data were used to compute the concentration indices, we cannot infer causality (Wagstaff et al., 2003).

7.4 Recommendations

7.4.1 Policy recommendations

This thesis provides the following overarching recommendations based on the findings and discussions. Chapter three noted that overweight and obesity prevalence among WCBA in South Africa has increased between 1998 and 2017. Also, if the current trend continues, the country may not meet the national targets on overweight and obesity set out in the National Strategic Plan for the Prevention and Control of NCDs 2013-2017—a 10% decrease in the prevalence of overweight and obesity by 2020 (Republic of South Africa, 2013a, Republic of South Africa, 2015a). It is, therefore, evident from this research that South Africa is off-track in meeting these national targets.

- Given the rise in overweight and obesity prevalence over two decades, the government should implement sensitisation and awareness-raising campaigns and programmes focusing on population-wide interventions - all ages, population groups, education statuses, areas of residence and socioeconomic statuses. A population-wide approach rather than the approach of targeting certain groups of women is appropriate because of the non-linearity of the determinants associated with overweight and obesity as seen in chapter three. Additionally, an approach of targeting certain groups of women is unnecessarily costly and difficult to implement. Moreover, the approach of targeting certain groups of women will amplify the management of overweight and obesity as opposed to prevention. Given the fact that the peoples' experience of the determinants is dynamic as seen in chapter three, a population-wide approach should address both the management and prevention of overweight and obesity concurrently. This will help to reverse or restrain the rise in overweight or obesity prevalence.
- Government policies need to shift towards discouraging UPF consumption and promoting the consumption of healthier food items. This is achievable by adding more healthy food items for zero-rating value-added tax, raising the tax on sugar-sweetened beverages and further subsidising fruits and vegetables.

- The policies to address socioeconomic inequality in UPF consumption include improving living standards that affect food consumption behaviours, implementing further social protection measures to protect the households at risk of poverty, changing cultural perceptions of norms and status to get families, including women, to adopt healthier eating habits through awareness-raising campaigns; and reducing availability and accessibility to UPF products, especially in urban areas.
- Although overweight and obesity are concentrated among the rich in South Africa, poorer individuals are more likely to have worse health outcomes related to obesity than their wealthier counterparts who have more access, especially financially, to health care. The government should, therefore, target women from all socioeconomic backgrounds, both rich and poor, but pay particular attention to more vulnerable women.
- The government should implement actions and interventions to reduce socioeconomic inequality in overweight and obesity among WCBA who are likely to transmit them to their offspring. Policy actions and interventions to reducing this inequality among WCBA in South Africa include improving living standards that affect health, implementing further social protection measures to protect the households at risk of poverty, increasing the availability and accessibility to good quality education, and culturally sensitive interventions promoting healthier lifestyles and physical activity in women.

The recommended course of action, which is about addressing the social determinants of health inequality, will reduce the burden of overweight and obesity in South Africa and possibly obesity-related health care expenses, putting less strain on the social protection system and the economy in the long term. Therefore, tackling overweight and obesity among South African WCBA is intrinsically essential, and it is an investment with considerable future gains. The recommended course of action will help achieve universal health coverage through the proposed National Health Insurance that seeks to ensure the “equitable and fair distribution and use of healthcare services” in South Africa (National Health Act, 2003).

7.4.2 Further research

Further research is needed to understand the context-specific factors among women with higher odds of being overweight or obese. This will help to tailor interventions to maximise benefits.

Also, research is needed to understand better why overweight and obesity in WCBA continue to rise. These future studies could use qualitative research methodologies for an in-depth understanding of the issues.

Future research on food consumption patterns is needed to explore factors other than household-level factors such as consumer-level dynamics and sociocultural factors affecting consumption patterns. Also, using individual-level data to assess inequality in food consumption, especially UPF, is needed.

Research is also needed to identify distal and commercial determinants of health and health inequalities in South Africa, focusing on WCBA.

There is also a need for research, especially using qualitative or quantitative approaches, to deeply understand the transmission pathways of obesity or overweight from mothers to offsprings.

Future research is needed, especially using mixed methods, to deeply understand the determinants of overweight and obesity, and how they operate at different levels such as micro (individual), meso (intermediary) and macro (public policy) levels. This approach will show policymakers ways to reduce unequal consequences, reduce vulnerabilities of people with overweight and obesity as well as reduce exposure to obesogenic environments. This would assist where to allocate limited public health resources among the competing interventions.

7.5 Contribution to knowledge

The contribution of the thesis to knowledge is mainly empirical. Female obesity is well documented in South Africa and elsewhere. While previous studies contribute to understanding the phenomenon in South Africa, analyses to understand trends and determinants among WCBA are yet to be conducted. This thesis addresses this gap by assessing the changes in overweight and obesity prevalence among WCBA in South Africa between 1998 and 2017 and by different stratifiers. The thesis also assesses the determinants of overweight and obesity among these women.

The food system has an impact on food consumption and ultimately overweight and obesity around the world. However, socioeconomic inequality in food consumption remains unclear, especially at individual level. This thesis contributes to this research using household-level data. It examined the changing patterns in socioeconomic inequalities in food consumption over the period 2005 to 2011 in South African households with women aged 15 to 49 years. This represents the first of such analyses and pointed to how households, poor and rich, spend on different food items.

In South Africa, overweight and obesity prevalence among WCBA has increased, but associated socioeconomic inequality remains unclear. This thesis addresses this gap by assessing the changing patterns in the socioeconomic inequality in overweight and obesity among South African non-pregnant WCBA between 1998 and 2016.

Overweight and obesity impact the health capital of parents and offsprings (Ojiegbe, 2016). In South Africa, 13% of children were overweight; and 27% and 41% of women aged 15 years and above were overweight and obese, respectively, in 2016 (National Department of Health et al., 2019a). This study adds new knowledge by estimating and decomposing the socioeconomic inequality in the intergenerational transmission of overweight and obesity in South Africa.

The thesis has contributed to knowledge translation and dissemination. Work from the thesis has been presented at the Non-communicable Disease Research Symposium held in Somerset West on 4 March 2020 and 11th Annual Consortium of Universities for Global Health Conference; April 18-20, 2020; Washington, DC (this conference was cancelled amidst the COVID-19 pandemic).

REFERENCES

- Abrha, S., Shiferaw, S. & Ahmed, K.Y. 2016. Overweight and obesity and its socio-demographic correlates among urban Ethiopian women: evidence from the 2011 EDHS. *BMC public health*. 16:636. DOI:10.1186/s12889-016-3315-3.
- Adamson, L., Brown, W., Byles, J., Chojenta, C., Dobson, A., Fitzgerald, D., Hockey, R., Loxton, D. et al. 2007. *Women's weight: findings from the Australian Longitudinal Study on Women's Health*. Canberra: : Australian Government Department of Health and Ageing.
- Adeboye, B., Bermano, G. & Rolland, C. 2012. Obesity and its health impact in Africa: a systematic review. *Cardiovascular journal of Africa*. 23(9):512-521. DOI:10.5830/cvja-2012-040.
- Adom, D., Hussein, E. & Joe, A.-A. 2018. Theoretical and conceptual framework: Mandatory ingredients of a quality research. *International Journal of Scientific Research*. 7:438-441.
- Agyemang, C., Boatemaa, S., Agyemang Frempong, G. & Aikins, A. 2015. Obesity in Sub-Saharan Africa. In *Metabolic Syndrome*. R. Ahima, Ed. Switzerland: Springer International Publishing. 1-13. DOI:10.1007/978-3-319-12125-3_5-1.
- Alaba, O. & Chola, L. 2014. Socioeconomic inequalities in adult obesity prevalence in South Africa: a decomposition analysis. *International journal of environmental research and public health*. 11(3):3387-3406. DOI:10.3390/ijerph110303387.
- Amugsi, D.A., Dimbuene, Z.T., Mberu, B., Muthuri, S. & Ezeh, A.C. 2017. Prevalence and time trends in overweight and obesity among urban women: an analysis of demographic and health surveys data from 24 African countries, 1991-2014. *BMJ open*. 7(10):e017344. DOI:10.1136/bmjopen-2017-017344.
- Anderson, P.M., Butcher, K.F. & Schanzenbach, D.W. 2007. *Childhood disadvantage and obesity: Is nurture trumping nature?* Cambridge: National Bureau of Economic Research.
- Appelhans, B.M., Milliron, B.J., Woolf, K., Johnson, T.J., Pagoto, S.L., Schneider, K.L., Whited, M.C. & Ventrelle, J.C. 2012. Socioeconomic status, energy cost, and nutrient content of supermarket food purchases. *American journal of preventive medicine*. 42(4):398-402. DOI:10.1016/j.amepre.2011.12.007.
- Ataguba, J.E. 2016. Assessing equitable health financing for universal health coverage: a case study of South Africa. *Applied Economics*. 48(35):3293-3306.
- Ataguba, J.E., Akazili, J. & McIntyre, D. 2011. Socioeconomic-related health inequality in South Africa: evidence from General Household Surveys. *International journal for equity in health*. 10:48. DOI:10.1186/1475-9276-10-48.
- Ataguba, J.E., Day, C. & McIntyre, D. 2015. Explaining the role of the social determinants of health on health inequality in South Africa. *Global health action*. 8: 28865.
- Ataguba, J.E., Asante, A.D., Limwattananon, S. & Wiseman, V. 2018. How to do (or not to do) ... a health financing incidence analysis. *Health policy and planning*. 33(3):436-444. DOI:10.1093/heapol/czx188.
- Averett, S.L., Stacey, N. & Wang, Y. 2014. Decomposing race and gender differences in underweight and obesity in South Africa. *Economics & Human Biology*. 15:23-40.
- Bai, J., Wahl, T.I., Lohmar, B.T. & Huang, J. 2010. Food away from home in Beijing: Effects of wealth, time and "free" meals. *China Economic Review*. 21(3):432-441.

