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Prevalence and time trends in overweight and obesity among urban women: An analysis of demographic and health surveys data from 24 African countries, 1991-2014

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Abstract

Objective(s): To examine the prevalence and trends in overweight and obesity among non-pregnant urban women in Africa over the past two and half decades.

Design: Cross-sectional surveys conducted between 1991 and 2014.

Settings: Demographic and Health Surveys (DHS), repeated cross-sectional data collected in 24 African countries.

Participants: Adult non-pregnant women aged 15–49 years. The earlier DHS surveys collected anthropometric data on only those women who had children aged 0–5 years. The main analyses were limited to this subgroup.

Results: The prevalence of overweight and obesity increased in all 24 countries. Trends were statistically significant in 17 of the 24 countries in the case of obesity and 13 of the 24 for overweight. In Ghana, overweight almost doubled while obesity tripled between 1993 and 2014. Egypt has the highest levels of overweight and obesity at 44% (95% CI: 42, 46.5) and 39% (95% CI: 36.6, 41.8) respectively in 2014 and the trend showed significant increase from 1995 levels. Also, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight, with overweight ranged from 7 to 12% and obesity from 1 to 4%.

Conclusions: Overweight and obesity are increasing in urban Africa, with obesity having more than doubled or tripled in 12 of the 24 countries. There is an urgent need for deliberate policies

and interventions to encourage active lifestyles and healthy eating behaviour to curb this trend in urban Africa.

Keywords: Overweight, obesity, Africa, prevalence, trends, urban

Strengths and Limitations of the Study

- Use of nationally representative data sets, thereby providing more robust estimates of the prevalence and trends of overweight and obesity
- Height and weight used in the calculation of BMI, was objectively measured, reducing possible misclassification
- Analysis limited to women with children under 5 years old and may affect the generalizability of the findings to all women
- Lack of uniformity in the definition of urban and rural settings across countries

Introduction

Overweight and obesity are global public health problems, especially among women in urban settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs) are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3). A recent study showed that overweight and obesity are linked to 13 different cancers (5). Thus, there is an increased risk of co-morbidities for individuals with a body mass index of 25.0 to 29.9 kg/m^2 (defined as overweight), and moderate to severe risk of co-morbidities for individuals with a body mass index greater than 30 kg/m^2 (defined as obesity) (3, 6). The World Health Organization (WHO) (3, 6) recommends that for optimum health, the median body mass index for an adult population should be in the range of 21 to 23 kg/m^2, while the goal for individuals should be to maintain body mass index in the range 18.5 to 24.9 kg/m^2. This is often difficult to achieve as evidence shows that global overweight and obesity trends are on the rise, with the developing world now bearing the brunt of the surge (7). This dynamic calls for more studies to systematically document these trends over time, especially in developing country contexts.

Hitherto, overweight and obesity were not public health issues on the African continent. However, rapid changes have been observed, and many countries in Africa are currently confronted with overweight and obesity, particularly among women, coupled with a resulting increase in the prevalence of non-communicable diseases (NCDs) (4, 7, 8). In Africa, women had approximately double the obesity prevalence of men (3), with urban settings being the most affected. Thus, the burden of overweight and obesity among urban women is increasing at an alarming rate in developing countries, and particularly in Africa for that matter (1, 9). This trend may be attributable to an increased intake of energy-dense foods that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature of many occupations, increased use of motorized transportation, and urbanization (1, 10-12). Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the increasing burden of overweight and obesity in urban settings of low and middle-income countries (LMIC) (13-15). Various other studies have argued that the association between urban residence and obesity in LMICs is driven largely by higher individual- and community-level socioeconomic status (SES) in urban areas, suggesting that urban residence alone may not cause increased body weight in developing countries (10). However, recent studies suggest that the distribution of overweight by SES is changing in developing countries (4, 16, 17). For example, lower SES populations in some of these countries now have higher prevalence of overweight, mimicking long-standing associations between low SES and poorer health in LMICs (4, 16-18). This changing trend is particularly widespread among the urban population. A study in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity among women (19). Another study using data from 7 African countries showed that the increase in overweight and obesity

was higher among the poorest urban dwellers compared to the richest population subgroup (13).

Despite the emerging and worrying trend of increased overweight and obesity, and recognition of the potential rise in chronic diseases in recent times in Africa, little effort has been made in addressing overweight and obesity on the continent (20). Consequently, an analysis of overweight and obesity in this study across several countries in the region, is a critical step in the provision of insights into the extent of the problem over time, especially in urban settings, which is needed to inform policy and program interventions to address the challenge in urban Africa.

It is worth noting that while there are a number of studies that investigated overweight and obesity in Africa; most either focused on one country (8), lumped urban and rural data together in their analyses (2, 8), analyzed overweight and obesity together (18), or used one data point (21). These attempts may mask the seriousness of the problem in urban settings and the important differences in the trends and prevalence of overweight and obesity over time. Also, the presentation of the results in some of these studies makes it difficult for policy makers to appreciate the extent of the problem. The present study elucidates the prevalence and time trends in overweight and obesity separately, and presents the results in a way that makes it easier for policy makers to understand the extent of the problem in urban settings.

Methods

Data sources and participants

The study used data from the Demographic and Health Surveys (DHS) programme. These are nationally representative, repeated cross-sectional household surveys collected primarily in lower- and middle-income countries approximately every 5 years and standardized to enable cross-country comparisons (22, 23). We restricted our analysis to data collected in 24 sub-Saharan African countries between 1991 and 2014, and containing individual anthropometric data. There were a total of 137 survey cycles in the 24 countries, and the number of survey cycles per country ranged between three (11/137, four (8/137), and five (5/137) in the time period under consideration. These countries were selected solely based on the number of data points (at least 3) and the availability of anthropometric data. Datasets of countries that met the minimum requirement in terms of data points were downloaded. Data from a total 29 countries were downloaded. The second stage was to examine the data for the availability of anthropometric data. All datasets missing anthropometric data were excluded in the analysis. For example, the very first DHS, conducted between 1987 and 1990 did not collect maternal anthropometric data. Hence, the dataset for this period were excluded in the analysis. Secondly, countries with three datasets, but reduced to two data points due to one of the datasets not having anthropometric data were also excluded in the analysis.

The DHS employs a multistage sampling design. The first stage involves selecting sample points or clusters from an updated master sampling frame constructed from the National Population

and Housing Census data of the respective countries. The clusters are then selected using systematic sampling with probability proportional to size. A household listing operation is then conducted in all the selected clusters to provide a sampling frame for the second stage selection of households. The second stage of selection involves the systematic sampling of households listed in each cluster. The primary objective of the second stage of selection is to ensure adequate numbers of completed individual interviews to provide estimates for key indicators with acceptable precision (23). We limited our analyses to adult non-pregnant women of reproductive age, 15–49 years in all countries. This is because pregnant women naturally gain weight during the cause of their pregnancy, including them in the analysis may present a misleading picture about the issue of overweight and obesity among women. Since the earlier DHS surveys collected anthropometry data on only those women who had children aged 0–5 years (18, 24), we further restricted our main analyses to this subgroup. For the total of 224,940 urban women who met eligibility criteria, anthropometric data were available for 191,836 (85.3 %).

Ethics statement

The DHS obtained ethical clearance from the ethical committees of the respective countries before the surveys were conducted. Written informed consent was obtained from the women before participation. The authors of this paper sought and obtained permission from the DHS program for the use of the data. The data were completely anonymized and therefore the authors did not seek further ethical clearance before their use.

Variables

Height and weight were measured objectively by trained field technicians using standard techniques (23). Weight measurements were taken using electronic Seca scales with a digital screen. Height measurements were taken using a measuring board produced by Shorr Productions. Height and weight measurements were then used to estimate the study participants' body mass index (BMI). BMI, also referred to as Quetelet's Index (25), was derived by dividing weight in kilograms by the squared height in meters. Based on the BMI (kg/m^2) estimates, and according to World Health Organization guidelines (26), the participants were classified as overweight (25.0-29.9 kg/m^2) and obese (≥ 30.0 kg/m^2). Trends and prevalence of overweight and obesity were estimated for each country. Place of residence was designated as rural and urban according to country specific definitions; however, the present analyses were restricted to the urban sample only. This is based on the evidence that the bane of overweight and obesity in Africa is more prevalent in the urban settings relative to other settings (10, 13).

Analytical strategy

We used STATA 13 to perform the data analyses. A data file was constructed by using place of residence, country, survey year, and sample size. The analyses were conducted in three key steps. Initially, prevalence of overweight and obesity in selected countries in Africa with at least three DHS data points was graphed. In this step, only point estimates were reported, and since point estimates are not affected by the complex survey design, the DHS weight for each survey

was used to get a reliable estimate. We then computed, at 95% confidence intervals (CI), the outcomes of interest by year of survey for each country in the second step. Because CIs are affected by the sampling design, we took into account the complex survey design (CSD) of DHS within the *svyset* and *svy* procedures in STATA. To avoid flawed variances and biased confidence intervals owing to the complex survey design, the analyses were conducted on the sub-sample with the full sample (urban+rural) maintained in the dataset. In STATA, this is achieved with the "subpop" in svy procedures. In the third step, we examined statistical significance of the trends of overweight and obesity. To achieve this, we performed a multinomial logistic regression with time (year of survey) as the key independent variable using BMI<25 kg/m^2 category as the base outcome and taking into account the CSD. While in steps 1 and 2 the time point data sets were treated independently, we pooled the data sets for trend analyses. As pooling the data may result in an overestimation of the statistical power, normalized weight was used. To this end, the weight in the pooled data was divided by the number of surveys available for the respective countries.

Results

Table 1 presents results of the samples in the selected countries. Tables 2 and 3 present the results of prevalence and trend analyses. Whereas Table 2 presents results for countries with four or more data points, Table 3 presents results of countries with three data points. The rationale for dividing the results tables into two categories is to ease interpretation of the results for the reader. Figure 1 displays the results for all the 24 countries included in the study.

Table 1: Results of samples used in the analysis

Country						
Ghana	**1993**	**1998**	**2003**	**2008**	**2014**	***Total***
Samples	583	656	966	2,023	2,130	6,358
Egypt	**1992**	**1995**	**2000**	**2005**	**2014**	
Samples	3,090	3,779	4,279	4,595	5,842	21,555
Kenya	**1993**	**1998**	**2003**	**2008**	**2014**	
Samples	623	500	1,398	1,342	6,369	10,232
Zambia	**1992**	**1996**	**2001**	**2007**	**2013**	
Samples	2,329	2,099	1,591	1,867	4,636	12,522
Burkina Faso	**1993**	**1998**	**2003**	**2010**	---	
Samples	1,774	873	3,136	3,006	---	8,789
Benin	**1996**	**2001**	**2006**	**2011**	---	
Samples	702	1,403	5,097	4,480	---	11,682
Mali	**1995**	**2001**	**2006**	**2011**	---	
Samples	1,630	2,395	3,673	2,323	---	10,021
Malawi	**1992**	**2000**	**2004**	**2010**	---	
Samples	999	1,864	1,022	1,801	---	5,686
Niger	**1992**	**1998**	**2006**	**2012**	---	
Samples	2,253	1,069	2,267	2,453	---	8,042
Rwanda	**2000**	**2005**	**2010**	**2014**	---	
Samples	1,528	1,524	1,112	1,604	---	5,768
Tanzania	**1991**	**1996**	**2004**	**2009**	---	

Samples	1,128	1,247	1,336	1,404	---	5115
Uganda	**1995**	**2000**	**2006**	**2011**	---	
Samples	1,462	1,510	826	1,539	---	4,593
Zimbabwe	**1994**	**1999**	**2005**	**2010**	---	
Samples	508	1,685	1,298	1,500	---	4,991
Senegal	**1993**	**2005**	**2010**	---	---	
Samples	1,683	3,180	3,373	---	---	8,236
Ivory Coast	**1994**	**1998**	**2011**	---	---	
Samples	1,470	1,040	2,344	---	---	4,854
Cameroon	**1998**	**2004**	**2011**	---	---	
Samples	838	2,819	4,161	---	---	7,818
Ethiopia	**2000**	**2005**	**2011**	---	---	
Samples	1,550	1,299	1,817	---	---	4,666
Guinea	**1999**	**2005**	**2012**	---	---	
Samples	1,415	1,263	1,818	---	---	4,496
Lesotho	**2004**	**2009**	**2014**	---	---	
Samples	640	648	761	---	---	2,049
Madagascar	**1997**	**2003**	**2008**	---	---	
Samples	722	2,708	2,079	---	---	5,509
Mozambique	**1997**	**2003**	**2011**	---	---	
Samples	949	3,320	3,308	---	---	7,577
Nigeria	**2003**	**2008**	**2013**	---	---	
Samples	1,831	6,659	8,976	---	---	17,466
Namibia	**1992**	**2006**	**2013**	---	---	
Samples	1,090	1,854	2,142	---	---	5,086
Chad	**1996**	**2004**	**2014**	---	---	
Samples	2,443	2,112	3,396	---	---	7,951
Total sample						**191,836**

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Table 2 provides period estimates and trends in overweight and obesity in 13 countries with 4 or more data points. These surveys cover periods between 14 years in Rwanda and 21 years in Ghana, Kenya and Zambia. The earliest data points in these countries were in the 1990s and the latest are after 2010. Across all 13 countries, levels of overweight reached or exceeded 20% only in Egypt (36%) and Zimbabwe (28%) in the 1990s surveys. Obesity reached a double digit of 10% or more only in Egypt (34%), and Zimbabwe (13%). In all the other countries, overweight was under 20% and obesity was under 10%. In the latest surveys conducted since 2010 in these countries, overweight exceeded 20% in all countries except Burkina Faso and Malawi where the prevalence was around 16%. The increase overtime was not also statistically significant in these two countries. In 4 countries, the prevalence of overweight exceeded 30% (Egypt (44%), Niger (32%), Rwanda (31%) and Ghana (30%)). Obesity exceeded 10% in all countries in the 2010s surveys with Egypt (39%) and Ghana (22%) leading in levels of obesity. Only in Burkina Faso was obesity still below 10% in the most recent survey.

