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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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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

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

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

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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

73 Introduction

74 Overweight and obesity are global public health problems, especially among women in urban
75 settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of
76 being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs)
77 are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart
78 disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body
79 mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found
80 to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3).
81 A recent study showed that overweight and obesity are linked to 13 different cancers (5). Thus,
82 there is an increased risk of co-morbidities for individuals with a body mass index of 25.0 to
83 29.9 kg/m² (defined as overweight), and moderate to severe risk of co-morbidities for
84 individuals with a body mass index greater than 30 kg/m² (defined as obesity) (3, 6). The World
85 Health Organization (WHO) (3, 6) recommends that for optimum health, the median body mass
86 index for an adult population should be in the range of 21 to 23 kg/m², while the goal for
87 individuals should be to maintain body mass index in the range 18.5 to 24.9 kg/m². This is often
88 difficult to achieve as evidence shows that global overweight and obesity trends are on the rise,
89 with the developing world now bearing the brunt of the surge (7). This dynamic calls for more
90 studies to systematically document these trends over time, especially in developing country
91 contexts.

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3 93 Hitherto, overweight and obesity were not public health issues on the African continent.
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6 94 However, rapid changes have been observed, and many countries in Africa are currently
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9 95 confronted with overweight and obesity, particularly among women, coupled with a resulting
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11 96 increase in the prevalence of non-communicable diseases (NCDs) (4, 7, 8). In Africa, women had
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13 97 approximately double the obesity prevalence of men (3), with urban settings being the most
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16 98 affected. Thus, the burden of overweight and obesity among urban women is increasing at an
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19 99 alarming rate in developing countries, and particularly in Africa for that matter (1, 9). This trend
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21 100 may be attributable to an increased intake of energy-dense foods that are high in fat; and an
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24 101 increase in physical inactivity due to the increasing sedentary nature of many occupations,
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26 102 increased use of motorized transportation, and urbanization (1, 10-12). Increasingly, sedentary
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28 103 lifestyles and high consumption of energy dense diets account for the increasing burden of
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31 104 overweight and obesity in urban settings of low and middle-income countries (LMIC) (13-15).
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34 105 Various other studies have argued that the association between urban residence and obesity in
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36 106 LMICs is driven largely by higher individual- and community-level socioeconomic status (SES) in
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38 107 urban areas, suggesting that urban residence alone may not cause increased body weight in
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41 108 developing countries (10). However, recent studies suggest that the distribution of overweight
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44 109 by SES is changing in developing countries (4, 16, 17). For example, lower SES populations in
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46 110 some of these countries now have higher prevalence of overweight, mimicking long-standing
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49 111 associations between low SES and poorer health in LMICs (4, 16-18). This changing trend is
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51 112 particularly widespread among the urban population. A study in urban poor settlements in
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54 113 Nairobi, Kenya confirmed high levels of overweight and obesity among women (19). Another
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56 114 study using data from 7 African countries showed that the increase in overweight and obesity
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115 was higher among the poorest urban dwellers compared to the richest population subgroup
 116 (13).

117
 118 Despite the emerging and worrying trend of increased overweight and obesity, and recognition
 119 of the potential rise in chronic diseases in recent times in Africa, little effort has been made in
 120 addressing overweight and obesity on the continent (20). Consequently, an analysis of
 121 overweight and obesity in this study across several countries in the region, is a critical step in
 122 the provision of insights into the extent of the problem over time, especially in urban settings,
 123 which is needed to inform policy and program interventions to address the challenge in urban
 124 Africa.

125
 126 It is worth noting that while there are a number of studies that investigated overweight and
 127 obesity in Africa; most either focused on one country (8), lumped urban and rural data together
 128 in their analyses (2, 8), analyzed overweight and obesity together (18), or used one data point
 129 (21). These attempts may mask the seriousness of the problem in urban settings and the
 130 important differences in the trends and prevalence of overweight and obesity over time. Also,
 131 the presentation of the results in some of these studies makes it difficult for policy makers to
 132 appreciate the extent of the problem. The present study elucidates the prevalence and time
 133 trends in overweight and obesity separately, and presents the results in a way that makes it
 134 easier for policy makers to understand the extent of the problem in urban settings.

