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## RESEARCH ARTICLE

### Socio-demographic Determinants of Overweight and Obesity Among Mothers of Primary School Children Living in a Rural Health and Demographic Surveillance System Site, South Africa

Perpetua Modjadji<sup>1,\*</sup>

<sup>1</sup>School of Health Care Sciences, Department of Public Health, Sefako Makgatho Health Sciences University, 1 Molotlegi Street, Ga-Rankuwa, 0208, South Africa

#### Abstract:

##### Background:

South Africa continues to have significant high prevalence rate of overweight/obesity relative to its African counterparts, particularly, among women, owing to several factors such as nutrition transition and socio-demographic factors. Nonetheless, little is known about the socio-demographic determinants of overweight/obesity, especially in the rural settings.

##### Objective:

To investigate the socio-demographic determinants of overweight and obesity among mothers of primary school children living in a rural Dikgale Health and Demographic Surveillance System Site in South Africa

##### Methods:

A cross-sectional study was conducted among 508 mothers of primary school children from a rural setting. Body mass index (BMI) was calculated by dividing the body weight by height squared and the prevalence of overweight (BMI  $\geq 25$ –29.9 kg/m<sup>2</sup>) and obesity (BMI  $\geq 30$  kg/m<sup>2</sup>) were determined. The socio-demographic variables were collected using an interviewer-administered questionnaire. Multiple logistic regression analysis was used to ascertain any relationships with overweight/obesity as an outcome measure. Data were analyzed using STATA 14.

##### Results:

The response rate was 98%. The mean age of mothers was 37 $\pm$ 7 years. Mothers were characterized by singlehood (63%), unemployed (82%) and low literacy (41%). The odds of being overweight/obese were significantly higher among mothers living with spouses as household heads (AOR=3.5 95%CI: 1.97-6.31), had two to three pregnancies (AOR=2.4, 95%CI: 1.40-4.20), and five pregnancies and above (AOR=2.5, 95%CI: 1.0-6.37). Mothers who lived in households with a monthly income between \$344.84 and \$524.60 were less likely to be overweight or obese (AOR=0.31 95%CI: 0.14-0.70). Additionally, age, marital status and age at first pregnancy were significantly associated with being overweight/obese ( $\chi^2$  test,  $p < 0.05$ ).

##### Conclusion:

The key determinants of overweight/obesity were living in spouse-headed household, household monthly income and more than one pregnancy. Evidence-based strategies that focus on strengthening the social aspects while addressing overweight and obesity among mothers of primary school children living in a rural Dikgale HDSS site, South Africa.

**Keywords:** Socio-demographic factors, Obstetric history, Overweight/obesity, Mothers of primary school children, Rural Dikgale HDSS site, South Africa.

#### Article History

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## 1. INTRODUCTION AND BACKGROUND

According to the World Health Organization, more than

1.2 billion adults are either overweight or obese, with overweight affecting more than 1 billion and obesity, 300 million, globally [1]. Approximately 39% of adults are overweight, while 13% are obese worldwide. Thirty nine percent of men and 40% of women are overweight while 11% men and 15% women are obese [1]. Historically, the burden of overweight

\* Address correspondence to this author at the Department of Public Health, Sefako Makgatho Health Sciences University, School of Health Care Sciences, PO Box 215, Ga-Rankuwa MEDUNSA, 0204, South Africa; Tel: +2712 521 3664; E-mail: Perpetua.modjadji@smu.ac.za

and obesity was once associated with High-income Countries (HICs), but lately, increasing rates are observed in Low-and-middle-income Countries (LMICs) [2].

The increasing burden of overweight and obesity in LMICs is well documented, particularly in Africa [3]. More than one third of women and a quarter of men are overweight in Africa, and these proportions are expected to increase by 41% and 30%, respectively, over the next ten years [4]. Amugsi *et al.* have reported the outstanding high prevalence of overweight and obesity among urban women in Zimbabwe (28% and 13%, respectively) and Egypt (36% and 34%) out of the 24 African countries studied [3]. While on the other hand, the prevalence of overweight and obesity among rural women has ranged from 5.6% to 27.7%, and 1.1% to 23%, respectively, in 32 Sub-Saharan countries [5]. In South Africa, an increase in the overall prevalence of overweight and obesity in women was estimated from 56% to 68% between 1998 and 2016 [6, 7].

