Trends and inequalities in the nutritional status of females of reproductive age in Zambia from 2001 to 2014: a cross-sectional study

Penias Tembo

Centre for International Health
Department of Global Public Health and Primary Care
Faculty of Medicine
University of Bergen, Norway
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Penias Tembo

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Main Supervisor:

Prof. Ingvild Sandøy

Center for International Health, University of Bergen

Co-Supervisors:

1. Dr Choolwe Jacobs

School of Public Health, University of Zambia

2. Prof. Charles Michelo

Nkwazi Research University, Zambia

Centre for International Health

Department of Global Public Health and Primary Care

Faculty of Medicine

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ABSTRACT

Background: Malnutrition is a serious public health concern, owing to its association with a range of both communicable and non-communicable diseases. While many countries in Sub-Saharan Africa have grappled with undernutrition for decades, nutritional, epidemiological, and demographic transitions have been associated with the emergence of overnutrition and thus the occurrence of a double burden of malnutrition. This study sought to examine the trends and inequalities in the prevalence of underweight, overweight and obesity among females of reproductive age in Zambia between 2001 and 2014.

Methods: Trends in the prevalence of underweight and overweight/obesity were assessed using a series of the Zambia Demographic and Health Survey (ZDHS) data from 2001 to 2014. Multivariable logistic regression was used to investigate the association between socioeconomic and demographic factors with underweight and overweight/obesity**.** Equiplots were used to assess inequalities in the prevalence of underweight and overweight/obesity.

Results: The prevalence of underweight decreased from 15% to 10% during the study period. However, the prevalence of overnutrition almost doubled during the same period from 14% to 24%. Working women had a lower risk of being underweight (aOR=0.81, 95% CI: 0.69 to 0.96) but a higher risk of overnutrition (aOR=1.23, 95% CI: 1.04 to 1.45) compared to women who were not working. Married women had a lower risk of being underweight compared to never-married women (aOR= 0.48, 95% CI: 0.36 to 0.64), and a higher risk of being overnourished (aOR= 2.08, 95% CI: 1.55 to 2.79). Women with higher education levels had a lower risk of being underweight (aOR= 0.47, 95% CI: 0.31 to 0.72) and a higher risk of overnutrition (aOR= 2.11, 95% CI: 1.38 to 3.24) compared to women with no education. Inequalities in overnutrition have increased over time between the working and non-working females, the never-married and married, the youngest (15-19) and oldest (40-49) as well as between the urban and rural residents. Underweight inequalities have increased between the youngest (15-19) and oldest (40-49), as well as between the richest (Q5) and poorest (Q1), while underweight inequalities have decreased between rural and urban residents, as well as between those with no education and those with the highest education.

Conclusion: The existence of undernutrition and overnutrition among women from different backgrounds calls for nutrition programs and interventions that respond to the double-burden of malnutrition. Such programs may include structural approaches such as better urban planning to promote/facilitate physical activity, sugar taxes and fat taxes to increase the prices

of unhealthy foods and subsidies for healthy foods. In addition, policies that can reduce poverty such as free education, social benefits for the sick, the unemployed and the elderly and support to small-scale farmers may reduce undernutrition among lower socioeconomic groups.

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ABBREVIATIONS

AIDS- Acquired Immunodeficiency Syndrome

BMI- Body Mass Index

CSO- Central Statistical Office

FISP-Farmer Input Support Program

FRA- Food Reserve Agency

HIV- Human Immunodeficiency Virus

LMIC- Low- and Middle-Income Country

MCDP- Most Critical Days Program

NAP- National Agriculture Policy

NCDs- Non-Communicable Diseases

NFNC- National Food and Nutrition Commission

SDG- Sustainable Development Goals

SEA- Standard Enumeration Area

SSA- Sub-Saharan Africa

WHO- World Health Organization

ZDHS- Zambia Demographic and Health Survey

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INTRODUCTION

The burden of Malnutrition

Malnutrition in its various manifestations affects all countries globally [1]. It is estimated that approximately 460 million adults globally are underweight [2]. Despite a consistent decrease in the prevalence of undernutrition, it continues to affect individuals particularly in low- and middle-income countries. On the other hand, the global prevalence of obesity has increased by almost threefold over the past four decades since 1975 [3]. According to the World Health Organization's 2016 estimation, over 1.9 billion adults aged 18 and above were classified as overnourished, with approximately 39% of the global adult population being overweight and 13% being obese [3]. It is estimated that approximately 70% of adults who are overnourished worldwide are located in countries with low- and middle-income status [2].

The prevalence of overnutrition in low – and middle-income countries is higher among females than males [4], with biological factors contributing to this outcome. According to Abubakari et al.'s research, females in West Africa exhibited a 3-fold higher likelihood of obesity compared to males [5]. This finding bears resemblance to the results of a study conducted by Ofori-Asenso et al., which revealed a greater prevalence of overweight by a factor of 1.3 and a considerably higher prevalence of obesity by a factor of approximately 3.7 among women in Ghana in comparison to men [4]. However, the prevalence of overweight and obesity among females in distinct geographic regions varies significantly. For example, an analysis of Demographic and Health Survey data from women from 32 Sub-Saharan African countries showed a lower prevalence of overweight in Madagascar at 5.6% in comparison to Swaziland which had a prevalence of 27.7% while the prevalence of obesity was 1.1% and 23% in the two countries, respectively [6].

Many countries experience the double burden of malnutrition, wherein both undernutrition and overnutrition coexist within the same population [6,7]. In high-income countries, individuals with a low socioeconomic status (SES) tend to exhibit a higher prevalence of obesity, whereas, in low-income countries, the opposite trend has been documented [8,9]. The findings of a recent analysis including 126 low and middle-income countries (LMIC) indicate that the rise in the global double burden of malnutrition was mainly driven by low- and middle-income countries as these countries tended to experience a significant increase in overnutrition rates and a marginal decline in undernutrition prevalence [9,10]. The double burden of malnutrition is more prevalent in nations undergoing a significant nutritional transition, a phenomenon that

occurs when economic conditions improve, allowing a shift from food scarcity to relative abundance [11,12]. This transition is commonly linked to decreased levels of bodily movement and a shift towards the consumption of "junk food", which possesses a high caloric content but lacks essential nutrients [11].

The state of malnutrition in sub-Saharan Africa serves as a prime example of the double burden of malnutrition, with high prevalence of undernutrition and a rising prevalence of overweight, and obesity [13]. Research shows that the likelihood of the sub-Saharan Africa region achieving the Sustainable Development Goals (SDGs) of eradicating hunger and all forms of malnutrition by 2030 is low if the current prevalence is sustained [1]. Countries in Sub-Saharan Africa such as Zambia have documented evidence in reports such as the demographic and health survey reports that support this school of thought [14].

Definition and classification of malnutrition

Nutritional status refers to the balance between intake, expenditure and utilization of nutrients by an organism [15]. Attaining an optimal nutritional status requires the consumption of sufficient but not excessive amounts of energy, essential nutrients, and other food constituents. Malnutrition is generally understood as an imbalance between the nutrients the body requires to function and the nutrients it receives. The World Health Organization (WHO) defines malnutrition as the “deficiencies, excesses, or imbalances in a person’s intake of energy and/or nutrients” [15]. The term malnutrition encompasses both undernutrition (insufficient calories or nutrients compared to what the body requires) and overnutrition (excess nutrients beyond what the body requires). There are four main forms of undernutrition: underweight, wasting, stunting, and mineral and vitamin deficiencies. Overnutrition on the other hand comprises both overweight and obesity [3].

Anthropometric measurements can be used to provide insight into the nutritional status of a particular population. Despite being less accurate than clinical or biomedical indicators of nutrition, they do provide a proxy for the overall nutritional status of an individual. BMI is a measurement used for determining an individual's nutritional status based on height and weight. The BMI classifies nutritional status into four different categories, which are underweight, normal weight, overweight and obesity. The World Health Organization classifies underweight as a BMI of less than 18.5kg/m^2, overweight as a BMI of 25-29.9kg/m^2 and obesity as represented by a BMI of greater than 30kg/m^2 [3].

The simultaneous occurrence of undernutrition and overnutrition in each population at a specific moment in time is widely referred to as the double burden of malnutrition. The World Health Organisation (WHO) defines the double burden of malnutrition as "the coexistence of undernutrition along with overweight and obesity, or diet-related non-communicable diseases, within individuals, households and populations, and across the life-course" [11,16]. In recent years, there have been growing concerns about a triple burden of malnutrition which in addition includes micronutrient deficiencies [16].

Effects of malnutrition on health outcomes

An abnormal nutritional status is one of the leading risk factors for premature death and loss of disability-adjusted life years (DALYs) [4]. Numerous studies have documented that overnutrition generally predisposes one to non-communicable diseases such as cardiovascular diseases (heart disease and stroke), type 2 diabetes, hypertension, some types of cancers and musculoskeletal disorders such as osteoarthritis [17,18].

For women of reproductive age, there are additional risks related to maternal health such as irregular menstrual patterns, reduced efficacy of contraceptives and an increased risk of miscarriages, increased risk of cesarean section, complications during delivery and mortality [18]. Maternal overnutrition contributes to adverse obstetric and neonatal outcomes such as an increased risk of gestational diabetes and pre-eclampsia in the mother and an increased risk of stillbirths [19]. Furthermore, maternal overnutrition at the point of pregnancy increases the risk of childhood obesity which continues into early adulthood thereby perpetuating the vicious cycle of overnutrition [19,20].

Undernutrition on the other hand can result in complications such as slow healing of wounds, hormonal abnormalities, higher susceptibility to infection, and a higher risk of chronic conditions such as osteoporosis [17]. Undernutrition in females of reproductive age increases the risk of anemia and maternal mortality [15,17]. For pregnant women, undernutrition is a contributing factor to fetal growth restriction which subsequently increases the risk of death of the fetus, and for survivors, it increases the risk of stunting by the age of 2 years [17]. A study that assessed the risk factors for childhood stunting in 137 developing countries showed that approximately 14 % of stunting in 44.1 million children under the age of two could be attributed to maternal undernutrition [21].

Trends and inequalities in underweight, overweight and obesity

Despite progress in achieving various nutritional targets at various levels, there continue to be persistent inequalities that pose a challenge to the ending of hunger for all [1]. Hasan M.M et al. in their study of the double burden of malnutrition among women in 55 low- and middle-income countries between 1990 and 2015, showed that although there has been an overall decline in the prevalence of underweight, there has been an increase in the prevalence of underweight among the richest women in 20 countries with only 2 of the 55 countries having a 50% chance of meeting the target of eradicating underweight among the poorest women and only one country expected to meet the target of eradicating underweight among the richest women by 2030 [22].

Disparities in the prevalence of malnutrition varied when females were stratified according to their place of residence, education, and age. For example, the increase in overweight in Bangladesh was highest among the poorest, rural, and below secondary educated women while Nepal showed an opposite trend with the highest increase in overweight among the richest women that lived in urban areas and had above secondary level education [22]. Reduced physical activity and low intake of fruits and vegetables with a preference for fast foods has also contributed to the increase in obesity among adult women [23].

An analysis of trends and inequalities in the nutritional status of females in 35 Sub-Saharan African countries by Jiwani et al. showed similar results to that of Hasan et al with declining yet persistent underweight among females but an unprecedented increase in the prevalence of overnutrition [8]. Overweight and obesity were noted to be increasing rapidly among adult women, those living in the richest households and urban areas. However, there were inconsistencies regarding overnutrition by educational level [8].