135

136 **Methods**

137 **Data sources and participants**

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

154
155 The DHS employs a multistage sampling design. The first stage involves selecting sample points
156 or clusters from an updated master sampling frame constructed from the National Population

157 and Housing Census data of the respective countries. The clusters are then selected using
 158 systematic sampling with probability proportional to size. A household listing operation is then
 159 conducted in all the selected clusters to provide a sampling frame for the second stage
 160 selection of households. The second stage of selection involves the systematic sampling of
 161 households listed in each cluster. The primary objective of the second stage of selection is to
 162 ensure adequate numbers of completed individual interviews to provide estimates for key
 163 indicators with acceptable precision (23). We limited our analyses to adult non-pregnant
 164 women of reproductive age, 15–49 years in all countries. This is because pregnant women
 165 naturally gain weight during the course of their pregnancy, including them in the analysis may
 166 present a misleading picture about the issue of overweight and obesity among women. Since
 167 the earlier DHS surveys collected anthropometry data on only those women who had children
 168 aged 0–5 years (18, 24), we further restricted our main analyses to this subgroup. For the total
 169 of 224,940 urban women who met eligibility criteria, anthropometric data were available for
 170 191,836 (85.3 %).

171

172 **Ethics statement**

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

178

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 ($25.0\text{--}29.9 \text{ kg}/\text{m}^2$) and obese ($\geq 30.0 \text{ kg}/\text{m}^2$). 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).

192

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

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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/m² 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
<i>Samples</i>	583	656	966	2,023	2,130	6,358
Egypt	1992	1995	2000	2005	2014	
<i>Samples</i>	3,090	3,779	4,279	4,595	5,842	21,555
Kenya	1993	1998	2003	2008	2014	
<i>Samples</i>	623	500	1,398	1,342	6,369	10,232
Zambia	1992	1996	2001	2007	2013	
<i>Samples</i>	2,329	2,099	1,591	1,867	4,636	12,522
Burkina Faso	1993	1998	2003	2010	---	
<i>Samples</i>	1,774	873	3,136	3,006	---	8,789
Benin	1996	2001	2006	2011	---	
<i>Samples</i>	702	1,403	5,097	4,480	---	11,682
Mali	1995	2001	2006	2011	---	
<i>Samples</i>	1,630	2,395	3,673	2,323	---	10,021
Malawi	1992	2000	2004	2010	---	
<i>Samples</i>	999	1,864	1,022	1,801	---	5,686
Niger	1992	1998	2006	2012	---	
<i>Samples</i>	2,253	1,069	2,267	2,453	---	8,042
Rwanda	2000	2005	2010	2014	---	
<i>Samples</i>	1,528	1,524	1,112	1,604	---	5,768
Tanzania	1991	1996	2004	2009	---	

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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
<i>Overweight</i>							
(%)	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		
<i>Obesity</i>							
(%)	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		
<i>Overweight</i>							
(%)	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		
<i>Obesity</i>							
(%)	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		

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Kenya	1993	1998	2003	2008	2014	
<i>Overweight</i>						
(%)	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	
<i>Overweight</i>						
(%)	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	
<i>Obesity</i>						
(%)	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	---	
<i>Overweight</i>					---	
(%)	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	---	
<i>Obesity</i>					---	
(%)	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	---	
<i>Overweight</i>					---	
(%)	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	---	
<i>Obesity</i>					---	
(%)	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	---	
<i>Overweight</i>					---	
(%)	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	---	
<i>Obesity</i>					---	

(%)	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					---		

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(%)	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

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240 Table 3 shows the results for the 11 countries with only three data points. The periods covered

241 by these surveys range from 10 years in Lesotho and Nigeria to 17 years in Senegal and Ivory

242 Coast. Some of the earliest surveys in these countries occurred in the 2000s and given

243 differences in timing and duration between the earliest and latest surveys, it made sense to

244 report these surveys separately. Lesotho has the highest prevalence of overweight, which

245 stood at 32% in 2004 and has barely changed over the subsequent 10-year period. Namibia and

246 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					

20

(%)	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

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

255

256 **Figure 1: Time trends of overweight and obesity**

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261 **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

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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

292 progressing to obesity. Thus, addressing overweight will, to a larger extent curtail the
293 increasing incidence of obesity in urban Africa.
294
295 Focusing on individual countries, we found significant differences in overweight and obesity
296 across the countries included in the analysis. For example, in the most recent surveys, Egypt has
297 the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with
298 an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two
299 other countries with overweight prevalence of 30% and above. The results on Egypt are not
300 surprising as the country was previously ranked among the countries in the world with the most
301 obese people (27). The results in Ghana are also consistent with previous findings (28). Egypt
302 and Ghana also experienced a significant increase in overweight and obesity in the past two and
303 half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in
304 Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and
305 Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the
306 prevalence of obesity in the aforementioned countries may be considered lower than that of
307 Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests
308 that in the next decades, the obesity rates in these countries may catch up with Egypt and
309 Ghana, which are currently leading in terms of the level of prevalence of both overweight and
310 obesity. However, overweight and obesity did not show any significant changes overtime in
311 Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest
312 prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and
313 Madagascar in a recent study using the DHS data from 32 African countries (21).