The global rise of overweight/obesity is primarily influenced by nutrition transitions, explained as the shift from a plant-based diet to obesogenic diets and reduction in energy expenditure [8 - 10]. Furthermore, the rise in overweight/obesity rates is attributable to socio-demographic [11], environmental [12], behavioral [12] and genetic factors [13]. Women have been reported to have a higher risk of overweight/obesity compared to men, while being employed and having a higher level of education were associated with increased risks for overweight and obesity [14]. Higher educational attainment in women and higher socioeconomic status (SES) in men were associated with higher BMI [15]. In both rural and urban settings, a higher SES was associated with an increased likelihood of being obese in both men and women in developing countries [12, 16]. In developed countries, obesity is widely considered a condition that affects people of lower socioeconomic status (SES) more so than those of higher SES [17]. Although overweight/obesity is prevalent among women, generally, in Africa, older women are more affected than younger women [18, 19].

Overweight/obesity is an important risk factor for non-communicable diseases (NCDs), such as cardiovascular diseases, diabetes, hypertension and certain cancers [20]. Further detrimental consequences of overweight/obesity among women of reproductive age increase the risk of preterm birth and low birth weight [21], preeclampsia and risk of adverse neonatal outcome [22]

South Africa continues to have significantly high prevalence rates relative to its African counterparts. In addition, the NCDs burden is also on the rise and already among the top causes of death [23]. Dikgale Health and Demographic Surveillance System Site (Dikgale HDSS site) are known for persistent childhood undernutrition and a high prevalence of overweight/obesity among adults associated with socioeconomic, demographic and behavioral factors [16, 24 - 26]. Despite the Dikgale HDSS site being well researched, overweight/obesity has been better studied among adults aged 40-60 years [16, 26]. Research on the socio-demographic determinants of overweight/obesity among women of reproductive age is crucial. In view of this, this study investigated the socio-demographic determinants of overweight

and obesity among women of reproductive age in a rural Dikgale HDSS site, South Africa.

## 2. MATERIALS AND METHODS

### 2.1. Study Design and Setting

This paper was taken out of a doctoral thesis written by the author. The main aim of the study was to determine the growth patterns of primary school children and the maternal factors influencing these growth patterns. The study used a convergent mixed method design with parallel data collection for the quantitative and qualitative phases and conducted from August 2017 to December 2017. This paper reports the cross-sectional quantitative survey conducted to determine the socio-demographic determinants of overweight/obesity among women who are mothers of primary school children. A detailed study design was described in the first two papers published by the author [25, 27]. The study population consisted of 508 mothers whose children were attending one of the five largest primary schools in the Dikgale HDSS site.

Dikgale HDSS Site, a rural site in the Limpopo Province of South Africa and forms part of the International Network for the Demographic Evaluation of Populations and their Health (INDEPTH). The study setting has previously been reported in details [28]. The sample size of 515 was calculated using the Rao software calculator [29], taking into consideration the enrolment number of children (n=7772) in the primary schools of Dikgale HDSS site (EMIS, 2016). Selected school children were paired with their mothers and a final sample size of 515 was obtained. In the original study, children who were younger than 5 years, or had physical disabilities that compromised their stature, or whose biological mothers were not available to participate were excluded from the study [30]. Mothers who reported to be pregnant at the time of the study were also excluded from the study. The nutritional status of the school children were reported in the first two published papers [25, 27].