Table 2: Analysis of trends in overweight and obesity for countries with four or more data points

Country							
Ghana	**1993**	**1998**	**2003**	**2008**	**2014**	***p***	**Nature of trend**
Overweight							
(%)	17.9	17.0	24.8	26.2	30.4	p<.05	↗
(95% CI)	17.9, 18.2	13.6, 21.1	21.3, 28.7	24.2, 28.3	26.3, 34.9		
Obesity							
(%)	7.7	13.8	17.9	14.2	22.0	p<.05	↗
(95% CI)	7.0, 8.5	10.6, 17.8	14.7, 21.5	12.7, 15.8	18.3, 26.3		
Egypt	**1995**	**2000**	**2005**	**2008**	**2014**		
Overweight							
(%)	35.5	35.0	40.6	39.1	44.2	p<.05	↗
(95% CI)	32.9, 38.2	32.7, 37.3	38.2, 43.2	36.7, 41.6	42.0, 46.5		
Obesity							
(%)	34.2	29.6	39.1	41.2	39.2	p<.05	↗
(95% CI)	31.0, 37.6	26.7, 32.7	36.4, 42.0	38.6, 43.9	36.6, 41.8		

Kenya	**1993**	**1998**	**2003**	**2008**	**2014**		
Overweight							
(%)	19.5	19.0	26.6	27.5	28.9	p<.05	↗
(95% CI)	15.0, 24.9	15.4, 23.3	23.3, 30.3	22.8, 32.9	26.1, 31.9		
Obesity							
(%)	6.4	5.1	10.7	10.5	15.0	P<.05	↗
(95% CI)	4.1, 9.8	3.3, 7.9	8.1, 14.1	7.7, 14.3	12.7, 17.6		
Zambia	**1992**	**1996**	**2001**	**2007**	**2013**		
Overweight							
(%)	17.3	15.7	12.1	22.0	23.1	p<.05	↗
(95% CI)	15.2, 19.6	13.8, 17.9	10.3, 14.2	18.9, 25.4	21.2, 25.2		
Obesity							
(%)	4.9	4.4	4.3	8.4	11.5	p<.05	↗
(95% CI)	3.8, 6.4	3.4, 5.7	3.2, 5.9	6.6, 10.5	9.8, 13.5		
Burkina Faso	**1993**	**1998**	**2003**	**2010**	---		
Overweight					---		
(%)	14.0	15.2	21.1	16.5	---	p>.05	→
(95% CI)	12.0, 16.3	12.2, 18.7	18.2, 24.3	13.8, 19.5	---		
Obesity					---		
(%)	3.8	6.0	8.3	9.5	---	p<.05	↗
(95% CI)	2.7, 5.2	4.3, 8.4	5.7, 11.8	7.2, 12.3	---		
Benin	**1996**	**2001**	**2006**	**2011**	---		
Overweight					---		
(%)	9.9	14.8	17.2	24.6	---	p<.05	↗
(95% CI)	7.3, 13.4	12.3, 17.6	15.5, 18.9	22.7, 26.7	---		
Obesity					---		
(%)	4.7	9.1	8.3	10.5	---	p<.05	↗
(95% CI)	3.1, 7.0	7.4, 11.3	7.1, 9.7	8.9, 12.4	---		
Mali	**1995**	**2001**	**2006**	**2011**	---		
Overweight					---		
(%)	14.9	21.6	21.0	22.5	---	p<.05	↗
(95% CI)	12.6, 17.4	18.4, 25.1	18.3, 23.9	19.1, 26.4	---		
Obesity					---		

(%)	4.3	8.8	9.4	14.4		p<.05	↗
(95% CI)	3.1, 5.8	6.9, 11.1	7.7, 11.4	11.7, 17.5			
Malawi	**1992**	**2000**	**2004**	**2010**			
Overweight							
(%)	15.8	15.9	15.4	16.4		p>.05	→
(95% CI)	12.3, 20.0	13.1, 19.1	12.1, 19.5	12.7, 21.1			
Obesity							
(%)	4.1	3.2	4.3	12.1		P<.05	↗
(95% CI)	2.6, 6.4	2.0, 5.1	2.8, 6.7	8.2, 17.5			
Niger	**1992**	**1998**	**2006**	**2012**			
Overweight							
(%)	19.2	19.0	32.0	32.23		p<.05	↗
(95% CI)	16.8, 22.0	15.5, 23.0	27.8, 36.6	28.5, 36.3			
Obesity							
(%)	6.1	7.0	12.1	14.4		p<.05	↗
(95% CI)	4.9, 7.6	5.2, 9.3	9.4, 15.4	11.7, 17.6			
Rwanda	**2000**	**2005**	**2010**	**2014**			
Overweight							
(%)	24.4	14.4	23.3	31.1		p<.05	↗
(95% CI)	23.1,25.6	11.0, 18.8	19.4, 27.6	26.5, 36.1			
Obesity							
(%)	6.8	4.5	7.5	12.6		p<.05	↗
(95% CI)	6.1,7.3	2.6, 7.8	4.9, 11.4	10.0, 15.7			
Tanzania	**1991**	**1996**	**2004**	**2009**			
Overweight							
(%)	14.1	20.5	18.9	21.0		p<.05	↗
(95% CI)	11.1, 17.8	20.1, 20.9	18.5, 19.3	20.4, 22.2			
Obesity							

(%)	3.6	7.8	9.7	11.8		p<.05	↗
(95% CI)	2.4, 5.3	7.2, 7.9	9.4, 10.1	11.1, 12.1			
Uganda	**1995**	**2000**	**2006**	**2011**			
Overweight							
(%)	14.1	22.7	23.7	25.4		p<.05	↗
(95% CI)	11.1, 17.8	18.9, 26.9	16.9, 32.2	20.0, 31.7			
Obesity							
(%)	5.6	5.5	10.0	11.4		p<.05*	↗
(95% CI)	4.2, 7.6	4.0, 7.6	5.2, 18.3	7.8, 16.4			
Zimbabwe	**1994**	**1999**	**2005**	**2010**			
Overweight							
(%)	28.2	23.1	25.1	26.5		p>.05	→
(95% CI)	23.3, 33.7	21.0, 25.4	22.0, 28.5	23.5, 29.7			
Obesity							
(%)	12.7	11.5	10.3	18.5		p>.05	↗
(95% CI)	9.6, 16.7	10.0, 13.2	8.6, 12.4	15.5, 21.9			

↗ = increasing); ↘ = decreasing; → = stable; CI = confidence interval; p = significance level

Table 3 shows the results for the 11 countries with only three data points. The periods covered by these surveys range from 10 years in Lesotho and Nigeria to 17 years in Senegal and Ivory Coast. Some of the earliest surveys in these countries occurred in the 2000s and given differences in timing and duration between the earliest and latest surveys, it made sense to report these surveys separately. Lesotho has the highest prevalence of overweight, which stood at 32% in 2004 and has barely changed over the subsequent 10-year period. Namibia and Cameroon also had high levels of overweight at more than 20%. On the other hand,

Madagascar and Ethiopia had the lowest levels of overweight and obesity. In Madagascar and Ethiopia, overweight is varied between 7 and 12% over the period covered by the surveys, while obesity is under 5% (under 2% in Madagascar). The change of overweight overtimes was statistically significant only in Guinea, Mozambique, Namibia and Chad, while obesity was significant only in Senegal, Guinea and Cameroon.

Table 3: Analysis of trends in overweight and obesity for countries with three data points

Country					
Senegal	**1993**	**2005**	**2010**	***p***	**Nature of trend**
Overweight					
(%)	18.8	21.9	21.6	p>.05	→
(95% CI)	16.3, 21.6	17.0, 27.6	18.2, 25.4		
Obesity					
(%)	8.5	12.8	15.2	p<.05	↗
(95% CI)	6.7, 10.8	9.5, 17.1	11.9, 19.3		
Ivory Coast	**1994**	**1998**	**2011**		
Overweight					
(%)	18.4	18.8	24.9	p>.05	→
(95% CI)	16.1, 20.8	16.1, 21.7	21.4, 28.8		
Obesity					
(%)	6.9	9.0	11.8	p>.05	→
(95% CI)	5.1, 9.2	7.1, 11.4	9.1, 15.1		
Cameroon	**1998**	**2004**	**2011**		
Overweight					
(%)	24.7	27.0	26.7	p>.05	→
(95% CI)	21.3, 28.3	23.8, 30.5	23.9, 29.3		
Obesity					
(%)	9.3	10.9	16.1	p>.05	↗
(95% CI)	6.7, 12.8	8.9, 13.4	14.1, 18.4		
Ethiopia	**2000**	**2005**	**2011**		
Overweight					
(%)	9.5	11.7	12.5	p>.05	→
(95% CI)	6.9, 12.9	7.5, 18.0	9.2, 16.8		
Obesity					
(%)	1.0	2.9	3.6	p<.05	↗
(95% CI)	0.5, 1.7	1.5, 5.8	2.3, 5.4		
Guinea	**1999**	**2005**	**2012**		
Overweight					
(%)	18.2	17.8	25.4	p<.05	↗

(95% CI)	15.7, 21.0	14.3, 22.0	20.9, 30.4		
Obesity					
(%)	6.2	7.9	9.4	p<.05	↗
(95% CI)	4.8, 7.9	4.6, 13.3	6.9, 12.8		
Lesotho	**2004**	**2009**	**2014**		
Overweight					
(%)	32.0	30.0	29.7	p>.05	→
(95% CI)	25.3, 39.5	23.3, 37.7	22.9, 37.4		
Obesity					
(%)	21.9	25.8	20.3	p>.05	→
(95% CI)	15.5, 30.0	20.1, 32.4	14.7, 27.4		
Madagascar	**1997**	**2003**	**2008**		
Overweight					
(%)	7.3	8.3	10.5	p>.05	→
(95% CI)	5.2, 10.1	6.6, 10.5	8.1, 13.5		
Obesity					
(%)	1.1	3.4	1.9	p>.05	→
(95% CI)	0.5, 2.6	2.4, 4.8	1.0, 3.5		
Mozambique	**1997**	**2003**	**2011**		
Overweight					
(%)	11.1	15.1	16.0	p<.05	↗
(95% CI)	8.4, 14.6	13.1, 19.1	14.1, 18.2		
Obesity					
(%)	4.0	3.2	6.3	p>.05	→
(95% CI)	2.3, 6.9	2.0, 5.1	4.7, 8.6		
Nigeria	**2003**	**2008**	**2013**		
Overweight					
(%)	19.7	24.3	25.2	p>.05	→
(95% CI)	15.2, 25.1	22.6, 26.1	23.4, 27.1		
Obesity					
(%)	11.5	11.0	11.5	p>.05	→
(95% CI)	8.3, 15.6	9.7, 12.5	10.3, 12.7		
Namibia	**1992**	**2006**	**2013**		
Overweight					
(%)	21.4	22.6	21.5	p>.05	→
(95% CI)	17.9, 25.4	19.2, 26.5	18.0, 25.4		
Obesity					
(%)	12.7	18.9	18.6	p<.05	↗
(95% CI)	10.3, 15.6	16.1, 22.1	15.2, 22.5		
Chad	**1996**	**2004**	**2014**		
Overweight					
(%)	10.4	14.9	16.6	p<.05	↗
(95% CI)	9.6,11.4	12.4, 17.7	13.9, 19.6		
Obesity					

(%)	3.8	5.7	6.5	p<.05	↗
(95% CI)	2.9,4.1	3.9, 8.4	4.8, 8.7		

↗ = increasing); ↘ = decreasing; → = stable; CI = confidence interval; p = significance level

The Figure 1 below depicts the increasing trends of overweight and obesity in all the 24 countries included in the analysis, except in Lesotho where there is semblance of a decrease.

Figure 1: Time trends of overweight and obesity

Countries: BF= Burkina Faso; BJ= Benin; CI=Ivory Coast; CM= Cameroon; EG= Egypt; ET=Ethiopia; GH= Ghana; GN= Guinea; KE= Kenya; LS= Lesotho; MD= Madagascar; ML= Mali; MW= Malawi; MZ= Mozambique; NG= Nigeria; NI= Niger; NM= Namibia; RW= Rwanda; SN= Senegal; TD = Chad; TZ= Tanzania; UG= Uganda; ZM=Zambia; ZW= Zimbabwe

Discussion

We set out to investigate the prevalence and time trends in overweight and obesity between 1991 and 2014 in 24 African countries. Primarily, we confirm that the prevalence of overweight and obesity among urban women has rapidly increased in the past two and a half decades. All 24 countries included in our analyses experienced an increase in overweight and obesity over the time period under consideration. However, the increase was only statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. The changes over time were particularly noticeable among countries with 4 or more survey data points, in which case, all the 13 countries showed a statistically significant increase in obesity, while 10 showed significant increase for overweight during the period of the study. For countries with three data points, only 4 of the 11 countries had a significant increase for overweight and 3 for obesity. This suggests that length of time plays an important role in understanding the changes in overweight and obesity over time. We also found that 18 of the 24 countries had an overweight prevalence above 20%, based on the most recent survey waves for the respective countries. This was not the case in the earlier surveys where only 6 countries had an overweight prevalence of 20% or above. Four countries of the 24 had an obesity prevalence that was above 20%, with the prevalence in the rest ranging between 10% and 19% based on the latest surveys. However, in the earlier surveys, only one country had obesity prevalence of 20% or more, while the rest had obesity rate ranging from 1 to 12%. This points to worsening phenomenon of obesity among urban women in the past two and half decades. Another key finding is that in most of the countries included in our analyses, obesity increased alongside overweight, suggesting that urban women who are overweight have a greater probability of

progressing to obesity. Thus, addressing overweight will, to a larger extend curtail the increasing incidence of obesity in urban Africa.

