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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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8 3 **Prevalence and time trends in overweight and obesity among urban women: An analysis of**
9 4 **demographic and health surveys data from 24 African countries, 1991-2014**
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2
3 29 **Abstract**
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6 30 **Objective(s):** To examine the prevalence and trends in overweight and obesity among non-
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9 31 pregnant urban women in Africa over the past two and half decades.
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12 32 **Design:** Cross-sectional surveys conducted between 1991 and 2014.
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15 33 **Settings:** Demographic and Health Surveys (DHS), repeated cross-sectional data collected in 24
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18 34 African countries.
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21 35 **Participants:** Adult non-pregnant women aged 15–49 years. The earlier DHS surveys collected
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24 36 anthropometric data on only those women who had children aged 0–5 years. The main
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26 37 analyses were limited to this subgroup.
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28
29 38 **Results:** The prevalence of overweight and obesity increased in all 24 countries. Trends were
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31
32 39 statistically significant in 17 of the 24 countries in the case of obesity and 13 of the 24 for
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34 40 overweight. In Ghana, overweight almost doubled while obesity tripled between 1993 and
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36
37 41 2014. Egypt has the highest levels of overweight and obesity at 44% (95% CI: 42, 46.5) and 39%
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39 42 (95% CI: 36.6, 41.8) respectively in 2014 and the trend showed significant increase from 1995
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41
42 43 levels. Also, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and
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44 44 Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Ethiopia and
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46
47 45 Madagascar had the lowest prevalence of both obesity and overweight, with overweight
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49 46 ranged from 7 to 12% and obesity from 1 to 4%.
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53 47 **Conclusions:** Overweight and obesity are increasing in urban Africa, with obesity having more
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55 48 than doubled or tripled in 12 of the 24 countries. There is an urgent need for deliberate policies
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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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3 54 **Strengths and Limitations of the Study**
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- 6
7 55 • Use of nationally representative data sets, thereby providing more robust estimates of
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9 56 the prevalence and trends of overweight and obesity
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11 57 • Height and weight used in the calculation of BMI, was objectively measured, reducing
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13 possible misclassification
14 58
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16 59 • Analysis limited to women with children under 5 years old and may affect the
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18 generalizability of the findings to all women
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21 61 • Lack of uniformity in the definition of urban and rural settings across countries
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3 73 **Introduction**
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6 74 Overweight and obesity are global public health problems, especially among women in urban
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8 75 settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of
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10 76 being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs)
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12 77 are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart
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14 78 disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body
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16 79 mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found
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18 80 to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3).
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20 81 A recent study showed that overweight and obesity are linked to 13 different cancers (5). Thus,
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22 82 there is an increased risk of co-morbidities for individuals with a body mass index of 25.0 to
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24 83 29.9 kg/m² (defined as overweight), and moderate to severe risk of co-morbidities for
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26 84 individuals with a body mass index greater than 30 kg/m² (defined as obesity) (3, 6). The World
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28 85 Health Organization (WHO) (3, 6) recommends that for optimum health, the median body mass
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30 86 index for an adult population should be in the range of 21 to 23 kg/m², while the goal for
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32 87 individuals should be to maintain body mass index in the range 18.5 to 24.9 kg/m². This is often
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34 88 difficult to achieve as evidence shows that global overweight and obesity trends are on the rise,
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36 89 with the developing world now bearing the brunt of the surge (7). This dynamic calls for more
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38 90 studies to systematically document these trends over time, especially in developing country
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40 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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23 101 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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33 105 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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39 107 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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47 110 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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3 115 was higher among the poorest urban dwellers compared to the richest population subgroup
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6 116 (13).
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12 118 Despite the emerging and worrying trend of increased overweight and obesity, and recognition
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15 119 of the potential rise in chronic diseases in recent times in Africa, little effort has been made in
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17 120 addressing overweight and obesity on the continent (20). Consequently, an analysis of
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20 121 overweight and obesity in this study across several countries in the region, is a critical step in
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22 122 the provision of insights into the extent of the problem over time, especially in urban settings,
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25 123 which is needed to inform policy and program interventions to address the challenge in urban
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27 124 Africa.
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34 126 It is worth noting that while there are a number of studies that investigated overweight and
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36 127 obesity in Africa; most either focused on one country (8), lumped urban and rural data together
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39 128 in their analyses (2, 8), analyzed overweight and obesity together (18), or used one data point
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41 129 (21). These attempts may mask the seriousness of the problem in urban settings and the
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44 130 important differences in the trends and prevalence of overweight and obesity over time. Also,
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46 131 the presentation of the results in some of these studies makes it difficult for policy makers to
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49 132 appreciate the extent of the problem. The present study elucidates the prevalence and time
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51 133 trends in overweight and obesity separately, and presents the results in a way that makes it
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54 134 easier for policy makers to understand the extent of the problem in urban settings.
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3 136 **Methods**
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7 137 **Data sources and participants**
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10 138 The study used data from the Demographic and Health Surveys (DHS) programme. These are
11
12 139 nationally representative, repeated cross-sectional household surveys collected primarily in
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14 140 lower- and middle-income countries approximately every 5 years and standardized to enable
15
16 141 cross-country comparisons (22, 23). We restricted our analysis to data collected in 24 sub-
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18 142 Saharan African countries between 1991 and 2014, and containing individual anthropometric
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20 143 data. There were a total of 137 survey cycles in the 24 countries, and the number of survey
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22 144 cycles per country ranged between three (11/137, four (8/137), and five (5/137) in the time
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24 145 period under consideration. These countries were selected solely based on the number of data
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26 146 points (at least 3) and the availability of anthropometric data. Datasets of countries that met
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28 147 the minimum requirement in terms of data points were downloaded. Data from a total 29
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30 148 countries were downloaded. The second stage was to examine the data for the availability of
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32 149 anthropometric data. All datasets missing anthropometric data were excluded in the analysis.
33
34 150 For example, the very first DHS, conducted between 1987 and 1990 did not collect maternal
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36 151 anthropometric data. Hence, the dataset for this period were excluded in the analysis.
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38 152 Secondly, countries with three datasets, but reduced to two data points due to one of the
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40 153 datasets not having anthropometric data were also excluded in the analysis.
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54 155 The DHS employs a multistage sampling design. The first stage involves selecting sample points
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56 156 or clusters from an updated master sampling frame constructed from the National Population
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3 157 and Housing Census data of the respective countries. The clusters are then selected using
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6 158 systematic sampling with probability proportional to size. A household listing operation is then
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9 159 conducted in all the selected clusters to provide a sampling frame for the second stage
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11 160 selection of households. The second stage of selection involves the systematic sampling of
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13 161 households listed in each cluster. The primary objective of the second stage of selection is to
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16 162 ensure adequate numbers of completed individual interviews to provide estimates for key
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18 163 indicators with acceptable precision (23). We limited our analyses to adult non-pregnant
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21 164 women of reproductive age, 15–49 years in all countries. This is because pregnant women
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23 165 naturally gain weight during the course of their pregnancy, including them in the analysis may
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26 166 present a misleading picture about the issue of overweight and obesity among women. Since
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28 167 the earlier DHS surveys collected anthropometry data on only those women who had children
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31 168 aged 0–5 years (18, 24), we further restricted our main analyses to this subgroup. For the total
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33 169 of 224,940 urban women who met eligibility criteria, anthropometric data were available for
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36 170 191,836 (85.3 %).
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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.

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7 179 **Variables**

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10 180 Height and weight were measured objectively by trained field technicians using standard
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12 181 techniques (23). Weight measurements were taken using electronic Seca scales with a digital
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14 182 screen. Height measurements were taken using a measuring board produced by Shorr
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17 183 Productions. Height and weight measurements were then used to estimate the study
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20 184 participants' body mass index (BMI). BMI, also referred to as Quetelet's Index (25), was derived
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22 185 by dividing weight in kilograms by the squared height in meters. Based on the BMI (kg/m^2)
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24 186 estimates, and according to World Health Organization guidelines (26), the participants were
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27 187 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
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30 188 overweight and obesity were estimated for each country. Place of residence was designated as
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32 189 rural and urban according to country specific definitions; however, the present analyses were
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35 190 restricted to the urban sample only. This is based on the evidence that the bane of overweight
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37 191 and obesity in Africa is more prevalent in the urban settings relative to other settings (10, 13).