### 2.2. Data Collection

Trained research assistants collected the data between a period of August 2017 to December 2017 using a previously tested questionnaire, including the sociodemographic status of women's personal and household information, and maternity history. Socio-demographic factors used in this study were based on the adapted theoretical framework for available multilevel factors driving adult obesity in South Africa [31]. The questionnaire covered a range of socio-demographic characteristics and the household situation of women, in accordance with the variables used in other studies conducted in Dikgale HDSS site [16, 24, 32], as well as, in other developing countries [33 - 35]. Age in years was classified into three groups, namely below 35 years, 36-45 years and >45 years. Marital status was categorized according to single and ever married. Level of educational status was classified into low literacy (*i.e.* did not go to school, primary school and did not complete secondary school) and high literacy (*i.e.* completed grade 12 and post Grade 12). Employment status was classified into unemployed and employed. Household structure entailed the type of house (brick or non-brick),

household head (self, spouse or other family member), household size (1-4 or  $\geq 5$ ), electricity (yes or no), refrigerator use (yes or no), water access (yes or no), and toilet type (pit toilet or flush toilet). Household monthly income was categorized into four groups;  $\leq \$52,20$ ,  $\$53,29$ – $\$262,26$ ,  $\$344,84$ – $\$524,60$ , and  $> \$524,65$ . The three categories for the variables; parity (1, 2-4 and  $\geq 5$ ) and number of pregnancies (1, 2-4 and  $\geq 5$ ), while the age of mothers at first pregnancy was divided into  $\leq 30$  years and  $> 30$  years.

All measurements were done according to WHO recommendations [36]. Weight and height were measured in duplicate and recorded as the average of the two measurements using a smart D-quip electronic scale and a stadiometer, respectively. A non-stretchable plastic tape measure was used to measure the waist and hip circumferences of the women. All the measurements for weight, height and waist and hip circumferences were measured to the nearest 0.1kg, 0.1cm and 0.1 cm, respectively. Body mass index (BMI) was calculated by dividing an individual's weight in kilograms (kg) by height in meters squared. Overweight and obesity, defined as BMI  $\geq 25\text{kg/m}^2$  and  $\geq 30\text{kg/m}^2$ , respectively, based on the WHO adult BMI classification. Central obesity was defined by a waist circumference  $\geq 88\text{cm}$  [37] and a waist-hip ratio (WHR),  $\geq 0.85$ . The waist-hip ratio (WHR) was computed as the waist circumference divided by the hip circumference. Waist-to-height ratio (WHtR $\geq 0.5$ ) is a proxy for central (visceral) adipose tissue [38, 39].

### 2.3. Data Analysis

At data analysis, seven questionnaires had missing data above 10% and were excluded for a final sample of 508 women, considered in this paper. Data were stored in Microsoft Excel and analyzed using Stata (Intercooled Stata® Version 14, College Station, TX). Descriptive statistics numerical and categorical variables were computed. To determine the association of overweight/obesity with independent variables, 2% (n=12) of mothers who were underweight were excluded from the analyses for a final sample size of 496, which did not compromise the sample power. Backward stepwise elimination procedure was used in a multivariate logistic regression analysis to determine the association between overweight/obesity and independent variables, and the reference group was normal. We put all the independent variables with a p-value  $\leq 0.20$  during bivariate analyses were included in the model.

Gradually, variables were eliminated from the regression model at each step to find a reduced model that best explained the data, controlled for confounders. Adjusted odds ratios (AOR) with a 95% confidence interval (CI) were generated and used to determine the independent strength of the associations. Results are presented as median (IQR), frequency (n), percentages (percentage) and AOR (95%CI). Significance was considered at  $p < 0.05$ .

## 3. RESULTS

### 3.1. Socio-demographic and Obstetric Characteristics of Mothers

Data were complete for 508 mothers of primary school children. The socio-demographic and obstetric characteristics of mothers are presented in Table 1. The mean age of mothers was  $37 \pm 7$  years. Forty eight percent (48%) of women in this study were younger (24-35 years), while 39% were middle-aged and 13% aged above 45 years. Mothers in this study were single (63%), unemployed (82%) and 41% had low literacy. Thirty eight percent (38%) of women lived in houses headed by spouses, while 34% were self-headed and 29% by other family members, while 36% lived in household with household size of five members and above. Most mothers (69%) had two to four pregnancies and 71% had a parity of two to four.