314

315 The increasing prevalence and trends of overweight and obesity in Africa is attributed largely to

316 rapid urbanization taking place in the continent and its associated nutritional transition. For

317 example, in 2010, the share of the African urban population was about 36% and is projected to

318 increase to 50% and 60% by 2030 and 2050 respectively (29). Using Ghana as a case in point,

319 for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%)

320 of country's population live in urban areas compared to rural areas (30). The growing

321 urbanization comes along with lifestyle changes such as decreased physical activity and

322 increase supply of high caloric fast foods and sugar sweetened beverages (31-34). Indeed,

323 sedentary lifestyle and high consumption of energy dense diets are found to account for the

324 increasing burden of overweight and obesity in urban settings of the low and middle income

325 countries (LMIC) (13-15). The consequences of which, is increase in non-communicable

326 diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart

327 disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body

328 mass index (BMI) (3, 4, 34). In addition, an increased burden of disability-adjusted life years

329 (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be

330 implemented to address the problem of overweight and obesity, thereby curbing associated

331 NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important

332 step towards curbing the surge of NCDs the continent is currently experiencing, which is likely

333 to surpass the toll of sickness and death from infectious diseases by 2030 (35). This will further

334 contribute greatly to the potential for African countries to achieve Sustainable Development

335 Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases

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

341

342 **Strengths and limitations**

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

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

358
359 **Conclusions**

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

371 **Acknowledgements**

372 We wish to express our profound gratitude to The DHS Program, USA for providing us access to
373 the data. We also wish to acknowledge institutions of respective countries that played critical
374 roles in the data collection process.

376 **Competing Interest**

377 The authors have no competing interests to declare.

378 **Funding**

379 This study did not receive funding from any source.

380 **Data Sharing Statement**

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

385 **Authors' Contribution**

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

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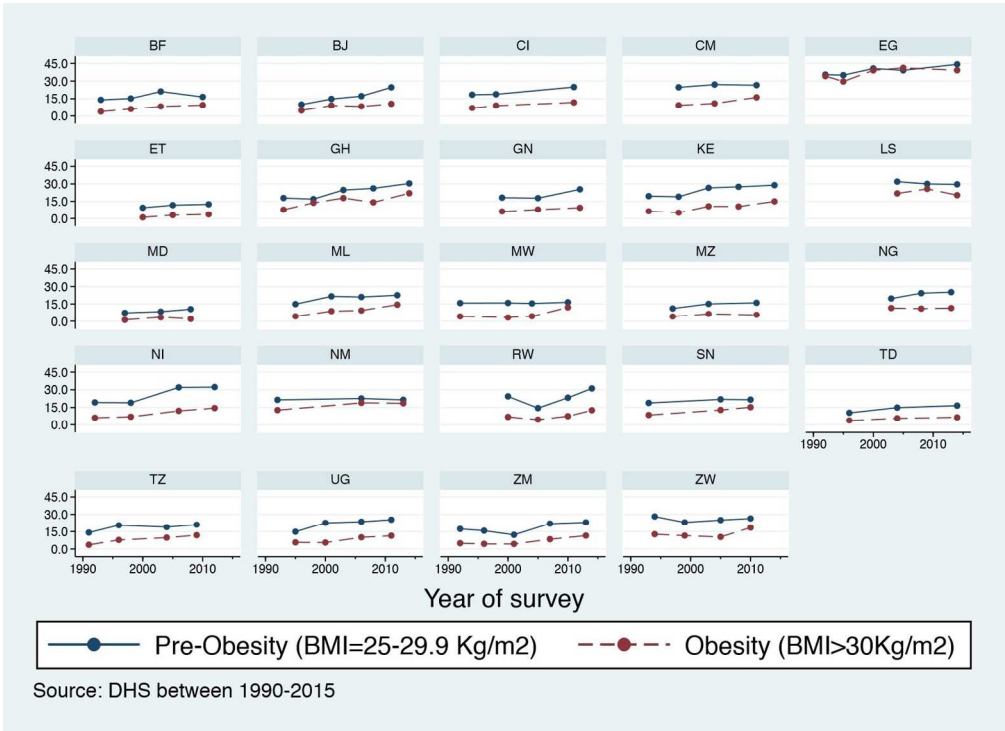
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139x101mm (300 x 300 DPI)

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.

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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/m²) and obese (≥ 30.0 kg/m²).