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44 193 **Analytical strategy**

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47 194 We used STATA 13 to perform the data analyses. A data file was constructed by using place of
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49 195 residence, country, survey year, and sample size. The analyses were conducted in three key
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52 196 steps. Initially, prevalence of overweight and obesity in selected countries in Africa with at least
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54 197 three DHS data points was graphed. In this step, only point estimates were reported, and since
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57 198 point estimates are not affected by the complex survey design, the DHS weight for each survey

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3 199 was used to get a reliable estimate. We then computed, at 95% confidence intervals (CI), the
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6 200 outcomes of interest by year of survey for each country in the second step. Because CIs are
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9 201 affected by the sampling design, we took into account the complex survey design (CSD) of DHS
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11 202 within the *svyset* and *svy* procedures in STATA. To avoid flawed variances and biased
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13 203 confidence intervals owing to the complex survey design, the analyses were conducted on the
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16 204 sub-sample with the full sample (urban+rural) maintained in the dataset. In STATA, this is
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18 205 achieved with the “subpop” in *svy* procedures. In the third step, we examined statistical
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21 206 significance of the trends of overweight and obesity. To achieve this, we performed a
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23 207 multinomial logistic regression with time (year of survey) as the key independent variable using
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26 208 BMI<25 kg/m² category as the base outcome and taking into account the CSD. While in steps 1
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28 209 and 2 the time point data sets were treated independently, we pooled the data sets for trend
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31 210 analyses. As pooling the data may result in an overestimation of the statistical power,
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33 211 normalized weight was used. To this end, the weight in the pooled data was divided by the
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36 212 number of surveys available for the respective countries.
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219 **Results**

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

20 **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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4	Samples	1,128	1,247	1,336	1,404	---	5115
5							
6	Uganda	1995	2000	2006	2011	---	
7							
8	Samples	1,462	1,510	826	1,539	---	4,593
9							
10	Zimbabwe	1994	1999	2005	2010	---	
11							
12	Samples	508	1,685	1,298	1,500	---	4,991
13							
14	Senegal	1993	2005	2010		---	
15							
16	Samples	1,683	3,180	3,373		---	8,236
17							
18	Ivory Coast	1994	1998	2011		---	
19							
20	Samples	1,470	1,040	2,344		---	4,854
21							
22	Cameroon	1998	2004	2011		---	
23							
24	Samples	838	2,819	4,161		---	7,818
25							
26	Ethiopia	2000	2005	2011		---	
27							
28	Samples	1,550	1,299	1,817		---	4,666
29							
30	Guinea	1999	2005	2012		---	
31							
32	Samples	1,415	1,263	1,818		---	4,496
33							
34	Lesotho	2004	2009	2014		---	
35							
36	Samples	640	648	761		---	2,049
37							
38	Madagascar	1997	2003	2008		---	
39							
40	Samples	722	2,708	2,079		---	5,509
41							
42	Mozambique	1997	2003	2011		---	
43							
44	Samples	949	3,320	3,308		---	7,577
45							
46	Nigeria	2003	2008	2013		---	
47							
48	Samples	1,831	6,659	8,976		---	17,466
49							
50	Namibia	1992	2006	2013		---	
51							
52	Samples	1,090	1,854	2,142		---	5,086
53							
54	Chad	1996	2004	2014		---	
55							
56	Samples	2,443	2,112	3,396		---	7,951
57	Total sample						191,836

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226 Table 2 provides period estimates and trends in overweight and obesity in 13 countries with 4
 227 or more data points. These surveys cover periods between 14 years in Rwanda and 21 years in
 228 Ghana, Kenya and Zambia. The earliest data points in these countries were in the 1990s and the
 229 latest are after 2010. Across all 13 countries, levels of overweight reached or exceeded 20%
 230 only in Egypt (36%) and Zimbabwe (28%) in the 1990s surveys. Obesity reached a double digit
 231 of 10% or more only in Egypt (34%), and Zimbabwe (13%). In all the other countries,
 232 overweight was under 20% and obesity was under 10%. In the latest surveys conducted since
 233 2010 in these countries, overweight exceeded 20% in all countries except Burkina Faso and
 234 Malawi where the prevalence was around 16%. The increase overtime was not also statistically
 235 significant in these two countries. In 4 countries, the prevalence of overweight exceeded 30%
 236 (Egypt (44%), Niger (32%), Rwanda (31%) and Ghana (30%)). Obesity exceeded 10% in all
 237 countries in the 2010s surveys with Egypt (39%) and Ghana (22%) leading in levels of obesity.
 238 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>					---		

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3							
4	(%)	4.3	8.8	9.4	14.4	---	p<.05 ↗
5							
6	(95% CI)	3.1, 5.8	6.9, 11.1	7.7, 11.4	11.7, 17.5	---	
7							
8	Malawi	1992	2000	2004	2010	---	
9							
10	Overweight						
11							
12	(%)	15.8	15.9	15.4	16.4	---	p>.05 →
13							
14	(95% CI)	12.3, 20.0	13.1, 19.1	12.1, 19.5	12.7, 21.1	---	
15							
16	Obesity						
17							
18	(%)	4.1	3.2	4.3	12.1	---	P<.05 ↗
19							
20	(95% CI)	2.6, 6.4	2.0, 5.1	2.8, 6.7	8.2, 17.5	---	
21							
22	Niger	1992	1998	2006	2012	---	
23							
24	Overweight						
25							
26	(%)	19.2	19.0	32.0	32.23	---	p<.05 ↗
27							
28	(95% CI)	16.8, 22.0	15.5, 23.0	27.8, 36.6	28.5, 36.3	---	
29							
30	Obesity						
31							
32	(%)	6.1	7.0	12.1	14.4	---	p<.05 ↗
33							
34	(95% CI)	4.9, 7.6	5.2, 9.3	9.4, 15.4	11.7, 17.6	---	
35							
36	Rwanda	2000	2005	2010	2014	---	
37							
38	Overweight						
39							
40	(%)	24.4	14.4	23.3	31.1	---	p<.05 ↗
41							
42	(95% CI)	23.1, 25.6	11.0, 18.8	19.4, 27.6	26.5, 36.1	---	
43							
44	Obesity						
45							
46	(%)	6.8	4.5	7.5	12.6	---	p<.05 ↗
47							
48	(95% CI)	6.1, 7.3	2.6, 7.8	4.9, 11.4	10.0, 15.7	---	
49							
50	Tanzania	1991	1996	2004	2009	---	
51							
52	Overweight						
53							
54	(%)	14.1	20.5	18.9	21.0	---	p<.05 ↗
55							
56	(95% CI)	11.1, 17.8	20.1, 20.9	18.5, 19.3	20.4, 22.2	---	
57							
58	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

239

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,

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

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

Country				<i>p</i>	Nature of trend
Senegal	1993	2005	2010		
Overweight					
(%)	18.8	21.9	21.6	<i>p</i> >.05	→
(95% CI)	16.3, 21.6	17.0, 27.6	18.2, 25.4		
Obesity					
(%)	8.5	12.8	15.2	<i>p</i> <.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	<i>p</i> >.05	→
(95% CI)	16.1, 20.8	16.1, 21.7	21.4, 28.8		
Obesity					
(%)	6.9	9.0	11.8	<i>p</i> >.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	<i>p</i> >.05	→
(95% CI)	21.3, 28.3	23.8, 30.5	23.9, 29.3		
Obesity					
(%)	9.3	10.9	16.1	<i>p</i> >.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	<i>p</i> >.05	→
(95% CI)	6.9, 12.9	7.5, 18.0	9.2, 16.8		
Obesity					
(%)	1.0	2.9	3.6	<i>p</i> <.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	<i>p</i> <.05	↗