### 3.2. Overweight/obesity Among Mothers

The analysis of the means for weight, height, BMI, WC, HC, WHR, WHtR by age group, using Kruskal Wallis test, are reported in Table 2. Significant differences in weight ( $p=0.011$ ), BMI ( $p=0.001$ ), WC ( $p=0.001$ ), WHR ( $p=0.001$ ) and WHtR ( $p=0.0004$ ) were observed by age groups. No significant difference was observed for height and HC. Medians for weight, BMI, WC, WHR and WHtR increased significantly with age group. Table 3 presents the prevalence of BMI, WC, WHR and WHtR by age group, using a chi-square test ( $\chi^2$ ). The prevalence of overweight and obesity was 27% and 42%, respectively, while only 2% of the mothers were underweight. Abdominal obesity was prevalent, as indicated by increased WC in 53%, WHR in 33% and WHtR in 41% of mothers. All nutritional indicators were significantly different from the age groups. The prevalence of obesity increased with increasing age, with the highest prevalence of obesity observed in the oldest group, by BMI (65%), WC (75%), WHR (46%) and WHtR (63%).

**Table 1. Demographic and obstetric characteristics of women.**

Variables	Categories	Frequency (n)	Percentages (%)
Age groups	18-34 years	246	48
	35-45 years	197	39
	>45 years	65	13
Age at first pregnancy	$\leq 30$ years	357	70
	$> 30$ years	151	30
Number of pregnancies	1	122	24
	2-4	347	68
	$\geq 5$	39	8
Parity	1	114	22
	2-4	252	69
	5+	42	9

(Table 1) contd....

Variables	Categories	Frequency (n)	Percentages (%)
Marital status	Ever Married	187	37
	Single	321	63
Level of education	Low literacy	206	41
	High literacy	302	59
Employment	Employed	90	18
	Unemployed	418	82
Household monthly income	≤\$52,50	180	35
	\$53,29-\$262,26	261	51
	\$344,84-\$524,60	34	7
	≥524,65	33	7
House type	Brick	321	63
	Non-brick	187	37
Household head	Self	170	38
	Spouse	193	34
	Other family member	145	29
Household size	1-4	325	64
	≥5	183	36
Source of energy	Electricity	486	96
	None	22	4
Refrigerator use	Yes	331	65
	No	177	35
Water Access	Yes	375	74
	No	133	26
Toilet type	Pit	486	96
	Flush	22	4

Table 2. Comparison of medians for nutritional indicators by age group.

Variables	All Median (IQR)	18-35 years Median (IQR)	36-45 years Median (IQR)	>45years Median (IQR)	P-value
Weight (kg)	72 (61.6; 85.7)	70.7 (61; 81.1)	71 (61.4; 88.6)	79.3 (72.3; 89)	0.011*
Height (m)	1.6 (1.6; 1.6)	1.6 (1.6; 1.7)	1.6 (1.6; 1.6)	1.6 (1.6; 1.6)	0.568
BMI (kg/m <sup>2</sup> )	28.7 (24.2; 33.4)	28.2 (24.5; 32.6)	28.7 (24; 34.2)	31.6 (28.2; 34.6)	0.001*
HC (cm)	107 (100; 117)	106 (99; 116.5)	107.7 (100; 117)	112 (102; 122)	0.057
WC (cm)	88.2 (97.6; 99)	87 (78; 96)	88 (80; 101)	95.5 (88; 104)	0.001*
WHR	0.8 (0.8; 0.9)	0.82 (0.76; 0.85)	0.83 (0.78; 0.87)	0.85 (0.79; 0.91)	0.001*
WHtR	0.55 (0.50; 0.62)	0.54 (0.49; 0.61)	0.55 (0.50; 0.62)	0.61 (0.53; 0.65)	0.0004*

Kruskal Wallis test was used. \*Indicates significant differences between the medians. BMI – body mass index, HC – hip circumference, WC – waist circumference, WHR – waist hip ratio, WHtR – waist-to-height ratio.

Table 3. Comparison of the nutritional status indicators by age group.