Higher income per capita appears to increase the obesity burden in individuals located in rural communities and the poor, with over half of the rise in the global level of obesity occurring in rural areas. In Latin America and the Caribbean, evidence suggests obesity is increasing faster among poorer socioeconomic groups and rural residents but remains overall higher among urban residents [11]. In contrast, Sub-Saharan Africa shows a greater prevalence of obesity among wealthier individuals and households and those located in urban regions as reflected in the Jiwani SS et al. study [8].

Studies from more economically developed countries have shown that women with a higher level of education are less likely to become overweight or obese than those with a lower level

of education [24,25]. In LMICs, however, educated women were more prone to be overweight/obese than uneducated women [24,26]. This relationship could be the result of a variety of factors. First, women in LMICs view overweight/obesity or a 'round body' frame as a sign of beauty and socioeconomic success, and this notion may encourage women to 'celebrate' weight gain [7,27]. Second, it may be the result of a transition from physically active to sedentary occupations (e.g. construction labor to office work) [23,28].

Literature has established that sedentary behaviors, such as watching television, and insufficient levels of physical activity are associated with an increased risk of being overweight and obese [22]. The correlation between overweight/obesity and television viewing has been documented in various studies, including those conducted in Ghana[13], Bangladesh [26], and Myanmar [9]. Moreover, within Low- and Middle-Income Countries (LMICs), the possession of television may serve as an indirect indicator of the higher socioeconomic standing of women. Watching TV may reduce physical activity by increasing sitting time, thereby increasing the chances of being overweight than those who do not have televisions, most of which are in rural areas [6]. Furthermore, reduced physical activity may be due to limited opportunities to exercise, fuel powered mode of transport and low awareness about the importance of physical activity.

Furthermore, studies in Sub-Saharan Africa, including Zambia and Zimbabwe have found a positive association between marriage and overweight/obesity among women of reproductive age [23,29]. Some scholars have argued that the differences in overnutrition rates between married and never-married women stem from the fact that married women may be less concerned with their weight and less motivated to maintain it when they no longer need to attract a husband [30]. On the other hand, women who have never been married need to maintain a healthy weight to continue to attract potential suitors and improve their chances in the marriage market [30].

In addition, studies in Sub-Saharan Africa have found childbearing to be a predictor for overweight and obesity in Sub-Saharan African countries [31]. A probable reason for this is during pregnancy and upon giving birth, mothers in the African context are generally encouraged to eat more for their own and their child's health, resulting in excessive weight gain [13]. Hence, encouraging pregnant women to eat more may contribute to the perpetuation of overnutrition among childbearing women, who are more likely to have consumed more calories during pregnancy and lactation.

Underweight and overnutrition in the Zambian context

For a long time, Zambia, like other sub-Saharan African countries has grappled with the challenge of undernutrition that has been driven by food insecurity. In Zambia, food security is threatened by high dependence on rain-fed agriculture and a lack of market incentives that would encourage a shift from subsistence to commercial farming [32]. Despite economic progress evidenced by the change in status from low to lower-middle-income country, 60% of Zambia's population remains below the poverty line and approximately 42% live in extreme poverty in rural areas [33]. A USAID report on Zambia's nutritional profile reported that there have not been substantial efforts to promote agricultural diversity among small-scale farmers that constitute the majority in the agricultural sector [34]. As a result, there has been lower availability of nutritious food, especially in rural areas [33].

Zambia has made strides in reducing undernutrition among women of reproductive age in the population. The Zambia Demographic and Health Survey 2014 reported that the percentage of women that are undernourished reduced from 15% in 2001/2002 to about 10% in 2013/2014. However, there was a counter transition in overnutrition evidenced by a gradual increase in the percentage of women that were over nourished from 12% in 2001 to 23% in 2014 [14]. This trend is similar to Zimbabwe's which has shown an increase in the prevalence of overnutrition among women of reproductive age by 11.6% from 2005 to 2015 [29]. This increase in the prevalence of overnutrition can be attributed to modernization and urbanization which caused a shift towards the consumption of processed and ultra-processed foods, which are high in caloric content but lacks essential nutrients [11,22].

Due to rapid urbanization and easy access and affordability of high energy-dense foods, preference for such foods and a lack of physical activity, there has been a notable increase in the prevalence of overweight and obesity. The Zambia Demographic and Health Survey 2014 reported a high prevalence of obesity of 23% among females of reproductive age. A high prevalence of obesity presents an extra burden to a health system that has traditionally devoted resources to combat undernutrition and infectious diseases such as HIV. As a result, Zambia now has to realign resources that were previously dedicated to combating undernutrition and infectious diseases to diet-related Non-Communicable Diseases (NCDs).

An overview of the Zambian nutrition policy

Zambia's efforts to fight malnutrition date back to its early period of independence as evidenced by the establishment of the National Food and Nutrition Commission (NFNC) in

1967 by an Act of Parliament under the Ministry of Health. Since its inception, the NFNC's primary mission has been to promote and oversee food and nutrition initiatives nationwide [35]. Zambia's health sector became responsible for developing and implementing policies and programs to combat malnutrition in the country. From the early 1970s to the early 1990s, the Zambian government prioritized the distribution of micronutrients to combat iron, iodine, and vitamin-A deficiency through several initiatives, including fortification and supplementation programs run by the national health system and the private sector. Although other micronutrient deficiencies not addressed by these single-nutrient initiatives persist, the prevalence of iodine and vitamin-A deficiency has been substantially reduced [35]. The 1990s saw a shift in focus towards infant and child feeding and HIV-related nutrition education, which became the focal point of the Zambian nutrition initiatives in the years that followed.

Historically, the Zambian food policy has been shaped by the goal to alleviate chronic hunger and food insecurity. Due to recurrent drought and periodic food shortages, the agriculture sector has historically been more concerned with boosting staple crop production to feed a growing population than with nutrition. Since maize is the staple food for poor rural Zambians and a favoured food option for urban families [36], most of Zambia's agricultural policy has centered on maize production. Through its Agriculture sector, the government established the Food Reserve Agency (FRA) and the Farmer Input Support Program to increase food security in Zambia. The FRA was established in 1972, then revised in 1996 and 2005, to purchase maize from farmers at guaranteed prices and build a strategic grain reserve [37] while the Farmer Input Support Program was formed in 2002 to provide cheap inputs for grain growing. Analysis of policy papers revealed that despite the FRA and FISP's role in alleviating food insecurity [38], neither program expressly targets malnutrition. However, nutrition issues were incorporated more explicitly in the National Agriculture Policy (NAP 2004-2015) [35].

Although nutrition schemes have existed in Zambia for decades, a review of nutrition-related policies in many sectors indicated that Zambia's nutrition policy environment has been inconsistent and fragmented for several decades before the 21st century [35]. The passing of the National Food and Nutrition Policy (NFNP) in 2006 contributed to the consolidation of nutrition policies and programs. The NFNP was followed by the establishment of the National Food and Nutrition Strategic Plan (NFNSP) in 2011 and the Most Critical Days Program (MCDP) in 2013, which is Zambia's current nutrition implementation strategy. While the current nutrition policy was developed within the health sector, it refers to non-health sectors

[39]. For instance, per the NFNP, the agriculture sector altered food security strategies to take dietary quality into account; The Ministry of Community Development and Social Welfare implements the food security pack (FSP), which aims to improve household food security for vulnerable small-scale farmers, while the Ministry of Education administers a home-grown school feeding program and nutrition education in collaboration with the World Food Program.

The overview of Zambia's policy environment reveals that, despite the government's efforts to increase food security, none of the policies and programs specifically target overnutrition and underweight. The policies emphasize increasing staple crop production and reducing hunger more than promoting nutrient-dense crops and vegetables known to enhance nutrition. Through its policies and programs, the government has not managed to promote dietary diversification, awareness and physical activities that are known to reduce both underweight and overnutrition among adults in general and women of reproductive age in particular.

Rationale

Despite the economic progress that Zambia has made from the beginning of the 21st century and the policy efforts made by different sectors to combat malnutrition, the country still experiences a double burden of malnutrition. Research has shown that while the rates of undernutrition among women of reproductive age in Zambia are slightly decreasing, the prevalence of overnutrition is increasing [23]. However, it is important to note that national-level estimates tend to mask the inequalities that exist between subgroups. For example, despite an overall decrease in the prevalence of undernutrition in Cambodia in the 14 years beginning in 2000, subgroup analysis showed that undernutrition of females below the age of 20 had remained at 27% while that of older women decreased by two-thirds [40]. Thus there is a need not only to describe the trends and prevalence of underweight and overnutrition among women but to also examine the inequalities that exist between subgroups of women of reproductive age in the Zambian context.

Some studies have focused on the prevalence and correlates of malnutrition among children under the age of 5 in Zambia [41,42]. However, few studies have given attention to females of reproductive age. One study focused on the rural-urban differences in the prevalence of overweight and obesity in Zambia among women of childbearing age [43]. They, however, did not consider undernutrition in this group of women and focused on the data from only the 2013/2014 Demographic Health Survey. Moise IK et al. were more holistic and focused on

trends in obesity among women of reproductive age from 2000 to 2014 but in a similar vein did not consider the undernutrition trends in this population and did not assess inequalities [23].

Unlike overweight and obesity there are relatively fewer studies that have focused on underweight among women of reproductive age and none in Zambia from my literature search. This study may help to address the gap in knowledge on whether there were inequalities in underweight and overnutrition in Zambia from 2001 to 2014. Results may help to inform future policy and programs aimed at addressing overnutrition and underweight in Zambia.

For progress to be made in breaking the intergenerational chain of undernutrition and overnutrition, it may be helpful to assess whether undernutrition and/or overnutrition is prevalent within specific groups of females in terms of their age, residence, marital status, socioeconomic status and education. Gaining a thorough understanding of the trends and existing inequalities associated with the various forms of malnutrition will help in tracking progress and guiding targeted policy adoption and equitable distribution of already scarce resources in the country.

RESEARCH QUESTION AND OBJECTIVES

Research Question

What were the trends and inequalities in the nutritional status of females of reproductive age in Zambia from 2001-2014?

Objectives

General Objective

To assess the trends and inequalities in the nutritional status of females of reproductive age from 2001 to 2014 in Zambia.

Specific Objectives

- To describe the trends in underweight and overnutrition (overweight/obesity) among women of reproductive age from 2001 to 2014
- To assess the association between underweight and overnutrition and socio-economic status, geographical location, employment status, marital status and age among women of reproductive age.
- To assess inequalities in the prevalence of underweight and overnutrition among women of reproductive age in the period between 2001 and 2014.