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3						
4	(95% CI)	15.7, 21.0	14.3, 22.0	20.9, 30.4		
5	Obesity					
6	(%)	6.2	7.9	9.4	p<.05	↗
7	(95% CI)	4.8, 7.9	4.6, 13.3	6.9, 12.8		
8	Lesotho	2004	2009	2014		
9	Overweight					
10	(%)	32.0	30.0	29.7	p>.05	→
11	(95% CI)	25.3, 39.5	23.3, 37.7	22.9, 37.4		
12	Obesity					
13	(%)	21.9	25.8	20.3	p>.05	→
14	(95% CI)	15.5, 30.0	20.1, 32.4	14.7, 27.4		
15	Madagascar	1997	2003	2008		
16	Overweight					
17	(%)	7.3	8.3	10.5	p>.05	→
18	(95% CI)	5.2, 10.1	6.6, 10.5	8.1, 13.5		
19	Obesity					
20	(%)	1.1	3.4	1.9	p>.05	→
21	(95% CI)	0.5, 2.6	2.4, 4.8	1.0, 3.5		
22	Mozambique	1997	2003	2011		
23	Overweight					
24	(%)	11.1	15.1	16.0	p<.05	↗
25	(95% CI)	8.4, 14.6	13.1, 19.1	14.1, 18.2		
26	Obesity					
27	(%)	4.0	3.2	6.3	p>.05	→
28	(95% CI)	2.3, 6.9	2.0, 5.1	4.7, 8.6		
29	Nigeria	2003	2008	2013		
30	Overweight					
31	(%)	19.7	24.3	25.2	p>.05	→
32	(95% CI)	15.2, 25.1	22.6, 26.1	23.4, 27.1		
33	Obesity					
34	(%)	11.5	11.0	11.5	p>.05	→
35	(95% CI)	8.3, 15.6	9.7, 12.5	10.3, 12.7		
36	Namibia	1992	2006	2013		
37	Overweight					
38	(%)	21.4	22.6	21.5	p>.05	→
39	(95% CI)	17.9, 25.4	19.2, 26.5	18.0, 25.4		
40	Obesity					
41	(%)	12.7	18.9	18.6	p<.05	↗
42	(95% CI)	10.3, 15.6	16.1, 22.1	15.2, 22.5		
43	Chad	1996	2004	2014		
44	Overweight					
45	(%)	10.4	14.9	16.6	p<.05	↗
46	(95% CI)	9.6, 11.4	12.4, 17.7	13.9, 19.6		
47	Obesity					
48	(%)					
49	(95% CI)					
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(%)	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=
 262 Guinea; KE= Kenya; LS= Lesotho; MD= Madagascar; ML= Mali; MW= Malawi; MZ= Mozambique; NG= Nigeria; NI=
 263 Niger; NM= Namibia; RW= Rwanda; SN= Senegal; TD = Chad; TZ= Tanzania; UG= Uganda; ZM=Zambia; ZW=
 264 Zimbabwe

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3 270 **Discussion**
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7 271 We set out to investigate the prevalence and time trends in overweight and obesity between
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9 272 1991 and 2014 in 24 African countries. Primarily, we confirm that the prevalence of overweight
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11 273 and obesity among urban women has rapidly increased in the past two and a half decades. All
12
13 274 24 countries included in our analyses experienced an increase in overweight and obesity over
14
15 275 the time period under consideration. However, the increase was only statistically significant in
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17 276 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. The changes
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19 277 over time were particularly noticeable among countries with 4 or more survey data points, in
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21 278 which case, all the 13 countries showed a statistically significant increase in obesity, while 10
22
23 279 showed significant increase for overweight during the period of the study. For countries with
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25 280 three data points, only 4 of the 11 countries had a significant increase for overweight and 3 for
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27 281 obesity. This suggests that length of time plays an important role in understanding the changes
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29 282 in overweight and obesity over time. We also found that 18 of the 24 countries had an
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31 283 overweight prevalence above 20%, based on the most recent survey waves for the respective
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33 284 countries. This was not the case in the earlier surveys where only 6 countries had an overweight
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35 285 prevalence of 20% or above. Four countries of the 24 had an obesity prevalence that was
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37 286 above 20%, with the prevalence in the rest ranging between 10% and 19% based on the latest
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39 287 surveys. However, in the earlier surveys, only one country had obesity prevalence of 20% or
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41 288 more, while the rest had obesity rate ranging from 1 to 12%. This points to worsening
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43 289 phenomenon of obesity among urban women in the past two and half decades. Another key
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45 290 finding is that in most of the countries included in our analyses, obesity increased alongside
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47 291 overweight, suggesting that urban women who are overweight have a greater probability of
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3 292 progressing to obesity. Thus, addressing overweight will, to a larger extent curtail the
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6 293 increasing incidence of obesity in urban Africa.
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12 295 Focusing on individual countries, we found significant differences in overweight and obesity
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14 296 across the countries included in the analysis. For example, in the most recent surveys, Egypt has
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17 297 the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with
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20 298 an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two
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22 299 other countries with overweight prevalence of 30% and above. The results on Egypt are not
23
24 300 surprising as the country was previously ranked among the countries in the world with the most
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26
27 301 obese people (27). The results in Ghana are also consistent with previous findings (28). Egypt
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29 302 and Ghana also experienced a significant increase in overweight and obesity in the past two and
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31
32 303 half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in
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34 304 Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and
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37 305 Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the
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39 306 prevalence of obesity in the aforementioned countries may be considered lower than that of
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42 307 Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests
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44 308 that in the next decades, the obesity rates in these countries may catch up with Egypt and
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47 309 Ghana, which are currently leading in terms of the level of prevalence of both overweight and
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49
50 310 obesity. However, overweight and obesity did not show any significant changes overtime in
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53 311 Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest
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55 312 prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and
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58 313 Madagascar in a recent study using the DHS data from 32 African countries (21).
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7 315 The increasing prevalence and trends of overweight and obesity in Africa is attributed largely to
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9 316 rapid urbanization taking place in the continent and its associated nutritional transition. For
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11 317 example, in 2010, the share of the African urban population was about 36% and is projected to
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13 318 increase to 50% and 60% by 2030 and 2050 respectively (29). Using Ghana as a case in point,
14
15 319 for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%)
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17 320 of country's population live in urban areas compared to rural areas (30). The growing
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19 321 urbanization comes along with lifestyle changes such as decreased physical activity and
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21 322 increase supply of high caloric fast foods and sugar sweetened beverages (31-34). Indeed,
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23 323 sedentary lifestyle and high consumption of energy dense diets are found to account for the
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25 324 increasing burden of overweight and obesity in urban settings of the low and middle income
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27 325 countries (LMIC) (13-15). The consequences of which, is increase in non-communicable
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29 326 diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart
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31 327 disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body
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33 328 mass index (BMI) (3, 4, 34). In addition, an increased burden of disability-adjusted life years
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35 329 (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be
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37 330 implemented to address the problem of overweight and obesity, thereby curbing associated
38
39 331 NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important
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41 332 step towards curbing the surge of NCDs the continent is currently experiencing, which is likely
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43 333 to surpass the toll of sickness and death from infectious diseases by 2030 (35). This will further
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45 334 contribute greatly to the potential for African countries to achieve Sustainable Development
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47 335 Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases
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3 336 through prevention, and treatment, and promote mental health and wellbeing by 2030 (36). In
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6 337 the light of the findings of our study and literature discussed above, we particularly advocate
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9 338 for interventions to address increasing sedentary lifestyles and poor eating behaviour among
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11 339 urban dwelling women, as this will go a long way in reducing the incidence of overweight and
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13 340 obesity in these settings.
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20 342 **Strengths and limitations**

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23 343 The key strength of this study is the use of nationally representative data sets, thereby
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25 344 providing more robust estimates of the prevalence and trends of overweight and obesity in the
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27
28 345 respective countries. Further, height and weight as used in the calculation of BMI, was
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30 346 objectively measured by well-trained technicians, reducing possible misclassification of
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33 347 overweight and obesity. The study is also associated with some limitations. To maintain sample
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35 348 comparability over time, we had to limit our sample to women with children under 5 years old.
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38 349 This may, to some extent, affect the generalizability of the findings, as the sample may not be
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40 350 representative of the entire female population. Another limitation is the cross-sectional nature
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43 351 of the data, which makes it impossible to ascertain the changes in BMI over time. Lack of
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45 352 uniformity in the definition of urban and rural settings may also affect the generalizability of the
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48 353 findings across countries, since different countries have different definitions of what constitutes
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50 354 urban versus rural. Lastly, one methodological limitation is that we pooled the data to perform
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53 355 the trend analysis, which may lead to an overestimation of statistical power. To address this
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3 356 limitation, the weight in the pooled data was divided by the number of surveys available for the
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12 359 **Conclusions**

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15 360 The study provided clear evidence of increase in overweight and obesity among women in the
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17 361 urban settings of all the countries included in the analysis, with the increase overtime being
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19 362 statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for
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21 363 overweight. We have supported the finding that urbanization is associated with increased
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23 364 prevalence of overweight and obesity among women. The prevalence of obesity increased
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25 365 more than two fold in most countries and more than three fold in others. The prevalence of
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27 366 obesity also increased alongside overweight, suggesting that urban women who were
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29 367 overweight were likely to progress to obesity status with time. These findings call for deliberate
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31 368 strategies and interventions by policy makers, politicians and health promotion experts to
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33 369 encourage active lifestyles and healthy eating behaviour to curb the growing proportion of
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35 370 unhealthy weight women of child bearing age in urban Africa.