- Balasooriya, N.N., Bandara, J.S. & Rohde, N. 2021. The intergenerational effects of socioeconomic inequality on unhealthy bodyweight. *Health economics*. 30(4):729-747. DOI:10.1002/hec.4216.
- Baraldi, L.G., Martinez Steele, E., Canella, D.S. & Monteiro, C.A. 2018. Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: evidence from a nationally representative cross-sectional study. *BMJ open*. 8(3):e020574. DOI:10.1136/bmjopen-2017-020574.
- Bartley, M. 2017. *Health inequality an introduction to concepts, theories and methods*. 2nd ed. Cambridge: Polity.
- Bartley, M., Blane, D. & Montgomery, S. 1997. Health and the life course: why safety nets matter. *BMJ (Clinical research ed.)*. 314(7088):1194-1196. DOI:10.1136/bmj.314.7088.1194.
- Belahsen, R., Mziwira, M. & Fertat, F. 2004. Anthropometry of women of childbearing age in Morocco: body composition and prevalence of overweight and obesity. *Public health nutrition*. 7(4):523-530. DOI:10.1079/phn2003570.
- Ben-Shlomo, Y. & Kuh, D. 2002. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *International journal of epidemiology*. 31(2):285-293.
- Bhargava, A. & Amialchuk, A. 2007. Added sugars displaced the use of vital nutrients in the National Food Stamp Program Survey. *The Journal of nutrition*. 137(2):453-460. DOI:10.1093/jn/137.2.453.
- Biswas, T., Uddin, M.J., Mamun, A.A., Pervin, S. & Garnett, S.P. 2017. Increasing prevalence of overweight and obesity in Bangladeshi women of reproductive age: Findings from 2004 to 2014. *PloS one*. 12(7):e0181080. DOI:10.1371/journal.pone.0181080.
- Blane, D. 1985. An assessment of the Black Report's explanations of health inequalities. *Sociology of Health & Illness*. 7(3):423-445.
- Blane, D., Smith, G.D. & Bartley, M. 1993. Social selection: what does it contribute to social class differences in health? *Sociology of Health & Illness*. 15(1):1-15.
- Blane, D., Bartley, M. & Smith, G.D. 1997. Disease aetiology and materialist explanations of socioeconomic mortality differentials. *The European Journal of Public Health*. 7(4):385-391.
- Bourdieu, P. 1984. *Distinction: A social critique of the judgement of taste*. Harvard: Harvard University Press.
- Boutelle, K.N., Cafri, G. & Crow, S.J. 2012. Parent predictors of child weight change in family based behavioral obesity treatment. *Obesity (Silver Spring, Md.)*. 20(7):1539-1543. DOI:10.1038/oby.2012.48.
- Boylan, S., Lallukka, T., Lahelma, E., Pikhart, H., Malyutina, S., Pajak, A., Kubinova, R., Bragina, O. et al. 2011. Socio-economic circumstances and food habits in Eastern, Central and Western European populations. *Public health nutrition*. 14(4):678-687. DOI:10.1017/s1368980010002570.
- Brophy, T., Branson, N., Daniels, R.C., Leibbrandt, M., Mlatsheni, C. & Woolard, I. 2018. *National Income Dynamics Study Panel User Manual. Release 2018. Version 1*. Cape Town: Southern Africa Labour and Development Research Unit.
- Brown, G.W. & Harris, T. 1978. *Social origins of depression: A study of Psychiatric Disorders in Women*. London: Tavistock.
- Brown, H. & Roberts, J. 2013. Born to be wide? Exploring correlations in mother and adolescent body mass index. *Economics Letters*. 120(3):413-415.

- Bwalya, B.B., Mapoma, C.C. & Mulenga, J.N. 2017. Rural-urban differentials in the prevalence of overweight and obesity among women of child bearing age in Zambia. *Epidemiology, Biostatistics and Public Health*. 14(2):e12247. DOI:10.2427/12247.
- Cardozo, E., Pavone, M.E. & Hirshfeld-Cytron, J.E. 2011. Metabolic syndrome and oocyte quality. *Trends in endocrinology and metabolism: TEM*. 22(3):103-109. DOI:10.1016/j.tem.2010.12.002.
- Cediël, G., Reyes, M., da Costa Louzada, M.L., Martinez Steele, E., Monteiro, C.A., Corvalán, C. & Uauy, R. 2018. Ultra-processed foods and added sugars in the Chilean diet (2010). *Public health nutrition*. 21(1):125-133. DOI:10.1017/s1368980017001161.
- Charafeddine, R., Van Oyen, H. & Demarest, S. 2009. Trends in social inequalities in obesity: Belgium, 1997 to 2004. *Preventive medicine*. 48(1):54-58. DOI:10.1016/j.ypmed.2008.09.010.
- Chiolero, A., Faeh, D., Paccaud, F. & Cornuz, J. 2008. Consequences of smoking for body weight, body fat distribution, and insulin resistance. *The American journal of clinical nutrition*. 87(4):801-809. DOI:10.1093/ajcn/87.4.801.
- Chowdhury, M.A.B., Bachman, D.J., Adnan, M.M. & Hassan, M.Z. 2018. Trends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: a pooled analysis of five national cross-sectional surveys. *BMJ open*. 8(7):e018468. DOI:10.1136/bmjopen-2017-018468.
- Chu, S.Y., Bachman, D.J., Callaghan, W.M., Whitlock, E.P., Dietz, P.M., Berg, C.J., O'Keeffe-Rosetti, M., Bruce, F.C. et al. 2008. Association between obesity during pregnancy and increased use of health care. *The New England journal of medicine*. 358(14):1444-1453. DOI:10.1056/NEJMoa0706786.
- Classen, T. & Hokayem, C. 2005. Childhood influences on youth obesity. *Economics and human biology*. 3(2):165-187. DOI:10.1016/j.ehb.2005.05.008.
- Classen, T.J. 2010. Measures of the intergenerational transmission of body mass index between mothers and their children in the United States, 1981-2004. *Economics and human biology*. 8(1):30-43. DOI:10.1016/j.ehb.2009.11.002.
- Classen, T.J. & Thompson, O. 2016. Genes and the intergenerational transmission of BMI and obesity. *Economics and human biology*. 23:121-133. DOI:10.1016/j.ehb.2016.08.001.
- Cois, A. & Day, C. 2015. Obesity trends and risk factors in the South African adult population. *BMC obesity*. 2:42. DOI:10.1186/s40608-015-0072-2.
- Costa-Font, J. & Gil, J. 2008. What lies behind socio-economic inequalities in obesity in Spain? A decomposition approach. *Food policy*. 33(1):61-73.
- Cresswell, J.A., Campbell, O.M., De Silva, M.J. & Filippi, V. 2012. Effect of maternal obesity on neonatal death in sub-Saharan Africa: multivariable analysis of 27 national datasets. *Lancet (London, England)*. 380(9850):1325-1330. DOI:10.1016/s0140-6736(12)60869-1.
- Creswell, J. 2008. The use of theory. In *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks: Sage. 49-72.
- Cumming, G. & Finch, S. 2005. Inference by eye: confidence intervals and how to read pictures of data. *American Psychologist*. 60(2):170-180.
- Dahlgren, G. & Whitehead, M. 1991. *Policies and strategies to promote social equity in health*. Stockholm: Institute for future studies.
- Dahlgren, G. & Whitehead, M. 2021. The Dahlgren-Whitehead model of health determinants: 30 years on and still chasing rainbows. *Public health*. 199:20-24. DOI:10.1016/j.puhe.2021.08.009.

- Dake, F.A., Tawiah, E.O. & Badasu, D.M. 2011. Sociodemographic correlates of obesity among Ghanaian women. *Public health nutrition*. 14(7):1285-1291. DOI:10.1017/s1368980010002879.
- Dalal, S., Beunza, J.J., Volmink, J., Adebamowo, C., Bajunirwe, F., Njelekela, M., Mozaffarian, D., Fawzi, W. et al. 2011. Non-communicable diseases in sub-Saharan Africa: what we know now. *International journal of epidemiology*. 40(4):885-901. DOI:10.1093/ije/dyr050.
- Darmon, N. & Drewnowski, A. 2008. Does social class predict diet quality? *The American journal of clinical nutrition*. 87(5):1107-1117. DOI:10.1093/ajcn/87.5.1107.
- Darmon, N. & Drewnowski, A. 2015. Contribution of food prices and diet cost to socioeconomic disparities in diet quality and health: a systematic review and analysis. *Nutrition reviews*. 73(10):643-660. DOI:10.1093/nutrit/nuv027.
- de Hoop, M. 2019. *NDOH update on healthy food option industry initiative: [PowerPoint Presentation]*. FSI Compliance Committee Meeting.
- Deaton, A. & Grosh, M. 2000. Consumption. In *Designing household survey questionnaires for developing countries*. M. Grosh and P. Glewwe, Eds.: Washington, DC: World Bank. 91 - 133.
- Department of Transport. 2003. *Pedestrian and bicycle facility guidelines*. Pretoria, South Africa: Department of Transport.
- Di Cesare, M., Khang, Y.H., Asaria, P., Blakely, T., Cowan, M.J., Farzadfar, F., Guerrero, R., Ikeda, N. et al. 2013. Inequalities in non-communicable diseases and effective responses. *Lancet (London, England)*. 381(9866):585-597. DOI:10.1016/s0140-6736(12)61851-0.
- Dinour, L.M., Bergen, D. & Yeh, M.C. 2007. The food insecurity-obesity paradox: a review of the literature and the role food stamps may play. *Journal of the American Dietetic Association*. 107(11):1952-1961. DOI:10.1016/j.jada.2007.08.006.
- Dinsa, G.D., Goryakin, Y., Fumagalli, E. & Suhrcke, M. 2012. Obesity and socioeconomic status in developing countries: a systematic review. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 13(11):1067-1079. DOI:10.1111/j.1467-789X.2012.01017.x.
- Discovery. 2021a. *HealthyFood*. Available: <https://www.discovery.co.za/vitality/healthyfood> [29 December 2021].
- Discovery. 2021b. *Vitality points*. Available: <https://www.discovery.co.za/vitality/help-points> [29 December 2021].
- Discovery. 2021c. *About our business*. Available: <https://www.discovery.co.za/corporate/sustainability-who-we-are> [29 December 2021].
- Djupegot, I.L., Nenseth, C.B., Bere, E., Bjørnarå, H.B.T., Helland, S.H., Øverby, N.C., Torstveit, M.K. & Stea, T.H. 2017. The association between time scarcity, sociodemographic correlates and consumption of ultra-processed foods among parents in Norway: a cross-sectional study. *BMC public health*. 17(1):447. DOI:10.1186/s12889-017-4408-3.
- Dolton, P. & Xiao, M. 2015. The intergenerational transmission of BMI in China. *Economics and human biology*. 19:90-113. DOI:10.1016/j.ehb.2015.06.002.
- Dolton, P. & Xiao, M. 2017. The intergenerational transmission of body mass index across countries. *Economics and human biology*. 24:140-152. DOI:10.1016/j.ehb.2016.11.005.