METHODOLOGY

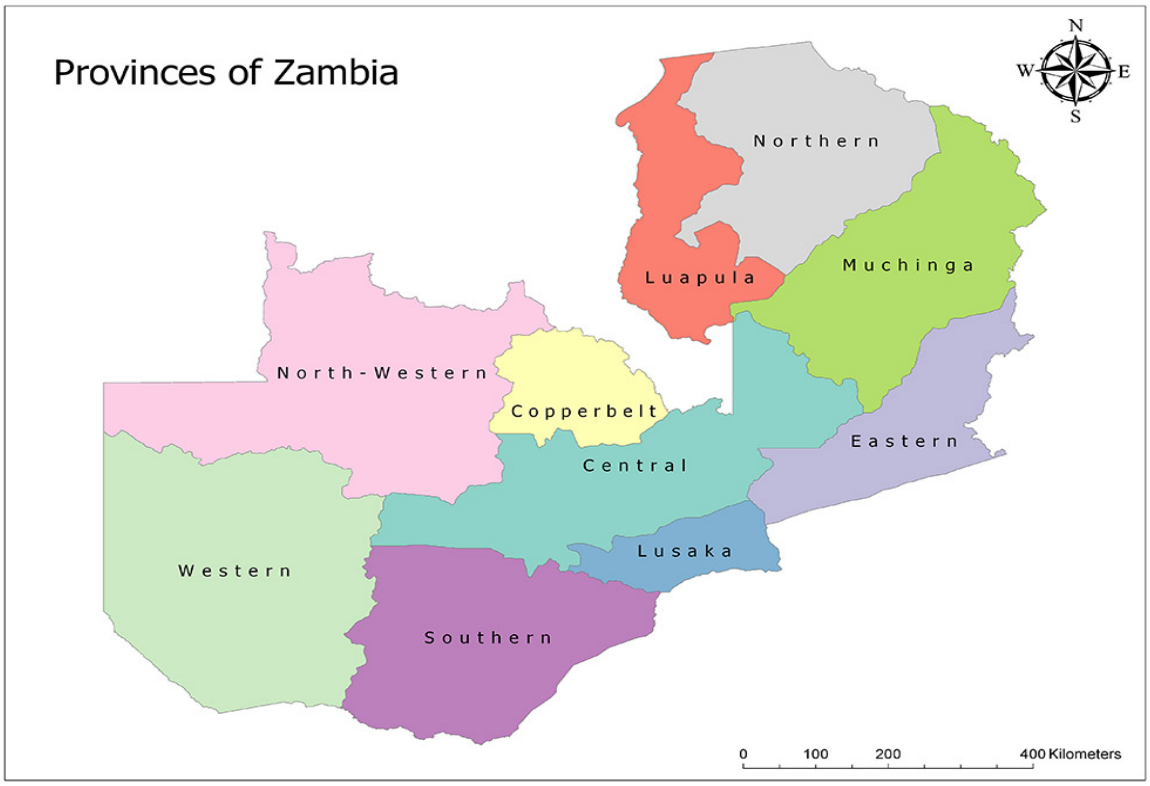
Study Design

This was a cross sectional study that utilized data from the 2001, 2007 and 2014 Zambia Demographic and Health Surveys (ZDHS). The ZDHS is a nationally representative survey that is designed to provide up-to-date estimates of basic demographic and health indicators of men, women and children.

Study setting

Zambia is a landlocked country in Southern Africa with a total land area of about 743,390 km^2. It is divided into 10 provinces (Figure 1) with about 45.3% of its population residing in urban areas. It is estimated to have a population of around 18 million. There are about 4 million females of reproductive age in Zambia. [25]

Figure 1: The Zambian map



Source: https://www.mappr.co/counties/zambia/

Sampling

The ZDHS used a two-stage stratified cluster sampling method based on census enumeration areas and household samples. Stratification was achieved by separating each province into urban and rural areas. The first stage was the selection of Standard Enumeration Areas (SEAs)

with probability proportional to size. A SEA is a convenient geographical area with a map which shows its boundaries and contains information about the type of residences within its jurisdiction, the number of households and individuals. The second stage involved random selection of households and participants.

In the 2001 and 2007 Demographic and Health Surveys, a list of SEAs that was initially prepared for the population census of the year 2000 constituted the sampling frame. It consisted of 16 757 SEA. A representative sample of 8000 households formed the sample for the 2001 ZDHS and a representative sample of 8000 households formed the sample for the 2007 ZDHS. An updated list of enumeration areas from the 2010 Population and Housing Census provided the sampling frame for the 2013/2014 survey. The frame consisted of 25,631 enumeration areas and 2,815,897 households. A representative sample of 18,052 households was used.

Inclusion and Exclusion Criteria

The ZDHS included a separate women's questionnaire that aimed to collect data specifically from women of reproductive age. This study adopted the same inclusion and exclusion criteria as the women's questionnaires of the ZDHS. All women aged 15-49 who were either permanent residents of the households or visitors present in the households on the night before the survey were included. Pregnant women, women who gave birth two months before the survey and females living in institutional households such as army barracks, hospitals, police camps and boarding schools were excluded from the survey.

Data collection

For each of the three surveys, standardized questionnaires were used to collect data. Anthropometric measurements of weight in kilograms and height in meters were collected by trained professionals using standard techniques. Calibration of measuring weight scales was done as they arrived in Zambia, during training and routinely throughout fieldwork. Weighing scales used took measurements in 0.1kg increments. Females were weighed on scales without shoes and wearing light clothes, and height was also measured without shoes with an adjustable measuring board. A standardized woman's questionnaire was used to collect information from all women aged 15-49. In addition to English, the questionnaires were translated into seven local languages namely Bemba, Lozi, Nyanja, Kaonde, Lunda, Tonga and Luvale. A pretest was done to pilot both the questionnaires and take the anthropometric measurements. Debriefing sessions were held with the pretest field staff, and modifications to the questionnaires were made based on lessons drawn from the exercise.

Operational definitions

Body Mass Index (BMI): Weight in kilograms divided by height in meters squared.

Underweight: BMI of less than 18.5kg/m^2.

Overweight: BMI of 25kg/m^2 to 29.9kg/m^2

Obesity: BMI of 30kg/m^2 or greater.

Overnutrition (Overweight and obesity): BMI of 25.00kg/m^2 or greater.

Variables

The dependent variables were (i) underweight and (ii) overnutrition, which is a combination of overweight and obesity. The independent variables in this study were age, residence, region, educational level, employment status, marital status, number of children born and wealth quintile. Age was divided into four categories: 15-19 years, 20-29 years, 30-39 years and 40-49 years. Residence is classified as either rural or urban. Regions referred to the country's provinces. Educational level was categorized as no education, primary education, secondary education and post-secondary education. Employment status was categorized as either employed or unemployed. Marital status was classified as never married, married and other while wealth status was divided into five quintiles which were poorer, poor, middle, richer and richest.

Data Analysis

Firstly, descriptive analysis of the study participants was done by calculating frequencies and percentages of the study variables. The prevalence of underweight and overnutrition was then estimated using study variables for individual survey years and the duration of the investigation (2001 to 2014). From 2001 to 2014, percentage point changes in the prevalence of underweight and overnutrition were estimated, and results were given with a 95% confidence interval.

A consolidated dataset from 2001 to 2014 was utilized to boost the statistical power of the study to identify relationships between independent variables and outcomes of interest (underweight and overnutrition). Logistic regression was used to analyze the associations between each of the dependent variables (underweight and overnutrition) and the independent variables of interest in univariate and multivariable models (adjusting for other sociodemographic variables as these could be potential confounders). Equiplots were used to compare the magnitude and changes in inequality in nutrition status among women of

reproductive age. The equiplot is a graphical representation that employs dots to facilitate comparisons of inequalities both within and between subgroups. The distance between the dots represents the absolute difference/ inequality between the subgroups.

Data analysis was performed in Stata software version 17. In the analysis, sampling weights and the cluster survey design were accounted for using the svy command. Equiplots were constructed in Microsoft Excel.

Ethical Considerations

This study was based on secondary data analysis of the identified publicly available information from the Demographic and Health Survey program. The Ethical Review Committee at the University of Zambia and the Institutional Review Board of ORC Macro approved the 2001 ZDHS. The 2007 and 2014 ZDHS obtained ethical approval from the Tropical Disease and Research Centre (TDRC) ethical committee, the Institutional Review Board of Macro International and the Centers for Disease Control and Prevention (CDC) Atlanta research ethics review board. Participation in the surveys was based on informed and voluntary consent.

RESULTS

Description of the study sample

This study consisted of 27 096 females of reproductive age (15-49 years) between 2001 and 2014. Fifty-five per cent of the participants resided in rural areas while forty-five per cent resided in urban areas. The provinces that had the highest number of participants were Copperbelt (5014) and Lusaka (4988), each accounting for over 18% of the sample, while the North-Western province had the lowest number, with only 5% of the participants residing there. The proportion of women who reported being married at the time of the surveys was almost double the proportion who reported never being married (56% and 29% respectively).

The proportion of females who reported having some sort of schooling substantially outweighed those with no educational background. Approximately 9% of the participants indicated having no formal education, while 91% reported having completed at least primary school. However, only 35% of the participants claimed having completed secondary school and 5% reported having completed post-secondary school. Fifty-four percent of females reported being in some form of employment and 46% reported that they were unemployed. Approximately 26% of the participants reported never having had a child in their lifetime while 74% reported having had at least one child. Table 1 below shows the background characteristics of the study sample.

Table 1: Background characteristics of the study variables among women aged 15 – 49 years from 2001 - 2014