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47
48 373 the data. We also wish to acknowledge institutions of respective countries that played critical
49
50 374 roles in the data collection process.

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3 376 **Competing Interest**
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6 377 The authors have no competing interests to declare.
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9
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12
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16 380 **Data Sharing Statement**
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19 381 This study was a re-analysis of existing data that are publicly available from The DHS Program at
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21 382 <http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm>. Data are
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23
24 383 accessible free of charge upon a registration with the Demographic and Health Survey program
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26
27 384 (The DHS Program). The registration is done on the DHS website indicated above.
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29
30 385 **Authors' Contribution**
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32
33 386 DAA conceived and designed the study, interpreted the results, wrote the first draft of the
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35
36 387 manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD
37
38 388 contributed to the drafting of the analytical strategy. ZTD, SM BM and ACE contributed to
39
40
41 389 study design, data interpretation, and critical revision of the manuscript. All authors take
42
43 390 responsibility of any issues that might arise from the publication of this manuscript.
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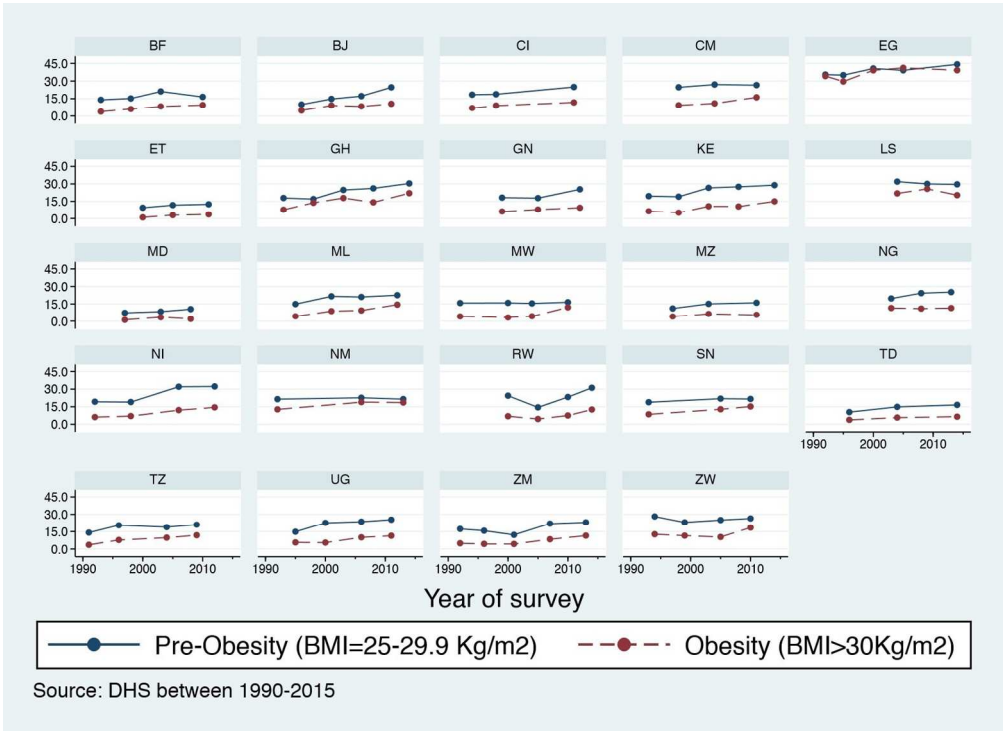
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Review only

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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	9
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —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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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Nutrition and metabolism, Public health, Global health
Keywords:	Overweight, Obesity, Africa, Prevalence, Trends, Urban

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Manuscripts

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10 4 **demographic and health surveys data from 24 African countries, 1991-2014**
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3 37 **Abstract**
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6 38 **Objective(s):** To examine the prevalence and trends in overweight and obesity among non-
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9 39 pregnant urban women in Africa over the past two and half decades.
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12 40 **Design:** Cross-sectional surveys conducted between 1991 and 2014.
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16 41 **Settings:** Demographic and Health Surveys (DHS), repeated cross-sectional data collected in 24
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18 42 African countries.
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21 43 **Participants:** Adult non-pregnant women aged 15–49 years. The earlier DHS surveys collected
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23 44 anthropometric data on only those women who had children aged 0–5 years. The main
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25 45 analyses were limited to this subgroup. The participants were classified as overweight (25.0-
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27 46 29.9 kg/m²) and obese (≥ 30.0 kg/m²).
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32 47 **Results:** The prevalence of overweight and obesity increased in all 24 countries. Trends were
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34 48 statistically significant in 17 of the 24 countries in the case of obesity and 13 of the 24 for
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36 49 overweight. In Ghana, overweight almost doubled ($p = .001$) while obesity tripled ($p = .001$)
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38 50 between 1993 and 2014. Egypt has the highest levels of overweight and obesity at 44% (95%
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40 51 CI: 42, 46.5) and 39% (95% CI: 36.6, 41.8) respectively in 2014 and the trend showed significant
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42 52 increase ($p = .005$) from 1995 levels. Also, increase in obesity doubled in Kenya, Benin, Niger,
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44 53 Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and
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46 54 Tanzania. Ethiopia and Madagascar had the lowest prevalence of both obesity and overweight,
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48 55 with overweight ranged from 7 to 12% and obesity from 1 to 4%.
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3 56 **Conclusions:** Overweight and obesity are increasing in urban Africa, with obesity having more
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6 57 than doubled or tripled in 12 of the 24 countries. There is an urgent need for deliberate policies
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9 58 and interventions to encourage active lifestyles and healthy eating behaviour to curb this trend
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11 59 in urban Africa.

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14 60 **Keywords:** Overweight, obesity, Africa, prevalence, trends, urban
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3 63 **Strengths and Limitations of the Study**
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7 64 • Use of nationally representative data sets, thereby enhancing the generalizability of the
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9 65 findings
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11 66 • Height and weight used in the calculation of BMI, was objectively measured, possibly
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13 67 reducing misclassification
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15 68 • Analysis limited to women with children under 5 years old and may affect the
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17 69 generalizability of the findings to all women
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19 70 • Lack of uniformity in the definition of urban and rural settings across countries
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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,

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3 104 11). Together, these findings show the varied effects of overweight and obesity on women of
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6 105 reproductive age and their children.
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12 107 The literature demonstrates that the magnitude of the effect of BMI on health is largely linked
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15 108 to the level of BMI. For instance, there is an increased risk of co-morbidities for individuals with
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17 109 a BMI of 25.0 to 29.9 kg/m² (defined as overweight), and moderate to severe risk of co-
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20 110 morbidities for individuals with a BMI greater than 30 kg/m² (defined as obesity) (3, 6). The
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22 111 World Health Organization (WHO) (3, 6) recommends that for optimum health, the median
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25 112 body mass index for an adult population should be in the range of 21 to 23 kg/m², while the
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27 113 goal for individuals should be to maintain body mass index in the range of 18.5 to 24.9 kg/m².
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30 114 This is often difficult to achieve as evidence shows that global overweight and obesity trends
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32 115 are on the rise, with the developing world now bearing the brunt of the surge (7). This dynamic
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35 116 calls for more studies to systematically document these trends over time, especially in
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37 117 developing country contexts.
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44 119 Hitherto, overweight and obesity were not public health issues on the African continent.
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46 120 However, rapid changes have been observed, and many countries in Africa are currently
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49 121 confronted with overweight and obesity, particularly among women, coupled with a resulting
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51 122 increase in the prevalence of non-communicable diseases (NCDs) (4, 12, 13). In Africa, women
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54 123 had approximately double the obesity prevalence of men (3), with urban settings being the
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56 124 most affected. Thus, the burden of overweight and obesity among urban women is increasing
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3 125 at an alarming rate in developing countries, and particularly in Africa for that matter (1, 14). In
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6 126 Ghana for example, systematic review and meta-analysis revealed that overweight among
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9 127 urban women was 11 percentage points higher than rural women, while obesity was two times
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11 128 higher in urban relative to rural women (15). Similar trends were obtained using data from 42
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13 129 countries in Asia, the Middle East, Africa (East, West, Central and Southern), and Latin America,
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16 130 with a combined overweight/obesity prevalence of 37.2% among urban women compared to
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19 131 19% of rural women (16). The study however noted regional differences, with rural women in
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21 132 Latin America, the Middle East, and North Africa having much higher increases in the
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23 133 prevalence of overweight/obesity compared to their urban counterparts. Conversely, in
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26 134 different multi-country analysis, overweight was increasing more quickly in urban areas than in
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29 135 rural areas of lower-income countries such as Bangladesh and Uganda, but increasing more
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31 136 quickly in rural areas compared to urban areas of upper-middle-income countries, such as
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34 137 Jordan and Peru (17).