- Doorslaer, E.v. & Koolman, X. 2004. Explaining the differences in income-related health inequalities across European countries. *Health economics*. 13(7):609-628.
- Dorfman, S.E., Laurent, D., Gounarides, J.S., Li, X., Mullarkey, T.L., Rocheford, E.C., Sari-Sarraf, F., Hirsch, E.A. et al. 2009. Metabolic implications of dietary trans-fatty acids. *Obesity (Silver Spring, Md.)*. 17(6):1200-1207. DOI:10.1038/oby.2008.662.
- Dover, D.C. & Belon, A.P. 2019. The health equity measurement framework: a comprehensive model to measure social inequities in health. *International journal for equity in health*. 18(1):36. DOI:10.1186/s12939-019-0935-0.
- Drake, A.J. & Reynolds, R.M. 2010. Impact of maternal obesity on offspring obesity and cardiometabolic disease risk. *Reproduction (Cambridge, England)*. 140(3):387-398. DOI:10.1530/rep-10-0077.
- Dubowitz, T., Heron, M., Bird, C.E., Lurie, N., Finch, B.K., Basurto-Davila, R., Hale, L. & Escarce, J.J. 2008. Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *The American journal of clinical nutrition*. 87(6):1883-1891. DOI:10.1093/ajcn/87.6.1883.
- Dutton, G.R., Kim, Y., Jacobs, D.R., Jr., Li, X., Loria, C.M., Reis, J.P., Carnethon, M., Durant, N.H. et al. 2016. 25-year weight gain in a racially balanced sample of U.S. adults: The CARDIA study. *Obesity (Silver Spring, Md.)*. 24(9):1962-1968. DOI:10.1002/oby.21573.
- Elizabeth, L., Machado, P., Zinöcker, M., Baker, P. & Lawrence, M. 2020. Ultra-Processed Foods and Health Outcomes: A Narrative Review. *Nutrients*. 12(7). DOI:10.3390/nu12071955.
- Emamian, M.H., Fateh, M., Hosseinpour, A.R., Alami, A. & Fotouhi, A. 2017. Obesity and its socioeconomic determinants in Iran. *Economics and human biology*. 26:144-150. DOI:10.1016/j.ehb.2017.03.005.
- Esping-Andersen, G. 1990. *The three worlds of welfare capitalism*. Princeton, N.J: Princeton University Press.
- Essman, M., Taillie, L.S., Frank, T., Ng, S.W., Popkin, B.M. & Swart, E.C. 2021. Taxed and untaxed beverage intake by South African young adults after a national sugar-sweetened beverage tax: A before-and-after study. *PLoS medicine*. 18(5):e1003574. DOI:10.1371/journal.pmed.1003574.
- Faber, M. & Kruger, H.S. 2005. Dietary intake, perceptions regarding body weight, and attitudes toward weight control of normal weight, overweight, and obese Black females in a rural village in South Africa. *Ethnicity & disease*. 15(2):238-245.
- Fanzo, J. & McLaren, R. 2020. *The product reformulation journey so far: An assessment. Geneva, Switzerland: GAIN Discussion Paper Series 8*. Geneva, Switzerland: The Global Alliance for Improved Nutrition.
- Ferraro, K.F. & Shippee, T.P. 2009. Aging and cumulative inequality: how does inequality get under the skin? *The Gerontologist*. 49(3):333-343. DOI:10.1093/geront/gnp034.
- Ferraro, K.F., Shippee, T.P. & Schafer, M.H. 2009. Cumulative inequality theory for research on aging and the life course. In *Handbook of theories of aging*. V. L. Bengtson, D. Gans, N. M. Pulney and M. Silverstein, Eds.: Springer Publishing Company. 413–433.
- Finucane, M.M., Stevens, G.A., Cowan, M.J., Danaei, G., Lin, J.K., Paciorek, C.J., Singh, G.M., Gutierrez, H.R. et al. 2011. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet (London, England)*. 377(9765):557-567. DOI:10.1016/s0140-6736(10)62037-5.

- Flegal, K.M., Kit, B.K., Orpana, H. & Graubard, B.I. 2013. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *Jama*. 309(1):71-82. DOI:10.1001/jama.2012.113905.
- Food Safety Initiative. 2021. Healthy food option initiative. Available:<https://www.cgcsa.co.za/service-offering/food-safety-initiative/healthy-food-options-initiatives/> [29 December 2021].
- Foodstuffs, Cosmetics and Disinfectants Act, No. 54 of 1972, as amended. 2011. *Regulation relating to trans-fat n foods*. *Government Gazette 34029*. *Government Notice no. R127*. 17 February. Cape Town: Government Printers.
- Foodstuffs, Cosmetics and Disinfectants Act, No. 54 of 1972, as amended. 2014. *Regulation relating to the labelling and advertisement of foods*. *Government Gazette 37695*. *Government Notice no. R429*. 29 May. Cape Town: Government Printers.
- Foodstuffs, Cosmetics and Disinfectants Act, No. 54 of 1972, as amended. 2019. *Regulation relating to reduction of sodium in certain foodstuffs and related matters*. *Government Gazette 42496*. *Government Notice no. 812*. 31 May. Cape Town: Government Printers.
- Forouzanfar, M.H., Alexander, L., Anderson, H.R., Bachman, V.F., Biryukov, S., Brauer, M., Burnett, R., Casey, D. et al. 2015. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet (London, England)*. 386(10010):2287-2323. DOI:10.1016/s0140-6736(15)00128-2.
- Galobardes, B., Shaw, M., Lawlor, D.A. & Lynch, J.W. 2006. Indicators of socioeconomic position (part 1). *Journal of epidemiology and community health*. 60(1):7-12. DOI:10.1136/jech.2004.023531.
- Garrett, J. & Ruel, M.T. 2005. The coexistence of child undernutrition and maternal overweight: prevalence, hypotheses, and programme and policy implications. *Maternal & child nutrition*. 1(3):185-196. DOI:10.1111/j.1740-8709.2005.00034.x.
- Geronimus, A.T. 1992. The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethnicity & disease*. 2(3):207-221.
- Giskes, K., Avendano, M., Brug, J. & Kunst, A.E. 2010. A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 11(6):413-429. DOI:10.1111/j.1467-789X.2009.00658.x.
- Global Burden of Disease 2016 Risk Factors Collaborators. 2017. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet (London, England)*. 390(10100):1345-1422. DOI:10.1016/s0140-6736(17)32366-8.
- Global Burden of Disease 2019 Risk Factors Collaborators. 2020. Global burden of 87 risk factors in 204 countries and territories, 1990 - 2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*. 396(10258):1223-1249. DOI:10.1016/S0140-6736(20)30752-2.
- Goedecke, J.H., Mtintsilana, A., Dlamini, S.N. & Kengne, A.P. 2017. Type 2 diabetes mellitus in African women. *Diabetes research and clinical practice*. 123:87-96. DOI:10.1016/j.diabres.2016.11.017.

- Goedecke, J.H., Micklesfield, L.K., Levitt, N.S., Lambert, E.V., West, S., Maartens, G. & Dave, J.A. 2013. Effect of different antiretroviral drug regimens on body fat distribution of HIV-infected South African women. *AIDS research and human retroviruses*. 29(3):557-563. DOI:10.1089/aid.2012.0252.
- Goldberg, D.S. 2012. Social justice, health inequalities and methodological individualism in US health promotion. *Public Health Ethics*. 5(2):104-115.
- Gordon-Larsen, P., The, N.S. & Adair, L.S. 2010. Longitudinal trends in obesity in the United States from adolescence to the third decade of life. *Obesity (Silver Spring, Md.)*. 18(9):1801-1804. DOI:10.1038/oby.2009.451.
- Goryakin, Y., Aldea, A., Lerouge, A. & Guillemette, Y. 2019. *Special focus: The health and economic impact of food reformulation*. DOI:doi:<https://doi.org/10.1787/c031ce2c-en>.
- Gould, B.W. & Villarreal, H.J. 2006. An assessment of the current structure of food demand in urban China. *Agricultural Economics*. 34(1):1-16.
- Grajek, M., Kryska, S., Bielaszka, A., Kiciak, A. & Kardas, M. 2015. Psychosocial opinions on determinants of food choices. *Problemy Higieny Epidemiologii*. 96(1):37-41.
- Gray, L. & Leyland, A.H. 2009. A multilevel analysis of diet and socio-economic status in Scotland: investigating the 'Glasgow effect'. *Public health nutrition*. 12(9):1351-1358. DOI:10.1017/s1368980008004047.
- Groth, M.V., Fagt, S. & Brondsted, L. 2001. Social determinants of dietary habits in Denmark. *European journal of clinical nutrition*. 55(11):959-966. DOI:10.1038/sj.ejcn.1601251.
- Gwatkin, D.R. 2000. Health inequalities and the health of the poor: what do we know? What can we do? *Bulletin of the World Health Organization*. 78(1):3-18.
- Hajizadeh, M., Campbell, M.K. & Sarma, S. 2014. Socioeconomic inequalities in adult obesity risk in Canada: trends and decomposition analyses. *The European Journal of Health Economics*. 15(2):203-221.
- Hambidge, K.M., Krebs, N.F., Garcés, A., Westcott, J.E., Figueroa, L., Goudar, S.S., Dhaded, S., Pasha, O. et al. 2018. Anthropometric indices for non-pregnant women of childbearing age differ widely among four low-middle income populations. *BMC public health*. 18(1):45. DOI:10.1186/s12905-020-01135-x.
- Hamid, S., Groot, W. & Pavlova, M. 2019. Trends in cardiovascular diseases and associated risks in sub-Saharan Africa: a review of the evidence for Ghana, Nigeria, South Africa, Sudan and Tanzania. *The aging male : the official journal of the International Society for the Study of the Aging Male*. 22(3):1-8. DOI:10.1080/13685538.2019.1582621.
- Hasan, E., Khanam, M. & Shimul, S.N. 2020. Socio-economic inequalities in overweight and obesity among women of reproductive age in Bangladesh: a decomposition approach. *BMC women's health*. 20(1):263. DOI:10.1186/s12905-020-01135-x.
- Hawkes, C. 2006. Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Globalization and health*. 2:4. DOI:10.1186/1744-8603-2-4.
- He, Y., Pan, A., Yang, Y., Wang, Y., Xu, J., Zhang, Y., Liu, D., Wang, Q. et al. 2016. Prevalence of Underweight, Overweight, and Obesity Among Reproductive-Age Women and Adolescent Girls in Rural China. *American journal of public health*. 106(12):2103-2110. DOI:10.2105/ajph.2016.303499.
- Hemingway, H. & Marmot, M. 1999. Clinical Evidence: Psychosocial factors in the etiology and prognosis of coronary heart disease: systematic review of prospective cohort studies. *The Western journal of medicine*. 171(5-6):342-350.