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

82 Introduction

83 Overweight and obesity are global public health problems, especially among women in urban
84 settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of
85 being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs)
86 are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart
87 disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body
88 mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found
89 to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3).
90 A recent study showed that overweight and obesity are linked to 13 different cancers (5).
91 The consequences of overweight and obesity on women of reproductive age are more serious,
92 especially during pregnancy. Studies have shown that maternal obesity can result in negative
93 outcomes in both mothers and fetuses, including gestational diabetes, preeclampsia, an
94 increased miscarriage rate (6, 7), and stillbirth and congenital anomalies. Obesity in pregnancy
95 can also affect health later in life for both mother and child, including increased risk of heart
96 disease, hypertension, and diabetes (6). Children also have a risk of future obesity. Overweight
97 and obesity are associated with decreased contraceptive efficacy and ovulatory disorders in
98 women of reproductive age (7), and increasing maternal BMI exerts a progressive adverse
99 effect on vaginal delivery rates for both primigravid and multigravid women (8). Obese mothers
100 were more likely than other mothers to terminate breastfeeding when the infant showed
101 satiation cues (9). Obese mothers with higher BMI were also reported using more restrictive
102 feeding practices, limiting the quantity and quality of foods provided to their toddlers, and were
103 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/m² (defined as overweight), and moderate to severe risk of co-morbidities for individuals with a BMI greater than 30 kg/m² (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/m², while the goal for individuals should be to maintain body mass index in the range of 18.5 to 24.9 kg/m². 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

125 at an alarming rate in developing countries, and particularly in Africa for that matter (1, 14). In
126 Ghana for example, systematic review and meta-analysis revealed that overweight among
127 urban women was 11 percentage points higher than rural women, while obesity was two times
128 higher in urban relative to rural women (15). Similar trends were obtained using data from 42
129 countries in Asia, the Middle East, Africa (East, West, Central and Southern), and Latin America,
130 with a combined overweight/obesity prevalence of 37.2% among urban women compared to
131 19% of rural women (16). The study however noted regional differences, with rural women in
132 Latin America, the Middle East, and North Africa having much higher increases in the
133 prevalence of overweight/obesity compared to their urban counterparts. Conversely, in
134 different multi-country analysis, overweight was increasing more quickly in urban areas than in
135 rural areas of lower-income countries such as Bangladesh and Uganda, but increasing more
136 quickly in rural areas compared to urban areas of upper-middle-income countries, such as
137 Jordan and Peru (17).

138
139 The trend observed above may be attributable to an increased intake of energy-dense foods
140 that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature
141 of many occupations, increased use of motorized transportation, and urbanization (1, 18-20).
142 Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the
143 increasing burden of overweight and obesity in urban settings of low and middle-income
144 countries (LMIC) (21-23). Various other studies have argued that the association between urban
145 residence and obesity in LMICs is driven largely by higher individual- and community-level
146 socioeconomic status (SES) in urban areas, suggesting that urban residence alone may not

147 cause increased body weight in developing countries (18). However, recent studies suggest that
 148 the distribution of overweight by SES is changing in developing countries (4, 24, 25). For
 149 example, lower SES populations in some of these countries now have higher prevalence of
 150 overweight, mimicking long-standing associations between low SES and poorer health in LMICs
 151 (4, 24-26). This changing trend is particularly widespread among the urban population. A study
 152 in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity
 153 among women (27). Another study using data from 7 African countries showed that the
 154 increase in overweight and obesity was higher among the poorest urban dwellers compared to
 155 the richest population subgroup (21).

156
 157 Despite the emerging and worrying trend of increased overweight and obesity, and recognition
 158 of the potential rise in chronic diseases in recent times in Africa, little effort has been made in
 159 addressing overweight and obesity on the continent (28). Consequently, an analysis of
 160 overweight and obesity in this study across several countries in the region, is a critical step in
 161 the provision of insights into the extent of the problem over time, especially in urban settings,
 162 which is needed to inform policy and program interventions to address the challenge in urban
 163 Africa.

164
 165 It is worth noting that while there are a number of studies that investigated overweight and
 166 obesity in Africa; most either focused on one country (13), lumped urban and rural data
 167 together in their analyses (2, 13), analysed overweight and obesity together (26), or used one

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

175 **Methods**

176 **Data sources and participants**

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

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189 For example, the very first DHS, conducted between 1987 and 1990 did not collect maternal
190 anthropometric data. Hence, the dataset for this period were excluded in the analysis.
191 Secondly, countries with three datasets, but reduced to two data points due to one of the
192 datasets not having anthropometric data were also excluded in the analysis.
193
194 The DHS employs a multistage sampling design. The first stage involves selecting sample points
195 or clusters from an updated master sampling frame constructed from the National Population
196 and Housing Census data of the respective countries. The clusters are then selected using
197 systematic sampling with probability proportional to size. A household listing operation is then
198 conducted in all the selected clusters to provide a sampling frame for the second stage
199 selection of households. The second stage of selection involves the systematic sampling of
200 households listed in each cluster. The primary objective of the second stage of selection is to
201 ensure adequate numbers of completed individual interviews to provide estimates for key
202 indicators with acceptable precision (31). We limited our analyses to adult non-pregnant
203 women of reproductive age, 15–49 years in all countries. This is because pregnant women
204 naturally gain weight during the course of their pregnancy, including them in the analysis may
205 present a misleading picture about the issue of overweight and obesity among women. Since
206 the earlier DHS surveys collected anthropometry data on only those women who had children
207 aged 0–5 years (26, 32), we further restricted our main analyses to this subgroup. For the total
208 of 224,940 urban women who met eligibility criteria, anthropometric data were available for
209 191,836 (85.3 %).