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40 139 The trend observed above may be attributable to an increased intake of energy-dense foods
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42 140 that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature
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45 141 of many occupations, increased use of motorized transportation, and urbanization (1, 18-20).
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48 142 Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the
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50 143 increasing burden of overweight and obesity in urban settings of low and middle-income
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52 144 countries (LMIC) (21-23). Various other studies have argued that the association between urban
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55 145 residence and obesity in LMICs is driven largely by higher individual- and community-level
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58 146 socioeconomic status (SES) in urban areas, suggesting that urban residence alone may not

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3 147 cause increased body weight in developing countries (18). However, recent studies suggest that
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6 148 the distribution of overweight by SES is changing in developing countries (4, 24, 25). For
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9 149 example, lower SES populations in some of these countries now have higher prevalence of
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11 150 overweight, mimicking long-standing associations between low SES and poorer health in LMICs
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13 151 (4, 24-26). This changing trend is particularly widespread among the urban population. A study
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16 152 in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity
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18 153 among women (27). Another study using data from 7 African countries showed that the
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21 154 increase in overweight and obesity was higher among the poorest urban dwellers compared to
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23 155 the richest population subgroup (21).
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30 157 Despite the emerging and worrying trend of increased overweight and obesity, and recognition
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32 158 of the potential rise in chronic diseases in recent times in Africa, little effort has been made in
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35 159 addressing overweight and obesity on the continent (28). Consequently, an analysis of
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37 160 overweight and obesity in this study across several countries in the region, is a critical step in
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40 161 the provision of insights into the extent of the problem over time, especially in urban settings,
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42 162 which is needed to inform policy and program interventions to address the challenge in urban
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51 165 It is worth noting that while there are a number of studies that investigated overweight and
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54 166 obesity in Africa; most either focused on one country (13), lumped urban and rural data
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56 167 together in their analyses (2, 13), analysed overweight and obesity together (26), or used one
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3 168 data point (29). These attempts may mask the seriousness of the problem in urban settings and
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6 169 the important differences in the trends and prevalence of overweight and obesity over time.
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9 170 Also, the presentation of the results in some of these studies makes it difficult for policy makers
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11 171 to appreciate the extent of the problem. The present study elucidates the prevalence and time
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13 172 trends in overweight and obesity separately, and presents the results in a way that makes it
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16 173 easier for policy makers to understand the extent of the problem in urban settings.
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22 175 **Methods**

25 176 **Data sources and participants**

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29 177 The study used data from the Demographic and Health Surveys (DHS) programme. These are
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31 178 nationally representative, repeated cross-sectional household surveys collected primarily in
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34 179 lower- and middle-income countries approximately every 5 years and standardized to enable
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36 180 cross-country comparisons (30, 31). We restricted our analysis to data collected in 24 sub-
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39 181 Saharan African countries between 1991 and 2014, and containing individual anthropometric
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41 182 data. There were a total of 137 survey cycles in the 24 countries, and the number of survey
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44 183 cycles per country ranged between three (11/137, four (8/137), and five (5/137) in the time
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46 184 period under consideration. These countries were selected solely based on the number of data
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49 185 points (at least 3) and the availability of anthropometric data. Datasets of countries that met
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51 186 the minimum requirement in terms of data points were downloaded. Data from a total 29
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54 187 countries were downloaded. The second stage was to examine the data for the availability of
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56 188 anthropometric data. All datasets missing anthropometric data were excluded in the analysis.
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3 189 For example, the very first DHS, conducted between 1987 and 1990 did not collect maternal
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6 190 anthropometric data. Hence, the dataset for this period were excluded in the analysis.

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8 191 Secondly, countries with three datasets, but reduced to two data points due to one of the
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10 192 datasets not having anthropometric data were also excluded in the analysis.

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17 194 The DHS employs a multistage sampling design. The first stage involves selecting sample points
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20 195 or clusters from an updated master sampling frame constructed from the National Population
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22 196 and Housing Census data of the respective countries. The clusters are then selected using
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25 197 systematic sampling with probability proportional to size. A household listing operation is then
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27 198 conducted in all the selected clusters to provide a sampling frame for the second stage
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30 199 selection of households. The second stage of selection involves the systematic sampling of
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32 200 households listed in each cluster. The primary objective of the second stage of selection is to
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35 201 ensure adequate numbers of completed individual interviews to provide estimates for key
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37 202 indicators with acceptable precision (31). We limited our analyses to adult non-pregnant
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40 203 women of reproductive age, 15–49 years in all countries. This is because pregnant women
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42 204 naturally gain weight during the course of their pregnancy, including them in the analysis may
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45 205 present a misleading picture about the issue of overweight and obesity among women. Since
46
47 206 the earlier DHS surveys collected anthropometry data on only those women who had children
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50 207 aged 0–5 years (26, 32), we further restricted our main analyses to this subgroup. For the total
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52 208 of 224,940 urban women who met eligibility criteria, anthropometric data were available for
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55 209 191,836 (85.3 %).

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67 **211 Ethics statement**

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10 212 The DHS obtained ethical clearance from the ethical committees of the respective countries
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12 213 before the surveys were conducted. Written informed consent was obtained from the women
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14 214 before participation. The authors of this paper sought and obtained permission from the DHS
15
16 215 program for the use of the data. The data were completely anonymized and therefore the
17
18 216 authors did not seek further ethical clearance before their use.
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2526 **218 Variables**

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29 219 Height and weight were measured objectively by trained field technicians using standard
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31 220 techniques (31). Weight measurements were taken using electronic Seca scales with a digital
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33 221 screen. Height measurements were taken using a measuring board produced by Shorr
34
35 222 Productions. Height and weight measurements were then used to estimate the study
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37 223 participants' body mass index (BMI). BMI, also referred to as Quetelet's Index (33), was derived
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39 224 by dividing weight in kilograms by the squared height in meters. Based on the BMI (kg/m^2)
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41 225 estimates, and according to World Health Organization guidelines (34), the participants were
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43 226 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
44
45 227 overweight and obesity were estimated for each country. Place of residence was designated as
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47 228 rural and urban according to country specific definitions; however, the present analyses were
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49 229 restricted to the urban sample only. This is based on the evidence that the bane of overweight
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51 230 and obesity in Africa is more prevalent in the urban settings relative to other settings (18, 21).
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232 **Analytical strategy**

233 We used STATA 13 to perform the data analyses. A data file was constructed by using place of
234 residence, country, survey year, and sample size. The analyses were conducted in three key
235 steps. Initially, prevalence of overweight and obesity in selected countries in Africa with at least
236 three DHS data points was graphed. In this step, only point estimates were reported, and since
237 point estimates are not affected by the complex survey design, the DHS weight for each survey
238 was used to get a reliable estimate. We then computed, at 95% confidence intervals (CI), the
239 outcomes of interest by year of survey for each country in the second step. Because CIs are
240 affected by the sampling design, we took into account the complex survey design (CSD) of DHS
241 within the *svyset* and *svy* procedures in STATA. To avoid flawed variances and biased
242 confidence intervals owing to the complex survey design, the analyses were conducted on the
243 sub-sample with the full sample (urban+rural) maintained in the dataset. In STATA, this is
244 achieved with the "subpop" in *svy* procedures. In the third step, we examined statistical
245 significance of the trends of overweight and obesity. To achieve this, we performed a
246 multinomial logistic regression with time (year of survey) as the key independent variable using
247 BMI<25 kg/m² category as the base outcome and taking into account the CSD. While in steps 1
248 and 2 the time point data sets were treated independently, we pooled the data sets for trend
249 analyses. To account for sampling weight, the weight in the pooled data was divided by the
250 number of surveys available for the respective countries.