- Herbert-Magee, S. 2019. Is Advertising a Social Determinant of Health—You Bet! *Harvard Public Health Review*. 22:1-3.
- High Level Panel of Experts. 2017. *Nutritoin and food systems: a report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*. Rome.
- Hoffmann, K., De Gelder, R., Hu, Y., Bopp, M., Vitrai, J., Lahelma, E., Menvielle, G., Santana, P. et al. 2017. Trends in educational inequalities in obesity in 15 European countries between 1990 and 2010. *International Journal of Behavioral Nutrition and Physical Activity*. 14(1):63. DOI:10.1186/s12966-017-0517-8.
- Hong, S.A., Kim, K. & Kim, M.K. 2012. Trends in the inequality of fruit and vegetable consumption between education levels indicated by the Korea National Health and Nutrition Examination Surveys. *European journal of clinical nutrition*. 66(8):942-949. DOI:10.1038/ejcn.2012.39.
- Hosseini Shokouh, S.M., Arab, M., Emamgholipour, S., Rashidian, A., Montazeri, A. & Zaboli, R. 2017. Conceptual Models of Social Determinants of Health: A Narrative Review. *Iranian Journal of Public Health*. 46(4):435-446.
- Hosseinpour, A.R., Van Doorslaer, E., Speybroeck, N., Naghavi, M., Mohammad, K., Majdzadeh, R., Delavar, B., Jamshidi, H. et al. 2006. Decomposing socioeconomic inequality in infant mortality in Iran. *International journal of epidemiology*. 35(5):1211-1219.
- Hulshof, K.F., Brussaard, J.H., Kruizinga, A.G., Telman, J. & Lowik, M.R. 2003. Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. *European journal of clinical nutrition*. 57(1):128-137. DOI:10.1038/sj.ejcn.1601503.
- Hunter-Adams, J., Battersby, J. & Oni, T. 2019. Food insecurity in relation to obesity in peri-urban Cape Town, South Africa: Implications for diet-related non-communicable disease. *Appetite*. 137:244-249. DOI:10.1016/j.appet.2019.03.012.
- Hunter, J., Chandran, T., Asmall, S., Tucker, J. & Ntshengedzeni, R. 2017. *South African Health Review 2017*. Durban: Health Systems Trust.
- Hwang, J., Lee, E.Y. & Lee, C.G. 2019. Measuring Socioeconomic Inequalities in Obesity among Korean Adults, 1998-2015. *International journal of environmental research and public health*. 16(9):1617. DOI:10.3390/ijerph16091617.
- Igumbor, E.U., Sanders, D., Puoane, T.R., Tsolekile, L., Schwarz, C., Purdy, C., Swart, R., Durão, S. et al. 2012. "Big food," the consumer food environment, health, and the policy response in South Africa. *PLoS medicine*. 9(7):e1001253. DOI:10.1371/journal.pmed.1001253.
- Institute for Health Metrics and Evaluation. 2017a. *GBD Compare. Data Vizualization*. Seattle, Washington: IHME, University of Washington. Available: <http://vizhub.healthdata.org/gbd-compare> [22 December 2017].
- Institute for Health Metrics and Evaluation. 2017b. *Overweight and Obesity Viz*. Seattle, Washington: IHME, University of Washington. Available: <http://vizhub.healthdata.org/obesity>. [21 February 2019].
- Institute for Health Metrics and Evaluation. 2019. *GBD Compare. Data Vizualization*. Seattle, Washington: IHME, University of Washington. Available: <http://vizhub.healthdata.org/gbd-compare> [21 February 2019].
- Jackson, P. 2004. Local consumption cultures in a globalizing world. *Transactions of the Institute of British Geographers*. 29(2):165-178.

- Jackson, R.T., Rashed, M. & Saad-Eldin, R. 2003. Rural urban differences in weight, body image, and dieting behavior among adolescent Egyptian schoolgirls. *International journal of food sciences and nutrition*. 54(1):1-11. DOI:10.1080/096374803/000062047.
- James, F.R., Wootton, S., Jackson, A., Wiseman, M., Copson, E.R. & Cutress, R.I. 2015. Obesity in breast cancer--what is the risk factor? *European journal of cancer (Oxford, England : 1990)*. 51(6):705-720. DOI:10.1016/j.ejca.2015.01.057.
- Jansen, A. & Calitz, E. 2017. Considering the efficacy of value-added tax zero-rating as pro-poor policy: The case of South Africa. *Development Southern Africa*. 34(1):56-73.
- Jungheim, E.S., Schoeller, E.L., Marquard, K.L., Loudon, E.D., Schaffer, J.E. & Moley, K.H. 2010. Diet-induced obesity model: abnormal oocytes and persistent growth abnormalities in the offspring. *Endocrinology*. 151(8):4039-4046. DOI:10.1210/en.2010-0098.
- Kakwani, N., Wagstaff, A. & Van Doorslaer, E. 1997. Socioeconomic inequalities in health: measurement, computation, and statistical inference. *Journal of econometrics*. 77(1):87-103.
- Kamphuis, C.B., van Lenthe, F.J., Giskes, K., Brug, J. & Mackenbach, J.P. 2007. Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health & place*. 13(2):493-503. DOI:10.1016/j.healthplace.2006.05.008.
- Kawachi, I. & Kennedy, B.P. 1997. The relationship of income inequality to mortality: does the choice of indicator matter? *Social science & medicine (1982)*. 45(7):1121-1127. DOI:10.1016/s0277-9536(97)00044-0.
- Kearney, J. 2010. Food consumption trends and drivers. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*. 365(1554):2793-2807. DOI:10.1098/rstb.2010.0149.
- Kickbusch, I., Allen, L. & Franz, C. 2016. The commercial determinants of health. *The Lancet. Global health*. 4(12):e895-e896. DOI:10.1016/s2214-109x(16)30217-0.
- Kirk, D. 1996. Demographic transition theory. *Population studies*. 50(3):361-387. DOI:10.1080/0032472031000149536.
- Kirsten, A.P., Marais, D. & Schübl, C. 2013. The influence of socio-demographic factors on the nutritional status of children in the Stellenbosch area, Western Cape. *South African Journal of Clinical Nutrition*. 26(3):124-131.
- Kolbe-Alexander, T.L., Conradie, J. & Lambert, E.V. 2013. Clustering of risk factors for non-communicable disease and healthcare expenditure in employees with private health insurance presenting for health risk appraisal: a cross-sectional study. *BMC public health*. 13:1213. DOI:10.1186/1471-2458-13-1213.
- Kolbe-Alexander, T.L., Pacheco, K., Tomaz, S.A., Karpul, D. & Lambert, E.V. 2015. The relationship between the built environment and habitual levels of physical activity in South African older adults: a pilot study. *BMC public health*. 15(1):518.
- Kriaucioniene, V., Petkeviciene, J., Klumbiene, J., Sakyte, E. & Raskiliene, A. 2016. Socio-demographic inequalities in overweight and obesity among Lithuanian adults: time trends from 1994 to 2014. *Scandinavian journal of public health*. 44(4):377-384.
- Krieger, N., Williams, D.R. & Moss, N.E. 1997. Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annual review of public health*. 18:341-378. DOI:10.1146/annurev.publhealth.18.1.341.

- Kroll, F., Swart, E.C., Annan, R.A., Thow, A.M., Neves, D., Apprey, C., Aduku, L.N.E., Agyapong, N.A.F. et al. 2019. Mapping obesogenic food environments in South Africa and Ghana: Correlations and contradictions. *Sustainability*. 11(14):3924.
- Lake, A. & Townshend, T. 2006. Obesogenic environments: exploring the built and food environments. *The journal of the Royal Society for the Promotion of Health*. 126(6):262-267.
- Lambert, E.V. & Kolbe-Alexander, T.L. 2013. Innovative strategies targeting obesity and non-communicable diseases in South Africa: what can we learn from the private healthcare sector? *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 14 Suppl 2:141-149. DOI:10.1111/obr.12094.
- Lang, T. & Rayner, G. 2007. Overcoming policy cacophony on obesity: an ecological public health framework for policymakers. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 8 Suppl 1:165-181. DOI:10.1111/j.1467-789X.2007.00338.x.
- Langellier, B.A. 2015. Consumption and expenditure on food prepared away from home among Mexican adults in 2006. *Salud publica de Mexico*. 57(1):4-13.
- Leary, C., Leese, H.J. & Sturmey, R.G. 2015. Human embryos from overweight and obese women display phenotypic and metabolic abnormalities. *Human reproduction (Oxford, England)*. 30(1):122-132. DOI:10.1093/humrep/deu276.
- Lee, K.W., Song, W.O. & Cho, M.S. 2016. Dietary quality differs by consumption of meals prepared at home vs. outside in Korean adults. *Nutrition research and practice*. 10(3):294-304. DOI:10.4162/nrp.2016.10.3.294.
- Leibbrandt, C.M. & Woolard, I. 2016. *National Income Dynamics Study Panel User Manual*. Cape Town: Southern Africa Labour and Development Research Unit.
- Leibbrandt, M., Woolard, I. & de Villiers, L. 2009. *Methodology: Report on NIDS wave 1. Technical paper no. 1*. Cape Town: Southern Africa Labour and Development Research Unit.
- Letamo, G. 2011. The prevalence of, and factors associated with, overweight and obesity in Botswana. *Journal of biosocial science*. 43(1):75-84. DOI:10.1017/s0021932010000519.
- Li, M., Sloboda, D.M. & Vickers, M.H. 2011. Maternal obesity and developmental programming of metabolic disorders in offspring: evidence from animal models. *Experimental diabetes research*. 2011:592408. DOI:10.1155/2011/592408.
- Link, B.G. & Phelan, J. 1995. Social conditions as fundamental causes of disease. *Journal of health and social behavior*. Spec No:80-94.
- Little, M., Humphries, S., Patel, K. & Dewey, C. 2016. Factors associated with BMI, underweight, overweight, and obesity among adults in a population of rural south India: a cross-sectional study. *BMC obesity*. 3(1):12.
- Ljungvall, A. & Gerdtham, U.G. 2010. More equal but heavier: a longitudinal analysis of income-related obesity inequalities in an adult Swedish cohort. *Social science & medicine (1982)*. 70(2):221-231. DOI:10.1016/j.socscimed.2009.10.014.
- Lokuruka, M.N.I. 2013. A literature review of role of obesity in adult health with reference to Africa. *The African Journal of Food, Agriculture, Nutrition and Development*. 13(1):1-17.
- Lynch, C.M., Sexton, D.J., Hession, M. & Morrison, J.J. 2008. Obesity and mode of delivery in primigravid and multigravid women. *American journal of perinatology*. 25(3):163-167. DOI:10.1055/s-2008-1061496.