210

211 Ethics statement

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

217

218 Variables

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

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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/m² 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
<i>Samples</i>	583	656	966	2,023	2,130	6,358
Egypt	1992	1995	2000	2005	2014	
<i>Samples</i>	3,090	3,779	4,279	4,595	5,842	21,555
Kenya	1993	1998	2003	2008	2014	
<i>Samples</i>	623	500	1,398	1,342	6,369	10,232
Zambia	1992	1996	2001	2007	2013	
<i>Samples</i>	2,329	2,099	1,591	1,867	4,636	12,522
Burkina Faso	1993	1998	2003	2010	---	
<i>Samples</i>	1,774	873	3,136	3,006	---	8,789
Benin	1996	2001	2006	2011	---	
<i>Samples</i>	702	1,403	5,097	4,480	---	11,682

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	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

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Obesity

(%)	7.7	13.8	17.9	14.2	22.0	p<.05	↗
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(95% CI)	7.0, 8.5	10.6, 17.8	14.7, 21.5	12.7, 15.8	18.3, 26.3		
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Egypt	1995	2000	2005	2008	2014		
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Overweight

(%)	35.5	35.0	40.6	39.1	44.2	p<.05	↗
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(95% CI)	32.9, 38.2	32.7, 37.3	38.2, 43.2	36.7, 41.6	42.0, 46.5		
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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		
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Kenya	1993	1998	2003	2008	2014		
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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		
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Obesity

(%)	6.4	5.1	10.7	10.5	15.0	P<.05	↗
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(95% CI)	4.1, 9.8	3.3, 7.9	8.1, 14.1	7.7, 14.3	12.7, 17.6		
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Zambia	1992	1996	2001	2007	2013		
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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		
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Obesity

(%)	4.9	4.4	4.3	8.4	11.5	p<.05	↗
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(95% CI)	3.8, 6.4	3.4, 5.7	3.2, 5.9	6.6, 10.5	9.8, 13.5		
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	Burkina Faso	1993	1998	2003	2010	---	
	<i>Overweight</i>					---	
	(%)	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	---	
	<i>Obesity</i>					---	
	(%)	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	---	
	<i>Overweight</i>					---	
	(%)	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	---	
	<i>Obesity</i>					---	
	(%)	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	---	
	<i>Overweight</i>					---	
	(%)	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**

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3							
4	Overweight				---		
5							
6							
7	(%)	24.4	14.4	23.3	31.1	---	p<.05 ↗
8							
9							
10	(95% CI)	23.1,25.6	11.0, 18.8	19.4, 27.6	26.5, 36.1	---	
11							
12							
13	Obesity					---	
14							
15							
16	(%)	6.8	4.5	7.5	12.6	---	p<.05 ↗
17							
18							
19	(95% CI)	6.1,7.3	2.6, 7.8	4.9, 11.4	10.0, 15.7	---	
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22	Tanzania	1991	1996	2004	2009	---	
23							
24							
25	Overweight					---	
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27							
28	(%)	14.1	20.5	18.9	21.0	---	p<.05 ↗
29							
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31	(95% CI)	11.1, 17.8	20.1, 20.9	18.5, 19.3	20.4, 22.2	---	
32							
33							
34	Obesity					---	
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36							
37	(%)	3.6	7.8	9.7	11.8	---	p<.05 ↗
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40	(95% CI)	2.4, 5.3	7.2, 7.9	9.4, 10.1	11.1, 12.1	---	
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43	Uganda	1995	2000	2006	2011	---	
44							
45							
46	Overweight					---	
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48							
49	(%)	14.1	22.7	23.7	25.4	---	p<.05 ↗
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52	(95% CI)	11.1, 17.8	18.9, 26.9	16.9, 32.2	20.0, 31.7	---	
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54							
55	Obesity					---	
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				22			
(%)	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

281 Ethiopia, overweight is varied between 7 and 12% over the period covered by the surveys,
282 while obesity is under 5% (under 2% in Madagascar). The change of overweight over time was
283 statistically significant only in Guinea, Mozambique, Namibia and Chad, while obesity was
284 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					

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(%)	24.7	27.0	26.7	p>.05	→
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(95% CI)	21.3, 28.3	23.8, 30.5	23.9, 29.3		
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Obesity