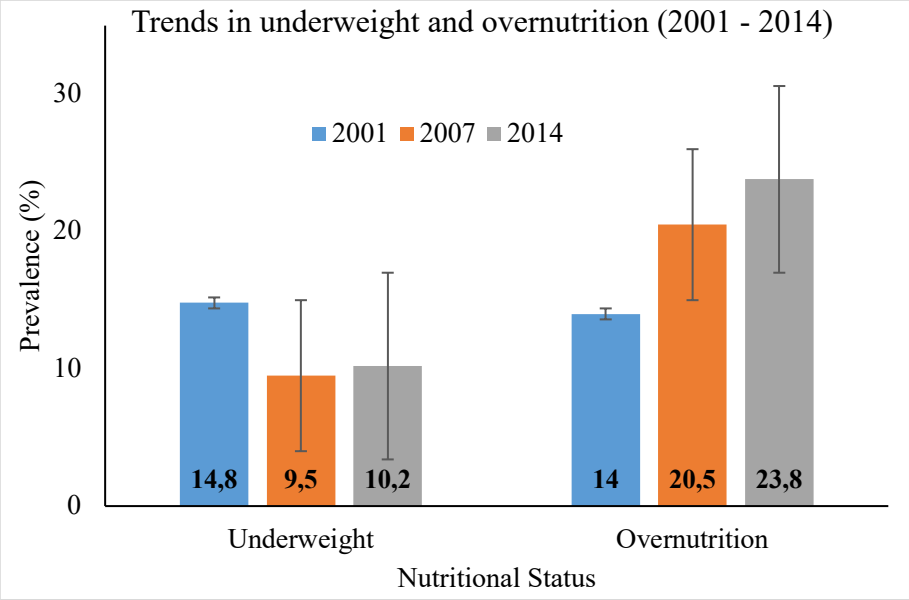
Variable	2001 N (%)	2007 N (%)	2014 N (%)	2001 – 2014 N (%)
Nutritional status				
Normal weight	4696 (72.7)	4247 (71.12)	9543 (66.8)	18486 (69.1)
Underweight	971 (15.0)	575 (9.62)	1472 (10.3)	3018 (11.3)
Overweight	596 (9.22)	822 (13.76)	2311 (16.2)	3728 (14.0)
Obesity	197 (3.1)	328 (5.49)	958 (6.7)	1484 (5.5)
Woman's age (years), median (IQR)	26 (20, 35)	27 (20, 35)	27 (20, 36)	27 (20, 36)
Woman's age (years)				
15 - 19	1629 (24.8)	1404 (23.2)	3292 (22.8)	6326 (23.4)
20 - 29	2428 (36.9)	2165 (35.7)	4863 (33.7)	9456 (34.9)
30 - 39	1498 (22.8)	1488 (24.5)	3898 (27.0)	6885 (25.4)
40 - 49	1027 (15.6)	1007 (16.6)	2395 (16.6)	4428 (16.3)
Residence				
Urban	2750 (41.8)	2676 (44.1)	6874 (47.6)	12300 (45.4)
Rural	3833 (58.2)	3389 (55.9)	7574 (52.4)	14795 (54.6)
Region				
Central	469 (7.1)	557 (9.2)	1291 (8.9)	2316 (8.6)
Copperbelt	1358 (20.6)	1102 (18.2)	2554 (17.7)	5014 (18.5)
Eastern	790 (12.0)	828 (13.7)	1697 (11.8)	3314 (12.2)
Luapula	510 (7.8)	418 (6.9)	956 (6.6)	1884 (7.0)
Lusaka	1009 (15.3)	1033 (17.0)	2946 (20.4)	4988 (18.4)
Muchinga	-	-	751 (5.2)	-
Northern	877 (13.3)	801 (13.2)	1007 (7.0)	2684 (10.2)
North-Western	303 (4.6)	302 (5.0)	622 (4.3)	1228 (4.5)
Southern	695 (10.6)	611 (10.1)	1760 (12.2)	3066 (11.3)
Western	571 (8.7)	413 (6.8)	865 (6)	1849 (6.8)
Marital Status				
Never married	1809 (27.5)	1760 (29.0)	4350 (30.1)	7919 (29.2)
Married	3712 (56.4)	3434 (56.6)	8143 (56.4)	15289 (56.4)
Other	1062 (16.1)	871 (14.4)	1956 (13.5)	3888 (14.4)
Education level				
No education	772 (11.7)	623 (10.3)	1162 (8.1)	2557 (9.4)
Primary	3764 (57.2)	3219 (53.1)	6682 (46.3)	13665 (50.5)
Secondary	1829 (27.8)	1888 (31.1)	5840 (40.5)	9557 (35.3)
Higher	217 (3.3)	335 (5.5)	756 (5.2)	1308 (4.8)
Occupation				
Not working	2869 (43.6)	2735 (45.1)	6915 (47.9)	12519 (46.2)
Working	3714 (56.4)	3329 (54.9)	7533 (52.1)	14576 (53.8)
Number of children born				
No children	1728 (26.3)	1588 (26.2)	3642 (25.2)	6959 (25.7)
1 - 3 Children	2484 (37.7)	2197 (36.2)	5435 (37.6)	10116 (37.3)
4 or more children	2371 (36.0)	2278 (37.6)	5372 (37.2)	10021 (37.0)
Wealth status				
Poorest	-	1004 (16.6)	2417 (16.7)	3420 (16.7)
Poorer	-	1064 (17.6)	2435 (16.9)	3499 (17.1)
Middle	-	1033 (17.0)	2703 (18.7)	3737 (18.2)

Richer	-	1349 (22.2)	3110 (21.5)	4459 (21.7)
Richest	-	1614 (26.6)	3784 (26.2)	5398 (26.3)

Prevalence of underweight and overweight /obesity (overnutrition)

Over the study period from 2001 to 2014, there was an overall decrease in the prevalence of underweight among females of reproductive age from 14.8% in 2001 to 10.2 % in 2014. However, during the same period, an opposite trend was noticed with an increase in the prevalence of overnutrition from 14% to 24%. Figure 2 below illustrates the overall changes in the prevalence of underweight and overnutrition among females of reproductive age from 2001 to 2014.

Figure 2: Trends in underweight and overnutrition among women aged 15 – 49 years old from 2001 – 2014



Trends in the prevalence of underweight

Between 2001 and 2014, the highest prevalence of underweight stratified by age was observed among females between the ages of 15 to 19 (19%, 14%, and 16% in 2001, 2007 and 2014 respectively). There was no decrease in the prevalence of underweight in the age groups 20-29 and 30-39 between 2007 and 2014 with the prevalence of underweight remaining at approximately 8% in both age groups. The largest decrease in underweight in the period 2001 to 2014 was observed in women aged 40 – 49 years (diff = -5.9% 95% CI = -15.0, 3.2). (Table 2).

Across all three surveys, the prevalence of underweight was higher among rural residents compared to their urban counterparts. Furthermore, females with no children had a greater

prevalence of being underweight 15.8%, than those with 1 to 3 children (9.3%) and those with more than 4 children (9.8%).

The prevalence of underweight in rural areas decreased from 17.2% in 2001 to 11.9% in 2014, while a decrease from 11.4% in 2001 to 8.2% in 2014 was observed in urban areas. However, much of this change occurred between 2001 and 2007 when the prevalence of underweight decreased from 17.2% in 2001 to 11.1% in 2007 among rural residents, while it decreased from 11.4% to 7.5%, respectively, among urban residents. Neither rural nor urban areas experienced important changes in underweight between 2007 and 2014.

Almost all regions experienced a decrease in the prevalence of underweight between 2001 and 2014 (Table 2). Most of this decrease occurred in the period between 2001 and 2007, with no substantial changes occurring between 2007 and 2014 in most of the regions (Table 2). Only Lusaka and the Western region exhibited trends that are different from the rest of the regions. Lusaka experienced no decrease in underweight during the period in question as evidenced by the prevalence of approximately 8% in 2001, 2007 and 2014. The Western region experienced a decline in underweight prevalence from 18.2% in 2001 to 14.3 % in 2007 but the region saw an increase in underweight prevalence from 14.3% in 2007 to 19.9% in 2014. The largest decrease in the prevalence of underweight across the study period was observed in North-Western Province with a 10.5%-point decrease (95% CI -23.5, 2.5%) between 2001 and 2014.

Across the study period, women with no education had a high prevalence of being underweight, 19.2% in 2001, 13.2% in 2007 and 14.9% in 2014 compared to women with the highest level of education who had the prevalence of 8.3%, 6.0% and 5.2%, respectively. However, both groups experienced a decrease in the prevalence of underweight across the study period with females with no education experiencing a decrease of 6.2% points (95% CI -15.3, 2.9%) and those with more than secondary level education experiencing a 3.1% points (95% CI -7.1, 0.9%) decrease.

There was a comparable decrease in the overall prevalence of underweight between working and non-working females of reproductive age across the study period (-4.9%, 95% CI -12.4, 2.6% and -4.4%, 95% CI -11.2, 2.4% respectively). There was a decrease in the prevalence of underweight in females belonging to the 3rd and 4th quintiles, but an increase was observed among the females in the other wealth quintiles. Females belonging to the 1st quintile were observed to have had a 5.1% points (95% CI -27.4, 376) increase in the prevalence of underweight between 2007 and 2014.

Table 2: Prevalence of underweight among women of reproductive age by study variables from 2001 to 2014

Variable	2001 n (%)	2007 n (%)	2014 n (%)	2001 – 2014 Diff (CI)
Females Age (years)				
15 - 19	316 (19.4)	200 (14.2)	539 (16.4)	-3.0 (-9.4, 3.4)
20 - 29	308 (12.7)	182 (8.4)	409 (8.4)	-4.3 (-10.4, 1.8)
30 - 39	202 (13.5)	119 (8.0)	313 (8.0)	-5.5 (-13.3, 2.3)
40 - 49	144 (14.0)	73 (7.2)	212 (8.2)	-5.9 (-15.0, 3.2)
Residence				
Urban	313 (11.4)	200 (7.5)	567 (8.2)	-3.1 (-8.2, 2.0)
Rural	658 (17.2)	375 (11.1)	905 (11.9)	-5.2 (-13.4, 3.0)
Region				
Central	86 (18.3)	51 (9.2)	133 (10.3)	-8.0 (-20.4, 4.4)
Copperbelt	192 (14.1)	81 (7.4)	228 (8.9)	-5.2 (-14.0, 3.6)
Eastern	111 (14.1)	55 (6.6)	132 (7.8)	-6.3 (-16.2, 3.6)
Luapula	98 (19.2)	54 (12.9)	103 (10.8)	-8.4 (-19.3, 2.5)
Lusaka	76 (7.5)	79 (7.6)	238 (8.1)	0.5 (-0.2, 1.2)
Muchinga			105 (14.0)	
Northern	137 (15.6)	102 (12.7)	136 (13.5)	-2.1 (-5.8, 1.6)
North-Western	60 (19.8)	42 (13.9)	58 (9.3)	-10.5 (-23.5, 2.5)
Southern	108 (15.5)	51 (8.3)	166 (9.4)	-6.1 (-15.7, 3.5)
Western	104 (18.2)	59 (14.3)	172 (19.9)	1.7 (-5.4, 8.8)
Marital Status				
Never married	347 (19.2)	233 (13.2)	647 (14.9)	-4.3 (-11.9, 3.3)
Married	481 (13.0)	260 (7.6)	662 (8.1)	-4.8 (-12.2, 2.6)
Other	143 (13.5)	82 (14.4)	164 (8.4)	-5.1 (-11.8, 1.6)
Education level				
No education	139 (18.0)	72 (11.6)	137 (11.8)	-6.2 (-15.3, 2.9)
Primary	596 (15.8)	337 (10.5)	783 (11.7)	-4.1 (-11.1, 2.9)
Secondary	219 (12.0)	146 (7.7)	510 (8.7)	-3.2 (-8.7, 2.3)
Higher	18 (8.3)	20 (6.0)	39 (5.2)	-3.1 (-7.1, 0.9)
Occupation				
Not working	455 (15.9)	295 (10.8)	793 (11.5)	-4.4 (-11.2, 2.4)
Working	516 (13.9)	280 (8.4)	679 (9.0)	-4.9 (-12.4, 2.6)
Number of children				
No children	342 (19.8)	211 (13.3)	547 (15.0)	-4.8 (-13.2, 3.6)
1 - 3 Children	293 (11.8)	187 (8.5)	457 (8.4)	-3.4 (-8.2, 1.4)
4 or more children	336 (14.2)	177 (7.8)	468 (8.7)	-5.5 (-14.1, 3.1)
Wealth status				
1st quintile	-	106 (10.6)	379 (15.7)	-
2nd quintile	-	132 (12.4)	314 (12.9)	-
3rd quintile	-	117 (11.3)	267 (9.9)	-
4th quintile	-	111 (8.2)	225 (7.2)	-
5th quintile	-	108 (6.7)	287 (7.6)	-

Trends in the prevalence of overnutrition (overweight/obesity)

The highest prevalence of overnutrition was observed among females aged 40-49 years across all three survey years while the lowest prevalence of overnutrition was observed among females aged 15-19. There was a general increase in the prevalence of overnutrition in all age groups (Table 3). The largest increase in the prevalence of overnutrition was observed among females between the ages of 30 to 39 years with a 15.3% points (95% CI -3.5, 34.1%) rise.

There was an increase in the prevalence of overnutrition among both urban residents (12.2% points, 95% CI -3.4, 27.8%) and rural areas residents (7.7% points, 95% CI -0.8, 16.2) from 2001 to 2014. Almost all regions experienced an increase in the prevalence of overnutrition between 2001 and 2014 (Table 3). The largest increase in the prevalence of overnutrition was observed in Copperbelt (13.1% points, 95% CI -5.0, 31.2%) while the lowest increase was observed in Northern Province (4.1% points, 95% CI -1.1, 9.3%) from 2001 to 2014.