- Lynch, J. 2000. Income inequality and health: expanding the debate. *Social science & medicine* (1982). 51(7):1001-1005; discussion 1009-1010. DOI:10.1016/s0277-9536(00)00080-0.
- Lynch, J., Smith, G.D., Harper, S., Hillemeier, M., Ross, N., Kaplan, G.A. & Wolfson, M. 2004. Is income inequality a determinant of population health? Part 1. A systematic review. *The Milbank quarterly*. 82(1):5-99. DOI:10.1111/j.0887-378x.2004.00302.x.
- Lynch, J.W., Smith, G.D., Kaplan, G.A. & House, J.S. 2000. Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. *BMJ (Clinical research ed.)*. 320(7243):1200-1204.
- Lynch, J.W., Kaplan, G.A., Pamuk, E.R., Cohen, R.D., Heck, K.E., Balfour, J.L. & Yen, I.H. 1998. Income inequality and mortality in metropolitan areas of the United States. *American journal of public health*. 88(7):1074-1080. DOI:10.2105/ajph.88.7.1074.
- Ma, Y., He, F.J. & MacGregor, G.A. 2015. High salt intake: independent risk factor for obesity? *Hypertension (Dallas, Tex. : 1979)*. 66(4):843-849. DOI:10.1161/hypertensionaha.115.05948.
- Mackenbach, J.P., Kulhánová, I., Menvielle, G., Bopp, M., Borrell, C., Costa, G., Deboosere, P., Esnaola, S. et al. 2015. Trends in inequalities in premature mortality: a study of 3.2 million deaths in 13 European countries. *Journal of epidemiology and community health*. 69(3):207-217; discussion 205-206. DOI:10.1136/jech-2014-204319.
- Mahapatra, P. & Latha, P. 2002. *Reproductive Health Status in Andhra Pradesh*. Hyderabad, India: Institute of Health Systems.
- Mahlathi, P. & Dlamini, J. 2015. Minimum data sets for human resources for health and the surgical workforce in South Africa's health system: a rapid analysis of stock and migration. *Pretoria, South Africa: African Institute of Health and Leadership Development and World Health Organization*.
- Malambo, P., Kengne, A.P., Lambert, E.V., De Villiers, A. & Puoane, T. 2017. Association between perceived built environmental attributes and physical activity among adults in South Africa. *BMC public health*. 17(1):1-16.
- Manyema, M., Veerman, L.J., Chola, L., Tugendhaft, A., Sartorius, B., Labadarios, D. & Hofman, K.J. 2014. The potential impact of a 20% tax on sugar-sweetened beverages on obesity in South African adults: a mathematical model. *PLoS One*. 9(8):e105287.
- Marmot, M., Siegrist, J. & Theorell, T. 2006. Health and the psychosocial work environment. In *Social determinants of health*. M.G. Marmot and R.G. Wilkinson, Eds. Oxford: Oxford University Press. 97 -130.
- Marmot, M.G., Stansfeld, S., Patel, C., North, F., Head, J., White, I., Brunner, E., Feeney, A. et al. 1991. Health inequalities among British civil servants: the Whitehall II study. *The Lancet*. 337(8754):1387-1393. DOI:[https://doi.org/10.1016/0140-6736\(91\)93068-K](https://doi.org/10.1016/0140-6736(91)93068-K).
- Marrón-Ponce, J.A., Tolentino-Mayo, L., Hernández, F.M. & Batis, C. 2018a. Trends in Ultra-Processed Food Purchases from 1984 to 2016 in Mexican Households. *Nutrients*. 11(1). DOI:10.3390/nu11010045.
- Marrón-Ponce, J.A., Sánchez-Pimienta, T.G., Louzada, M. & Batis, C. 2018b. Energy contribution of NOVA food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. *Public health nutrition*. 21(1):87-93. DOI:10.1017/s1368980017002129.
- Martin, C. 2015. Southern welfare states: Configuration of the welfare balance between state and the family. *Southern Europe*.77-100.

- Martin, M.A. 2008. The intergenerational correlation in weight: How genetic resemblance reveals the social role of families. *American Journal of Sociology*. 114(SUPPL. 1):S67-S105. DOI:10.1086/592203.
- Martins, A.P., Levy, R.B., Claro, R.M., Moubarac, J.C. & Monteiro, C.A. 2013. Increased contribution of ultra-processed food products in the Brazilian diet (1987-2009). *Rev Saude Publica*. 47(4):656-665. DOI:10.1590/s0034-8910.2013047004968.
- Mayen, A.L., Bovet, P., Marti-Soler, H., Viswanathan, B., Gedeon, J., Paccaud, F., Marques-Vidal, P. & Stringhini, S. 2016. Socioeconomic Differences in Dietary Patterns in an East African Country: Evidence from the Republic of Seychelles. *PLoS one*. 11(5):e0155617. DOI:10.1371/journal.pone.0155617.
- McCartney, D.M., Younger, K.M., Walsh, J., O'Neill, M., Sheridan, C. & Kearney, J.M. 2013. Socio-economic differences in food group and nutrient intakes among young women in Ireland. *The British journal of nutrition*. 110(11):2084-2097. DOI:10.1017/s0007114513001463.
- McLaren, L. 2007. Socioeconomic status and obesity. *Epidemiologic reviews*. 29:29-48. DOI:10.1093/epirev/mxm001.
- Meko, L.N., Slabber-Stretch, M., Walsh, C.M., Kruger, S.H. & Nel, M. 2015. School environment, socioeconomic status and weight of children in Bloemfontein, South Africa. *African journal of primary health care & family medicine*. 7(1):751. DOI:10.4102/phcfm.v7i1.751.
- Metcalf, P., Scragg, R. & Davis, P. 2006. Dietary intakes by different markers of socioeconomic status: results of a New Zealand workforce survey. *The New Zealand medical journal*. 119(1240):U2127.
- Mfenyana, K., Griffin, M., Yogeswaran, P., Modell, B., Modell, M., Chandia, J. & Nazareth, I. 2006. Socio-economic inequalities as a predictor of health in South Africa--the Yenza cross-sectional study. *South African medical journal*. 96(4):323-330.
- Mia, M.N., Rahman, M.S. & Roy, P.K. 2018. Sociodemographic and geographical inequalities in under- and overnutrition among children and mothers in Bangladesh: a spatial modelling approach to a nationally representative survey. *Public health nutrition*. 21(13):2471-2481. DOI:10.1017/s1368980018000988.
- Micha, R., Mannar, V., Afshin, A., Allemandi, L., Baker, P., Battersby, J., Bhutta, Z., Chen, K. et al. 2020. *2020 Global nutrition report: action on equity to end malnutrition*. (1916445276). Bristol, United Kingdom.
- Micklesfield, L.K., Lambert, E.V., Hume, D.J., Chantler, S., Pienaar, P.R., Dickie, K., Puoane, T. & Goedecke, J.H. 2013. Socio-cultural, environmental and behavioural determinants of obesity in black South African women. *Cardiovascular journal of Africa*. 24(9-10):369-375. DOI:10.5830/cvja-2013-069.
- Miller, V., Yusuf, S., Chow, C.K., Dehghan, M., Corsi, D.J., Lock, K., Popkin, B., Rangarajan, S. et al. 2016. Availability, affordability, and consumption of fruits and vegetables in 18 countries across income levels: findings from the Prospective Urban Rural Epidemiology (PURE) study. *The lancet global health*. 4(10):e695-e703.
- Misselhorn, A. & Hendriks, S.L. 2017. A systematic review of sub-national food insecurity research in South Africa: Missed opportunities for policy insights. *PLoS one*. 12(8):e0182399. DOI:10.1371/journal.pone.0182399.
- Miura, K., Giskes, K. & Turrell, G. 2009. Socioeconomic differences in takeaway food consumption and their contribution to inequalities in dietary intakes. *Journal of Epidemiology & Community Health*. 63(10):820-826.

- Miura, K., Giskes, K. & Turrell, G. 2012. Socio-economic differences in takeaway food consumption among adults. *Public health nutrition*. 15(2):218-226.
- Mlangeni, L., Makola, L., Naidoo, I., Chibi, B., Sokhela, Z., Silimfe, Z. & Mabaso, M. 2018. Factors associated with physical activity in South Africa: evidence from a National Population Based Survey. *The Open Public Health Journal*. 11(1):516-525.
- Monteiro, C., Cannon, G., Levy, R., Claro, R., Moubarac, J., Martins, A., Louzada, M., Baraldi, L. et al. 2012. The Food System. Processing. The big issue for disease, good health, well-being. *World Nutr*. 3(12):527–569.
- Monteiro, C.A., Levy, R.B., Claro, R.M., de Castro, I.R.R. & Cannon, G. 2010. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. *Public health nutrition*. 14(1):5-13.
- Monteiro, C.A., Cannon, G., Levy, R., Moubarac, J.-C., Jaime, P., Martins, A.P., Canella, D., Louzada, M. et al. 2016. NOVA. The star shines bright. *World Nutrition*. 7(1-3):28-38.
- Morland, K.B. & Evenson, K.R. 2009. Obesity prevalence and the local food environment. *Health & place*. 15(2):491-495.
- Moubarac, J.-C., Parra, D.C., Cannon, G. & Monteiro, C.A. 2014. Food classification systems based on food processing: significance and implications for policies and actions: a systematic literature review and assessment. *Current obesity reports*. 3(2):256-272.
- Moubarac, J.-C., Martins, A.P.B., Claro, R.M., Levy, R.B., Cannon, G. & Monteiro, C.A. 2013. Consumption of ultra-processed foods and likely impact on human health. Evidence from Canada. *Public health nutrition*. 16(12):2240-2248.
- Moubarac, J.C., Claro, R.M., Baraldi, L.G., Levy, R.B., Martins, A.P., Cannon, G. & Monteiro, C.A. 2013. International differences in cost and consumption of ready-to-consume food and drink products: United Kingdom and Brazil, 2008-2009. *Global public health*. 8(7):845-856. DOI:10.1080/17441692.2013.796401.
- Mukabutera, A., Nsereko, E., Aline, U., Umwungerimwiza, Y.D. & Cyprien, M. 2016. Overweight or obesity prevalence, trends and risk factors among women in Rwanda: A cross-sectional study using the Rwanda Demographic and Health Surveys, 2000–2010. *Rwanda Journal*. 3(1):14-20.
- Mukora-Mutseyekwa, F., Zeeb, H., Nengomasha, L. & Kofi Adjei, N. 2019. Trends in Prevalence and Related Risk Factors of Overweight and Obesity among Women of Reproductive Age in Zimbabwe, 2005-2015. *International journal of environmental research and public health*. 16(15):2758. DOI:10.3390/ijerph16152758.
- Mummert, A., Esche, E., Robinson, J. & Armelagos, G.J. 2011. Stature and robusticity during the agricultural transition: evidence from the bioarchaeological record. *Economics and human biology*. 9(3):284-301. DOI:10.1016/j.ehb.2011.03.004.
- Najafi, F., Pasdar, Y., Hamzeh, B., Rezaei, S., Moradi Nazar, M. & Soofi, M. 2018. Measuring and Decomposing Socioeconomic Inequalities in Adult Obesity in Western Iran. *Journal of preventive medicine and public health = Yebang Uihakhoe chi*. 51(6):289-297. DOI:10.3961/jpmp.18.062.
- Najafi, F., Soltani, S., Karami Matin, B., Kazemi Karyani, A., Rezaei, S., Soofi, M., Salimi, Y., Moradinazar, M. et al. 2020. Socioeconomic - related inequalities in overweight and obesity: findings from the PERSIAN cohort study. *BMC public health*. 20(1):214. DOI:10.1186/s12889-020-8322-8.
- Nakimuli, B. 2016. Socioeconomic inequalities of childhood obesity in South Africa. Master of Public Health (Health Economics) Thesis. University of Cape Town.