(%)	9.3	10.9	16.1	p>.05	↗
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(95% CI)	6.7, 12.8	8.9, 13.4	14.1, 18.4		
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Ethiopia	2000	2005	2011		
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Overweight

(%)	9.5	11.7	12.5	p>.05	→
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(95% CI)	6.9, 12.9	7.5, 18.0	9.2, 16.8		
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Obesity

(%)	1.0	2.9	3.6	p<.05	↗
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(95% CI)	0.5, 1.7	1.5, 5.8	2.3, 5.4		
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Guinea	1999	2005	2012		
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Overweight

(%)	18.2	17.8	25.4	p<.05	↗
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(95% CI)	15.7, 21.0	14.3, 22.0	20.9, 30.4		
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Obesity

(%)	6.2	7.9	9.4	p<.05	↗
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(95% CI)	4.8, 7.9	4.6, 13.3	6.9, 12.8		
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Lesotho	2004	2009	2014		
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Overweight

(%)	32.0	30.0	29.7	p>.05	→
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(95% CI)	25.3, 39.5	23.3, 37.7	22.9, 37.4		
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Obesity

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(%)	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

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 extent 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

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

347

348 The increasing prevalence and trends of overweight and obesity in Africa is attributed largely to
349 rapid urbanization taking place in the continent and its associated nutritional transition. For
350 example, in 2010, the share of the African urban population was about 36% and is projected to
351 increase to 50% and 60% by 2030 and 2050 respectively (36). Using Ghana as a case in point,
352 for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%)
353 of country's population live in urban areas compared to rural areas (37). The growing
354 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

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

389
390 **Strengths and limitations**

391 The key strength of this study is the use of nationally representative data sets, thereby
392 providing more robust estimates of the prevalence and trends of overweight and obesity in the
393 respective countries. Further, height and weight as used in the calculation of BMI, was
394 objectively measured by well-trained technicians, reducing possible misclassification of
395 overweight and obesity. The study is also associated with some limitations. To maintain sample
396 comparability over time, we had to limit our sample to women with children under 5 years old.
397 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

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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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439 **Data Sharing Statement**

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

444 **Authors' Contribution**

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

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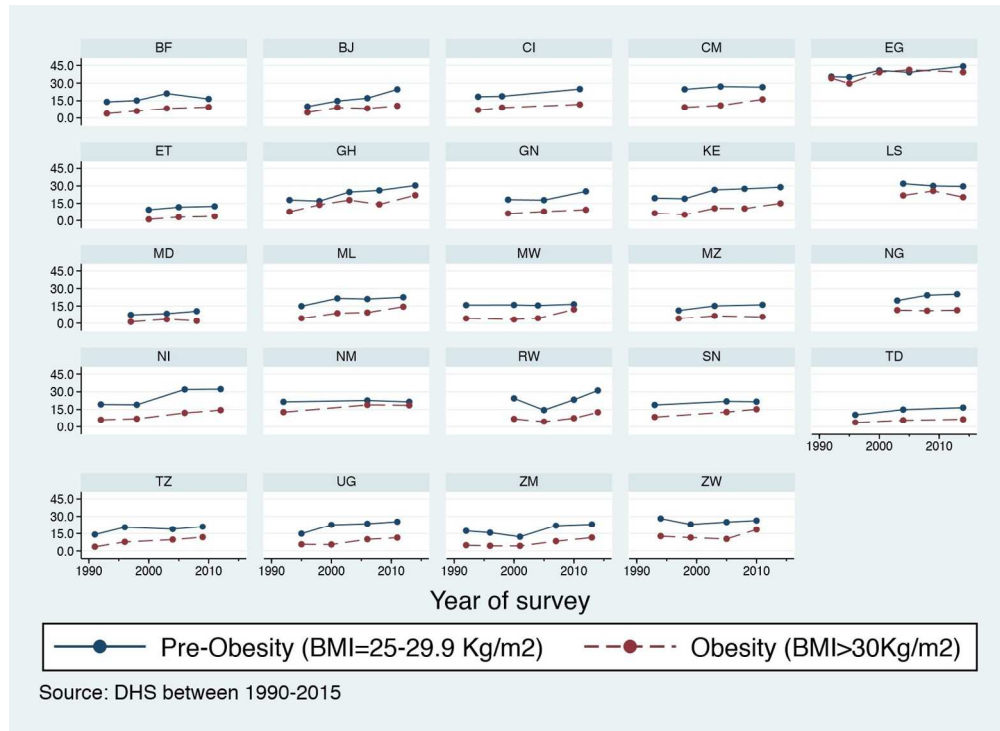
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139x101mm (300 x 300 DPI)

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	

		<i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —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

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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/m²) and obese (≥ 30.0 kg/m²).