Variables	All n (%) n=508	18-35 years n (%) n=246	36-45 years n (%) n=197	>45 years n (%) n=65	P-value
<b>BMI</b>					0.002*
Normal	142 (28)	71 (29)	61 (31)	10 (15)	
Overweight	139 (27)	81 (33)	46 (23)	12 (18)	
Obese	215 (42)	88 (36)	85 (43)	42 (65)	
Underweight	12 (2)	6 (2)	5 (3)	1 (2)	
<b>WC</b>					≤0.0001*
Normal	239 (47)	126 (51)	97 (49)	16 (25)	
Abdominal obesity	269 (53)	120 (49)	100 (51)	49 (75)	
<b>WHR</b>					0.005*
Normal	340 (66)	180 (73)	125 (64)	35 (54)	
Abdominal obesity	168 (33)	66 (27)	72 (37)	30 (46)	
<b>WHtR</b>					0.017*

(Table 3) contd.....

Variables	All n (%) n=508	18-35 years n (%) n=246	36-45 years n (%) n=197	>45 years n (%) n=65	P-value
Normal	126 (25)	71 (29)	47 (24)	8 (12)	
Abdominal obesity	382 (75)	175 (71)	150 (76)	57 (88)	

Chi-square test was used. \*Indicates significant differences. BMI stands for body mass index: normal (18.5 to 24.9kg/m<sup>2</sup>), underweight (<18.5kg/m<sup>2</sup>), overweight (25 to 29.9kg/m<sup>2</sup>), obesity (≥30kg/m<sup>2</sup>), WC stands for waist circumference: normal (<88cm), abdominal obesity (≥88cm), WHR stands for waist to hip ratio: normal (<0.85), abdominal obesity (≥0.85), WHtR for waist to height ratio: normal (<0.5), abdominal obesity (≥0.5) (WHO, 1995; WHO, 2011).

### 3.3. Weight Status of Mothers by their Characteristics

Weight status of mothers is compared by their characteristics in Table 4. Significant associations between being overweight or obese were observed by age category (p=0.042), age of childbirth (p=0.038), marital status (p=0.011), household head (p=≤0.0001) and household monthly income (p=0.053). Overweight/obesity was more prevalent among mothers who gave birth after 30 years (78%) compared to those who gave birth before 30 years (69%). The prevalence of overweight/obesity was significantly higher

among mothers who were married (78%) as compared to those who were single (67%). In addition, overweight/obesity was significantly higher among mothers in households with a monthly income of >\$524,65 (82%), in comparison to households with a monthly income of ≤\$52,50 (71%), \$53,29–\$262,26 (73%), and \$344,84–\$524,60 (53%). The prevalence of overweight/obesity was significantly higher in mothers living in households headed by their spouses (83%), compared to those living in a household headed by themselves (65%) or other family members (63%).

**Table 4. Association of weight status of women with socio-demographic and obstetric characteristics.**

Variables	Normal, n=142	Overweight/obese, n=354	P-value
<b>Age</b>			
18-34 years	71 (30)	169 (70)	0.042*
35-45 years	61 (32)	131 (68)	
>45years	10 (16)	54 (84)	
<b>Age at first pregnancy</b>			
≤30 years	110 (31)	241 (69)	0.038*
>30 years	32 (22)	113 (78)	
<b>Number of pregnancies</b>			
1	40 (34)	77 (66)	0.251
2-4	90 (26)	251 (74)	
≥5	12 (32)	26 (68)	
<b>Parity</b>			
1	13 (32)	28 (68)	0.231
2-4	91 (26)	254 (74)	
5+	38 (35)	72 (65)	
<b>Marital status</b>			
Single	102 (33)	211 (67)	0.011*
Married	40 (23)	143 (78)	
<b>Level of education</b>			
Low literacy	65 (46)	77 (54)	0.131
High literacy	136 (38)	218 (62)	
<b>Employment status</b>			
Unemployed	121 (30)	288 (70)	0.307
Employed	21 (24)	66 (76)	
<b>Household monthly income</b>			
≤\$52,50	51 (29)	124 (71)	0.053*
\$53,29–\$262,26	69 (27)	185 (73)	
\$344,84–\$524,60	16 (47)	18 (53)	
≥524,65	6 (18)	27 (82)	
<b>House type</b>			
Brick	55 (30)	127 (70)	0.551
Non-brick	87 (28)	227 (72)	
<b>Household head</b>			
Self	57 (35)	108 (65)	≤0.0001*
Spouse	33 (17)	157 (83)	
Other family member	52 (37)	89 (63)	
<b>Household size</b>			
1-4	99 (31)	218 (69)	0.088
≥5	43 (24)	136 (76)	

(Table 4) contd....