Table 3: Prevalence of overnutrition among women of reproductive age by study variables from 2001 to 2014

Variable	2001 n (%)	2007 n (%)	2014 n (%)	2001 – 2014 Diff (CI)
Woman's age groups (years)				
15 – 19	89 (5.5)	111 (7.9)	234 (7.1)	1.6 (-0.9, 4.2)
20 – 29	256 (10.5)	345 (15.9)	967 (19.9)	9.3 (-9.7, 28.4)
30 – 39	217 (14.5)	378 (25.4)	1162 (29.8)	15.3 (-3.5, 34.1)
40 – 49	231 (22.5)	315 (31.3)	857 (35.8)	13.3 (-2.6, 29.2)
Residence				
Urban	534 (19.4)	783 (29.3)	2174 (31.6)	12.2 (-3.4, 27.8)
Rural	259 (6.8)	367 (10.8)	1094 (14.4)	7.7 (-0.8, 16.2)
Region				
Central	51 (10.9)	88 (15.8)	240 (18.6)	7.7 (-1.3, 16.8)
Copper belt	224 (16.5)	274 (24.9)	757 (29.6)	13.1 (-5.0, 31.2)
Eastern	69 (8.7)	118 (14.3)	330 (19.4)	10.7 (1.4, 20.1)
Luapula	32 (6.3)	40 (9.6)	121 (12.7)	6.4 (-1.6, 14.3)
Lusaka	231 (22.9)	341 (33.0)	1033 (35.1)	12.2 (-3.0, 27.4)
Muchinga	-	-	99 (13.2)	
Northern	72 (8.2)	91 (11.4)	124 (12.3)	4.1 (-1.1, 9.3)
North-Western	27 (8.9)	38 (12.6)	93 (15.0)	6.0 (-1.7, 13.8)
Southern	63 (9.1)	132 (21.6)	384 (21.8)	12.8 (-2.7, 28.2)
Western	24 (4.2)	28 (6.8)	88 (10.2)	6.0 (-1.0, 12.9)
Marital Status				
Never married	142 (7.8)	209 (11.9)	554 (12.7)	4.9 (-0.1, 9.9)
Married	506 (13.6)	724 (21.1)	2210 (27.1)	13.5 (-2.8, 29.8)
Other	146 (13.7)	217 (24.9)	505 (25.8)	12.1 (-3.8, 27.9)
Education level				

No education	51 (6.6)	59 (9.5)	211 (18.2)	11.6 (-3.5, 26.6)
Primary	377 (10.0)	530 (16.5)	1287 (19.3)	9.2 (-2.0, 20.5)
Secondary	288 (15.7)	405 (21.5)	1425 (24.4)	8.7 (-0.8, 18.1)
Higher	77 (35.5)	155 (46.3)	345 (45.6)	10.2 (-5.5, 25.8)
Occupation				
Not working	302 (10.5)	394 (14.4)	1342 (19.4)	8.9 (-0.8, 18.5)
Working	491 (13.2)	756 (22.7)	1927 (25.6)	12.4 (-3.2, 27.9)
Number of children				
No children	128 (7.4)	187 (11.8)	454 (12.5)	5.1 (0.0, 10.1)
1 – 3 children	281 (11.3)	406 (18.5)	1315 (24.2)	12.9 (-2.8, 28.6)
4 or more children	384 (16.2)	557 (24.5)	1500 (27.9)	11.7 (-2.6, 26.1)
Wealth status				
1st quintile	-	75 (7.5)	205 (8.5)	-
2nd quintile	-	95 (8.9)	293 (12.0)	-
3rd quintile	-	116 (11.2)	496 (18.3)	-
4th quintile	-	302 (22.4)	921 (29.6)	-
5th quintile	-	561 (34.8)	1381 (36.5)	-

Predictors of underweight and overnutrition

The results suggest that marital status and education level were associated with both underweight and overnutrition. Married women had a lower risk of being underweight compared to never-married women (aOR= 0.48, 95% CI: 0.36 to 0.64), and a higher risk of being overnourished (aOR= 2.08, 95% CI: 1.55 to 2.79). Similarly, women with higher education levels had a lower risk of being underweight (aOR= 0.47, 95% CI: 0.31 to 0.72) and a higher risk of overnutrition (aOR= 2.11, 95% CI: 1.38 to 3.24) compared to women with no education.

Employment status and wealth status were also found to be associated with both underweight and overnutrition. Working women had a lower risk of being underweight (aOR=0.81, 95% CI: 0.69 to 0.96) but a higher risk of overnutrition (aOR=1.23, 95% CI: 1.04 to 1.45) compared to women who were not working. Women in the 4th and 5th quintiles had a lower risk of being underweight (aOR=0.19, 95% CI: 0.14 to 0.26 and aOR=0.14, 95% CI: 0.09 to 0.20, respectively) and a higher risk of overnutrition (aOR=5.18, 95% CI: 3.79 to 7.08 and aOR=7.26, 95% CI: 4.98 to 10.58, respectively) compared to women from the poorest wealth category.

Women's age and parity were also found to be associated with both underweight and overnutrition (Table 4). Women aged 20-29 years had a lower risk of being underweight (aOR=0.62, 95% CI: 0.45 to 0.84) and a higher risk of overnutrition (aOR=1.62, 95% CI: 1.18 to 2.21) compared to women aged 15-19 years. Women with 1-3 children had a slightly lower

risk of being underweight (aOR=0.85, 95% CI: 0.65 to 1.10) and a slightly higher risk of overnutrition (aOR=1.18, 95% CI: 0.91 to 1.53) compared to women with no children.

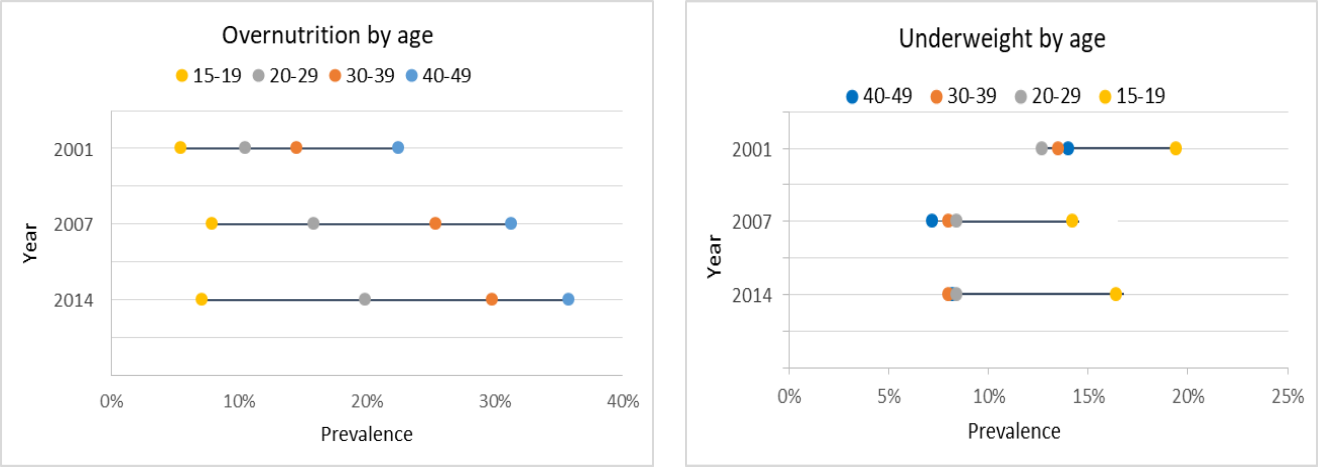
Table 4: Univariate and multivariable results for underweight and overnutrition among women of reproductive age from 2001 – 2014 (combined dataset)

	Underweight		Overnutrition	
	Crude OR (95% CI)	**aOR (95% CI)**	**Crude OR (95% CI)**	**aOR (95% CI)**
Marital Status				
Never married	1	1	1	1
Married	0.32 (0.28, 0.37)	0.48 (0.36, 0.64)	3.08 (2.69,3.52)	2.08 (1.55, 2.79)
Other	0.34 (0.29, 0.40)	0.56 (0.40, 0.79)	2.91 (2.47,3.42)	1.78 (1.27, 2.51)
Education level				
No education	1	1	1	1
Primary	0.78 (0.65, 0.93)	0.84 (0.67, 1.06)	1.29 (1.08,1.54)	1.19 (0.94,1.49)
Secondary	0.42 (0.35, 0.52)	0.56 (0.42, 0.75)	2.35 (1.93,2.87)	1.79 (1.34,2.37)
Higher	0.14 (0.10, 0.20)	0.47 (0.31, 0.72)	7.20 (5.12,10.11)	2.11 (1.38,3.24)
Occupation				
Not working	1	1	1	1
Working	0.62 (0.56, 0.69)	0.81 (0.69, 0.96)	1.6 (1.44,1.78)	1.23 (1.04, 1.45)
Wealth status				
Poorest	1	1	1	1
Poorer	0.67 (0.54, 0.83)	0.64 (0.50,0.83)	1.49 (0.16,1.85)	1.55 (1.21,2.00)
Middle	0.41 (0.33, 0.52)	0.43 (0.33,0.56)	2.42 (0.28,3.03)	2.33 (1.78,3.04)
Richer	0.18 (0.14, 0.22)	0.19 (0.14,0.26)	5.66 (0.66,7.02)	5.18 (3.79, 7.08)
Richest	0.13 (0.10, 0.17)	0.14 (0.09,0.20)	7.58 (0.94,9.66)	7.26 (4.98,10.58)
Woman's age (years)				
15 – 19	1	1	1	1
20 – 29	0.30 (0.25, 0.35)	0.62 (0.45, 0.84)	3.35 (2.85,3.93)	1.62 (1.18,2.21)
30 – 39	0.19 (0.16, 0.23)	0.68 (0.41, 1.12)	5.21 (4.44,6.12)	1.48 (0.89, 2.45)
40 – 49	0.16 (0.14, 0.19)	0.83 (0.40, 1.73)	6.16 (5.18,7.33)	1.21 (0.58, 2.53)
Number of children				
No children	1	1	1	1
1 – 3 Children	0.36 (0.31, 0.41)	0.85 (0.65, 1.10)	2.79 (2.44,3.19)	1.18 (0.91, 1.53)
4 or more children	0.31 (0.27, 0.35)	0.76 (0.55, 1.05)	3.23 (2.82,3.72)	1.31 (0.95, 1.82)
Residence				
Urban	1	1	1	1
Rural	3.37 (2.95, 3.85)	1.08 (0.87, 1.34)	0.3 (0.26,0.34)	0.92 (0.74,1.14)
Region				
Central	1	1	1	1
Copperbelt	0.58 (0.46, 0.74)	1.02 (0.73, 1.42)	1.71 (1.35,2.17)	0.98 (0.71, 1.36)
Eastern	0.80 (0.62, 1.04)	0.49 (0.34, 0.72)	1.25 (0.96,1.61)	2.03 (1.39,2.95)
Luapula	1.86 (1.42, 2.42)	1.39 (0.94, 2.04)	0.54 (0.41,0.70)	0.72 (0.49,1.06)
Lusaka	0.37 (0.30, 0.47)	0.87 (0.63, 1.19)	2.69 (2.14,3.39)	1.15 (0.84,1.58)