251

252 **Results**

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

20 **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

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4	Cameroon	1998	2004	2011	---	---
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7	Samples	838	2,819	4,161	---	7,818
8						
9						
10	Ethiopia	2000	2005	2011	---	---
11						
12						
13	Samples	1,550	1,299	1,817	---	4,666
14						
15						
16	Guinea	1999	2005	2012	---	---
17						
18						
19	Samples	1,415	1,263	1,818	---	4,496
20						
21						
22	Lesotho	2004	2009	2014	---	---
23						
24						
25	Samples	640	648	761	---	2,049
26						
27						
28	Madagascar	1997	2003	2008	---	---
29						
30						
31	Samples	722	2,708	2,079	---	5,509
32						
33						
34	Mozambique	1997	2003	2011	---	---
35						
36						
37	Samples	949	3,320	3,308	---	7,577
38						
39						
40	Nigeria	2003	2008	2013	---	---
41						
42						
43	Samples	1,831	6,659	8,976	---	17,466
44						
45						
46	Namibia	1992	2006	2013	---	---
47						
48						
49	Samples	1,090	1,854	2,142	---	5,086
50						
51						
52	Chad	1996	2004	2014	---	---
53						
54						
55	Samples	2,443	2,112	3,396	---	7,951
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Total sample

191,836

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259 Table 2 provides period estimates and trends in overweight and obesity in 13 countries with 4
 260 or more data points. These surveys cover periods between 14 years in Rwanda and 21 years in
 261 Ghana, Kenya and Zambia. The earliest data points in these countries were in the 1990s and the
 262 latest are after 2010. Across all 13 countries, levels of overweight reached or exceeded 20%
 263 only in Egypt (36%) and Zimbabwe (28%) in the 1990s surveys. Obesity reached a double digit
 264 of 10% or more only in Egypt (34%), and Zimbabwe (13%). In all the other countries,
 265 overweight was under 20% and obesity was under 10%. In the latest surveys conducted since
 266 2010 in these countries, overweight exceeded 20% in all countries except Burkina Faso and
 267 Malawi where the prevalence was around 16%. The increase overtime was not also statistically
 268 significant in these two countries. In 4 countries, the prevalence of overweight exceeded 30%
 269 (Egypt (44%), Niger (32%), Rwanda (31%) and Ghana (30%)). Obesity exceeded 10% in all
 270 countries in the 2010s surveys with Egypt (39%) and Ghana (22%) leading in levels of obesity.
 271 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	1993	1998	2003	2008	2014	<i>p</i>	Nature of trend
Ghana							
<i>Overweight</i>							
(%)	17.9	17.0	24.8	26.2	30.4	<i>p</i> <.05	↗
(95% CI)	17.9, 18.2	13.6, 21.1	21.3, 28.7	24.2, 28.3	26.3, 34.9		

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Obesity

(%)	7.7	13.8	17.9	14.2	22.0	p<.05	↗
(95% CI)	7.0, 8.5	10.6, 17.8	14.7, 21.5	12.7, 15.8	18.3, 26.3		

Egypt*Overweight*

(%)	35.5	35.0	40.6	39.1	44.2	p<.05	↗
(95% CI)	32.9, 38.2	32.7, 37.3	38.2, 43.2	36.7, 41.6	42.0, 46.5		

Obesity

(%)	34.2	29.6	39.1	41.2	39.2	p<.05	↗
(95% CI)	31.0, 37.6	26.7, 32.7	36.4, 42.0	38.6, 43.9	36.6, 41.8		

Kenya*Overweight*

(%)	19.5	19.0	26.6	27.5	28.9	p<.05	↗
(95% CI)	15.0, 24.9	15.4, 23.3	23.3, 30.3	22.8, 32.9	26.1, 31.9		

Obesity

(%)	6.4	5.1	10.7	10.5	15.0	P<.05	↗
(95% CI)	4.1, 9.8	3.3, 7.9	8.1, 14.1	7.7, 14.3	12.7, 17.6		

Zambia*Overweight*

(%)	17.3	15.7	12.1	22.0	23.1	p<.05	↗
(95% CI)	15.2, 19.6	13.8, 17.9	10.3, 14.2	18.9, 25.4	21.2, 25.2		

Obesity

(%)	4.9	4.4	4.3	8.4	11.5	p<.05	↗
(95% CI)	3.8, 6.4	3.4, 5.7	3.2, 5.9	6.6, 10.5	9.8, 13.5		

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	1993	1998	2003	2010			
Burkina Faso					---		
<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					---		
<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					---		
<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	---		

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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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Overweight

(%)

24.4

14.4

23.3

31.1

p<.05

↗

(95% CI)

23.1, 25.6

11.0, 18.8

19.4, 27.6

26.5, 36.1

Obesity

(%)

6.8

4.5

7.5

12.6

p<.05

↗

(95% CI)

6.1, 7.3

2.6, 7.8

4.9, 11.4

10.0, 15.7

Tanzania**1991****1996****2004****2009**

Overweight

(%)

14.1

20.5

18.9

21.0

p<.05

↗

(95% CI)

11.1, 17.8

20.1, 20.9

18.5, 19.3

20.4, 22.2

Obesity

(%)

3.6

7.8

9.7

11.8

p<.05

↗

(95% CI)

2.4, 5.3

7.2, 7.9

9.4, 10.1

11.1, 12.1

Uganda**1995****2000****2006****2011**

Overweight

(%)

14.1

22.7

23.7

25.4

p<.05

↗

(95% CI)

11.1, 17.8

18.9, 26.9

16.9, 32.2

20.0, 31.7

Obesity

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	1994	1999	2005	2010			
(%)	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

272

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

22

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				<i>p</i>	Nature of trend
Senegal	1993	2005	2010		
Overweight					
(%)	18.8	21.9	21.6	<i>p</i> >.05	→
(95% CI)	16.3, 21.6	17.0, 27.6	18.2, 25.4		
Obesity					
(%)	8.5	12.8	15.2	<i>p</i> <.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	<i>p</i> >.05	→
(95% CI)	16.1, 20.8	16.1, 21.7	21.4, 28.8		
Obesity					
(%)	6.9	9.0	11.8	<i>p</i> >.05	→
(95% CI)	5.1, 9.2	7.1, 11.4	9.1, 15.1		
Cameroon	1998	2004	2011		
Overweight					

24

(%) 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

24

25

(%) 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

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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
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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

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

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

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13 294 **Countries:** BF= Burkina Faso; BJ= Benin; CI=Ivory Coast; CM= Cameroon; EG= Egypt; ET=Ethiopia; GH= Ghana; GN=

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15 295 Guinea; KE= Kenya; LS= Lesotho; MD= Madagascar; ML= Mali; MW= Malawi; MZ= Mozambique; NG= Nigeria; NI=

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17 296 Niger; NM= Namibia; RW= Rwanda; SN= Senegal; TD = Chad; TZ= Tanzania; UG= Uganda; ZM=Zambia; ZW=

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38 303 **Discussion**

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41 304 We set out to investigate the prevalence and time trends in overweight and obesity between

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44 305 1991 and 2014 in 24 African countries. Primarily, we confirm that the prevalence of overweight

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47 306 and obesity among urban women has rapidly increased in the past two and a half decades. All

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50 307 24 countries included in our analyses experienced an increase in overweight and obesity over

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53 308 the time period under consideration. However, the increase was only statistically significant in

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56 309 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. The changes

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59 310 over time were particularly noticeable among countries with 4 or more survey data points, in