Variables	Normal, n=142	Overweight/obese, n=354	P-value
<b>Refrigerator use</b>			
Yes	91 (28)	234 (72)	0.669
No	51 (30)	120 (70)	
<b>Water Access</b>			
Yes	106 (29)	259 (71)	0.735
No	36 (25)	95 (73)	

Chi-square test was used. \*Indicates significant differences in the prevalence and an association between normal, overweight/obese, and socio-demographic factors. Overweight/obesity was  $\geq 25\text{kg/m}^2$ .

Table 5. Multiple logistic analysis; factors associated with overweight/obesity among women.

Overweight/obesity	AOR (95%CI)	P-value
<b>Age groups</b>		
18-35 years	1 [Reference]	
36-45 years	0.8 (0.45 - 1.28)	0.307
> 45 years	2.0 (0.78 - 5.13)	0.148
<b>Age at first pregnancy</b>		
$\leq 30$ years	1 [Reference]	
>31 years	1.75 (0.97 - 3.17)	0.063
<b>Number of pregnancies</b>		
1	1 [Reference]	
2-4	2.4 (1.40 - 4.20)	0.002*
$\geq 5$	2.5 (0.99 - 6.37)	0.052*
<b>Household head</b>		
Self	1 [Reference]	
Other family members	1.1 (0.68 - 1.96)	0.593
Spouse	3.5 (1.97 - 6.31)	$\leq 0.0001^*$
<b>Household income</b>		
$\leq \$52,50$	1 [Reference]	
\$53,29–\$262,26	1.1 (0.70 - 1.73)	0.681
\$344,84–\$524,60	0.31 (0.14 - 0.70)	0.005*
$\geq \$524,65$	1.03 (0.37 - 2.81)	0.960

Multiple logistic regression analysis was used. \*Indicates a significant association with the likelihood of being overweight/obese.

### 3.4. Factors Associated with Overweight/Obesity

In the bivariate logistic regression, the age of mothers, marital status, education, household size, household income, household head, and age at first pregnancy were associated with overweight/obesity ( $p < 0.20$ ). To determine the association of overweight/obesity with socio-demographic factors and obstetric history, multivariate logistic regression analysis was performed. Results are presented in Table 5 and showed a significant association between overweight/obesity and household monthly income, household head and number of pregnancies after controlling for potential confounders. The odds of being overweight/obese were significantly higher among mothers living with spouses as household heads (AOR=3.5 95%CI: 1.97-6.31), had two to three pregnancies (AOR=2.4, 95%CI: 1.40-4.20), and five pregnancies and above (AOR=2.5, 95%CI: 1.0-6.37). Mothers who lived in households with a monthly income between \$344,84 and \$524,60 were less likely to be overweight or obese (AOR=0.31 95%CI: 0.14-0.70).

## 4. DISCUSSION

The main objective of the study was to determine the

socio-demographic determinants of overweight and obesity among mothers of primary school children living in a rural Dikgale HDSS site in South Africa. Mothers in this study were underprivileged due to poor socioeconomic status, as described by high rates of singleness (72%), unemployment (82%), and a household monthly income below \$262,26 (86%). These socioeconomic components suggest poverty or poor living conditions in the Dikgale HDSS site, consistent with other studies conducted in the area [24, 28]. Poor living conditions in South Africa, are predominant, countrywide [40, 41].

South Africa is still battling with issues of poverty, inequality, unemployment and hunger, two decades after democracy [42]. A high prevalence of unemployment (87%) and poverty (59%) have been reported nationally, with the highest prevalence of poverty in Limpopo Province; the province in which the current study was conducted [43, 44]. Literature documents that low-income individuals and families face a number of challenges in the acquisition of sufficient, nutritious food for a healthy and active lifestyle [45]. SANHANES-1 found that 51% of people living in rural areas reported that they did not have enough money for basic necessities such as foods [41]. According to Govendor *et al.*, lack of access to nutritious and balanced diets remain a major

impediment to the health and well-being of people living in rural areas [46].