Northern	2.05 (1.61, 2.62)	1.78 (1.29, 2.45)	0.49 (0.38,0.62)	0.56 (0.41, 0.77)
North-Western	1.85 (1.40, 2.45)	1.40 (0.97, 2.03)	0.54 (0.41,0.72)	0.71 (0.49,1.03)
Southern	1.08 (0.82, 1.42)	0.95 (0.66, 1.37)	0.93 (0.71,1.22)	1.05 (0.73, 1.51)
Western	1.12 (0.83, 1.52)	1.12 (0.76, 1.64)	0.89 (0.66,1.2)	0.89 (0.61, 1.31)

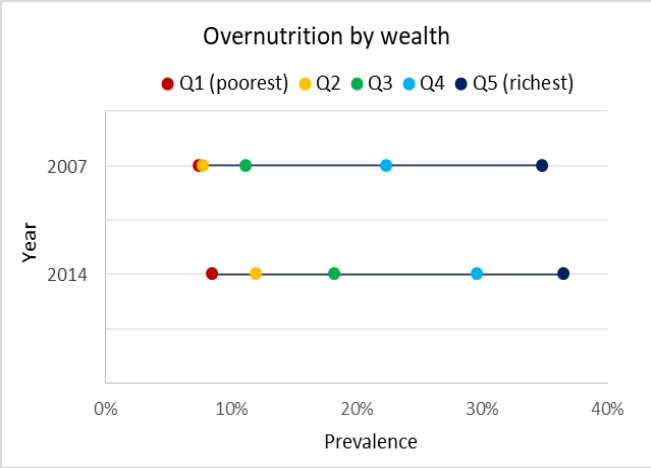
Inequalities in overnutrition and undernutrition

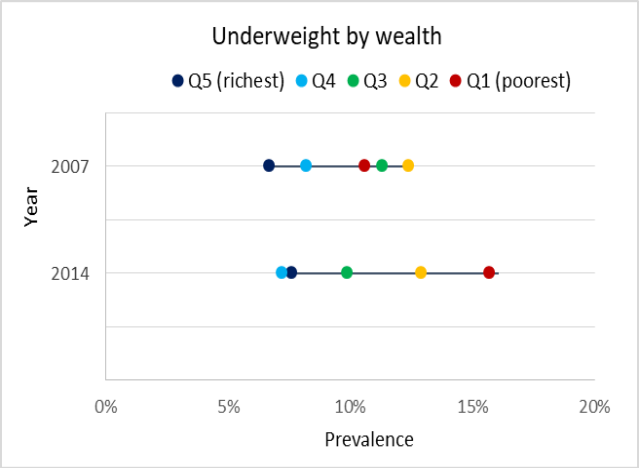
Figure 3: Absolute change in inequalities in underweight and overnutrition among women by age



The above equiplots indicate that the absolute inequality in overnutrition between the youngest (15-19 years) and oldest (40-49 years) age groups has increased from approximately 17% points in 2001 to approximately 29% points in 2014. Inequalities in underweight remained virtually unchanged between 2001 and 2007, with underweight being concentrated in the lowest age group compared to other age groups. There has been a slight increase in inequalities in underweight between the youngest age group and all other age groups between 2007 and 2014.

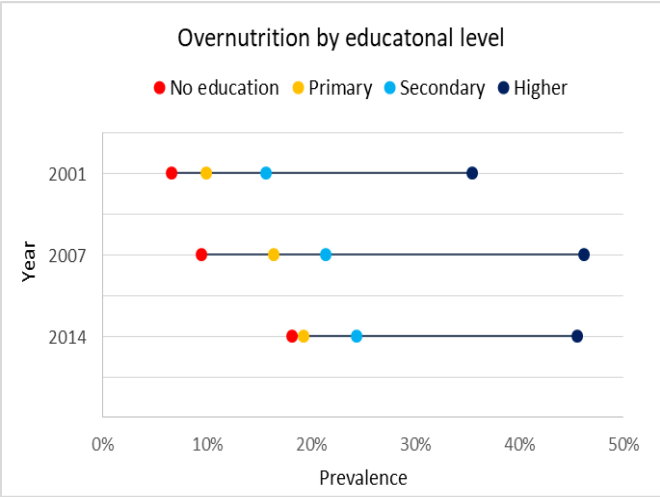
Figure 4: Absolute change in inequalities in underweight and overnutrition among women by wealth

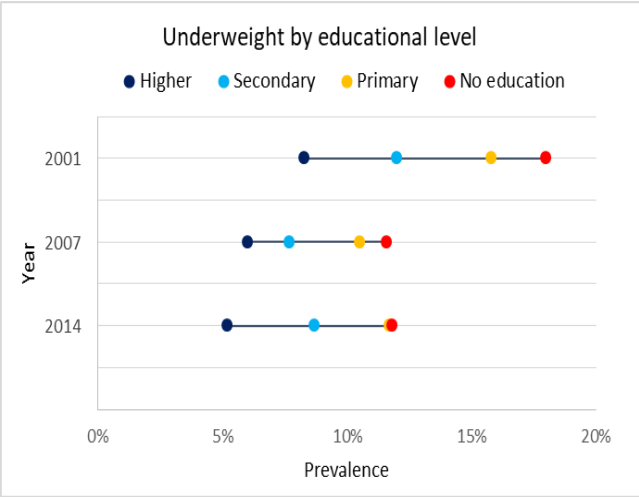




The above equiplots indicate that the absolute inequality in underweight between the poorest (Q1) and the richest (Q5) quintiles has increased from approximately 4% points in 2007 to approximately 8% points in 2014. The absolute difference in underweight between the richer (Q4) and the poorest has also increased from about 2% points in 2007 to approximately 9% points in 2014. The absolute inequality in overweight between the poorest and the richest groups from 2001 to 2014 has slightly increased.

Fig 5: Absolute change in inequalities in underweight and overnutrition among women by educational level



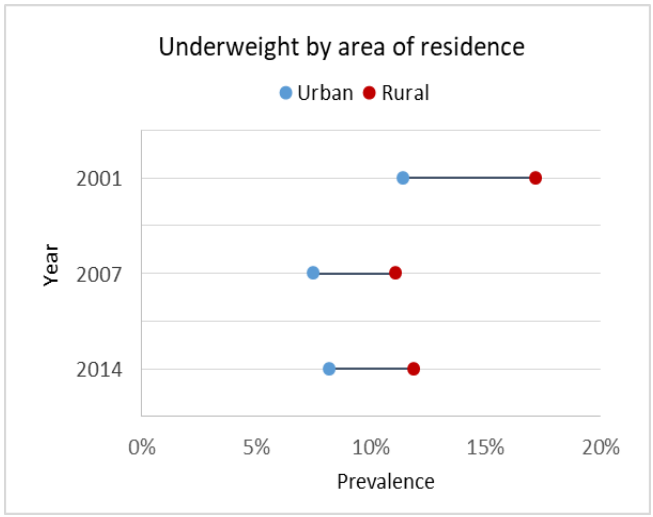


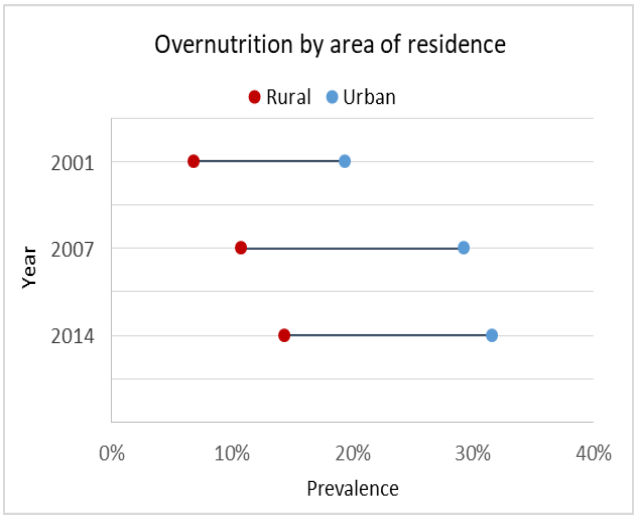
The equiplots above indicate that the absolute inequality in overnutrition between those with no education and those with higher education increased from about 29% points in 2001 to approximately 37% points in 2007. However, the inequality in overnutrition between those with no education and those with higher education decreased from approximately 37% points in 2007 to approximately 27% points in 2014. The absolute inequality in underweight between those with higher education and those without education has slightly decreased from approximately 10% points in 2001 to approximately 6% points in 2007 and it was almost the same in the 2007 and 2014.

Figure 6: Absolute change in inequalities in underweight and overnutrition among women by employment status

The equiplots above indicate that the absolute inequality in overnutrition between those who are working and those who are not working increased from approximately 3% points in 2001 to approximately 8% points in 2007. No big change in inequality in overnutrition occurred between 2007 and 2014, as indicated by the difference of 6% points between those who were working and those not working in 2014. The absolute inequality in undernutrition between those who were working and those who were not working remained almost the same (approximately 2% points) throughout the study period.

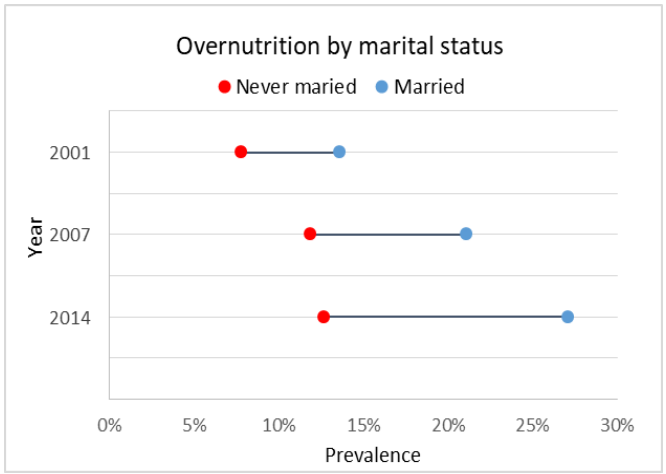
Fig 7: Absolute change in inequalities in underweight and overnutrition among women by area of residence

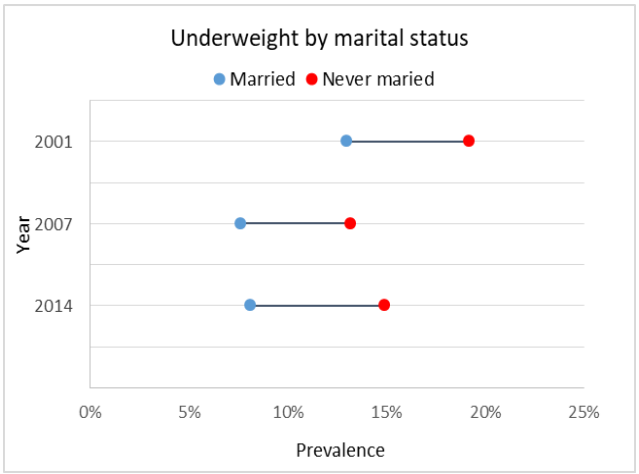




The above equiplots indicate that the absolute inequality in overnutrition between rural and urban residents increased from about 13% points in 2001 to approximately 19% points in 2007 while it remained almost the same between 2007 and 2014. The absolute inequality in undernutrition between urban residents and rural residents slightly decreased from approximately 6% points in 2001 to just over 3% points in 2007 and no important change in inequality occurred between 2007 and 2014.