- National Committee on the Confidential Enquiries into Maternal Deaths. 2015. *Saving mothers 2011–2013: sixth report on confidential enquiries into maternal deaths in South Africa, short report*. Pretoria: National Department of Health.
- National Department of Health. 2016. National guide for healthy meal provisioning in the workplace. Pretoria, South Africa: National Department of Health.
- National Department of Health & Macro International. 2002. *South Africa Demographic and Health Survey 1998*. Pretoria, South Africa. Available: <http://dhsprogram.com/pubs/pdf/FR131/FR131.pdf> [22 December 2017].
- National Department of Health, South African Medical Research Council & Macri International Inc. 2007. *South African Demographic and Health Survey 2003*. Pretoria, South Africa.
- National Department of Health, Medical Research Council & The DHS Program. 2017. *South Africa Demographic and Health Survey 2016: Key Indicator Report*. Pretoria: Statistics South Africa
- National Department of Health, Medical Research Council & ICF. 2019a. South Africa Demographic and Health Survey 2016. Available: <https://www.samrc.ac.za/reports/sadhs2016> [22 February 2019].
- National Department of Health, Statistics South Africa, South African Medical Research Council & ICF. 2019b. *South Africa Demographic and Health Survey 2016*. Pretoria, South Africa and Rockville, Maryland, United States: National Department of Health, Statistics South Africa, South African Medical Research Council, and ICF.
- National Health Act. 2003. *National Health Insurance Policy*. *Government Gazette 40965*. *Government Notice no. 627*. 30 June. Cape Town: Government Printers.
- National Sports and Recreation Act, No. 110 of 1998. 1998. *Government Gazette 19551*. *Government Notice no. 1577*. 4 December. Cape Town: Government Printers.
- Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E.C., Biryukov, S. et al. 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet (London, England)*. 384(9945):766-781. DOI:10.1016/s0140-6736(14)60460-8.
- Nieuwoudt, M., van der Merwe, J.L., Harvey, J. & Hall, D.R. 2014. Pregnancy outcomes in super-obese women—an even bigger problem? A prospective cohort study. *South African Journal of Obstetrics and Gynaecology*. 20(2):54-59.
- Nikolaou, A. & Nikolaou, D. 2008. Income-related inequality in the distribution of obesity among Europeans. *Journal of Public Health*. 16(6):403-411.
- Njelekela, M.A., Liu, E., Mpembeni, R., Muhihi, A., Mligiliche, N., Spiegelman, D., Finkelstein, J.L., Fawzi, W.W. et al. 2011. Socio-economic status, urbanization, and cardiometabolic risk factors among middle-aged adults in Tanzania. *East African journal of public health*. 8(3):216-223.
- Nojilana, B., Bradshaw, D., Pillay-van Wyk, V., Msemburi, W., Somdyala, N., Joubert, J.D., Groenewald, P., Laubscher, R. et al. 2016. Persistent burden from non-communicable diseases in South Africa needs strong action. *South African medical journal*. 106(5):23-24. DOI:10.7196/SAMJ.2016.v106i5.10776.
- Non-Communicable Disease Countdown 2030 Collaborators. 2020. NCD Countdown 2030: pathways to achieving Sustainable Development Goal target 3.4. *Lancet (London, England)*. 396:918-934. DOI:10.1016/s0140-6736(20)31761-x.
- Non-Communicable Disease Risk Factor Collaboration – Africa Working Group. 2017. Worldwide trends in body-mass index, underweight, overweight, and obesity from

- 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet (London, England)*. 390(10113):2627-2642. DOI:10.1016/s0140-6736(17)32129-3.
- Non-Communicable Diseases Risk Factor Collaboration – Africa Working Group. 2017. Trends in obesity and diabetes across Africa from 1980 to 2014: an analysis of pooled population-based studies. *International journal of epidemiology*. 46(5):1421-1432. DOI:10.1093/ije/dyx078.
- Norman, J.E., Bild, D., Lewis, C.E., Liu, K. & West, D.S. 2003. The impact of weight change on cardiovascular disease risk factors in young black and white adults: the CARDIA study. *International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity*. 27(3):369-376. DOI:10.1038/sj.ijo.0802243.
- Ntsie, R. 2018. *Implementation of the strategy for the prevention and control of obesity in South Africa 2015 - 2020 [PowerPoint Presentation]*. CGCSA Summit.
- O' Donnell, O., Van Doorslaer, E., Wagstaff, A. & Lindelow, M. 2008. Analyzing health equity using household survey data. *Washington, DC: World Bank*.
- Oakes, J.M. & Kaufman, J.S. 2017. *Methods in social epidemiology*. New York: John Wiley & Sons.
- Oaxaca, R. 1973. Male-female wage differentials in urban labor markets. *International economic review*. 14(3):693-709.
- Offer, A. 1998. *Epidemics of Abundance: Overeating and Slimming in the USA and Britain since the 1950s*. Oxford: University of Oxford.
- Offer, A., Pechey, R. & Ulijaszek, S. 2010. Obesity under affluence varies by welfare regimes: the effect of fast food, insecurity, and inequality. *Economics and human biology*. 8(3):297-308. DOI:10.1016/j.ehb.2010.07.002.
- Ojiegbe, I. 2016. Impacts of obesity on the health of women of childbearing age: A call for action. *International Journal of Medicine and Biomedical Research*. 5(1):19-27.
- Okoh, M. 2013. Socio-demographic correlates of overweight and obesity among women of reproductive age in Nigeria. *African journal of reproductive health*. 17(4):66-76.
- Okop, K.J., Levitt, N. & Puoane, T. 2015. Factors Associated with Excessive Body Fat in Men and Women: Cross-Sectional Data from Black South Africans Living in a Rural Community and an Urban Township. *PloS one*. 10(10):e0140153. DOI:10.1371/journal.pone.0140153.
- Okop, K.J., Mukumbang, F.C., Mathole, T., Levitt, N. & Puoane, T. 2016. Perceptions of body size, obesity threat and the willingness to lose weight among black South African adults: a qualitative study. *BMC public health*. 16:365. DOI:10.1186/s12889-016-3028-7.
- Okop, K.J., Ndayi, K., Tsolekile, L., Sanders, D. & Puoane, T. 2019. Low intake of commonly available fruits and vegetables in socio-economically disadvantaged communities of South Africa: influence of affordability and sugary drinks intake. *BMC public health*. 19(1):1-14.
- Olatunbosun, S.T., Kaufman, J.S. & Bella, A.F. 2011. Prevalence of obesity and overweight in urban adult Nigerians. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 12(4):233-241. DOI:10.1111/j.1467-789X.2010.00801.x.
- Olstad, D.L., Teychenne, M., Minaker, L.M., Taber, D.R., Raine, K.D., Nykiforuk, C.I. & Ball, K. 2016. Can policy ameliorate socioeconomic inequities in obesity and obesity-related

- behaviours? A systematic review of the impact of universal policies on adults and children. *Obesity reviews : an official journal of the International Association for the Study of Obesity*. 17(12):1198-1217. DOI:10.1111/obr.12457.
- Omran, A.R. 1971. *The epidemiologic transition: A theory of the epidemiology of population change*. New York: Milbank Memorial Fund.
- Oyeyemi, A.L., Adegoke, B.O., Oyeyemi, A.Y., Deforche, B., De Bourdeaudhuij, I. & Sallis, J.F. 2012. Environmental factors associated with overweight among adults in Nigeria. *The international journal of behavioral nutrition and physical activity*. 9(1):32. DOI:10.1186/1479-5868-9-32.
- Pampel, F.C., Krueger, P.M. & Denney, J.T. 2010. Socioeconomic Disparities in Health Behaviors. *Annual review of sociology*. 36:349-370. DOI:10.1146/annurev.soc.012809.102529.
- Pechey, R., Jebb, S.A., Kelly, M.P., Almiron-Roig, E., Conde, S., Nakamura, R., Shemilt, I., Suhrcke, M. et al. 2013. Socioeconomic differences in purchases of more vs. less healthy foods and beverages: analysis of over 25,000 British households in 2010. *Social science & medicine (1982)*. 92:22-26. DOI:10.1016/j.socscimed.2013.05.012.
- Pedrana, L., Pamponet, M., Walker, R., Costa, F. & Rasella, D. 2016. Scoping review: national monitoring frameworks for social determinants of health and health equity. *Global health action*. 9(1):28831. DOI:10.3402/gha.v9.28831.
- Peer, N., Lombard, C., Steyn, K., Gwebushe, N. & Levitt, N. 2014. Differing patterns of overweight and obesity among black men and women in Cape Town: the CRIBSA study. *PloS one*. 9(9):e107471. DOI:10.1371/journal.pone.0107471.
- Phillips, E.A., Comeau, D.L., Pisa, P.T., Stein, A.D. & Norris, S.A. 2016. Perceptions of diet, physical activity, and obesity-related health among black daughter-mother pairs in Soweto, South Africa: a qualitative study. *BMC public health*. 16:750. DOI:10.1186/s12889-016-3436-8.
- Pisa, P.T. & Pisa, N.M. 2017. Economic growth and obesity in South African adults: an ecological analysis between 1994 and 2014. *European journal of public health*. 27(3):404-409. DOI:10.1093/eurpub/ckw119.
- Popham, F. & Bamba, C. 2010. Evidence from the 2001 English Census on the contribution of employment status to the social gradient in self-rated health. *Journal of epidemiology and community health*. 64(3):277-280. DOI:10.1136/jech.2009.087452.
- Popkin, B.M. 1993. Nutritional patterns and transitions. *Population and development review*. 19(1):138-157.
- Popkin, B.M. 2002a. An overview on the nutrition transition and its health implications: the Bellagio meeting. *Public health nutrition*. 5(1a):93-103.
- Popkin, B.M. 2002b. The shift in stages of the nutrition transition in the developing world differs from past experiences! *Public health nutrition*. 5(1a):205-214. DOI:10.1079/phn2001295.
- Popkin, B.M., Adair, L.S. & Ng, S.W. 2012. Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition reviews*. 70(1):3-21. DOI:10.1111/j.1753-4887.2011.00456.x.
- Popkin, B.M., Corvalan, C. & Grummer-Strawn, L.M. 2020. Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet (London, England)*. 395(10217):65-74. DOI:10.1016/s0140-6736(19)32497-3.
- Pradeilles, R., Griffiths, P.L., Norris, S.A., Feeley, A.B. & Rousham, E.K. 2015. Socio-economic influences on anthropometric status in urban South African adolescents: sex