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3 311 which case, all the 13 countries showed a statistically significant increase in obesity, while 10
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6 312 showed significant increase for overweight during the period of the study. For countries with
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9 313 three data points, only 4 of the 11 countries had a significant increase for overweight and 3 for
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11 314 obesity. This suggests that length of time (number of data points) plays a role in understanding
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13 315 the changes in overweight and obesity over time. We also found that 18 of the 24 countries had
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16 316 an overweight prevalence above 20%, based on the most recent survey waves for the
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19 317 respective countries. This was not the case in the earlier surveys where only 6 countries had an
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21 318 overweight prevalence of 20% or above. Four countries of the 24 had an obesity prevalence
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23 319 that was above 20%, with the prevalence in the rest ranging between 10% and 19% based on
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26 320 the latest surveys. However, in the earlier surveys, only one country had obesity prevalence of
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29 321 20% or more, while the rest had obesity rate ranging from 1 to 12%. This points to worsening
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31 322 phenomenon of obesity among urban women in the past two and half decades. Another key
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33 323 finding is that in most of the countries included in our analyses, obesity increased alongside
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36 324 overweight, suggesting that urban women who are overweight have a greater probability of
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39 325 progressing to obesity. Thus, addressing overweight will, to a larger extent curtail the
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41 326 increasing incidence of obesity in urban Africa.
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328 Focusing on individual countries, we found significant differences in overweight and obesity
329 across the countries included in the analysis. For example, in the most recent surveys, Egypt has
330 the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with
331 an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two
332 other countries with overweight prevalence of 30% and above. The results on Egypt are not

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3 333 surprising as the country was previously ranked among the countries in the world with the most
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6 334 obese people (35). The results in Ghana are also consistent with previous findings (15). Egypt
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9 335 and Ghana also experienced a significant increase in overweight and obesity in the past two and
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11 336 half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in
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13 337 Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and
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16 338 Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the
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18 339 prevalence of obesity in the aforementioned countries may be considered lower than that of
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21 340 Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests
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23 341 that in the next decades, the obesity rates in these countries may catch up with Egypt and
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26 342 Ghana, which are currently leading in terms of the level of prevalence of both overweight and
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28 343 obesity. However, overweight and obesity did not show any significant changes over time in
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31 344 Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest
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33 345 prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and
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36 346 Madagascar in a recent study using the DHS data from 32 African countries (29).
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42 348 The increasing prevalence and trends of overweight and obesity in Africa is attributed largely to
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45 349 rapid urbanization taking place in the continent and its associated nutritional transition. For
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48 350 example, in 2010, the share of the African urban population was about 36% and is projected to
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50 351 increase to 50% and 60% by 2030 and 2050 respectively (36). Using Ghana as a case in point,
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52 352 for the first time, the Ghana Population and Housing Census shows that a little over half (50.9%)
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55 353 of country's population live in urban areas compared to rural areas (37). The growing
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57 354 urbanization comes along with lifestyle changes such as decreased physical activity and
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3 355 increase supply of high caloric fast foods and sugar sweetened beverages (16, 38-40). Indeed,
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6 356 sedentary lifestyle and high consumption of energy dense diets are found to account for the
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9 357 increasing burden of overweight and obesity in urban settings of the low and middle income
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11 358 countries (LMIC) (21-23). The consequences of which, is increase in non-communicable
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13 359 diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart
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16 360 disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body
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19 361 mass index (BMI) (3, 4, 40). In addition, an increased burden of disability-adjusted life years
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21 362 (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be
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23 363 implemented to address the problem of overweight and obesity, thereby curbing associated
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26 364 NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important
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29 365 step towards curbing the surge of NCDs the continent is currently experiencing, which is likely
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31 366 to surpass the toll of sickness and death from infectious diseases by 2030 (41). This will further
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33 367 contribute greatly to the potential for African countries to achieve Sustainable Development
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36 368 Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases
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39 369 through prevention, and treatment, and promote mental health and wellbeing by 2030 (42).

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45 371 In the light of the findings of our study and literature discussed above, we particularly advocate
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47 372 for targeted interventions to address the incidence of overweight and obesity among urban
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50 373 dwelling women. Intervention strategies, described in the literature as 'effective and essential'
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52 374 (43) in addressing overweight and obesity in a developing country context include, policy
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55 375 interventions and inter-sectoral partnerships; addressing food system drivers of caloric over-
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58 376 consumption; and improving eating and physical activity environments in key community

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3 377 settings (43). It is believed that effective implementation of these strategies has the potential to
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6 378 curtail the incidence of overweight and obesity. It is important to recognize that large
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9 379 inequalities remain a major issue in many African countries, which may have a bearing on areas
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11 380 that ought to be prioritized and targeted for interventions. For example, in many African
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13 381 countries, it is common to see problems of undernutrition alongside increasing rates of
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16 382 overweight and obesity. This “dual burden” of undernutrition and obesity exists not only at
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19 383 country- or community-level, but all the way down to households (16, 44). Undernutrition
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21 384 persists as a significant problem (45) in many African countries, and interventions have been
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23 385 put in place to address it (46-48). However, the issue of overweight and obesity has not
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26 386 received adequate attention as yet in Africa (16, 48). More attention of policy makers and
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29 387 public health practitioners on ways to address the overweight and obesity epidemic, taking into
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31 388 account undernutrition is warranted.

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37 390 **Strengths and limitations**

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40 391 The key strength of this study is the use of nationally representative data sets, thereby
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43 392 providing more robust estimates of the prevalence and trends of overweight and obesity in the
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45
46 393 respective countries. Further, height and weight as used in the calculation of BMI, was
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49 394 objectively measured by well-trained technicians, reducing possible misclassification of
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51 395 overweight and obesity. The study is also associated with some limitations. To maintain sample
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53 396 comparability over time, we had to limit our sample to women with children under 5 years old.
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56 397 This may, to some extent, affect the generalizability of the findings, as the sample may not be
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3 398 representative of the entire female population. Another limitation is the cross-sectional nature
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6 399 of the data. Because the surveys used in this analysis were conducted at different times across
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9 400 countries, we were unable to estimate the change in BMI across all countries for the entire
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11 401 survey period. Lack of uniformity in the definition of urban and rural settings may also affect
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13 402 the comparability of the findings across countries, since different countries have different
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16 403 definitions of what constitutes urban versus rural. Lastly, one methodological limitation is that
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19 404 we pooled the data to perform the trend analysis, which may lead to an overestimation of
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21 405 statistical power. To address this limitation, the weight in the pooled data was divided by the
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23 406 number of surveys available for the country.
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36 410 **Conclusions**

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39 411 The study provided clear evidence of increase in overweight and obesity among women in the
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41 412 urban settings of all the countries included in the analysis, with the increase overtime being
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43 413 statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for
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46 414 overweight. We have supported the finding that women dwelling in urban settings are prone
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49 415 to overweight and obesity. The prevalence of obesity increased more than two fold in most
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52 416 countries and more than three fold in others. The prevalence of obesity increased alongside
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55 417 overweight. These findings call for deliberate strategies and interventions by policy makers,
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57 418 politicians and health promotion experts, focusing on healthy diet, physical activity, weight
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3 419 reduction and maintenance strategies in African countries, particularly in urban areas to curb
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6 420 the growing proportion of unhealthy weight women of child bearing age in urban Africa.
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9 421 Strategies should include measures such as price reduction for healthy foods (e.g., fruits and
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11 422 vegetables) and promotion of physical activity.
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41
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43
44
45 433 roles in the data collection process.
46
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48 434

51 435 **Competing Interest**

52
53
54 436 The authors have no competing interests to declare.
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56

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1
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6
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8