Focusing on individual countries, we found significant differences in overweight and obesity across the countries included in the analysis. For example, in the most recent surveys, Egypt has the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two other countries with overweight prevalence of 30% and above. The results on Egypt are not surprising as the country was previously ranked among the countries in the world with the most obese people (27). The results in Ghana are also consistent with previous findings (28). Egypt and Ghana also experienced a significant increase in overweight and obesity in the past two and half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the prevalence of obesity in the aforementioned countries may be considered lower than that of Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests that in the next decades, the obesity rates in these countries may catch up with Egypt and Ghana, which are currently leading in terms of the level of prevalence of both overweight and obesity. However, overweight and obesity did not show any significant changes overtime in Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and Madagascar in a recent study using the DHS data from 32 African countries (21).

The increasing prevalence and trends of overweight and obesity in Africa is attributed largely to rapid urbanization taking place in the continent and its associated nutritional transition. For example, in 2010, the share of the African urban population was about 36% and is projected to increase to 50% and 60% by 2030 and 2050 respectively (29). Using Ghana as a case in point, for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%) of country's population live in urban areas compared to rural areas (30). The growing urbanization comes along with lifestyle changes such as decreased physical activity and increase supply of high caloric fast foods and sugar sweetened beverages (31-34). Indeed, sedentary lifestyle and high consumption of energy dense diets are found to account for the increasing burden of overweight and obesity in urban settings of the low and middle income countries (LMIC) (13-15). The consequences of which, is increase in non-communicable diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body mass index (BMI) (3, 4, 34). In addition, an increased burden of disability-adjusted life years (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be implemented to address the problem of overweight and obesity, thereby curbing associated NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important step towards curbing the surge of NCDs the continent is currently experiencing, which is likely to surpass the toll of sickness and death from infectious diseases by 2030 (35). This will further contribute greatly to the potential for African countries to achieve Sustainable Development Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases

through prevention, and treatment, and promote mental health and wellbeing by 2030 (36). In the light of the findings of our study and literature discussed above, we particularly advocate for interventions to address increasing sedentary lifestyles and poor eating behaviour among urban dwelling women, as this will go a long way in reducing the incidence of overweight and obesity in these settings.

Strengths and limitations

The key strength of this study is the use of nationally representative data sets, thereby providing more robust estimates of the prevalence and trends of overweight and obesity in the respective countries. Further, height and weight as used in the calculation of BMI, was objectively measured by well-trained technicians, reducing possible misclassification of overweight and obesity. The study is also associated with some limitations. To maintain sample comparability over time, we had to limit our sample to women with children under 5 years old. This may, to some extent, affect the generalizability of the findings, as the sample may not be representative of the entire female population. Another limitation is the cross-sectional nature of the data, which makes it impossible to ascertain the changes in BMI over time. Lack of uniformity in the definition of urban and rural settings may also affect the generalizability of the findings across countries, since different countries have different definitions of what constitutes urban versus rural. Lastly, one methodological limitation is that we pooled the data to perform the trend analysis, which may lead to an overestimation of statistical power. To address this

limitation, the weight in the pooled data was divided by the number of surveys available for the country.

Conclusions

The study provided clear evidence of increase in overweight and obesity among women in the urban settings of all the countries included in the analysis, with the increase overtime being statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. We have supported the finding that urbanization is associated with increased prevalence of overweight and obesity among women. The prevalence of obesity increased more than two fold in most countries and more than three fold in others. The prevalence of obesity also increased alongside overweight, suggesting that urban women who were overweight were likely to progress to obesity status with time. These findings call for deliberate strategies and interventions by policy makers, politicians and health promotion experts to encourage active lifestyles and healthy eating behaviour to curb the growing proportion of unhealthy weight women of child bearing age in urban Africa.

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Competing Interest

The authors have no competing interests to declare.

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This study did not receive funding from any source.

Data Sharing Statement

This study was a re-analysis of existing data that are publicly available from The DHS Program at http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm. Data are accessible free of charge upon a registration with the Demographic and Health Survey program (The DHS Program). The registration is done on the DHS website indicated above.

Authors' Contribution

DAA conceived and designed the study, interpreted the results, wrote the first draft of the manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD contributed to the drafting of the analytical strategy. ZTD, SM BM and ACE contributed to study design, data interpretation, and critical revision of the manuscript. All authors take responsibility of any issues that might arise from the publication of this manuscript.

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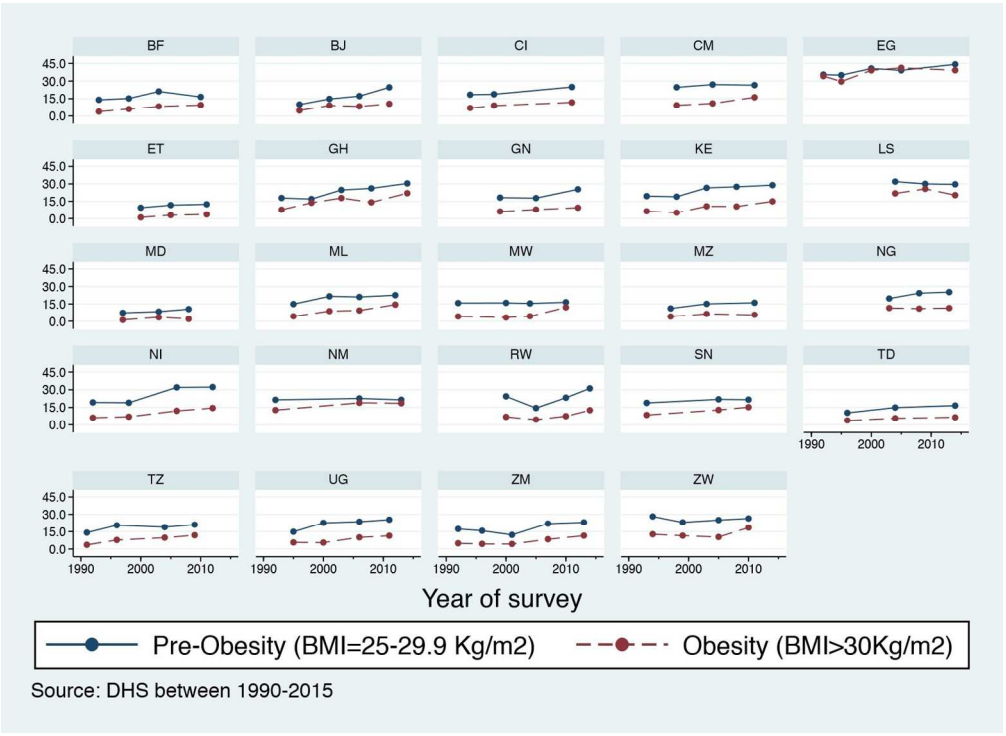

139x101mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-11
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	9
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-11*
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	10-11
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	16-17
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12-13
		(b) Indicate number of participants with missing data for each variable of interest	ND
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-20
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	24-25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	24-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	24-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Prevalence and time trends in overweight and obesity among urban women: An analysis of demographic and health surveys data from 24 African countries, 1991-2014

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Keywords:	Overweight, Obesity, Africa, Prevalence, Trends, Urban

Prevalence and time trends in overweight and obesity among urban women: An analysis of demographic and health surveys data from 24 African countries, 1991-2014

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Abstract

Objective(s): To examine the prevalence and trends in overweight and obesity among non-pregnant urban women in Africa over the past two and half decades.

Design: Cross-sectional surveys conducted between 1991 and 2014.

Settings: Demographic and Health Surveys (DHS), repeated cross-sectional data collected in 24 African countries.

Participants: Adult non-pregnant women aged 15–49 years. The earlier DHS surveys collected anthropometric data on only those women who had children aged 0–5 years. The main analyses were limited to this subgroup. The participants were classified as overweight (25.0-29.9 kg/m^2) and obese (≥ 30.0 kg/m^2).

Results: The prevalence of overweight and obesity increased in all 24 countries. Trends were statistically significant in 17 of the 24 countries in the case of obesity and 13 of the 24 for overweight. In Ghana, overweight almost doubled (p = .001) while obesity tripled (p = .001) between 1993 and 2014. Egypt has the highest levels of overweight and obesity at 44% (95% CI: 42, 46.5) and 39% (95% CI: 36.6, 41.8) respectively in 2014 and the trend showed significant increase (p = .005) from 1995 levels. Also, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight, with overweight ranged from 7 to 12% and obesity from 1 to 4%.

Conclusions: Overweight and obesity are increasing in urban Africa, with obesity having more than doubled or tripled in 12 of the 24 countries. There is an urgent need for deliberate policies and interventions to encourage active lifestyles and healthy eating behaviour to curb this trend in urban Africa.

Keywords: Overweight, obesity, Africa, prevalence, trends, urban

Strengths and Limitations of the Study

- Use of nationally representative data sets, thereby enhancing the generalizability of the findings
- Height and weight used in the calculation of BMI, was objectively measured, possibly reducing misclassification
- Analysis limited to women with children under 5 years old and may affect the generalizability of the findings to all women
- Lack of uniformity in the definition of urban and rural settings across countries

Introduction

Overweight and obesity are global public health problems, especially among women in urban settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs) are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3). A recent study showed that overweight and obesity are linked to 13 different cancers (5).

The consequences of overweight and obesity on women of reproductive age are more serious, especially during pregnancy. Studies have shown that maternal obesity can result in negative outcomes in both mothers and fetuses, including gestational diabetes, preeclampsia, an increased miscarriage rate (6, 7), and stillbirth and congenital anomalies. Obesity in pregnancy can also affect health later in life for both mother and child, including increased risk of heart disease, hypertension, and diabetes (6). Children also have a risk of future obesity. Overweight and obesity are associated with decreased contraceptive efficacy and ovulatory disorders in women of reproductive age (7), and increasing maternal BMI exerts a progressive adverse effect on vaginal delivery rates for both primigravid and multigravid women (8). Obese mothers were more likely than other mothers to terminate breastfeeding when the infant showed satiation cues (9). Obese mothers with higher BMI were also reported using more restrictive feeding practices, limiting the quantity and quality of foods provided to their toddlers, and were observed to use more pressure in getting their children to eat during mealtimes (10,

11).Together, these findings show the varied effects of overweight and obesity on women of reproductive age and their children.

The literature demonstrates that the magnitude of the effect of BMI on health is largely linked to the level of BMI. For instance, there is an increased risk of co-morbidities for individuals with a BMI of 25.0 to 29.9 kg/m^2 (defined as overweight), and moderate to severe risk of co-morbidities for individuals with a BMI greater than 30 kg/m^2 (defined as obesity) (3, 6). The World Health Organization (WHO) (3, 6) recommends that for optimum health, the median body mass index for an adult population should be in the range of 21 to 23 kg/m^2, while the goal for individuals should be to maintain body mass index in the range of 18.5 to 24.9 kg/m^2. This is often difficult to achieve as evidence shows that global overweight and obesity trends are on the rise, with the developing world now bearing the brunt of the surge (7). This dynamic calls for more studies to systematically document these trends over time, especially in developing country contexts.

Hitherto, overweight and obesity were not public health issues on the African continent. However, rapid changes have been observed, and many countries in Africa are currently confronted with overweight and obesity, particularly among women, coupled with a resulting increase in the prevalence of non-communicable diseases (NCDs) (4, 12, 13)**.** In Africa, women had approximately double the obesity prevalence of men (3), with urban settings being the most affected. Thus, the burden of overweight and obesity among urban women is increasing

at an alarming rate in developing countries, and particularly in Africa for that matter (1, 14). In Ghana for example, systematic review and meta-analysis revealed that overweight among urban women was 11 percentage points higher than rural women, while obesity was two times higher in urban relative to rural women (15). Similar trends were obtained using data from 42 countries in Asia, the Middle East, Africa (East, West, Central and Southern), and Latin America, with a combined overweight/obesity prevalence of 37.2% among urban women compared to 19% of rural women (16). The study however noted regional differences, with rural women in Latin America, the Middle East, and North Africa having much higher increases in the prevalence of overweight/obesity compared to their urban counterparts. Conversely, in different multi-country analysis, overweight was increasing more quickly in urban areas than in rural areas of lower-income countries such as Bangladesh and Uganda, but increasing more quickly in rural areas compared to urban areas of upper-middle-income countries, such as Jordan and Peru (17).

The trend observed above may be attributable to an increased intake of energy-dense foods that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature of many occupations, increased use of motorized transportation, and urbanization (1, 18-20). Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the increasing burden of overweight and obesity in urban settings of low and middle-income countries (LMIC) (21-23). Various other studies have argued that the association between urban residence and obesity in LMICs is driven largely by higher individual- and community-level socioeconomic status (SES) in urban areas, suggesting that urban residence alone may not

cause increased body weight in developing countries (18). However, recent studies suggest that the distribution of overweight by SES is changing in developing countries (4, 24, 25). For example, lower SES populations in some of these countries now have higher prevalence of overweight, mimicking long-standing associations between low SES and poorer health in LMICs (4, 24-26). This changing trend is particularly widespread among the urban population. A study in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity among women (27). Another study using data from 7 African countries showed that the increase in overweight and obesity was higher among the poorest urban dwellers compared to the richest population subgroup (21).

Despite the emerging and worrying trend of increased overweight and obesity, and recognition of the potential rise in chronic diseases in recent times in Africa, little effort has been made in addressing overweight and obesity on the continent (28). Consequently, an analysis of overweight and obesity in this study across several countries in the region, is a critical step in the provision of insights into the extent of the problem over time, especially in urban settings, which is needed to inform policy and program interventions to address the challenge in urban Africa.