Socioeconomic status has been linked to both higher rates of overweight/obesity and poor dietary quality, particularly among women [2, 12, 47]. Although the mechanism behind the link is unclear, poverty has been associated with unhealthy behaviours [48, 49]. The importance of the association of socioeconomic with living conditions is explained through factors such as education and income. For example, education is considered a fundamental component of socioeconomic as it provides knowledge and life skills that allow better-educated individuals to gain better access to information and resources for the promotion of health. In addition, higher household incomes provide better nutrition, housing, schooling, and recreation [50].

The prevalence of overweight/obesity (69%) observed among mothers of primary school children in this study was high. Abdominal/central obesity was also prevalent among these women, as evident by an increased WHtR (41%) and WC (53%). Both prevalence of overweight/obesity and abdominal obesity were higher among the oldest women in the current study. The high prevalence of overweight/obesity and abdominal obesity among black South African women is a public health concern. In South Africa, various studies in different parts of the country have reported the prevalence of overweight/obesity to be between 54% and 76% [16, 24, 51], while the country-wide prevalence is estimated to be in the range of 65% to 68% [40, 41]. The findings of the current study are comparable with the countrywide prevalence estimate as well as prevalence reports from various parts of the country. In addition, an increase in the prevalence of overweight/obesity with an increase in age has been reported in previous studies. Literature suggests that body weight increases with age and the prevalence of overweight/obesity are higher among older women, as compared to younger women [18, 19, 52].

The overall high prevalence of overweight/obesity observed in the current study may be explained by the intake of more energy-dense food as well as a reduction in the level of physical activity [53 - 55]. Previous studies conducted in Dikgale HDSS site have reported a high prevalence of physical inactivity in women (70.8%) has been reported [24] as well as the possibility of consumption of energy dense foods contributing to overweight/obesity among women [27]. It is believed that the environment in South Africa has changed over the past decades, with increasing availability and accessibility of energy-dense food. In addition, the World Health survey reported that, in general, women worldwide were physically inactive [56]. The high rates of overweight and obesity could also be explained by the nutrition transition and urbanization that Africa is facing [19].

The prevalence of overweight and obesity among rural women in our study was higher than the prevalence reported in other countries, such as Lesotho, Zimbabwe, Kenya and Nigeria [57 - 62]. In Lesotho, the prevalence of overweight/obesity among women was estimated to be 44.4% by BMI, and 54.1% by WC. A prevalence of 35% has been reported in Zimbabwe [62], while in Kenya the prevalence was estimated to be between 20.5% and 43% [58, 59, 61]. In rural

Nigeria, a prevalence of 49.3% has been reported among women [57]. These studies attributed the increase in overweight/obesity among women to nutrition transition associated with frequent intake of processed and sugary, as well as high-calorie and high fat diets, cultural lifestyles, dietary choices and socio-demographic characteristics [57, 60, 62, 63]. In contrast to these findings, some countries in sub-Saharan Africa still report a higher prevalence of underweight in comparison to the findings of the current study (2%). High prevalence of underweight/undernutrition has been reported in Ethiopia (30%), Uganda (12%) and Tanzania (11%) [64].

Women who lived in households with a middle-income bracket were less likely to be overweight or obese. Studies have suggested that the prevalence of obesity varies with income level, although patterns differ between high-income and low-income countries [65, 66]. As explained by Drewnoski and Spector, the association between low household income and overweight/obesity in this study could be mediated, in part, by the low cost of energy-dense foods and may be reinforced by the consumption of high sugar and fat [67].

A significant association between weight status and household heads was observed. Further analysis showed that women who lived in households headed by spouses were 3.5 times more likely (95%CI: 1.97-6.31) to be overweight or obese in comparison to those who lived in self-headed households. This might be that married individuals tend to eat a greater number of meals per day and have a higher total intake of energy [65 - 67]. This may account for the higher prevalence of overweight and obesity observed in mothers who are married in the current study, compared to those who are not. Furthermore, the likelihood of mothers who are married being overweight or obesity has been previously reported in South Africa, and may be related to food affordability [15]. A similar association has been reported in both Kenya and Poland [67, 68]. In contrast, for women in the self-headed household, this likely reflects the challenges of being both the sole provider and caretaker within a household. The effect of cultural dimensions on most single parent families headed by women has been reported, with single mothers being placed at a greater risk for poverty and food insecurity, and to some extent, obesity [69].