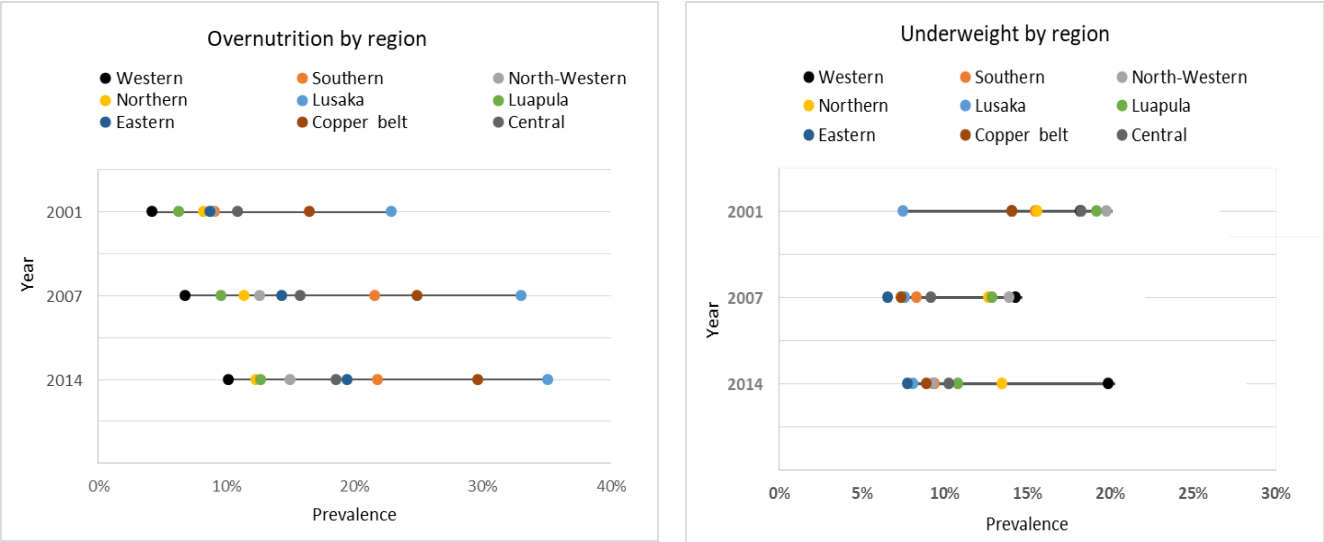
Figure 8: Absolute change in inequalities in underweight and overnutrition among women by marital status





The above equiplots indicate that the absolute inequality in overnutrition between married and unmarried women gradually increased from approximately 6% points in 2001 to approximately 9% points in 2007 and further increased by over 14% points in 2014. The difference in underweight between married and unmarried remained almost the same across the three surveys.

Figure 9: Absolute change in inequalities in underweight and overnutrition among women by province



The above equiplots show that the absolute inequalities in overnutrition between regions have almost remained the same. The most notable difference in overnutrition is between the Western region and Lusaka which increased from approximately 19% points in 2001 to just over 26% points in 2007 and remained almost the same between 2007 and 2014. Inequalities in underweight across regions with Lusaka and Eastern province constantly having prevalence from 2001 to 2014. However, as the prevalence of underweight has decreased in other regions, it only decreased in 2007 in the Western region and increased in 2014, thereby widening the inequality between Western and all other regions.

DISCUSSION

The findings of the study suggest that while the prevalence of being underweight among women of reproductive age from 2001 to 2014 has decreased, the prevalence of overnutrition has almost doubled during the same period. For instance, the prevalence of overnutrition among women of reproductive age was approximately 14% in 2001, but it increased to 24% in 2014. Factors associated with being overweight include living in urban areas, higher educational attainment, being employed, higher wealth, being married and being old. Living in rural areas, never being married, lower educational attainment, unemployment and being young were associated with being underweight. The prevalence of overweight was greatest among 40-49-year-old women and lowest among the youngest age group (15-29 years). Similar results have been reported in other developing countries [28,44,45].

This study suggests that wealthier women were more likely to be overnourished than poor women, which is consistent with studies from other low- and medium-income countries [7,28,13]. The inequality in the prevalence of overnutrition between the wealthy and the poor could be attributed to variations in dietary and lifestyle options. Individuals belonging to higher socioeconomic groups are more likely to be able to afford diets rich in saturated fats, which are related to overweight and obesity, compared to those belonging to lower socioeconomic groups [46,47]. Furthermore, wealthy women tend to adopt a sedentary lifestyle and engage in decreased levels of physical activity [48], both of which are known risk factors for overnutrition. The prevalence of overnutrition was also higher among employed and educated women as compared to their unemployed counterparts and those with no education, respectively. This is in contrast to the risk of overnutrition in high-income countries were women who attained higher education had a reduced risk of developing overweight/obesity compared to those with lower education [24,25,49]. However, the findings are consistent with other studies from lower- and middle-income countries where a positive association between educational attainment and overnutrition was reported [7,13,26]. Potential reasons for an increased rate of overnutrition among educated women overlap with employment and wealth-related ones. This is because, in low- and middle countries, educated individuals are more likely to engage in sedentary employment patterns [28,29], and may also have the purchasing power to eat out at restaurants and fast food outlets where most of the food is processed.

Urban women of reproductive age had a higher prevalence of overnutrition than their rural counterparts, which is consistent with prior research [23]. This may be due to the adoption of western lifestyle and dietary practices in urban areas, which involve the consumption of

processed foods that are known to be high in energy density, salt, and fat [6,50]. Urban dwellers in Zambia are highly exposed to fast-food outlets such as KFC, Hungry Lion, Pizza Hut and supermarkets that sell processed foods. A household survey in urban Zambia revealed that 40% of food expenditures in urban Zambia are primarily processed food while 35% are for ultra-processed food, and only 25% for unprocessed food [51]. The rise in fast food advertisements on mainstream and social media may also contribute to the spread of unhealthy eating habits among urban residents, who are more likely than their rural counterparts to watch television [23] and use social media. In addition, the discrepancies in overnutrition between women living in urban and rural settings could be ascribed to differences in physical activity participation. While the majority of people who live in rural areas regularly engage in physical activity by walking and working on farms, urbanisation has resulted in the replacement of physical activity with the use of fuel-powered modes of transportation and sedentary leisure activities that are linked to an increased risk of overweight and obesity [31].

This study also suggests that overnutrition continues to affect married women disproportionately compared to their counterparts, as evidenced by the increasing inequality in overnutrition between married and never-married women. This is consistent with other studies that demonstrated a positive connection between marriage and overweight/obesity among women [23,29]. This difference in overnutrition rates between married and never-married women could possibly be attributed to the perception of the overweight body as a sign of marital harmony, thereby encouraging women to gain excessive weight [27,52]. This difference may also be a function of age, as women who have ever been married, are more likely to be older than those who have never been married. Old age is associated with reduced physical activity and hormonal changes which increases the chance of being overweight [28,44].

In addition, the general increase in overnutrition among women of reproductive age between 2001 and 2014 may be attributable to societal attitudes and a cultural preference for being overweight. The belief that being overweight is beautiful, healthy, and a symbol of success is prevalent in many African societies [13,52]. The association of being overweight with wealth, health, and beauty has coexisted for a long time with the stigmatisation of thinness [53,54]. The HIV/AIDS pandemic amplified the stigmatisation of thinness, as an underweight body was strongly associated with being HIV positive [27,53,54]. To avoid being perceived as ill and HIV-positive, women may have been prompted to eat more, thereby gaining excessive weight [27,53]. However, this is not always the case, as other studies have shown that some

African societies appreciate a healthy body weight, which correlates to a curvy rather than obese body size [55,56]. This shows that the association between body weight perceptions and overnutrition is far more nuanced than it may appear.

Just as there were differences and inequalities in the prevalence of overnutrition between 2001 and 2014, this study suggests that the prevalence of underweight varied according to socio-economic status. Consistent with the results observed in a Tanzanian study, results from this study show that poor women had a higher risk of being underweight in comparison to wealthy women [12]. One possible explanation for this phenomenon could be that individuals with low socioeconomic status may experience limited access to resources and insufficient purchasing power, which may impede their ability to obtain sufficient quantities of nutrient-dense foods. The unequal distribution of underweight and overnutrition by wealth quintiles, in which the risk of being underweight increases with decreasing wealth, was also documented in other studies done in South Asia [10,48,57] and Sub-Saharan Africa [58].

Women who reside in rural areas had a higher prevalence of being underweight than those who reside in urban areas. This is consistent with studies that were done in other low- and middle-income countries [12,59]. The high prevalence of underweight in rural areas may partly be attributed to the loss of agricultural productivity due to climate change. Recent decades have been marked by a rise in the frequency of extreme climatic events, such as droughts and floods, which have a direct impact on agricultural output and food security [60,61]. Agriculture has been an important source of food in Zambia and many other African nations. Unfortunately, as a result of climate change, farmers are not always able to produce enough crops and vegetables to sustain themselves and supply to the markets [51]. The availability of fresh fruits and vegetables is crucial to a balanced diet. A decrease in the availability of fresh produce such as crops, livestock, fruits, and vegetables may have contributed to malnutrition and underweight in rural areas where people depend mostly on their agricultural produce for consumption. On the other hand, it may have prompted wealthier individuals, particularly in metropolitan areas, to rely increasingly on processed foods, thereby increasing the prevalence of overnutrition in urban areas. However, although the prevalence of underweight among rural residents remains disproportionately high, there has been a gradual reduction in the inequality in undernutrition between rural and urban populations. This trend may be attributed to the growing interconnectedness between urban and rural areas, which results in an improvement in the overall standard of living in rural regions [62].

Unemployed women (non-working) were more prone to be underweight than their counterparts. This could be a result of the psychosocial stress and financial constraints that accompany unemployment. Studies in high-income countries found that unemployed individuals tend to have less income and consume less overall energy than compared to their employed counterparts [63], suggesting that a limited income can contribute to a reduction in food consumption. In addition to lower energy intake as a result of financial constraints, unemployed individuals are more inclined to engage in active transport and less likely to own a personal vehicle [64], indicating that despite having limited food options, they may expend more energy through transportation. Although the absolute inequality in underweight between those with higher education and those with no education has slightly decreased from approximately 10% points in 2001 to approximately 6% points in 2007 and 2014, the problem of being underweight remained more concentrated among uneducated women in comparison with their counterparts. This is consistent with findings from Nepal, which found that women with no formal education were more likely to be underweight. These results may also reflect a correlation between education, employment, and wealth, as uneducated individuals are less likely to be employed and therefore lack the purchasing power required to acquire a balanced diet. The fact that the adjusted odds ratio was lower than the crude odds ratio means that the other variables included in the adjustment were confounding the relationship between education and underweight.

The findings suggest that married women were at a lower risk of being undernourished compared to their unmarried counterparts. Comparable results were documented in Bangladesh [65] and Tanzania [12,59]. A possible explanation for this is that, unlike many married women who are financially supported by their husbands, unmarried women - especially single mothers - do not have the same privilege and often struggle to achieve food security, obtain a balanced diet and maintain optimal health on a long-term basis [66]. Studies in other regions have also associated single motherhood with poor health outcomes, including undernutrition [66,67]. The results suggest that the problem of being underweight continues to affect the youngest age group (15-19) disproportionately compared to all other age groups, as indicated by the persistently high absolute difference in underweight between the youngest and older age groups. The lack of decision-making power regarding food distribution within households may result in marginalisation and suboptimal nutritional status among adolescent females [59]. Insufficient knowledge among adolescent females regarding their personal health and

nutritional well-being may also be a contributing factor to their inadequate nutritional status [68,69].