- differences in the Birth to Twenty Plus cohort. *Public health nutrition*. 18(16):2998-3012. DOI:10.1017/s1368980015000415.
- Prochaska, F.J. & Schrimper, R.A. 1973. Opportunity cost of time and other socioeconomic effects on away-from-home food consumption. *American Journal of Agricultural Economics*. 55(4_Part_1):595-603.
- Puoane, T., Steyn, K., Bradshaw, D., Laubscher, R., Fourie, J., Lambert, V. & Mbananga, N. 2002. Obesity in South Africa: the South African demographic and health survey. *Obesity research*. 10(10):1038-1048. DOI:10.1038/oby.2002.141.
- Puoane, T.R., Tsolekile, L.P., Caldbeck, S., Igumbor, E.U., Meghnath, K. & Sanders, D. 2012. Chronic non-communicable diseases in South Africa: Progress and challenges: Social and environmental determinants of health. *South African Health Review*. 2012(1):115-126.
- Ramsay, J.E., Greer, I. & Sattar, N. 2006. ABC of obesity. Obesity and reproduction. *BMJ (Clinical research ed.)*. 333(7579):1159-1162. DOI:10.1136/bmj.39049.439444.DE1.
- Rasmussen, M., Krolner, R., Klepp, K.I., Lytle, L., Brug, J., Bere, E. & Due, P. 2006. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. *The international journal of behavioral nutrition and physical activity*. 3:22. DOI:10.1186/1479-5868-3-22.
- Rates and Monetary Amounts and Amendment of Revenue Laws Act, No. 14 of 2017. 2017. *Government Gazette 630(41323)*. 14 December. Government notice no. 1426. Cape Town: Government Printers.
- Reddy, S.P., Resnicow, K., James, S., Funani, I.N., Kambaran, N.S., Omardien, R.G., Masuka, P., Sewpaul, R. et al. 2012. Rapid increases in overweight and obesity among South African adolescents: comparison of data from the South African National Youth Risk Behaviour Survey in 2002 and 2008. *American journal of public health*. 102(2):262-268. DOI:10.2105/ajph.2011.300222.
- Republic of South Africa. 2013a. *Strategic Plan for the Prevention and Control of Non-Communicable Diseases 2013-17*. Pretoria: National Department of Health.
- Republic of South Africa. 2013b. *National Policy on Food and Nutrition Security*. Pretoria: Government Printers.
- Republic of South Africa. 2015a. *Strategy for the Prevention and Control of Obesity in South Africa 2015-2020*. Pretoria: National Department of Health.
- Republic of South Africa. 2015b. *National Intergrated Early Childhood Development Policy*. Pretoria: Government Printers.
- Republic of South Africa. 2016. *Taxation of sugar sweetened beverages*. Pretoria: National Treasury.
- Romieu, I., L., D. & Willett, W.C. 2017. Energy Balance and Obesity. Lyon, France: International Agency for Research on Cancer (IARC Working Group Reports, No. 10). Available: <http://publications.iarc.fr/553> [22 December 2017].
- Ronquest-Ross, L.-C., Vink, N. & Sigge, G.O. 2015. Food consumption changes in South Africa since 1994. *South African Journal of Science*. 111(9-10):01-12.
- Roos, E., Talala, K., Laaksonen, M., Helakorpi, S., Rahkonen, O., Uutela, A. & Prattala, R. 2008. Trends of socioeconomic differences in daily vegetable consumption, 1979-2002. *European journal of clinical nutrition*. 62(7):823-833. DOI:10.1038/sj.ejcn.1602798.
- Roos, E.L., Horridge, J.M., van Heerden, J.H., Adams, P.D., Bohlmann, H.R., Kobe, K.K. & Vumbukani-Lepolesa, B. 2020. National and Regional Impacts of an Increase in Value-

- Added Tax: A CGE Analysis for South Africa. *South African Journal of Economics*. 88(1):90-120.
- Ross, N.A., Wolfson, M.C., Dunn, J.R., Berthelot, J.M., Kaplan, G.A. & Lynch, J.W. 2000. Relation between income inequality and mortality in Canada and in the United States: cross sectional assessment using census data and vital statistics. *BMJ (Clinical research ed.)*. 320(7239):898-902. DOI:10.1136/bmj.320.7239.898.
- Rutsein, S.O. & Johnson, K. 2004. *The DHS Wealth Index. DHS Comparative Reports No. 6.* . Calverton, Maryland, USA: ORC Macro.
- Sartorius, B., Veerman, L.J., Manyema, M., Chola, L. & Hofman, K. 2015. Determinants of Obesity and Associated Population Attributability, South Africa: Empirical Evidence from a National Panel Survey, 2008-2012. *PloS one*. 10(6):e0130218. DOI:10.1371/journal.pone.0130218.
- Schmidt, H. & Barnhill, A. 2015. Equity and Noncommunicable Disease Reduction under the Sustainable Development Goals. *PLoS medicine*. 12(9):e1001872. DOI:10.1371/journal.pmed.1001872.
- Schnabel, L., Kesse-Guyot, E., Allès, B., Touvier, M., Srour, B., Hercberg, S., Buscail, C. & Julia, C. 2019. Association Between Ultraprocessed Food Consumption and Risk of Mortality Among Middle-aged Adults in France. *JAMA internal medicine*. 179(4):490-498. DOI:10.1001/jamainternmed.2018.7289.
- Sen, A.K. 1992. *Inequality reexamined*. Oxford: Clarendon Press.
- Shekar, M. & Popkin, B. 2020. *Obesity Health and Economic Consequences of an Impending Global Challenge*. Washington, D. C.: World Bank Publications.
- Shohaimi, S., Welch, A., Bingham, S., Luben, R., Day, N., Wareham, N. & Khaw, K.T. 2004. Residential area deprivation predicts fruit and vegetable consumption independently of individual educational level and occupational social class: a cross sectional population study in the Norfolk cohort of the European Prospective Investigation into Cancer (EPIC-Norfolk). *Journal of epidemiology and community health*. 58(8):686-691. DOI:10.1136/jech.2003.008490.
- Shrewsbury, V. & Wardle, J. 2008. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity (Silver Spring, Md.)*. 16(2):275-284. DOI:10.1038/oby.2007.35.
- Sidik, S.M. & Rampal, L. 2009. The prevalence and factors associated with obesity among adult women in Selangor, Malaysia. *Asia Pacific family medicine*. 8(1):2. DOI:10.1186/1447-056x-8-2.
- Simões, B.D.S., Barreto, S.M., Molina, M., Luft, V.C., Duncan, B.B., Schmidt, M.I., Benseñor, I.J.M., Cardoso, L.O. et al. 2018. Consumption of ultra-processed foods and socioeconomic position: a cross-sectional analysis of the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *Cad Saude Publica*. 34(3):e00019717. DOI:10.1590/0102-311x00019717.
- Sithole, S. & Mmakola, K. 2018. Debunking the myths of the South African welfare system. *Sociol Int J*. 2(6):484-489.
- Smith, J., Cianflone, K., Biron, S., Hould, F.S., Lebel, S., Marceau, S., Lescelleur, O., Biertho, L. et al. 2009. Effects of maternal surgical weight loss in mothers on intergenerational transmission of obesity. *The Journal of clinical endocrinology and metabolism*. 94(11):4275-4283. DOI:10.1210/jc.2009-0709.
- Sobal, J. & Stunkard, A.J. 1989. Socioeconomic status and obesity: a review of the literature. *Psychological bulletin*. 105(2):260-275.

- South African Government. 2021a. National Recreation Day 2019. Available: <https://www.gov.za/NationalRecreationDay2019> [30 December 2021].
- South African Government. 2021b. *National Nutrition Week and National Obesity Week 2020*. Available: <https://www.gov.za/NationalNutritionWeek-and-NationalObesityWeek2020> [29 December 2021].
- Srour, B., Fezeu, L.K., Kesse-Guyot, E., Allès, B., Méjean, C., Andrianasolo, R.M., Chazelas, E., Deschasaux, M. et al. 2019. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). *BMJ (Clinical research ed.)*. 365:l1451.
- StataCorp. 2017. *Stata: release 15 - Statistical software*. College Station, Texas: StataCorp LP.
- Statistics South Africa. 2008. *Income and Expenditure of Households 2005/2006: Statistical Release P0100*. Statistics South Africa.
- Statistics South Africa. 2012. *Income and Expenditure of Households 2010/2011: Statistical Release P0100*. Statistics South Africa.
- Steyn, K., Kazenellenbogen, J.M., Lombard, C.J. & Bourne, L.T. 1997. Urbanization and the risk for chronic diseases of lifestyle in the black population of the Cape Peninsula, South Africa. *Journal of cardiovascular risk*. 4(2):135-142.
- Steyn, N.P., Labadarios, D., Nel, J., Kruger, H.S. & Maunder, E.M. 2011a. What is the nutritional status of children of obese mothers in South Africa? *Nutrition (Burbank, Los Angeles County, Calif.)*. 27(9):904-911. DOI:10.1016/j.nut.2010.10.007.
- Steyn, N.P., Nel, J.H., Parker, W.A., Ayah, R. & Mbithe, D. 2011b. Dietary, social, and environmental determinants of obesity in Kenyan women. *Scandinavian journal of public health*. 39(1):88-97. DOI:10.1177/1403494810384426.
- Sulcas, A. 2022. Food justice part one: Child targets: South Africa faces an obesity-related health catastrophe linked to poor regulation of food advertising. Available: <https://www.dailymaverick.co.za/article/2022-01-17-child-targets-south-africa-faces-an-obesity-related-health-catastrophe-linked-to-poor-regulation-of-food-advertising/> [10 January 2022].
- Swinburn, B., Kraak, V., Rutter, H., Vandevijvere, S., Lobstein, T., Sacks, G., Gomes, F., Marsh, T. et al. 2015. Strengthening of accountability systems to create healthy food environments and reduce global obesity. *Lancet (London, England)*. 385(9986):2534-2545. DOI:10.1016/s0140-6736(14)61747-5.
- Swinburn, B.A., Sacks, G., Hall, K.D., McPherson, K., Finegood, D.T., Moodie, M.L. & Gortmaker, S.L. 2011. The global obesity pandemic: shaped by global drivers and local environments. *Lancet (London, England)*. 378(9793):804-814. DOI:10.1016/s0140-6736(11)60813-1.
- Tadesse, Y., Derso, T., Alene, K.A. & Wassie, M.M. 2017. Prevalence and factors associated with overweight and obesity among private kindergarten school children in Bahirdar Town, Northwest Ethiopia: cross-sectional study. *BMC research notes*. 10(1):22. DOI:10.1186/s13104-016-2308-8.
- Te Morenga, L., Mallard, S. & Mann, J. 2012. Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. *BMJ (Clinical research ed.)*. 346:e7492. DOI:10.1136/bmj.e7492.
- The Department of Planning, Monitoring and Evaluation. 2020. *National Food and Nutrition Security Communication Strategy for South Africa 2018 - 2023*. Pretoria: The Department of Planning, Monitoring and Evaluation.