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%.

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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/m² (defined as overweight), and moderate to severe risk of co-morbidities for individuals with a BMI greater than 30 kg/m² (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/m², while the goal for individuals should be to maintain body mass index in the range of 18.5 to 24.9 kg/m². 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

118 at an alarming rate in developing countries, and particularly in Africa for that matter (1, 14). In
 119 Ghana for example, systematic review and meta-analysis revealed that overweight among
 120 urban women was 11 percentage points higher than rural women, while obesity was two times
 121 higher in urban relative to rural women (15). Similar trends were obtained using data from 42
 122 countries in Asia, the Middle East, Africa (East, West, Central and Southern), and Latin America,
 123 with a combined overweight/obesity prevalence of 37.2% among urban women compared to
 124 19% of rural women (16). The study however noted regional differences, with rural women in
 125 Latin America, the Middle East, and North Africa having much higher increases in the
 126 prevalence of overweight/obesity compared to their urban counterparts. Conversely, in
 127 different multi-country analysis, overweight was increasing more quickly in urban areas than in
 128 rural areas of lower-income countries such as Bangladesh and Uganda, but increasing more
 129 quickly in rural areas compared to urban areas of upper-middle-income countries, such as
 130 Jordan and Peru (17).
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 132 The trend observed above may be attributable to an increased intake of energy-dense foods
 133 that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature
 134 of many occupations, increased use of motorized transportation, and urbanization (1, 18-20).
 135 Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the
 136 increasing burden of overweight and obesity in urban settings of low and middle-income
 137 countries (LMIC) (21-23). Various other studies have argued that the association between urban
 138 residence and obesity in LMICs is driven largely by higher individual- and community-level
 139 socioeconomic status (SES) in urban areas, suggesting that urban residence alone may not

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3 140 cause increased body weight in developing countries (18). However, recent studies suggest that
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6 141 the distribution of overweight by SES is changing in developing countries (4, 24, 25). For
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8 142 example, lower SES populations in some of these countries now have higher prevalence of
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10 143 overweight, mimicking long-standing associations between low SES and poorer health in LMICs
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12 144 (4, 24-26). This changing trend is particularly widespread among the urban population. A study
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14 145 in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity
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16 146 among women (27). Another study using data from 7 African countries showed that the
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18 147 increase in overweight and obesity was higher among the poorest urban dwellers compared to
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20 148 the richest population subgroup (21).
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30 150 Despite the emerging and worrying trend of increased overweight and obesity, and recognition
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32 151 of the potential rise in chronic diseases in recent times in Africa, little effort has been made in
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34 152 addressing overweight and obesity on the continent (28). Consequently, an analysis of
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36 153 overweight and obesity in this study across several countries in the region, is a critical step in
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38 154 the provision of insights into the extent of the problem over time, especially in urban settings,
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40 155 which is needed to inform policy and program interventions to address the challenge in urban
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51 158 It is worth noting that while there are a number of studies that investigated overweight and
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53 159 obesity in Africa; most either focused on one country (13), lumped urban and rural data
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55 160 together in their analyses (2, 13), analysed overweight and obesity together (26), or used one
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161 data point (29). These attempts may mask the seriousness of the problem in urban settings and
162 the important differences in the trends and prevalence of overweight and obesity over time.
163 Also, the presentation of the results in some of these studies makes it difficult for policy makers
164 to appreciate the extent of the problem. The present study elucidates the prevalence and time
165 trends in overweight and obesity separately, and presents the results in a way that makes it
166 easier for policy makers to understand the extent of the problem in urban settings.

For peer review only

180 Methods

181 Data sources and participants

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

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

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201 and Housing Census data of the respective countries. The clusters are then selected using
202 systematic sampling with probability proportional to size. A household listing operation is then
203 conducted in all the selected clusters to provide a sampling frame for the second stage
204 selection of households. The second stage of selection involves the systematic sampling of
205 households listed in each cluster. The primary objective of the second stage of selection is to
206 ensure adequate numbers of completed individual interviews to provide estimates for key
207 indicators with acceptable precision (31). We limited our analyses to adult non-pregnant
208 women of reproductive age, 15–49 years in all countries. This is because pregnant women
209 naturally gain weight during the course of their pregnancy, including them in the analysis may
210 present a misleading picture about the issue of overweight and obesity among women. Since
211 the earlier DHS surveys collected anthropometry data on only those women who had children
212 aged 0–5 years (26, 32), we further restricted our main analyses to this subgroup. For the total
213 of 224,940 urban women who met eligibility criteria, anthropometric data were available for
214 191,836 (85.3 %).