It is worth noting that while there are a number of studies that investigated overweight and obesity in Africa; most either focused on one country (13), lumped urban and rural data together in their analyses (2, 13), analysed overweight and obesity together (26), or used one

data point (29). These attempts may mask the seriousness of the problem in urban settings and the important differences in the trends and prevalence of overweight and obesity over time. Also, the presentation of the results in some of these studies makes it difficult for policy makers to appreciate the extent of the problem. The present study elucidates the prevalence and time trends in overweight and obesity separately, and presents the results in a way that makes it easier for policy makers to understand the extent of the problem in urban settings.

Methods

Data sources and participants

The study used data from the Demographic and Health Surveys (DHS) programme. These are nationally representative, repeated cross-sectional household surveys collected primarily in lower- and middle-income countries approximately every 5 years and standardized to enable cross-country comparisons (30, 31). We restricted our analysis to data collected in 24 sub-Saharan African countries between 1991 and 2014, and containing individual anthropometric data. There were a total of 137 survey cycles in the 24 countries, and the number of survey cycles per country ranged between three (11/137, four (8/137), and five (5/137) in the time period under consideration. These countries were selected solely based on the number of data points (at least 3) and the availability of anthropometric data. Datasets of countries that met the minimum requirement in terms of data points were downloaded. Data from a total 29 countries were downloaded. The second stage was to examine the data for the availability of anthropometric data. All datasets missing anthropometric data were excluded in the analysis.

For example, the very first DHS, conducted between 1987 and 1990 did not collect maternal anthropometric data. Hence, the dataset for this period were excluded in the analysis. Secondly, countries with three datasets, but reduced to two data points due to one of the datasets not having anthropometric data were also excluded in the analysis.

The DHS employs a multistage sampling design. The first stage involves selecting sample points or clusters from an updated master sampling frame constructed from the National Population and Housing Census data of the respective countries. The clusters are then selected using systematic sampling with probability proportional to size. A household listing operation is then conducted in all the selected clusters to provide a sampling frame for the second stage selection of households. The second stage of selection involves the systematic sampling of households listed in each cluster. The primary objective of the second stage of selection is to ensure adequate numbers of completed individual interviews to provide estimates for key indicators with acceptable precision (31). We limited our analyses to adult non-pregnant women of reproductive age, 15–49 years in all countries. This is because pregnant women naturally gain weight during the cause of their pregnancy, including them in the analysis may present a misleading picture about the issue of overweight and obesity among women. Since the earlier DHS surveys collected anthropometry data on only those women who had children aged 0–5 years (26, 32), we further restricted our main analyses to this subgroup. For the total of 224,940 urban women who met eligibility criteria, anthropometric data were available for 191,836 (85.3 %).

Ethics statement

The DHS obtained ethical clearance from the ethical committees of the respective countries before the surveys were conducted. Written informed consent was obtained from the women before participation. The authors of this paper sought and obtained permission from the DHS program for the use of the data. The data were completely anonymized and therefore the authors did not seek further ethical clearance before their use.

Variables

Height and weight were measured objectively by trained field technicians using standard techniques (31)**.** Weight measurements were taken using electronic Seca scales with a digital screen. Height measurements were taken using a measuring board produced by Shorr Productions. Height and weight measurements were then used to estimate the study participants' body mass index (BMI). BMI, also referred to as Quetelet's Index (33), was derived by dividing weight in kilograms by the squared height in meters. Based on the BMI (kg/m^2) estimates, and according to World Health Organization guidelines (34), the participants were classified as overweight (25.0-29.9 kg/m^2) and obese (≥ 30.0 kg/m^2). Trends and prevalence of overweight and obesity were estimated for each country. Place of residence was designated as rural and urban according to country specific definitions; however, the present analyses were restricted to the urban sample only. This is based on the evidence that the bane of overweight and obesity in Africa is more prevalent in the urban settings relative to other settings (18, 21).

Analytical strategy

We used STATA 13 to perform the data analyses. A data file was constructed by using place of residence, country, survey year, and sample size. The analyses were conducted in three key steps. Initially, prevalence of overweight and obesity in selected countries in Africa with at least three DHS data points was graphed. In this step, only point estimates were reported, and since point estimates are not affected by the complex survey design, the DHS weight for each survey was used to get a reliable estimate. We then computed, at 95% confidence intervals (CI), the outcomes of interest by year of survey for each country in the second step. Because CIs are affected by the sampling design, we took into account the complex survey design (CSD) of DHS within the *svyset* and *svy* procedures in STATA. To avoid flawed variances and biased confidence intervals owing to the complex survey design, the analyses were conducted on the sub-sample with the full sample (urban+rural) maintained in the dataset. In STATA, this is achieved with the "subpop" in svy procedures. In the third step, we examined statistical significance of the trends of overweight and obesity. To achieve this, we performed a multinomial logistic regression with time (year of survey) as the key independent variable using BMI<25 kg/m^2 category as the base outcome and taking into account the CSD. While in steps 1 and 2 the time point data sets were treated independently, we pooled the data sets for trend analyses. To account for sampling weight, the weight in the pooled data was divided by the number of surveys available for the respective countries.

Results

Table 1 presents results of the samples in the selected countries. Tables 2 and 3 present the results of prevalence and trend analyses. Whereas Table 2 presents results for countries with four or more data points, Table 3 presents results of countries with three data points. The rationale for dividing the results tables into two categories is to ease interpretation of the results for the reader. Figure 1 displays the results for all the 24 countries included in the study.

Table 1: Results of samples used in the analysis

Country						
Ghana	**1993**	**1998**	**2003**	**2008**	**2014**	***Total***
Samples	583	656	966	2,023	2,130	6,358
Egypt	**1992**	**1995**	**2000**	**2005**	**2014**	
Samples	3,090	3,779	4,279	4,595	5,842	21,555
Kenya	**1993**	**1998**	**2003**	**2008**	**2014**	
Samples	623	500	1,398	1,342	6,369	10,232
Zambia	**1992**	**1996**	**2001**	**2007**	**2013**	
Samples	2,329	2,099	1,591	1,867	4,636	12,522
Burkina Faso	**1993**	**1998**	**2003**	**2010**	---	
Samples	1,774	873	3,136	3,006	---	8,789
Benin	**1996**	**2001**	**2006**	**2011**	---	
Samples	702	1,403	5,097	4,480	---	11,682

Mali	**1995**	**2001**	**2006**	**2011**	---	
Samples	1,630	2,395	3,673	2,323	---	10,021
Malawi	**1992**	**2000**	**2004**	**2010**	---	
Samples	999	1,864	1,022	1,801	---	5,686
Niger	**1992**	**1998**	**2006**	**2012**	---	
Samples	2,253	1,069	2,267	2,453	---	8,042
Rwanda	**2000**	**2005**	**2010**	**2014**	---	
Samples	1,528	1,524	1,112	1,604	---	5,768
Tanzania	**1991**	**1996**	**2004**	**2009**	---	
Samples	1,128	1,247	1,336	1,404	---	5115
Uganda	**1995**	**2000**	**2006**	**2011**	---	
Samples	1,462	1,510	826	1,539	---	4,593
Zimbabwe	**1994**	**1999**	**2005**	**2010**	---	
Samples	508	1,685	1,298	1,500	---	4,991
Senegal	**1993**	**2005**	**2010**	---	---	
Samples	1,683	3,180	3,373	---	---	8,236
Ivory Coast	**1994**	**1998**	**2011**	---	---	
Samples	1,470	1,040	2,344	---	---	4,854

Cameroon	**1998**	**2004**	**2011**	---	---	
Samples	838	2,819	4,161	---	---	7,818
Ethiopia	**2000**	**2005**	**2011**	---	---	
Samples	1,550	1,299	1,817	---	---	4,666
Guinea	**1999**	**2005**	**2012**	---	---	
Samples	1,415	1,263	1,818	---	---	4,496
Lesotho	**2004**	**2009**	**2014**	---	---	
Samples	640	648	761	---	---	2,049
Madagascar	**1997**	**2003**	**2008**	---	---	
Samples	722	2,708	2,079	---	---	5,509
Mozambique	**1997**	**2003**	**2011**	---	---	
Samples	949	3,320	3,308	---	---	7,577
Nigeria	**2003**	**2008**	**2013**	---	---	
Samples	1,831	6,659	8,976	---	---	17,466
Namibia	**1992**	**2006**	**2013**	---	---	
Samples	1,090	1,854	2,142	---	---	5,086
Chad	**1996**	**2004**	**2014**	---	---	
Samples	2,443	2,112	3,396	---	---	7,951

Total sample	**191,836**

Table 2 provides period estimates and trends in overweight and obesity in 13 countries with 4 or more data points. These surveys cover periods between 14 years in Rwanda and 21 years in Ghana, Kenya and Zambia. The earliest data points in these countries were in the 1990s and the latest are after 2010. Across all 13 countries, levels of overweight reached or exceeded 20% only in Egypt (36%) and Zimbabwe (28%) in the 1990s surveys. Obesity reached a double digit of 10% or more only in Egypt (34%), and Zimbabwe (13%). In all the other countries, overweight was under 20% and obesity was under 10%. In the latest surveys conducted since 2010 in these countries, overweight exceeded 20% in all countries except Burkina Faso and Malawi where the prevalence was around 16%. The increase overtime was not also statistically significant in these two countries. In 4 countries, the prevalence of overweight exceeded 30% (Egypt (44%), Niger (32%), Rwanda (31%) and Ghana (30%)). Obesity exceeded 10% in all countries in the 2010s surveys with Egypt (39%) and Ghana (22%) leading in levels of obesity. Only in Burkina Faso was obesity still below 10% in the most recent survey.

Table 2: Analysis of trends in overweight and obesity for countries with four or more data points

Country							
Ghana	**1993**	**1998**	**2003**	**2008**	**2014**	***p***	**Nature of trend**
Overweight							
(%)	17.9	17.0	24.8	26.2	30.4	p<.05	↗
(95% CI)	17.9, 18.2	13.6, 21.1	21.3, 28.7	24.2, 28.3	26.3, 34.9		

Obesity							
(%)	7.7	13.8	17.9	14.2	22.0	p<.05	↗
(95% CI)	7.0, 8.5	10.6, 17.8	14.7, 21.5	12.7, 15.8	18.3, 26.3		
Egypt	**1995**	**2000**	**2005**	**2008**	**2014**		
Overweight							
(%)	35.5	35.0	40.6	39.1	44.2	p<.05	↗
(95% CI)	32.9, 38.2	32.7, 37.3	38.2, 43.2	36.7, 41.6	42.0, 46.5		
Obesity							
(%)	34.2	29.6	39.1	41.2	39.2	p<.05	↗
(95% CI)	31.0, 37.6	26.7, 32.7	36.4, 42.0	38.6, 43.9	36.6, 41.8		
Kenya	**1993**	**1998**	**2003**	**2008**	**2014**		
Overweight							
(%)	19.5	19.0	26.6	27.5	28.9	p<.05	↗
(95% CI)	15.0, 24.9	15.4, 23.3	23.3, 30.3	22.8, 32.9	26.1, 31.9		
Obesity							
(%)	6.4	5.1	10.7	10.5	15.0	P<.05	↗
(95% CI)	4.1, 9.8	3.3, 7.9	8.1, 14.1	7.7, 14.3	12.7, 17.6		
Zambia	**1992**	**1996**	**2001**	**2007**	**2013**		
Overweight							
(%)	17.3	15.7	12.1	22.0	23.1	p<.05	↗
(95% CI)	15.2, 19.6	13.8, 17.9	10.3, 14.2	18.9, 25.4	21.2, 25.2		
Obesity							
(%)	4.9	4.4	4.3	8.4	11.5	p<.05	↗
(95% CI)	3.8, 6.4	3.4, 5.7	3.2, 5.9	6.6, 10.5	9.8, 13.5		

Burkina Faso	**1993**	**1998**	**2003**	**2010**			
Overweight							
(%)	14.0	15.2	21.1	16.5		p>.05	→
(95% CI)	12.0, 16.3	12.2, 18.7	18.2, 24.3	13.8, 19.5			
Obesity							
(%)	3.8	6.0	8.3	9.5		p<.05	↗
(95% CI)	2.7, 5.2	4.3, 8.4	5.7, 11.8	7.2, 12.3			
Benin	**1996**	**2001**	**2006**	**2011**			
Overweight							
(%)	9.9	14.8	17.2	24.6		p<.05	↗
(95% CI)	7.3, 13.4	12.3, 17.6	15.5, 18.9	22.7, 26.7			
Obesity							
(%)	4.7	9.1	8.3	10.5		p<.05	↗
(95% CI)	3.1, 7.0	7.4, 11.3	7.1, 9.7	8.9, 12.4			
Mali	**1995**	**2001**	**2006**	**2011**			
Overweight							
(%)	14.9	21.6	21.0	22.5		p<.05	↗
(95% CI)	12.6, 17.4	18.4, 25.1	18.3, 23.9	19.1, 26.4			

Obesity							
(%)	4.3	8.8	9.4	14.4		p<.05	↗
(95% CI)	3.1, 5.8	6.9, 11.1	7.7, 11.4	11.7, 17.5			
Malawi	**1992**	**2000**	**2004**	**2010**			
Overweight							
(%)	15.8	15.9	15.4	16.4		p>.05	→
(95% CI)	12.3, 20.0	13.1, 19.1	12.1, 19.5	12.7, 21.1			
Obesity							
(%)	4.1	3.2	4.3	12.1		P<.05	↗
(95% CI)	2.6, 6.4	2.0, 5.1	2.8, 6.7	8.2, 17.5			
Niger	**1992**	**1998**	**2006**	**2012**			
Overweight							
(%)	19.2	19.0	32.0	32.23		p<.05	↗
(95% CI)	16.8, 22.0	15.5, 23.0	27.8, 36.6	28.5, 36.3			
Obesity							
(%)	6.1	7.0	12.1	14.4		p<.05	↗
(95% CI)	4.9, 7.6	5.2, 9.3	9.4, 15.4	11.7, 17.6			
Rwanda	**2000**	**2005**	**2010**	**2014**			