- Tiffin, R. & Salois, M. 2012. Inequalities in diet and nutrition. *The Proceedings of the Nutrition Society*. 71(1):105-111. DOI:10.1017/s0029665111003284.
- Tisane, M., Van der Merwe, J. & Hall, D. 2017. Weight-related quality of life in obese, pregnant women in South Africa. *Journal of Endocrinology, Metabolism and Diabetes of South Africa*. 22(3):43–46.
- Townsend, P., Davidson, N., Black, D., Whitehead, M., Great, B. & Working Group on Inequalities in, H. 1986. *Inequalities in health : the Black report and the health divide*. Harmondsworth: Penguin.
- Triaca, L.M., Dos Santos, A.M.A. & Tejada, C.A.O. 2020. Socioeconomic inequalities in obesity in Brazil. *Economics and human biology*. 39:100906. DOI:10.1016/j.ehb.2020.100906.
- Tuoyire, D.A., Kumi-Kyereme, A. & Doku, D.T. 2016. Socio-demographic trends in overweight and obesity among parous and nulliparous women in Ghana. *BMC obesity*. 3:44. DOI:10.1186/s40608-016-0124-2.
- Turrell, G. & Vandevijvere, S. 2015. Socio-economic inequalities in diet and body weight: evidence, causes and intervention options. *Public health nutrition*. 18(5):759-763. DOI:10.1017/s1368980015000233.
- United Nations Department of Economic and Social Affairs. 2017. *Sustainable Development Goals*. Available: <https://sustainabledevelopment.un.org/sdgs> [22 December 2017].
- Vahratian, A. 2009. Prevalence of overweight and obesity among women of childbearing age: results from the 2002 National Survey of Family Growth. *Maternal and child health journal*. 13(2):268-273. DOI:10.1007/s10995-008-0340-6.
- Value-added Tax Act, No. 89 of 1991. 1991. *Government Gazette 312(13307)*. 12 June. *Government notice no. 1342*. Cape Town: Government Printers.
- Vandevijvere, S. & Vanderlee, L. 2019. Effect of Formulation, Labelling, and Taxation Policies on the Nutritional Quality of the Food Supply. *Current nutrition reports*. 8(3):240-249. DOI:10.1007/s13668-019-00289-x.
- Vis, B. & Hylands, T. 2013. Fat government, thin populace? Is the growth of obesity prevalence lower in more generous welfare states? *International Journal of Social Welfare*. 22(4):360-373.
- Vorster, H.H., Kruger, A., Wentzel-Viljoen, E., Kruger, H.S. & Margetts, B.M. 2014. Added sugar intake in South Africa: findings from the Adult Prospective Urban and Rural Epidemiology cohort study. *The American journal of clinical nutrition*. 99(6):1479-1486. DOI:10.3945/ajcn.113.069005.
- Wagstaff, A., Paci, P. & van Doorslaer, E. 1991. On the measurement of inequalities in health. *Social science & medicine (1982)*. 33(5):545-557.
- Wagstaff, A., Van Doorslaer, E. & Watanabe, N. 2003. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam. *Journal of econometrics*. 112(1):207-223.
- Walls, H.L., Johnston, D., Mazalale, J. & Chirwa, E.W. 2018. Why we are still failing to measure the nutrition transition. *BMJ global health*. 3(1):e000657. DOI:10.1136/bmjgh-2017-000657.
- Wandai, M., Aagaard-Hansen, J., Day, C., Sartorius, B. & Hofman, K.J. 2017. Available data sources for monitoring non-communicable diseases and their risk factors in South Africa. *South African medical journal*. 107(4):331-337. DOI:10.7196/SAMJ.2017.v107i4.11438.

- Wandel, M. 1995. Dietary intake of fruits and vegetables in Norway: influence of life phase and socio-economic factors. *International journal of food sciences and nutrition*. 46(3):291-301.
- Wang, Y., Beydoun, M.A., Caballero, B., Gary, T.L. & Lawrence, R. 2010. Trends and correlates in meat consumption patterns in the US adult population. *Public health nutrition*. 13(9):1333-1345. DOI:10.1017/s1368980010000224.
- Wardle, J. & Boniface, D. 2008. Changes in the distributions of body mass index and waist circumference in English adults, 1993/1994 to 2002/2003. *International journal of obesity (2005)*. 32(3):527-532. DOI:10.1038/sj.ijo.0803740.
- Weatherspoon, D.D. & Reardon, T. 2003. The rise of supermarkets in Africa: implications for agrifood systems and the rural poor. *Development policy review*. 21(3):333-355.
- Whitaker, R.C. 2004. Predicting preschooler obesity at birth: the role of maternal obesity in early pregnancy. *Pediatrics*. 114(1):e29-36.
- Wilkinson, R.H. & Pickett, K. 2009. *The spirit level : why equality is better for everyone*. London: Penguin.
- Wilson, A., Renzaho, A., McCabe, M. & Swinburn, B. 2010. Towards understanding the new food environment for refugees from the Horn of Africa in Australia. *Health & place*. 16(5):969-976.
- Wittenberg, M. 2009. *Weights: report on NIDS Wave 1. Technical Paper no. 2*. Cape Town: Southern Africa Labour and Development Research Unit.
- Wojcicki, J.M. 2014. The double burden household in sub-Saharan Africa: maternal overweight and obesity and childhood undernutrition from the year 2000: results from World Health Organization Data (WHO) and Demographic Health Surveys (DHS). *BMC public health*. 14:1124. DOI:10.1186/1471-2458-14-1124.
- Wolfson, M., Gravelle, H., Wilkinson, R.G., Kaplan, G., Lynch, J., Ross, N. & Backlund, E. 1999. Relation between income inequality and mortality: empirical demonstrationDiminishing returns to aggregate level studiesTwo pathways, but how much do they diverge? *BMJ (Clinical research ed.)*. 319(7215):953-957.
- World Bank. 2020. World Development Indicators. Available: <https://databank.worldbank.org/source/world-development-indicators#> [28 May 2020].
- World Bank. 2021. *World Data Bank*. Washington D.C.: World Bank. Available: <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ZA> [2021, 26 March].
- World Health Organisation. 1995. *Physical status: the use and interpretation of anthropometry. Technical Report Series No. 854*. Geneva. Available: http://www.who.int/childgrowth/publications/physical_status/en/ [20 May 2016].
- World Health Organization. 2000. *Obesity: preventing and managing the global epidemic*. Geneva: World Health Organization.
- World Health Organization. 2001. *Dying for change: poor people's experience of health and ill-health*. Geneva: World Health Organization. Available: https://www.who.int/hdp/publications/dying_change.pdf [19 February 2018].
- World Health Organization. 2003. Global and regional food consumption patterns and trends. In *Diet, Nutrition and the Prevention of Chronic Diseases. Report of a joint WHO/FAO expert consultation*. Geneva: World Health Organization.
- World Health Organization. 2007. *The challenge of obesity in the WHO European Region and the strategies for response: summary*. Denmark: WHO Regional Office for Europe.

- World Health Organization. 2008. Closing a gap in a generation. Available: https://apps.who.int/iris/bitstream/handle/10665/43943/9789241563703_eng.pdf;jsession [16 June 2020].
- World Health Organization. 2009. *World Health Assembly 62.9. Commission on Social Determinants of Health*. Geneva: World Health Organization. Available: http://apps.who.int/gb/ebwha/pdf_files/A62/A62_9-en.pdf [18 February 2018].
- World Health Organization. 2010. A Conceptual Framework for Action on the Social Determinants of Health. Social Determinants of Health Discussion Paper 2. Available: https://www.who.int/sdhconference/resources/ConceptualframeworkforactiononSDH_eng.pdf [16 June 2020].
- World Health Organization. 2014a. *Health in all policies (HiAP) framework for country action*. Geneva: World Health Organization.
- World Health Organization. 2014b. *Obesity and inequities: Guidance for addressing inequities in overweight and obesity* Denmark: WHO Regional Office for Europe. Available: http://www.euro.who.int/_data/assets/pdf_file/0003/247638/obesity-090514.pdf [10 January 2018].
- World Health Organization. 2016. *Report of the commission on ending childhood obesity*. Geneva: World Health Organization.
- World Health Organization. 2017a. *Health Impact Assessment. Glossary of terms used* Geneva: World Health Organization. Available: https://www.who.int/docs/default-source/documents/publications/glossary-of-terms-hia.pdf?sfvrsn=cdd42e83_1&download=true [19 February 2018].
- World Health Organization. 2017b. Obesity and Overweight Fact sheet. Available: <http://www.who.int/mediacentre/factsheets/fs311/en/> [21 December 2017].
- World Health Organization. 2018a. *Global Health Estimates 2016: Disease burden by Cause, Age, Sex, by Country and by Region, 2000–2016*. Geneva: World Health Organization.
- World Health Organization. 2018b. *BMI classification* Available: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html [13 January 2018].
- World Health Organization. 2019a. *Global Health Observatory (GHO) data*. Available: https://www.who.int/gho/ncd/risk_factors/overweight/en/ [21 February 2019].
- World Health Organization. 2019b. Evidence and resources to act on health inequities, social determinants and meet the SDGs. Available: <https://www.euro.who.int/en/health-topics/health-determinants/social-determinants/publications/2019/evidence-and-resources-to-act-on-health-inequities,-social-determinants-and-meet-the-sdgs-2019> [16 June 2020].
- World Health Organization. 2020a. Health financing. Available: <https://www.who.int/health-financing/universal-coverage-definition/en/> [19 August 2020].
- World Health Organization. 2020b. Social Determinants of Health Key concepts. Available: <https://www.who.int/social-determinants/the-commission/final-report/key-concepts/en/> [16 June 2020].
- World Health Organization. 2020c. Social Determinants of Health Available: <https://www.who.int/social-determinants/sdh-definition/en/> [16 June 2020].
- World Health Organization. 2020d. World Conference on Social Determinants of Health. World Health Assembly endorses the Rio Political Declaration on Social Determinants of Health. Available: <https://www.who.int/sdhconference/background/en/> [16 June 2020].

- World Health Organization. 2020e. World Conference on Social Determinants of Health. Rio Political Declaration on Social Determinants of Health. Available: <https://www.who.int/sdhconference/declaration/en/#:~:text=The%20declaration%20expresses%20global%20political,national%20action%20plans%20and%20strategies.> [16 June 2020].
- World Health Organization, the United Nations Children's Fund, United Nations Fund for Population Activities, World Bank Group & the United Nations Population Division. 2019. *Trends in Maternal Mortality: 2000 to 2017*. Geneva: World Health Organization.
- World Obesity Federation. 2019a. World Obesity Federation Statement to the United Nations High Level Meeting. Available: <https://www.worldobesity.org/what-we-do/our-policy-priorities/obesity-in-universal-health-coverage> [27 January 2021].
- World Obesity Federation. 2019b. Obesity and Universal Health Coverage: Preparations for the UN High- level Meeting on UHC. Available: <https://www.worldobesity.org/what-we-do/our-policy-priorities/obesity-in-universal-health-coverage> [27 January 2021].
- Wrotniak, B.H., Epstein, L.H., Paluch, R.A. & Roemmich, J.N. 2004. Parent weight change as a predictor of child weight change in family-based behavioral obesity treatment. *Archives of pediatrics & adolescent medicine*. 158(4):342-347. DOI:10.1001/archpedi.158.4.342.
- Yaya, S. & Ghose, B. 2019. Trend in overweight and obesity among women of reproductive age in Uganda: 1995-2016. *Obesity science & practice*. 5(4):312-323. DOI:10.1002/osp4.351.
- Yen, S.T. 1993. Working wives and food away from home: the Box-Cox double hurdle model. *American Journal of Agricultural Economics*. 75(4):884-895.
- Zaninotto, P., Head, J., Stamatakis, E., Wardle, H. & Mindell, J. 2009. Trends in obesity among adults in England from 1993 to 2004 by age and social class and projections of prevalence to 2012. *Journal of epidemiology and community health*. 63(2):140-146. DOI:10.1136/jech.2008.077305.
- Zhang, Q. & Wang, Y. 2004. Trends in the association between obesity and socioeconomic status in U.S. adults: 1971 to 2000. *Obesity research*. 12(10):1622-1632. DOI:10.1038/oby.2004.202.
- Zhang, Q., Zheng, B., Zhang, N. & Wang, Y. 2011. Decomposing the intergenerational disparity in income and obesity. *The BE Journal of Economic Analysis & Policy*. 11(3):0-16. DOI:10.2202/1935-1682.2880.
- Zhu, J., Coombs, N. & Stamatakis, E. 2015. Temporal trends in socioeconomic inequalities in obesity prevalence among economically-active working-age adults in Scotland between 1995 and 2011: a population-based repeated cross-sectional study. *BMJ open*. 5(6):e006739.