216 **Ethics statement**

217 The DHS obtained ethical clearance from the ethical committees of the respective countries
218 before the surveys were conducted. Written informed consent was obtained from the women
219 before participation. The authors of this paper sought and obtained permission from the DHS
220 program for the use of the data. The data were completely anonymized and therefore the
221 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 ($25.0\text{--}29.9 \text{ kg/m}^2$) and obese ($\geq 30.0 \text{ kg/m}^2$). 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).

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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

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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/m² 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
<i>Samples</i>	583	656	966	2,023	2,130	6,358
Egypt	1992	1995	2000	2005	2014	
<i>Samples</i>	3,090	3,779	4,279	4,595	5,842	21,555
Kenya	1993	1998	2003	2008	2014	
<i>Samples</i>	623	500	1,398	1,342	6,369	10,232
Zambia	1992	1996	2001	2007	2013	
<i>Samples</i>	2,329	2,099	1,591	1,867	4,636	12,522
Burkina Faso	1993	1998	2003	2010	---	
<i>Samples</i>	1,774	873	3,136	3,006	---	8,789
Benin	1996	2001	2006	2011	---	
<i>Samples</i>	702	1,403	5,097	4,480	---	11,682
Mali	1995	2001	2006	2011	---	
<i>Samples</i>	1,630	2,395	3,673	2,323	---	10,021
Malawi	1992	2000	2004	2010	---	
<i>Samples</i>	999	1,864	1,022	1,801	---	5,686
Niger	1992	1998	2006	2012	---	
<i>Samples</i>	2,253	1,069	2,267	2,453	---	8,042

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	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
<i>Overweight</i>							
(%)	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		
<i>Obesity</i>							
(%)	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		

<i>Overweight</i>							
(%)	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		
<i>Obesity</i>							
(%)	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		
<i>Overweight</i>							
(%)	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		
<i>Obesity</i>							
(%)	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		
<i>Overweight</i>							
(%)	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		
<i>Obesity</i>							
(%)	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	---		
<i>Overweight</i>					---		
(%)	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	---		
<i>Obesity</i>					---		
(%)	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	---		
<i>Overweight</i>					---		
(%)	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	---		
<i>Obesity</i>					---		
(%)	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	---		

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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	---		

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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	↗

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(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

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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)

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

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

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

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

397 **Strengths and limitations**

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

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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.

For peer review only

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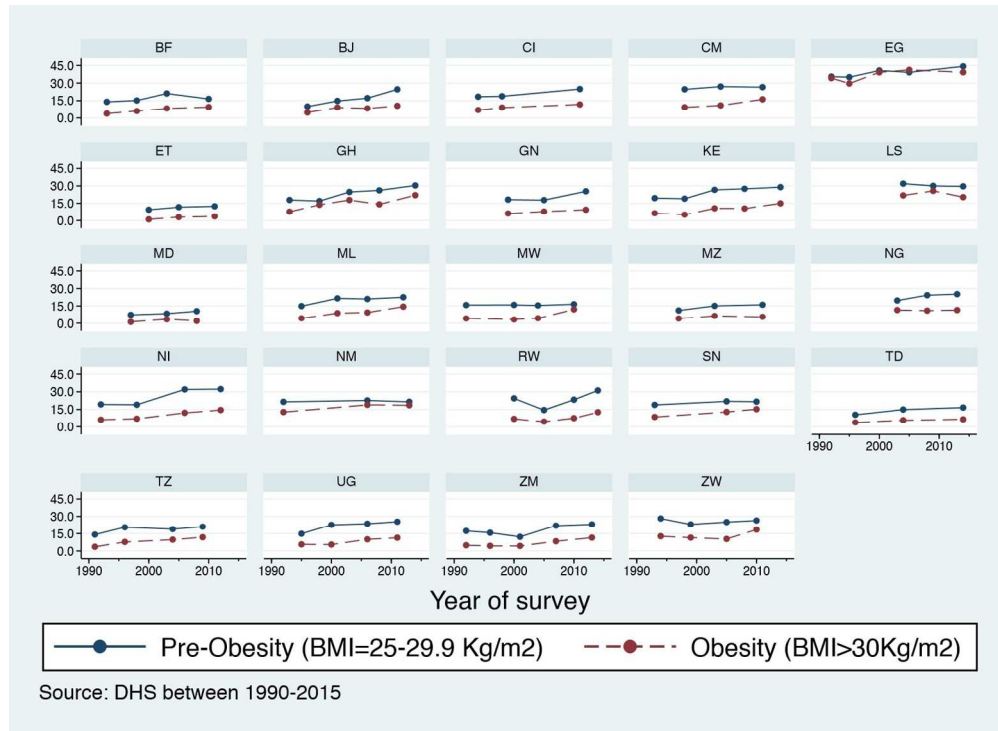
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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

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	

		<i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —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.