Overweight					---		
(%)	24.4	14.4	23.3	31.1	---	p<.05	↗
(95% CI)	23.1,25.6	11.0, 18.8	19.4, 27.6	26.5, 36.1	---		
Obesity					---		
(%)	6.8	4.5	7.5	12.6	---	p<.05	↗
(95% CI)	6.1,7.3	2.6, 7.8	4.9, 11.4	10.0, 15.7	---		
Tanzania	**1991**	**1996**	**2004**	**2009**	---		
Overweight					---		
(%)	14.1	20.5	18.9	21.0	---	p<.05	↗
(95% CI)	11.1, 17.8	20.1, 20.9	18.5, 19.3	20.4, 22.2	---		
Obesity					---		
(%)	3.6	7.8	9.7	11.8	---	p<.05	↗
(95% CI)	2.4, 5.3	7.2, 7.9	9.4, 10.1	11.1, 12.1	---		
Uganda	**1995**	**2000**	**2006**	**2011**	---		
Overweight					---		
(%)	14.1	22.7	23.7	25.4	---	p<.05	↗
(95% CI)	11.1, 17.8	18.9, 26.9	16.9, 32.2	20.0, 31.7	---		
Obesity					---		

(%)	5.6	5.5	10.0	11.4	---	p<.05*	↗
(95% CI)	4.2, 7.6	4.0, 7.6	5.2, 18.3	7.8, 16.4	---		
Zimbabwe	**1994**	**1999**	**2005**	**2010**	---		
Overweight					---		
(%)	28.2	23.1	25.1	26.5	---	p>.05	→
(95% CI)	23.3, 33.7	21.0, 25.4	22.0, 28.5	23.5, 29.7	---		
Obesity					---		
(%)	12.7	11.5	10.3	18.5	---	p>.05	↗
(95% CI)	9.6, 16.7	10.0, 13.2	8.6, 12.4	15.5, 21.9	---		

↗ = increasing); ↘ = decreasing; → = stable; CI = confidence interval; p = significance level

Table 3 shows the results for the 11 countries with only three data points. The periods covered by these surveys range from 10 years in Lesotho and Nigeria to 17 years in Senegal and Ivory Coast. Some of the earliest surveys in these countries occurred in the 2000s and given differences in timing and duration between the earliest and latest surveys, it made sense to report these surveys separately. Lesotho has the highest prevalence of overweight, which stood at 32% in 2004 and has barely changed over the subsequent 10-year period. Namibia and Cameroon also had high levels of overweight at more than 20%. On the other hand, Madagascar and Ethiopia had the lowest levels of overweight and obesity. In Madagascar and

Ethiopia, overweight is varied between 7 and 12% over the period covered by the surveys, while obesity is under 5% (under 2% in Madagascar). The change of overweight over time was statistically significant only in Guinea, Mozambique, Namibia and Chad, while obesity was significant only in Senegal, Guinea and Cameroon.

Table 3: Analysis of trends in overweight and obesity for countries with three data points

Country					
Senegal	**1993**	**2005**	**2010**	***p***	**Nature of trend**
Overweight					
(%)	18.8	21.9	21.6	p>.05	→
(95% CI)	16.3, 21.6	17.0, 27.6	18.2, 25.4		
Obesity					
(%)	8.5	12.8	15.2	p<.05	↗
(95% CI)	6.7, 10.8	9.5, 17.1	11.9, 19.3		
Ivory Coast	**1994**	**1998**	**2011**		
Overweight					
(%)	18.4	18.8	24.9	p>.05	→
(95% CI)	16.1, 20.8	16.1, 21.7	21.4, 28.8		
Obesity					
(%)	6.9	9.0	11.8	p>.05	→
(95% CI)	5.1, 9.2	7.1, 11.4	9.1, 15.1		
Cameroon	**1998**	**2004**	**2011**		
Overweight					

(%)	24.7	27.0	26.7	p>.05	→
(95% CI)	21.3, 28.3	23.8, 30.5	23.9, 29.3		
Obesity					
(%)	9.3	10.9	16.1	p>.05	↗
(95% CI)	6.7, 12.8	8.9, 13.4	14.1, 18.4		
Ethiopia	**2000**	**2005**	**2011**		
Overweight					
(%)	9.5	11.7	12.5	p>.05	→
(95% CI)	6.9, 12.9	7.5, 18.0	9.2, 16.8		
Obesity					
(%)	1.0	2.9	3.6	p<.05	↗
(95% CI)	0.5, 1.7	1.5, 5.8	2.3, 5.4		
Guinea	**1999**	**2005**	**2012**		
Overweight					
(%)	18.2	17.8	25.4	p<.05	↗
(95% CI)	15.7, 21.0	14.3, 22.0	20.9, 30.4		
Obesity					
(%)	6.2	7.9	9.4	p<.05	↗
(95% CI)	4.8, 7.9	4.6, 13.3	6.9, 12.8		
Lesotho	**2004**	**2009**	**2014**		
Overweight					
(%)	32.0	30.0	29.7	p>.05	→
(95% CI)	25.3, 39.5	23.3, 37.7	22.9, 37.4		
Obesity					

(%)	21.9	25.8	20.3	p>.05	→
(95% CI)	15.5, 30.0	20.1, 32.4	14.7, 27.4		
Madagascar	**1997**	**2003**	**2008**		
Overweight					
(%)	7.3	8.3	10.5	p>.05	→
(95% CI)	5.2, 10.1	6.6, 10.5	8.1, 13.5		
Obesity					
(%)	1.1	3.4	1.9	p>.05	→
(95% CI)	0.5, 2.6	2.4, 4.8	1.0, 3.5		
Mozambique	**1997**	**2003**	**2011**		
Overweight					
(%)	11.1	15.1	16.0	p<.05	↗
(95% CI)	8.4, 14.6	13.1, 19.1	14.1, 18.2		
Obesity					
(%)	4.0	3.2	6.3	p>.05	→
(95% CI)	2.3, 6.9	2.0, 5.1	4.7, 8.6		
Nigeria	**2003**	**2008**	**2013**		
Overweight					
(%)	19.7	24.3	25.2	p>.05	→
(95% CI)	15.2, 25.1	22.6, 26.1	23.4, 27.1		
Obesity					
(%)	11.5	11.0	11.5	p>.05	→
(95% CI)	8.3, 15.6	9.7, 12.5	10.3, 12.7		
Namibia	**1992**	**2006**	**2013**		

Overweight					
(%)	21.4	22.6	21.5	p>.05	→
(95% CI)	17.9, 25.4	19.2, 26.5	18.0, 25.4		
Obesity					
(%)	12.7	18.9	18.6	p<.05	↗
(95% CI)	10.3, 15.6	16.1, 22.1	15.2, 22.5		
Chad	**1996**	**2004**	**2014**		
Overweight					
(%)	10.4	14.9	16.6	p<.05	↗
(95% CI)	9.6,11.4	12.4, 17.7	13.9, 19.6		
Obesity					
(%)	3.8	5.7	6.5	p<.05	↗
(95% CI)	2.9,4.1	3.9, 8.4	4.8, 8.7		

↗ = increasing); ↘ = decreasing; → = stable; CI = confidence interval; p = significance level

The Figure 1 below depicts the increasing trends of overweight and obesity in all the 24 countries included in the analysis, except in Lesotho where there is semblance of a decrease.

Figure 1: Time trends of overweight and obesity

Countries: BF= Burkina Faso; BJ= Benin; CI=Ivory Coast; CM= Cameroon; EG= Egypt; ET=Ethiopia; GH= Ghana; GN= Guinea; KE= Kenya; LS= Lesotho; MD= Madagascar; ML= Mali; MW= Malawi; MZ= Mozambique; NG= Nigeria; NI= Niger; NM= Namibia; RW= Rwanda; SN= Senegal; TD = Chad; TZ= Tanzania; UG= Uganda; ZM=Zambia; ZW= Zimbabwe

Discussion

We set out to investigate the prevalence and time trends in overweight and obesity between 1991 and 2014 in 24 African countries. Primarily, we confirm that the prevalence of overweight and obesity among urban women has rapidly increased in the past two and a half decades. All 24 countries included in our analyses experienced an increase in overweight and obesity over the time period under consideration. However, the increase was only statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. The changes over time were particularly noticeable among countries with 4 or more survey data points, in

which case, all the 13 countries showed a statistically significant increase in obesity, while 10 showed significant increase for overweight during the period of the study. For countries with three data points, only 4 of the 11 countries had a significant increase for overweight and 3 for obesity. This suggests that length of time (number of data points) plays a role in understanding the changes in overweight and obesity over time. We also found that 18 of the 24 countries had an overweight prevalence above 20%, based on the most recent survey waves for the respective countries. This was not the case in the earlier surveys where only 6 countries had an overweight prevalence of 20% or above. Four countries of the 24 had an obesity prevalence that was above 20%, with the prevalence in the rest ranging between 10% and 19% based on the latest surveys. However, in the earlier surveys, only one country had obesity prevalence of 20% or more, while the rest had obesity rate ranging from 1 to 12%. This points to worsening phenomenon of obesity among urban women in the past two and half decades. Another key finding is that in most of the countries included in our analyses, obesity increased alongside overweight, suggesting that urban women who are overweight have a greater probability of progressing to obesity. Thus, addressing overweight will, to a larger extend curtail the increasing incidence of obesity in urban Africa.

Focusing on individual countries, we found significant differences in overweight and obesity across the countries included in the analysis. For example, in the most recent surveys, Egypt has the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two other countries with overweight prevalence of 30% and above. The results on Egypt are not

surprising as the country was previously ranked among the countries in the world with the most obese people (35). The results in Ghana are also consistent with previous findings (15). Egypt and Ghana also experienced a significant increase in overweight and obesity in the past two and half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the prevalence of obesity in the aforementioned countries may be considered lower than that of Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests that in the next decades, the obesity rates in these countries may catch up with Egypt and Ghana, which are currently leading in terms of the level of prevalence of both overweight and obesity. However, overweight and obesity did not show any significant changes over time in Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and Madagascar in a recent study using the DHS data from 32 African countries (29).

The increasing prevalence and trends of overweight and obesity in Africa is attributed largely to rapid urbanization taking place in the continent and its associated nutritional transition. For example, in 2010, the share of the African urban population was about 36% and is projected to increase to 50% and 60% by 2030 and 2050 respectively (36). Using Ghana as a case in point, for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%) of country's population live in urban areas compared to rural areas (37). The growing urbanization comes along with lifestyle changes such as decreased physical activity and

increase supply of high caloric fast foods and sugar sweetened beverages (16, 38-40). Indeed, sedentary lifestyle and high consumption of energy dense diets are found to account for the increasing burden of overweight and obesity in urban settings of the low and middle income countries (LMIC) (21-23). The consequences of which, is increase in non-communicable diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body mass index (BMI) (3, 4, 40). In addition, an increased burden of disability-adjusted life years (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be implemented to address the problem of overweight and obesity, thereby curbing associated NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important step towards curbing the surge of NCDs the continent is currently experiencing, which is likely to surpass the toll of sickness and death from infectious diseases by 2030 (41). This will further contribute greatly to the potential for African countries to achieve Sustainable Development Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases through prevention, and treatment, and promote mental health and wellbeing by 2030 (42).

In the light of the findings of our study and literature discussed above, we particularly advocate for targeted interventions to address the incidence of overweight and obesity among urban dwelling women. Intervention strategies, described in the literature as 'effective and essential' (43) in addressing overweight and obesity in a developing country context include, policy interventions and inter-sectoral partnerships; addressing food system drivers of caloric over-consumption; and improving eating and physical activity environments in key community

settings (43). It is believed that effective implementation of these strategies has the potential to curtail the incidence of overweight and obesity. It is important to recognize that large inequalities remain a major issue in many African countries, which may have a bearing on areas that ought to be prioritized and targeted for interventions. For example, in many African countries, it is common to see problems of undernutrition alongside increasing rates of overweight and obesity. This "dual burden" of undernutrition and obesity exists not only at country- or community-level, but all the way down to households (16, 44). Undernutrition persists as a significant problem (45) in many African countries, and interventions have been put in place to address it (46-48). However, the issue of overweight and obesity has not received adequate attention as yet in Africa (16, 48). More attention of policy makers and public health practitioners on ways to address the overweight and obesity epidemic, taking into account undernutrition is warranted.

Strengths and limitations

The key strength of this study is the use of nationally representative data sets, thereby providing more robust estimates of the prevalence and trends of overweight and obesity in the respective countries. Further, height and weight as used in the calculation of BMI, was objectively measured by well-trained technicians, reducing possible misclassification of overweight and obesity. The study is also associated with some limitations. To maintain sample comparability over time, we had to limit our sample to women with children under 5 years old. This may, to some extent, affect the generalizability of the findings, as the sample may not be

representative of the entire female population. Another limitation is the cross-sectional nature of the data. Because the surveys used in this analysis were conducted at different times across countries, we were unable to estimate the change in BMI across all countries for the entire survey period. Lack of uniformity in the definition of urban and rural settings may also affect the comparability of the findings across countries, since different countries have different definitions of what constitutes urban versus rural. Lastly, one methodological limitation is that we pooled the data to perform the trend analysis, which may lead to an overestimation of statistical power. To address this limitation, the weight in the pooled data was divided by the number of surveys available for the country.