In addition, while the prevalence of underweight decreased in nearly all regions between 2001 and 2014, the Western and Lusaka regions exhibited a slightly different trend. The Western region experienced a decline between 2001 and 2007, followed by an increase between 2007 and 2014. These regional variations in underweight prevalence may be attributed to variations in draught occurrence across different provinces. Climate change affects different regions differently throughout the country. For instance, the Western province is one of the regions that are most prone to draughts, which threatens food security with loss in livestock, crop, fruit and vegetable production while draughts occur less frequently in the Northern regions [32]. The soil in Western province is generally sandy and has low fertility, which makes it difficult for crops to grow and yield well. Lusaka has maintained a low prevalence of underweight across 3 surveys. A possible reason could be that Lusaka has a relatively higher standard of living compared to other provinces in the country, which may lead to better access to nutritious food and healthcare [70].

Strengths and limitations of the study

This study has a number of noteworthy strengths. One of the most significant strengths lies in the comprehensive analysis it provides. By examining the nutritional status of women of reproductive age in Zambia over 13 years (2001-2014), the study sheds light on trends, changes, and patterns in the dynamics of underweight and overnutrition. This extensive timeframe is essential for informing public health policies and interventions aimed at addressing malnutrition in this population.

Another critical strength of the study is the use of nationally representative data from the Zambian Demographic and Health Surveys (ZDHS). These surveys are designed to provide reliable estimates of demographic and health indicators, and their large sample size ensures that the study findings are generalizable to the broader population of Zambian women of reproductive age. The ZDHS are conducted by well-trained personnel, using standardized instruments that have undergone rigorous testing and the questionnaires were translated into seven local languages in addition to English to accommodate participants who did not understand English, thereby increasing the generalizability of the study.

Furthermore, the study employs sound statistical methods, including logistic regression and equiplots, to examine the associations between various sociodemographic factors and

nutritional status. Logistic regression allows for the control of potential confounders and the identification of independent predictors [71] of underweight and overnutrition. The use of equiplots enables a clear and effective visual representation of inequalities in nutritional status, both within and between subgroups, facilitating the interpretation and communication of the study's findings.

The inclusion of multiple explanatory variables is another significant strength of the study. By considering a wide range of sociodemographic factors such as age, residence, region, education level, employment status, marital status, and wealth quintile, the study provides an insight of the complex interplay between sociodemographic characteristics and malnutrition in Zambian women of reproductive age. This holistic approach is essential for identifying key drivers of malnutrition and informing targeted interventions to address the issue.

By addressing an important public health issue, the study may contribute to the development of evidence-based policies and interventions aimed at reducing malnutrition and improving health outcomes for Zambian women of reproductive age. Malnutrition is a significant public health concern with substantial consequences for the health and well-being of women and their families, and this study helps to shed light on the factors associated with being underweight and overnutrition in this population.

Finally, this study lays the foundation for future research on the nutritional status of women of reproductive age in Zambia and other similar settings. By identifying gaps in knowledge, methodological limitations, and areas for further investigation, this study may assist researchers interested in exploring the complex relationships between sociodemographic factors and malnutrition. As a result, this thesis may serve as a resource for researchers and policymakers alike, contributing to the ongoing efforts to address malnutrition and improve the health and well-being of women of reproductive age in Zambia and beyond.

While the strengths of this study are considerable, it is essential to acknowledge some weaknesses that may impact the interpretation and generalizability of the findings. One limitation of the study is its reliance on secondary data from the Zambian Demographic and Health Surveys. Surveys may not capture all relevant factors that could influence the nutritional status of women of reproductive age in Zambia. Moreover, the ZDHS are cross-sectional, which precludes the determination of causal relationships between the explanatory variables and the outcome variables (underweight and overnutrition).

Additionally, the use of self-reported data in the ZDHS may introduce the potential for reporting bias. Participants may not accurately recall or report information about their socioeconomic status, education level, or other factors included in the analysis. This could lead to the misclassification of the independent variables and may impact the observed associations between these factors and nutritional status.

The study uses BMI as the primary measure of nutritional status, categorizing participants as underweight, overweight, or obese based on their BMI values. However, BMI has several limitations, as it does not account for variations in body composition, such as differences in muscle mass or fat distribution [72]. Alternative measures that were not used in the surveys, such as waist circumference or waist-to-hip ratio, could provide a more accurate assessment of nutritional status and health risks associated with body composition.

The study's cross-sectional design may also lead to reverse causality, where the outcome variables could influence the explanatory variables rather than the other way around [73]. For instance, a woman's nutritional status could affect her employment opportunities or marital status, rather than these factors determining her nutritional status. Longitudinal data would be necessary to establish causal relationships and account for potential reverse causality. Additionally, the study focuses solely on quantitative data, which may limit the understanding of the underlying reasons for the observed trends and associations. The inclusion of qualitative data, such as interviews or focus group discussions with the target population, could provide valuable insights into the cultural, social, and behavioural factors that contribute to the nutritional status of Zambian women of reproductive age.

Furthermore, the analysis may not account for all potential confounders and mediators that could influence the associations between the independent variables and the dependent variables. Unmeasured or residual confounding could lead to biased estimates of the associations between sociodemographic factors and nutritional status. This study was constrained because the ZDHS did not collect data on some of the crucial determinants of underweight and overnutrition such as physical activity, dietary practices and sedentary behaviours. Future research should consider potential mediators, such as dietary intake and physical activity, and potential confounders such as cultural factors, to provide a more comprehensive understanding of the determinants of malnutrition in Zambian women of reproductive age.

Furthermore, while the study provides valuable information on the nutritional status of women of reproductive age in Zambia, the findings may not be generalizable to other populations or settings. The sociodemographic characteristics and contextual factors that influence malnutrition in Zambia may differ from those in other countries, limiting the applicability of the findings to other contexts. Future research should explore the relationships between sociodemographic factors and malnutrition in different populations and settings to provide a more global perspective on this critical public health issue.

In addition, regarding the independent variables, the 2001 ZDHS lacks wealth status data, and thus the wealth-related inequalities reported in this study are based on data from the 2007 and 2014 ZDHS only. Lastly, the most recent ZDHS, which was conducted in 2018, did not use anthropometric measures, so there is no data on underweight or overweight women in the 2018 ZDHS. As a result, the 2018 ZDHS was excluded from this study. Since the latest survey used in this study was conducted nine years ago (2014), results may not accurately reflect the current trends and inequalities in underweight and overnutrition. To determine the current prevalence and inequalities in underweight and overnutrition among women of reproductive age, another survey is needed.

Recommendations

The trends reported in this study suggest that if not mitigated, overnutrition among women of reproductive age in Zambia may continue to rise while on the other hand, undernutrition remains a problem and this double burden of malnutrition may weigh heavily on the healthcare system over time. The recommendations outlined below provide a starting point for addressing the dual burden of underweight and overnutrition among females of reproductive age in Zambia:

1. *Structural policies and interventions:* Introducing structural measures such as better urban planning to promote/facilitate physical activity, sugar taxes and fat taxes to increase the prices of unhealthy foods and subsidies for healthy foods.
2. *Develop and implement targeted interventions:* Since the distribution of underweight and overnutrition varies across different regions and places of residence, context-specific programmes must be developed to combat underweight and overnutrition in accordance with the specific needs of a given context, as opposed to one-size-fits-all programmes that may lack sensitivity to the specific needs of women in different regions. For example, programs targeting rural women and those with low education

levels could focus on improving access to quality, nutritious food, and promoting healthy eating habits. This might involve initiatives like food assistance programs, agricultural support, and home-based nutrition education interventions. Similarly, interventions for urban women and those with higher education levels could focus on promoting physical activity and raising awareness about the risks of overnutrition. Examples of such interventions include workplace wellness programs, community-based exercise initiatives, and media campaigns emphasizing the dangers of sedentary lifestyles and poor dietary choices. Women's group initiatives which have proven to be effective in improving nutritional and maternal health knowledge elsewhere [74], [75], [76] could be useful in promoting healthy behaviours and responding to the double burden of malnutrition among women of reproductive age in both urban and rural areas. Educational campaigns can be designed to raise awareness about the importance of proper nutrition, the risks of undernutrition and overnutrition, and ways to maintain a healthy diet and lifestyle [76]. These campaigns should be tailored to the specific needs and cultural contexts of the target population, utilizing a variety of communication channels such as radio, television, print media, and social media

3. *Empower women economically:* Economic empowerment is a key factor in improving women's nutritional status. The results show that women who are working have lower odds of being underweight and higher odds of overnutrition compared to those who are not working. This suggests that working women may have better access to resources and food but may also be more exposed to unhealthy food environments and sedentary occupations. Policies and programs should aim to provide economic opportunities for women, including access to credit, skill development, and entrepreneurship training. For example, vocational training programs can help women start small businesses or enter the formal labour market, potentially improving their socioeconomic status and nutritional outcomes. Moreover, interventions should address potential barriers that women face in accessing economic opportunities, such as gender discrimination, lack of childcare, and restrictive social norms [77]. Policymakers should also invest in improving access to quality education for women, particularly in rural areas and among disadvantaged populations. This may involve initiatives such as scholarships, school feeding programs, and teacher training to enhance educational quality
4. *Strengthen health systems:* Health systems should be strengthened to deliver quality nutrition and health services, including regular monitoring and assessment of

nutritional status, provision of micronutrient supplementation, and management of nutrition-related disorders.

5. *Multi-sectoral collaboration*: Multi-sectoral collaboration is crucial in designing and implementing effective policies and programs to address the complex and interrelated factors contributing to undernutrition and overnutrition [78]. Sectors such as agriculture, education, health, social protection, and urban planning should work together to create supportive environments for healthy diets and lifestyles.
6. *Monitor and evaluate nutrition interventions*: To ensure the effectiveness and sustainability of nutrition interventions, regular monitoring and evaluation should be conducted. This involves collecting and analyzing data on the implementation and outcomes of interventions, using indicators such as dietary intake, anthropometric measurements, and changes in knowledge, attitudes, and practices related to nutrition. By monitoring and evaluating the impact of nutrition interventions, policymakers and practitioners can identify areas of success and challenges, enabling them to make informed decisions about resource allocation and program adjustments. This continuous process of learning and improvement is essential for addressing the complex and dynamic nature of undernutrition and overnutrition among women of reproductive age.

CONCLUSION

This study provided an analysis of the trends, correlates, and inequalities in underweight and overnutrition among women of reproductive age in Zambia during the period between 2001 and 2014. The results revealed that while the prevalence of underweight among women of reproductive age in Zambia decreased from 15 to 10% during the aforementioned period, the prevalence of overnutrition almost doubled (14% to 24%) during the same period. The findings also showed that overnutrition and undernutrition were unequally distributed across wealth quartiles, whereby richer women were less likely to be underweight but had a higher risk of being overnourished while poor women were less likely to be overnourished but had a higher risk of being underweight. Results also show that undernutrition was concentrated towards those with no education, unemployed, and living in rural areas while overnutrition was concentrated among those who were educated, employed and living in urban areas. Inequalities in overnutrition have increased over time between the employed and the unemployed, the never-married and married, the youngest (15-19) and oldest (40-49) as well as between the urban and rural residents. Underweight inequalities have increased between the youngest (15-19) and oldest (40-49), as well as between the richest (Q5) and poorest (Q1), while underweight inequalities have decreased between rural and urban residents, as well as between those with no education and those with the highest education.

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