In Ethiopia, another LMIC, adults in the highest income quintile were 3.16 times (95% CI: 1.88–5.30) more likely to be overweight/obese as compared to adults from the lowest quintile [70]. Other studies from developing countries have documented an increase in obesity with wealth, partially explained by individuals from countries in transition overeating because of economic access to food [71, 72]. In contrast, in developed countries, studies suggest that poverty is associated with a higher risk for obesity, because economically disadvantaged people are more likely to consume junk and empty-calorie food, important risk factors for obesity [73, 74].

The current study showed that women who had been pregnant two to three times (AOR=2.4, 95%CI: 1.40-4.20) or five times and more (AOR=2.5, 95%CI: 0.99 - 6.37) were more likely to be overweight or obese than those reported to have been pregnant once. The literature on the association of

the number of historical pregnancies and overweight/obesity is scant. Martínéz *et al.* reported that women with  $\geq 4$  pregnancies, relative to those with 1–2 pregnancies, were 1.59 (95%CI: 1.01–2.47) more likely to be obese [75]. Parity, which is closely related to the number of pregnancies, was not associated with overweight and obesity in the current study. In agreement with our findings, higher parity ( $\geq 4$  pregnancies) was not significantly associated with a higher BMI in the study by Martínéz *et al.* [75]. In contrast, most studies reported a positive association between parity and weight gain or BMI [76 - 79]. Among Chinese middle- and older-aged women in Shanghai, weight gain was associated with increasing parity [80]. In Guangzhou in China, a positive correlation between parity and obesity, as measured by BMI, was reported [81].

The mechanisms underlying the association between parity and obesity are complicated and remain unknown [82]. Gestational weight gain has been found to be associated with higher postpartum weight retention [83] especially long term [84], suggesting that maternal transition during pregnancy may partially explain postpartum obesity [85]. A prospective study indicated that childbearing might increase visceral adipose tissue, independent of an overall increase in body fat [86]. However, it is worth noting that there is no consensus in the literature regarding a linear association between parity and obesity [87].

#### 4.1. Limitations of the Study

The current study had similar limitations to earlier studies [25, 27], extracted from the larger study [30]. The use of a cross-sectional study design resulted in only inferences being made about the associations of overweight/obesity with socio-demographic factors. The study could not establish causality or temporality of events. Nonetheless, the inferences estimated in this study could be a good measure of the association between the identified factors and overweight/obesity among women in the study area. It is worth mentioning that sampling for the larger study was primarily based on a representative sample of primary schools and schoolchildren in Dikgale HDSS site, hence, the women who participated in this study matched with their children. The results of this study are applicable to Dikgale HDSS site and cannot be generalized to other areas in South Africa, because this site is a very small rural area and the circumstances may vary considerably in urban areas.

#### CONCLUSION

This study aimed to investigate the socio-demographic determinants of overweight and obesity among women living in a rural Dikgale HDSS site in South Africa. The prevalence of overweight and obesity in women was 27% and 42%, respectively. The findings further showed that the key determinants were living in spouse-headed household, household monthly income and more than one pregnancy. With evidence on the rise of NCDs and the indisputable impact overweight and obesity have, there is a need for urgent action. Tailor-made women program focusing on strengthening the social aspects that promote overweight and obesity are necessary to address the high prevalence, in order to avert its consequences.

#### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All procedures involving human subjects were approved by the Sefako Makgatho Health Sciences University Research and Ethics Committee, South Africa [SMUREC/H/161/2016: PG]. Permission to conduct the study was obtained from the Limpopo Province Department of Education, South Africa.

#### HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with ethical standards of the committee responsible for human experiments (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

#### CONSENT FOR PUBLICATION

Written informed consent was obtained from each participant prior to the study.

#### AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available from the corresponding author [PM] upon reasonable request.

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#### CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

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