Conclusions

The study provided clear evidence of increase in overweight and obesity among women in the urban settings of all the countries included in the analysis, with the increase overtime being statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. We have supported the finding that women dwelling in urban settings are prone to overweight and obesity. The prevalence of obesity increased more than two fold in most countries and more than three fold in others. The prevalence of obesity increased alongside overweight. These findings call for deliberate strategies and interventions by policy makers, politicians and health promotion experts, focusing on healthy diet, physical activity, weight

reduction and maintenance strategies in African countries, particularly in urban areas to curb the growing proportion of unhealthy weight women of child bearing age in urban Africa. Strategies should include measures such as price reduction for healthy foods (e.g., fruits and vegetables) and promotion of physical activity.

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Competing Interest

The authors have no competing interests to declare.

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Data Sharing Statement

This study was a re-analysis of existing data that are publicly available from The DHS Program at http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm. Data are accessible free of charge upon a registration with the Demographic and Health Survey program (The DHS Program). The registration is done on the DHS website indicated above.

Authors' Contribution

DAA conceived and designed the study, interpreted the results, wrote the first draft of the manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD contributed to the drafting of the analytical strategy. ZTD, SM BM and ACE contributed to study design, data interpretation, and critical revision of the manuscript. All authors take responsibility of any issues that might arise from the publication of this manuscript.

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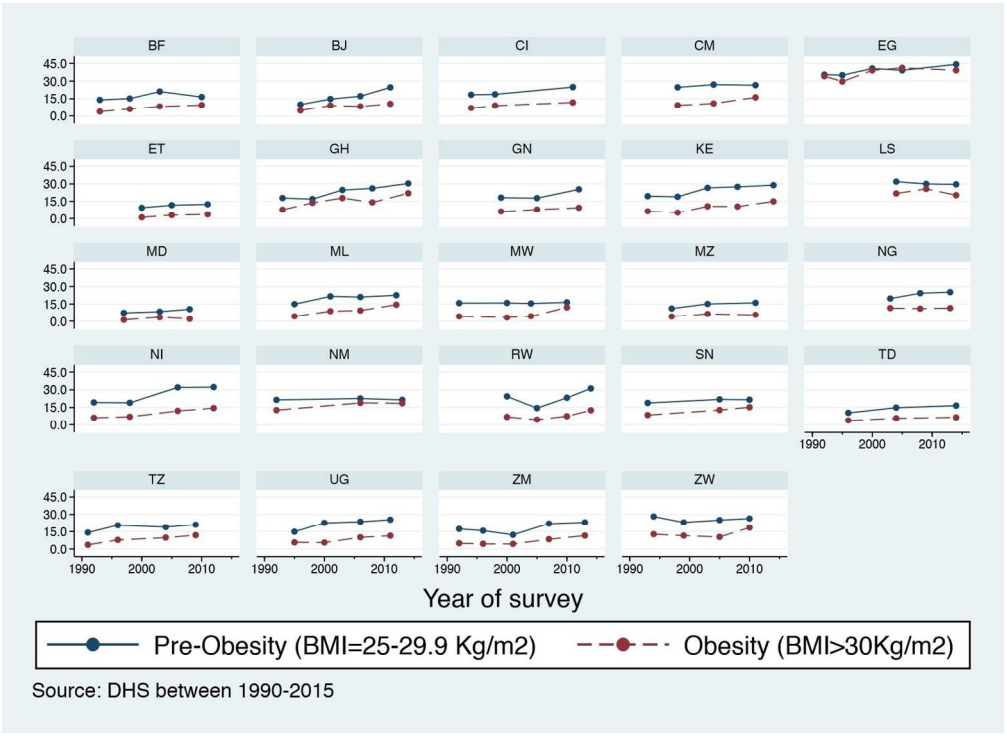

Source: DHS between 1990-2015

139x101mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-11
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	9
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-11*
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	10-11
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	16-17
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12-13
		(b) Indicate number of participants with missing data for each variable of interest	ND
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-20
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	24-25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	24-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	24-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Prevalence and time trends in overweight and obesity among urban women: An analysis of demographic and health surveys data from 24 African countries, 1991-2014

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Prevalence and time trends in overweight and obesity among urban women: An analysis of demographic and health surveys data from 24 African countries, 1991-2014

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Abstract

Objective(s): To examine the prevalence and trends in overweight and obesity among non-pregnant urban women in Africa over the past two and half decades.

Design: Cross-sectional surveys conducted between 1991 and 2014.

Settings: Demographic and Health Surveys (DHS), repeated cross-sectional data collected in 24 African countries.

Participants: Adult non-pregnant women aged 15–49 years. The earlier DHS surveys collected anthropometric data on only those women who had children aged 0–5 years. The main analyses were limited to this subgroup. The participants were classified as overweight (25.0-29.9 kg/m^2) and obese (≥ 30.0 kg/m^2).

Results: The prevalence of overweight and obesity among women increased in all the 24 countries. Trends were statistically significant in 17 of the 24 countries in the case of obesity and 13 of the 24 for overweight. In Ghana, overweight almost doubled (p = .001) while obesity tripled (p = .001) between 1993 and 2014. Egypt has the highest levels of overweight and obesity at 44% (95% CI: 42, 46.5) and 39% (95% CI: 36.6, 41.8) respectively in 2014 and the trend showed significant increase (p = .005) from 1995 levels. Also, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight, with overweight ranging from 7 to 12% and obesity from 1 to 4%.

Conclusions: Overweight and obesity are increasing among women of reproductive age in urban Africa, with obesity among this age group having more than doubled or tripled in 12 of the 24 countries. There is an urgent need for deliberate policies and interventions to encourage active lifestyles and healthy eating behaviour to curb this trend in urban Africa.

Keywords: Overweight, obesity, Africa, prevalence, trends, urban

Strengths and Limitations of the Study

- Use of nationally representative data sets, thereby enhancing the generalizability of the findings
- Height and weight used in the calculation of BMI, was objectively measured, possibly reducing misclassification
- Analysis limited to women with children under 5 years old and may affect the generalizability of the findings to all women
- Lack of uniformity in the definition of urban and rural settings across countries

Introduction

Overweight and obesity are global public health problems, especially among women in urban settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs) are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3). A recent study showed that overweight and obesity are linked to 13 different cancers (5).

The consequences of overweight and obesity on women of reproductive age are more serious, especially during pregnancy. Studies have shown that maternal obesity can result in negative outcomes in both mothers and fetuses, including gestational diabetes, preeclampsia, an increased miscarriage rate (6, 7), and stillbirth and congenital anomalies. Obesity in pregnancy can also affect health later in life for both mother and child, including increased risk of heart disease, hypertension, and diabetes (6). Children also have a risk of future obesity. Overweight and obesity are associated with decreased contraceptive efficacy and ovulatory disorders in women of reproductive age (7), and increasing maternal BMI exerts a progressive adverse effect on vaginal delivery rates for both primigravid and multigravid women (8). Obese mothers were more likely than other mothers to terminate breastfeeding when the infant showed satiation cues (9). Obese mothers with higher BMI were also reported using more restrictive feeding practices, limiting the quantity and quality of foods provided to their toddlers, and were observed to use more pressure in getting their children to eat during mealtimes (10,

11).Together, these findings show the varied effects of overweight and obesity on women of reproductive age and their children.

The literature demonstrates that the magnitude of the effect of BMI on health is largely linked to the level of BMI. For instance, there is an increased risk of co-morbidities for individuals with a BMI of 25.0 to 29.9 kg/m^2 (defined as overweight), and moderate to severe risk of co-morbidities for individuals with a BMI greater than 30 kg/m^2 (defined as obesity) (3, 6). The World Health Organization (WHO) (3, 6) recommends that for optimum health, the median body mass index for an adult population should be in the range of 21 to 23 kg/m^2, while the goal for individuals should be to maintain body mass index in the range of 18.5 to 24.9 kg/m^2. This is often difficult to achieve as evidence shows that global overweight and obesity trends are on the rise, with the developing world now bearing the brunt of the surge (7). This dynamic calls for more studies to systematically document these trends over time, especially in developing country contexts.

Hitherto, overweight and obesity were not public health issues on the African continent. However, rapid changes have been observed, and many countries in Africa are currently confronted with overweight and obesity, particularly among women, coupled with a resulting increase in the prevalence of non-communicable diseases (NCDs) (4, 12, 13)**.** In Africa, women had approximately double the obesity prevalence of men (3), with urban settings being the most affected. Thus, the burden of overweight and obesity among urban women is increasing

at an alarming rate in developing countries, and particularly in Africa for that matter (1, 14). In Ghana for example, systematic review and meta-analysis revealed that overweight among urban women was 11 percentage points higher than rural women, while obesity was two times higher in urban relative to rural women (15). Similar trends were obtained using data from 42 countries in Asia, the Middle East, Africa (East, West, Central and Southern), and Latin America, with a combined overweight/obesity prevalence of 37.2% among urban women compared to 19% of rural women (16). The study however noted regional differences, with rural women in Latin America, the Middle East, and North Africa having much higher increases in the prevalence of overweight/obesity compared to their urban counterparts. Conversely, in different multi-country analysis, overweight was increasing more quickly in urban areas than in rural areas of lower-income countries such as Bangladesh and Uganda, but increasing more quickly in rural areas compared to urban areas of upper-middle-income countries, such as Jordan and Peru (17).

The trend observed above may be attributable to an increased intake of energy-dense foods that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature of many occupations, increased use of motorized transportation, and urbanization (1, 18-20). Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the increasing burden of overweight and obesity in urban settings of low and middle-income countries (LMIC) (21-23). Various other studies have argued that the association between urban residence and obesity in LMICs is driven largely by higher individual- and community-level socioeconomic status (SES) in urban areas, suggesting that urban residence alone may not

cause increased body weight in developing countries (18). However, recent studies suggest that the distribution of overweight by SES is changing in developing countries (4, 24, 25). For example, lower SES populations in some of these countries now have higher prevalence of overweight, mimicking long-standing associations between low SES and poorer health in LMICs (4, 24-26). This changing trend is particularly widespread among the urban population. A study in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity among women (27). Another study using data from 7 African countries showed that the increase in overweight and obesity was higher among the poorest urban dwellers compared to the richest population subgroup (21).

Despite the emerging and worrying trend of increased overweight and obesity, and recognition of the potential rise in chronic diseases in recent times in Africa, little effort has been made in addressing overweight and obesity on the continent (28). Consequently, an analysis of overweight and obesity in this study across several countries in the region, is a critical step in the provision of insights into the extent of the problem over time, especially in urban settings, which is needed to inform policy and program interventions to address the challenge in urban Africa.

It is worth noting that while there are a number of studies that investigated overweight and obesity in Africa; most either focused on one country (13), lumped urban and rural data together in their analyses (2, 13), analysed overweight and obesity together (26), or used one

data point (29). These attempts may mask the seriousness of the problem in urban settings and the important differences in the trends and prevalence of overweight and obesity over time. Also, the presentation of the results in some of these studies makes it difficult for policy makers to appreciate the extent of the problem. The present study elucidates the prevalence and time trends in overweight and obesity separately, and presents the results in a way that makes it easier for policy makers to understand the extent of the problem in urban settings.

Methods

Data sources and participants

The study used data from the Demographic and Health Surveys (DHS) programme. These are nationally representative, repeated cross-sectional household surveys collected primarily in lower- and middle-income countries approximately every 5 years and standardized to enable cross-country comparisons (30, 31). We restricted our analysis to data collected in 24 sub-Saharan African countries between 1991 and 2014, and containing individual anthropometric data. There were a total of 137 survey cycles in the 24 countries, and the number of survey cycles per country ranged between three (11/137, four (8/137), and five (5/137) in the time period under consideration. These countries were selected solely based on the number of data points (at least 3) and the availability of anthropometric data. Data from a total 29 countries that met the minimum requirement in terms of data points were downloaded. The second stage was to examine the data for the availability of anthropometric data. All datasets missing anthropometric data were excluded in the analysis. For example, the very first DHS, conducted between 1987 and 1990 did not collect maternal anthropometric data. Hence, the dataset for this period were excluded in the analysis. Secondly, countries with three datasets, but reduced to two data points due to one of the datasets not having anthropometric data were also excluded in the analysis.

The DHS employs a multistage sampling design. The first stage involves selecting sample points or clusters from an updated master sampling frame constructed from the National Population

and Housing Census data of the respective countries. The clusters are then selected using systematic sampling with probability proportional to size. A household listing operation is then conducted in all the selected clusters to provide a sampling frame for the second stage selection of households. The second stage of selection involves the systematic sampling of households listed in each cluster. The primary objective of the second stage of selection is to ensure adequate numbers of completed individual interviews to provide estimates for key indicators with acceptable precision (31). We limited our analyses to adult non-pregnant women of reproductive age, 15–49 years in all countries. This is because pregnant women naturally gain weight during the cause of their pregnancy, including them in the analysis may present a misleading picture about the issue of overweight and obesity among women. Since the earlier DHS surveys collected anthropometry data on only those women who had children aged 0–5 years (26, 32), we further restricted our main analyses to this subgroup. For the total of 224,940 urban women who met eligibility criteria, anthropometric data were available for 191,836 (85.3 %).

Ethics statement

The DHS obtained ethical clearance from the ethical committees of the respective countries before the surveys were conducted. Written informed consent was obtained from the women before participation. The authors of this paper sought and obtained permission from the DHS program for the use of the data. The data were completely anonymized and therefore the authors did not seek further ethical clearance before their use.

Variables

Height and weight were measured objectively by trained field technicians using standard techniques (31). Weight measurements were taken using electronic Seca scales with a digital screen. Height measurements were taken using a measuring board produced by Shorr Productions. Height and weight measurements were then used to estimate the study participants' body mass index (BMI). BMI, also referred to as Quetelet's Index (33), was derived by dividing weight in kilograms by the squared height in meters. Based on the BMI (kg/m^2) estimates, and according to World Health Organization guidelines (34), the participants were classified as overweight (25.0-29.9 kg/m^2) and obese (≥ 30.0 kg/m^2). Trends and prevalence of overweight and obesity were estimated for each country. Place of residence was designated as rural and urban according to country specific definitions; however, the present analyses were restricted to the urban sample only. This is based on the evidence that the bane of overweight and obesity in Africa is more prevalent in the urban settings relative to other settings (18, 21).

Analytical strategy

We used STATA 13 to perform the data analyses. A data file was constructed by using place of residence, country, survey year, and sample size. The analyses were conducted in three key steps. Initially, prevalence of overweight and obesity in selected countries in Africa with at least three DHS data points was graphed. In this step, only point estimates were reported. We then computed, at 95% confidence intervals (CI), the outcomes of interest by year of survey for each country in the second step. Because CIs are affected by the sampling design, we took into

account the complex survey design (CSD) of DHS within the *svyset* and *svy* procedures in STATA. In STATA, this is achieved with the "subpop" in svy procedures. In the third step, we examined statistical significance of the trends of overweight and obesity. To achieve this, we performed a multinomial logistic regression with time (year of survey) as the key independent variable using BMI<25 kg/m^2 category as the base outcome and taking into account the CSD. While in steps 1 and 2 the time point data sets were treated independently, we pooled the data sets for trend analyses. To account for sampling weight, the weight in the pooled data was divided by the number of surveys available for the respective countries.

Results

Table 1 presents results of the samples in the selected countries. Both Table 2 and Table 3 present the results of prevalence and trend analyses. Whereas Table 2 presents results for countries with four or more data points, Table 3 presents results of countries with three data points. The rationale for dividing the results into two separate tables is to ease interpretation of the results for the reader. Figure 1 displays the results for all the 24 countries included in the study.

Table 1: Results of samples used in the analysis

Country						
Ghana	**1993**	**1998**	**2003**	**2008**	**2014**	***Total***
Samples	583	656	966	2,023	2,130	6,358
Egypt	**1992**	**1995**	**2000**	**2005**	**2014**	
Samples	3,090	3,779	4,279	4,595	5,842	21,555
Kenya	**1993**	**1998**	**2003**	**2008**	**2014**	
Samples	623	500	1,398	1,342	6,369	10,232
Zambia	**1992**	**1996**	**2001**	**2007**	**2013**	
Samples	2,329	2,099	1,591	1,867	4,636	12,522
Burkina Faso	**1993**	**1998**	**2003**	**2010**	---	
Samples	1,774	873	3,136	3,006	---	8,789
Benin	**1996**	**2001**	**2006**	**2011**	---	
Samples	702	1,403	5,097	4,480	---	11,682
Mali	**1995**	**2001**	**2006**	**2011**	---	
Samples	1,630	2,395	3,673	2,323	---	10,021
Malawi	**1992**	**2000**	**2004**	**2010**	---	
Samples	999	1,864	1,022	1,801	---	5,686
Niger	**1992**	**1998**	**2006**	**2012**	---	
Samples	2,253	1,069	2,267	2,453	---	8,042

Rwanda	**2000**	**2005**	**2010**	**2014**	---	
Samples	1,528	1,524	1,112	1,604	---	5,768
Tanzania	**1991**	**1996**	**2004**	**2009**	---	
Samples	1,128	1,247	1,336	1,404	---	5115
Uganda	**1995**	**2000**	**2006**	**2011**	---	
Samples	1,462	1,510	826	1,539	---	4,593
Zimbabwe	**1994**	**1999**	**2005**	**2010**	---	
Samples	508	1,685	1,298	1,500	---	4,991
Senegal	**1993**	**2005**	**2010**	---	---	
Samples	1,683	3,180	3,373	---	---	8,236
Ivory Coast	**1994**	**1998**	**2011**	---	---	
Samples	1,470	1,040	2,344	---	---	4,854
Cameroon	**1998**	**2004**	**2011**	---	---	
Samples	838	2,819	4,161	---	---	7,818
Ethiopia	**2000**	**2005**	**2011**	---	---	
Samples	1,550	1,299	1,817	---	---	4,666
Guinea	**1999**	**2005**	**2012**	---	---	
Samples	1,415	1,263	1,818	---	---	4,496
Lesotho	**2004**	**2009**	**2014**	---	---	
Samples	640	648	761	---	---	2,049
Madagascar	**1997**	**2003**	**2008**	---	---	
Samples	722	2,708	2,079	---	---	5,509
Mozambique	**1997**	**2003**	**2011**	---	---	
Samples	949	3,320	3,308	---	---	7,577
Nigeria	**2003**	**2008**	**2013**	---	---	
Samples	1,831	6,659	8,976	---	---	17,466
Namibia	**1992**	**2006**	**2013**	---	---	
Samples	1,090	1,854	2,142	---	---	5,086

Chad	**1996**	**2004**	**2014**	---	---	
Samples	2,443	2,112	3,396	---	---	7,951
Total sample						**191,836**

Table 2 provides period estimates and trends in overweight and obesity in 13 countries with 4 or more data points. These surveys cover periods between 14 years in Rwanda and 21 years in Ghana, Kenya and Zambia. The earliest data points in these countries were in the 1990s and the latest are after 2010. Across all 13 countries, levels of overweight reached or exceeded 20% only in Egypt (36%) and Zimbabwe (28%) in the 1990s surveys. Obesity reached a double digit of 10% or more only in Egypt (34%), and Zimbabwe (13%). In all the other countries, overweight was under 20% and obesity was under 10%. In the latest surveys conducted since 2010 in these countries, overweight exceeded 20% in all countries except Burkina Faso and Malawi where the prevalence was around 16%. The increase overtime was not also statistically significant in these two countries. In 4 countries, the prevalence of overweight exceeded 30% (Egypt (44%), Niger (32%), Rwanda (31%) and Ghana (30%)). Obesity exceeded 10% in all countries in the 2010s surveys with Egypt (39%) and Ghana (22%) leading in levels of obesity. Only in Burkina Faso was obesity still below 10% in the most recent survey.

Table 2: Analysis of trends in overweight and obesity for countries with four or more data points

Country							
Ghana	**1993**	**1998**	**2003**	**2008**	**2014**	***p***	**Nature of trend**
Overweight							
(%)	17.9	17.0	24.8	26.2	30.4	p<.05	↗
(95% CI)	17.9, 18.2	13.6, 21.1	21.3, 28.7	24.2, 28.3	26.3, 34.9		
Obesity							
(%)	7.7	13.8	17.9	14.2	22.0	p<.05	↗
(95% CI)	7.0, 8.5	10.6, 17.8	14.7, 21.5	12.7, 15.8	18.3, 26.3		
Egypt	**1995**	**2000**	**2005**	**2008**	**2014**		

Overweight							
(%)	35.5	35.0	40.6	39.1	44.2	p<.05	↗
(95% CI)	32.9, 38.2	32.7, 37.3	38.2, 43.2	36.7, 41.6	42.0, 46.5		
Obesity							
(%)	34.2	29.6	39.1	41.2	39.2	p<.05	↗
(95% CI)	31.0, 37.6	26.7, 32.7	36.4, 42.0	38.6, 43.9	36.6, 41.8		
Kenya	**1993**	**1998**	**2003**	**2008**	**2014**		
Overweight							
(%)	19.5	19.0	26.6	27.5	28.9	p<.05	↗
(95% CI)	15.0, 24.9	15.4, 23.3	23.3, 30.3	22.8, 32.9	26.1, 31.9		
Obesity							
(%)	6.4	5.1	10.7	10.5	15.0	P<.05	↗
(95% CI)	4.1, 9.8	3.3, 7.9	8.1, 14.1	7.7, 14.3	12.7, 17.6		
Zambia	**1992**	**1996**	**2001**	**2007**	**2013**		
Overweight							
(%)	17.3	15.7	12.1	22.0	23.1	p<.05	↗
(95% CI)	15.2, 19.6	13.8, 17.9	10.3, 14.2	18.9, 25.4	21.2, 25.2		
Obesity							
(%)	4.9	4.4	4.3	8.4	11.5	p<.05	↗
(95% CI)	3.8, 6.4	3.4, 5.7	3.2, 5.9	6.6, 10.5	9.8, 13.5		
Burkina Faso	**1993**	**1998**	**2003**	**2010**			
Overweight							
(%)	14.0	15.2	21.1	16.5		p>.05	→
(95% CI)	12.0, 16.3	12.2, 18.7	18.2, 24.3	13.8, 19.5			
Obesity							
(%)	3.8	6.0	8.3	9.5		p<.05	↗
(95% CI)	2.7, 5.2	4.3, 8.4	5.7, 11.8	7.2, 12.3			
Benin	**1996**	**2001**	**2006**	**2011**			
Overweight							
(%)	9.9	14.8	17.2	24.6		p<.05	↗
(95% CI)	7.3, 13.4	12.3, 17.6	15.5, 18.9	22.7, 26.7			
Obesity							
(%)	4.7	9.1	8.3	10.5		p<.05	↗
(95% CI)	3.1, 7.0	7.4, 11.3	7.1, 9.7	8.9, 12.4			
Mali	**1995**	**2001**	**2006**	**2011**			

Overweight							
(%)	14.9	21.6	21.0	22.5		p<.05	↗
(95% CI)	12.6, 17.4	18.4, 25.1	18.3, 23.9	19.1, 26.4			
Obesity							
(%)	4.3	8.8	9.4	14.4		p<.05	↗
(95% CI)	3.1, 5.8	6.9, 11.1	7.7, 11.4	11.7, 17.5			
Malawi	**1992**	**2000**	**2004**	**2010**			
Overweight							
(%)	15.8	15.9	15.4	16.4		p>.05	→
(95% CI)	12.3, 20.0	13.1, 19.1	12.1, 19.5	12.7, 21.1			
Obesity							
(%)	4.1	3.2	4.3	12.1		P<.05	↗
(95% CI)	2.6, 6.4	2.0, 5.1	2.8, 6.7	8.2, 17.5			
Niger	**1992**	**1998**	**2006**	**2012**			
Overweight							
(%)	19.2	19.0	32.0	32.23		p<.05	↗
(95% CI)	16.8, 22.0	15.5, 23.0	27.8, 36.6	28.5, 36.3			
Obesity							
(%)	6.1	7.0	12.1	14.4		p<.05	↗
(95% CI)	4.9, 7.6	5.2, 9.3	9.4, 15.4	11.7, 17.6			
Rwanda	**2000**	**2005**	**2010**	**2014**			
Overweight							
(%)	24.4	14.4	23.3	31.1		p<.05	↗
(95% CI)	23.1,25.6	11.0, 18.8	19.4, 27.6	26.5, 36.1			
Obesity							
(%)	6.8	4.5	7.5	12.6		p<.05	↗
(95% CI)	6.1,7.3	2.6, 7.8	4.9, 11.4	10.0, 15.7			
Tanzania	**1991**	**1996**	**2004**	**2009**			

Overweight							
(%)	14.1	20.5	18.9	21.0		p<.05	↗
(95% CI)	11.1, 17.8	20.1, 20.9	18.5, 19.3	20.4, 22.2			
Obesity							
(%)	3.6	7.8	9.7	11.8		p<.05	↗
(95% CI)	2.4, 5.3	7.2, 7.9	9.4, 10.1	11.1, 12.1			
Uganda	**1995**	**2000**	**2006**	**2011**			
Overweight							
(%)	14.1	22.7	23.7	25.4		p<.05	↗
(95% CI)	11.1, 17.8	18.9, 26.9	16.9, 32.2	20.0, 31.7			
Obesity							
(%)	5.6	5.5	10.0	11.4		p<.05*	↗
(95% CI)	4.2, 7.6	4.0, 7.6	5.2, 18.3	7.8, 16.4			
Zimbabwe	**1994**	**1999**	**2005**	**2010**			
Overweight							
(%)	28.2	23.1	25.1	26.5		p>.05	→
(95% CI)	23.3, 33.7	21.0, 25.4	22.0, 28.5	23.5, 29.7			
Obesity							
(%)	12.7	11.5	10.3	18.5		p>.05	↗
(95% CI)	9.6, 16.7	10.0, 13.2	8.6, 12.4	15.5, 21.9			

↗ = increasing); ↘ = decreasing; → = stable; CI = confidence interval; p = significance level

Table 3 shows the results for the 11 countries with only three data points. The periods covered by these surveys range from 10 years in Lesotho and Nigeria to 17 years in Senegal and Ivory Coast. Some of the earliest surveys in these countries occurred in the 2000s and given differences in timing and duration between the earliest and latest surveys, it made sense to

report these surveys separately. Lesotho has the highest prevalence of overweight, which stood at 32% in 2004 and has barely changed over the subsequent 10-year period. Namibia and Cameroon also had high levels of overweight at more than 20%. On the other hand, Madagascar and Ethiopia had the lowest levels of overweight and obesity. In Madagascar and Ethiopia, overweight is varied between 7 and 12% over the period covered by the surveys, while obesity is under 5% (under 2% in Madagascar). The change of overweight over time was statistically significant only in Guinea, Mozambique, Namibia and Chad, while obesity was significant only in Senegal, Guinea and Cameroon.

Table 3: Analysis of trends in overweight and obesity for countries with three data points

Country					
Senegal	**1993**	**2005**	**2010**	***p***	**Nature of trend**
Overweight					
(%)	18.8	21.9	21.6	p>.05	→
(95% CI)	16.3, 21.6	17.0, 27.6	18.2, 25.4		
Obesity					
(%)	8.5	12.8	15.2	p<.05	↗
(95% CI)	6.7, 10.8	9.5, 17.1	11.9, 19.3		
Ivory Coast	**1994**	**1998**	**2011**		
Overweight					
(%)	18.4	18.8	24.9	p>.05	→
(95% CI)	16.1, 20.8	16.1, 21.7	21.4, 28.8		
Obesity					
(%)	6.9	9.0	11.8	p>.05	→
(95% CI)	5.1, 9.2	7.1, 11.4	9.1, 15.1		
Cameroon	**1998**	**2004**	**2011**		
Overweight					
(%)	24.7	27.0	26.7	p>.05	→
(95% CI)	21.3, 28.3	23.8, 30.5	23.9, 29.3		
Obesity					
(%)	9.3	10.9	16.1	p>.05	↗
(95% CI)	6.7, 12.8	8.9, 13.4	14.1, 18.4		
Ethiopia	**2000**	**2005**	**2011**		
Overweight					
(%)	9.5	11.7	12.5	p>.05	→
(95% CI)	6.9, 12.9	7.5, 18.0	9.2, 16.8		

Obesity					
(%)	1.0	2.9	3.6	p<.05	↗
(95% CI)	0.5, 1.7	1.5, 5.8	2.3, 5.4		
Guinea	**1999**	**2005**	**2012**		
Overweight					
(%)	18.2	17.8	25.4	p<.05	↗
(95% CI)	15.7, 21.0	14.3, 22.0	20.9, 30.4		
Obesity					
(%)	6.2	7.9	9.4	p<.05	↗
(95% CI)	4.8, 7.9	4.6, 13.3	6.9, 12.8		
Lesotho	**2004**	**2009**	**2014**		
Overweight					
(%)	32.0	30.0	29.7	p>.05	→
(95% CI)	25.3, 39.5	23.3, 37.7	22.9, 37.4		
Obesity					
(%)	21.9	25.8	20.3	p>.05	→
(95% CI)	15.5, 30.0	20.1, 32.4	14.7, 27.4		
Madagascar	**1997**	**2003**	**2008**		
Overweight					
(%)	7.3	8.3	10.5	p>.05	→
(95% CI)	5.2, 10.1	6.6, 10.5	8.1, 13.5		
Obesity					
(%)	1.1	3.4	1.9	p>.05	→
(95% CI)	0.5, 2.6	2.4, 4.8	1.0, 3.5		
Mozambique	**1997**	**2003**	**2011**		
Overweight					
(%)	11.1	15.1	16.0	p<.05	↗
(95% CI)	8.4, 14.6	13.1, 19.1	14.1, 18.2		
Obesity					
(%)	4.0	3.2	6.3	p>.05	→
(95% CI)	2.3, 6.9	2.0, 5.1	4.7, 8.6		
Nigeria	**2003**	**2008**	**2013**		
Overweight					
(%)	19.7	24.3	25.2	p>.05	→
(95% CI)	15.2, 25.1	22.6, 26.1	23.4, 27.1		
Obesity					
(%)	11.5	11.0	11.5	p>.05	→
(95% CI)	8.3, 15.6	9.7, 12.5	10.3, 12.7		
Namibia	**1992**	**2006**	**2013**		
Overweight					
(%)	21.4	22.6	21.5	p>.05	→
(95% CI)	17.9, 25.4	19.2, 26.5	18.0, 25.4		
Obesity					
(%)	12.7	18.9	18.6	p<.05	↗

(95% CI)	10.3, 15.6	16.1, 22.1	15.2, 22.5		
Chad	**1996**	**2004**	**2014**		
Overweight					
(%)	10.4	14.9	16.6	p<.05	↗
(95% CI)	9.6,11.4	12.4, 17.7	13.9, 19.6		
Obesity					
(%)	3.8	5.7	6.5	p<.05	↗
(95% CI)	2.9,4.1	3.9, 8.4	4.8, 8.7		

↗ = increasing); ↘ = decreasing; → = stable; CI = confidence interval; p = significance level

The Figure 1 below depicts the increasing trends of overweight and obesity in all the 24 countries included in the analysis, except in Lesotho where there is semblance of a decrease.

Figure 1: Time trends of overweight and obesity

Countries: BF= Burkina Faso; BJ= Benin; CI=Ivory Coast; CM= Cameroon; EG= Egypt; ET=Ethiopia; GH= Ghana; GN= Guinea; KE= Kenya; LS= Lesotho; MD= Madagascar; ML= Mali; MW= Malawi; MZ= Mozambique; NG= Nigeria; NI= Niger; NM= Namibia; RW= Rwanda; SN= Senegal; TD = Chad; TZ= Tanzania; UG= Uganda; ZM=Zambia; ZW= Zimbabwe

Discussion

We set out to investigate the prevalence and time trends in overweight and obesity between 1991 and 2014 in 24 African countries. Primarily, we confirm that the prevalence of overweight and obesity among urban women has rapidly increased in the past two and a half decades. All 24 countries included in our analyses experienced an increase in overweight and obesity over the time period under consideration. However, the increase was only statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. The changes over time were particularly noticeable among countries with 4 or more survey data points, in which case, all the 13 countries showed a statistically significant increase in obesity, while 10 showed significant increase for overweight during the period of the study. For countries with three data points, only 4 of the 11 countries had a significant increase for overweight and 3 for obesity. This suggests that length of time (number of data points) plays a role in understanding the changes in overweight and obesity over time. We also found that 18 of the 24 countries had an overweight prevalence above 20%, based on the most recent survey waves for the respective countries. This was not the case in the earlier surveys where only 6 countries had an overweight prevalence of 20% or above. Four countries of the 24 had an obesity prevalence that was above 20%, with the prevalence in the rest ranging between 10% and 19% based on the latest surveys. However, in the earlier surveys, only one country had obesity prevalence of 20% or more, while the rest had obesity rate ranging from 1 to 12%. This points to worsening phenomenon of obesity among urban women in the past two and half decades. Another key finding is that in most of the countries included in our analyses, obesity increased alongside overweight. This is not unexpected, as women who are overweight (also known as pre-obesity)

are naturally likely to become obese if efforts are not made by such women to control their weight. Thus, addressing overweight may, to a larger extend curtail incidence of obesity.

Focusing on individual countries, we found significant differences in overweight and obesity across the countries included in the analysis. For example, in the most recent surveys, Egypt has the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two other countries with overweight prevalence of 30% and above. The results on Egypt are not surprising as the country was previously ranked among the countries in the world with the most obese people (35). The results in Ghana are also consistent with previous findings (15). Egypt and Ghana also experienced a significant increase in overweight and obesity in the past two and half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the prevalence of obesity in the aforementioned countries may be considered lower than that of Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests that in the next decades, the obesity rates in these countries may catch up with Egypt and Ghana, which are currently leading in terms of the level of prevalence of both overweight and obesity. However, overweight and obesity did not show any significant changes over time in Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and Madagascar in a recent study using the DHS data from 32 African countries (29).

The increasing prevalence and trends of overweight and obesity in Africa may be attributed largely to rapid urbanization taking place in the continent and its associated nutritional transition. For example, in 2010, the share of the African urban population was about 36% and is projected to increase to 50% and 60% by 2030 and 2050 respectively (36). Using Ghana as a case in point, for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%) of country's population live in urban areas compared to rural areas (37). The growing urbanization comes along with lifestyle changes such as decreased physical activity and increase supply of high caloric fast foods and sugar sweetened beverages (16, 38-40). Indeed, sedentary lifestyle and high consumption of energy dense diets are found to account for the increasing burden of overweight and obesity in urban settings of the low and middle income countries (LMIC) (21-23). The consequences of which, is increase in non-communicable diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body mass index (BMI) (3, 4, 40). In addition, an increased burden of disability-adjusted life years (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be implemented to address the problem of overweight and obesity, thereby curbing associated NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important step towards curbing the surge of NCDs the continent is currently experiencing, which is likely to surpass the toll of sickness and death from infectious diseases by 2030 (41). This will further contribute greatly to the potential for African countries to achieve Sustainable Development Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases through prevention, and treatment, and promote mental health and wellbeing by 2030 (42).

In the light of the findings of our study and the literature discussed above, we particularly advocate for targeted interventions to address the incidence of overweight and obesity among urban dwelling women. Intervention strategies, described in the literature as 'effective and essential' (43) in addressing overweight and obesity in a developing country context include, policy interventions and inter-sectoral partnerships; addressing food system drivers of caloric over-consumption; and improving eating and physical activity environments in key community settings (43). It is believed that effective implementation of these strategies has the potential to curtail the incidence of overweight and obesity. It is important to recognize that large inequalities remain a major issue in many African countries, which may have a bearing on areas that ought to be prioritized and targeted for interventions. For example, in many African countries, it is common to see problems of undernutrition alongside increasing rates of overweight and obesity. This "dual burden" of undernutrition and obesity exists not only at country- or community-level, but all the way down to households (16, 44). Undernutrition persists as a significant problem (45) in many African countries, and interventions have been put in place to address it (46-48). However, the issue of overweight and obesity has not received adequate attention as yet in Africa (16, 48). More attention of policy makers and public health practitioners on ways to address the overweight and obesity epidemic, taking into account undernutrition is warranted.

Strengths and limitations

The key strength of this study is the use of nationally representative data sets, thereby providing more robust estimates of the prevalence and trends of overweight and obesity in the respective countries. Further, height and weight as used in the calculation of BMI, was

objectively measured by well-trained technicians, reducing possible misclassification of overweight and obesity. The study is also associated with some limitations. To maintain sample comparability over time, we had to limit our sample to women with children under 5 years old. This may, to some extent, affect the generalizability of the findings, as the sample may not be representative of the entire female population. Another limitation is the cross-sectional nature of the data. Because the surveys used in this analysis were conducted at different times across countries, we were unable to estimate the change in BMI across all countries for the entire survey period. Lack of uniformity in the definition of urban and rural settings may also affect the comparability of the findings across countries, since different countries have different definitions of what constitutes urban versus rural. Lastly, one methodological limitation is that we pooled the data to perform the trend analysis, which may lead to an overestimation of statistical power. To address this limitation, the weight in the pooled data was divided by the number of surveys available for the country.

Conclusions

The study provided clear evidence of increase in overweight and obesity among women in the urban settings of all the countries included in the analysis, with the increase overtime being statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. We have supported the finding that women dwelling in urban settings are prone to overweight and obesity. The prevalence of obesity increased more than two fold in most countries and more than three fold in others. The prevalence of obesity increased alongside overweight. These findings call for deliberate strategies and interventions by policy makers, politicians and health promotion experts, focusing on healthy diet, physical activity, weight

reduction and maintenance strategies in African countries, particularly in urban areas to curb the growing proportion of unhealthy weight women of child bearing age in urban Africa. Strategies should include measures such as price reduction for healthy foods (e.g., fruits and vegetables) and promotion of physical activity. For future research, we suggest the conduct of longitudinal studies to systematically elucidate cumulative changes in individual's BMI over time. Longitudinal studies will also be able to ascertain the extent to which overweight can lead to mild-to-moderate obesity.

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Competing Interest

The authors have no competing interests to declare.

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Data Sharing Statement

This study was a re-analysis of existing data that are publicly available from The DHS Program at http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm. Data are accessible free of charge upon a registration with the Demographic and Health Survey program (The DHS Program). The registration is done on the DHS website indicated above.

Authors' Contribution

DAA conceived and designed the study, interpreted the results, wrote the first draft of the manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD contributed to the drafting of the analytical strategy. ZTD, SM BM and ACE contributed to

study design, data interpretation, and critical revision of the manuscript. All authors take responsibility of any issues that might arise from the publication of this manuscript.

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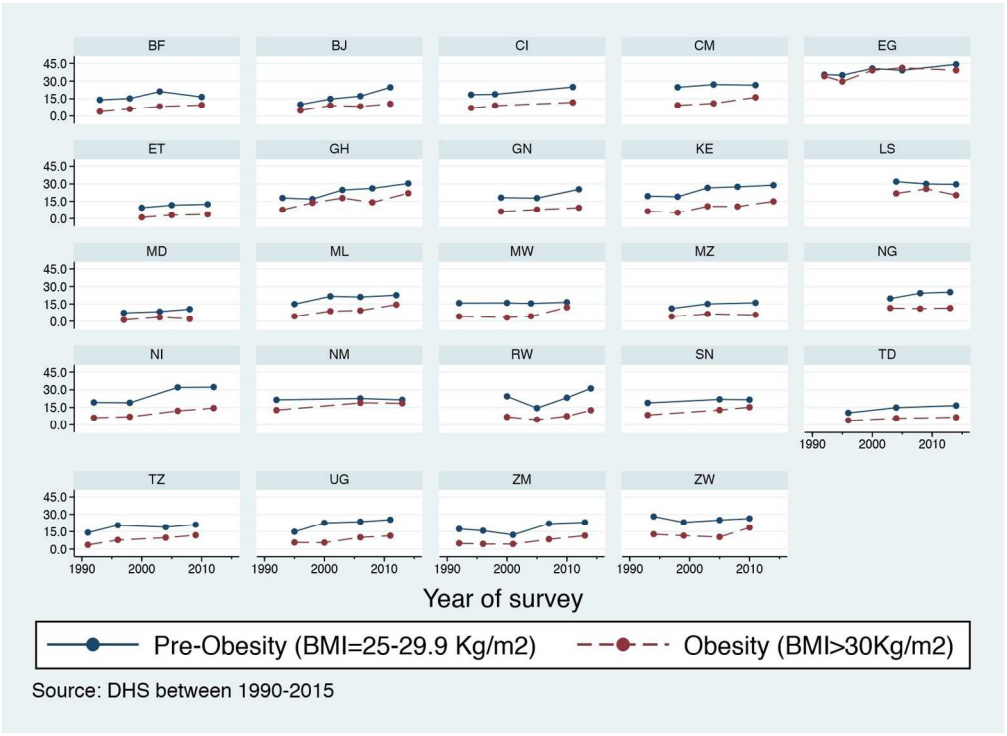

Source: DHS between 1990-2015

139x101mm (300 x 300 DPI)

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-11
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	9
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-11*
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	10-11
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	16-17
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12-13
		(b) Indicate number of participants with missing data for each variable of interest	ND
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14-20
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	24-25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	24-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	24-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.