9
10 440 This study was a re-analysis of existing data that are publicly available from The DHS Program at
11
12 441 <http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm>. Data are
13
14 442 accessible free of charge upon a registration with the Demographic and Health Survey program
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16
17 443 (The DHS Program). The registration is done on the DHS website indicated above.
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20 444 **Authors' Contribution**
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24 445 DAA conceived and designed the study, interpreted the results, wrote the first draft of the
25
26 446 manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD
27
28 447 contributed to the drafting of the analytical strategy. ZTD, SM BM and ACE contributed to
29
30 448 study design, data interpretation, and critical revision of the manuscript. All authors take
31
32 449 responsibility of any issues that might arise from the publication of this manuscript.
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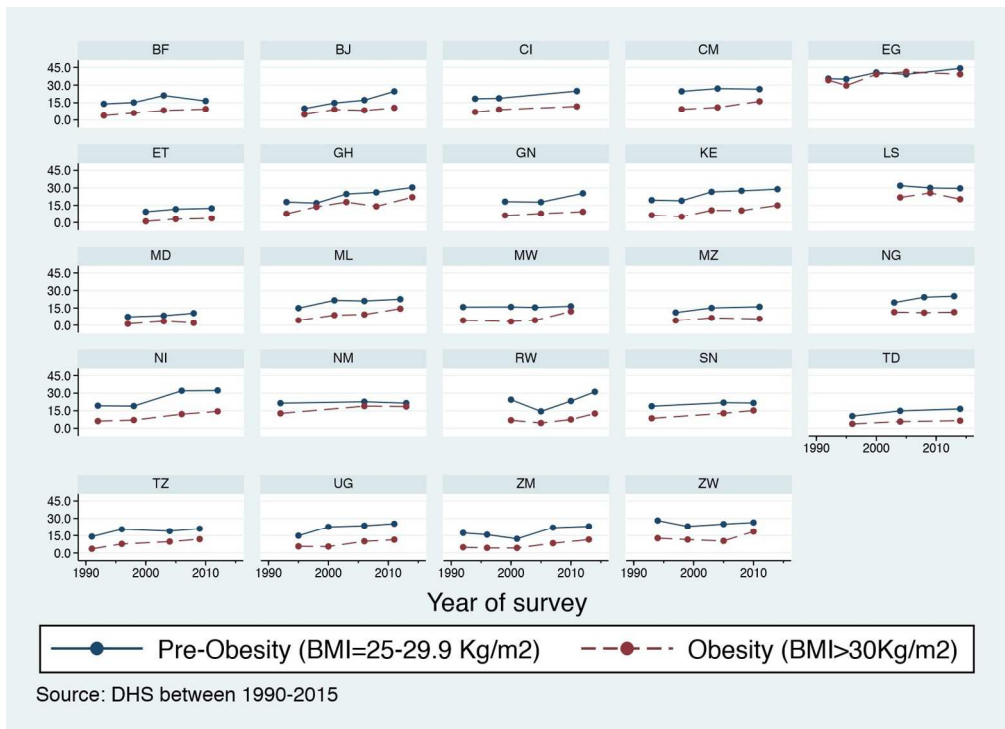
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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	9
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —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.

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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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2
3 29 **Abstract**
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6 30 **Objective(s):** To examine the prevalence and trends in overweight and obesity among non-
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9 31 pregnant urban women in Africa over the past two and half decades.
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12 32 **Design:** Cross-sectional surveys conducted between 1991 and 2014.
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15 33 **Settings:** Demographic and Health Surveys (DHS), repeated cross-sectional data collected in 24
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18 34 African countries.
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21 35 **Participants:** Adult non-pregnant women aged 15–49 years. The earlier DHS surveys collected
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24 36 anthropometric data on only those women who had children aged 0–5 years. The main
25
26 37 analyses were limited to this subgroup. The participants were classified as overweight (25.0-
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28 38 29.9 kg/m²) and obese (≥ 30.0 kg/m²).
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31
32 39 **Results:** The prevalence of overweight and obesity among women increased in all the 24
33
34 40 countries. Trends were statistically significant in 17 of the 24 countries in the case of obesity
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36 41 and 13 of the 24 for overweight. In Ghana, overweight almost doubled ($p = .001$) while obesity
37
38 42 tripled ($p = .001$) between 1993 and 2014. Egypt has the highest levels of overweight and
39
40 43 obesity at 44% (95% CI: 42, 46.5) and 39% (95% CI: 36.6, 41.8) respectively in 2014 and the
41
42 44 trend showed significant increase ($p = .005$) from 1995 levels. Also, increase in obesity doubled
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44 45 in Kenya, Benin, Niger, Rwanda, Ivory Coast and Uganda, while tripled in Zambia, Burkina Faso,
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46 46 Mali, Malawi and Tanzania. Ethiopia and Madagascar had the lowest prevalence of both obesity
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50 47 and overweight, with overweight ranging from 7 to 12% and obesity from 1 to 4%.
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4 48 **Conclusions:** Overweight and obesity are increasing among women of reproductive age in
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6 49 urban Africa, with obesity among this age group having more than doubled or tripled in 12 of
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9 50 the 24 countries. There is an urgent need for deliberate policies and interventions to encourage
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11 51 active lifestyles and healthy eating behaviour to curb this trend in urban Africa.
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14 52 **Keywords:** Overweight, obesity, Africa, prevalence, trends, urban
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7 57**Strengths and Limitations of the Study**

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10 58
- Use of nationally representative data sets, thereby enhancing the generalizability of the
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12 59 findings
- Height and weight used in the calculation of BMI, was objectively measured, possibly
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14 60 reducing misclassification
- Analysis limited to women with children under 5 years old and may affect the
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16 61 generalizability of the findings to all women
- Lack of uniformity in the definition of urban and rural settings across countries
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75 Introduction

76 Overweight and obesity are global public health problems, especially among women in urban
77 settings (1, 2). Worldwide, it is estimated that 2.8 million people die each year as a result of
78 being overweight or obese, and that 35.8 million of global disability-adjusted life years (DALYs)
79 are caused by overweight and obesity (3). There is also evidence that the risks of coronary heart
80 disease, ischemic stroke and type 2 diabetes mellitus increase steadily with increasing body
81 mass index (BMI), a measure of weight relative to height (3, 4). Furthermore, high BMI is found
82 to elevate the risk of breast, colon, prostate, endometrium, kidney and gall bladder cancers (3).
83 A recent study showed that overweight and obesity are linked to 13 different cancers (5).
84 The consequences of overweight and obesity on women of reproductive age are more serious,
85 especially during pregnancy. Studies have shown that maternal obesity can result in negative
86 outcomes in both mothers and fetuses, including gestational diabetes, preeclampsia, an
87 increased miscarriage rate (6, 7), and stillbirth and congenital anomalies. Obesity in pregnancy
88 can also affect health later in life for both mother and child, including increased risk of heart
89 disease, hypertension, and diabetes (6). Children also have a risk of future obesity. Overweight
90 and obesity are associated with decreased contraceptive efficacy and ovulatory disorders in
91 women of reproductive age (7), and increasing maternal BMI exerts a progressive adverse
92 effect on vaginal delivery rates for both primigravid and multigravid women (8). Obese mothers
93 were more likely than other mothers to terminate breastfeeding when the infant showed
94 satiation cues (9). Obese mothers with higher BMI were also reported using more restrictive
95 feeding practices, limiting the quantity and quality of foods provided to their toddlers, and were
96 observed to use more pressure in getting their children to eat during mealtimes (10,

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3 97 11). Together, these findings show the varied effects of overweight and obesity on women of
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6 98 reproductive age and their children.
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12 100 The literature demonstrates that the magnitude of the effect of BMI on health is largely linked
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15 101 to the level of BMI. For instance, there is an increased risk of co-morbidities for individuals with
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17 102 a BMI of 25.0 to 29.9 kg/m² (defined as overweight), and moderate to severe risk of co-
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20 103 morbidities for individuals with a BMI greater than 30 kg/m² (defined as obesity) (3, 6). The
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22 104 World Health Organization (WHO) (3, 6) recommends that for optimum health, the median
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25 105 body mass index for an adult population should be in the range of 21 to 23 kg/m², while the
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27 106 goal for individuals should be to maintain body mass index in the range of 18.5 to 24.9 kg/m².
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30 107 This is often difficult to achieve as evidence shows that global overweight and obesity trends
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32 108 are on the rise, with the developing world now bearing the brunt of the surge (7). This dynamic
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35 109 calls for more studies to systematically document these trends over time, especially in
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37 110 developing country contexts.
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44 112 Hitherto, overweight and obesity were not public health issues on the African continent.
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46 113 However, rapid changes have been observed, and many countries in Africa are currently
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49 114 confronted with overweight and obesity, particularly among women, coupled with a resulting
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51 115 increase in the prevalence of non-communicable diseases (NCDs) (4, 12, 13). In Africa, women
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54 116 had approximately double the obesity prevalence of men (3), with urban settings being the
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56 117 most affected. Thus, the burden of overweight and obesity among urban women is increasing
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3 118 at an alarming rate in developing countries, and particularly in Africa for that matter (1, 14). In
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6 119 Ghana for example, systematic review and meta-analysis revealed that overweight among
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9 120 urban women was 11 percentage points higher than rural women, while obesity was two times
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11 121 higher in urban relative to rural women (15). Similar trends were obtained using data from 42
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13 122 countries in Asia, the Middle East, Africa (East, West, Central and Southern), and Latin America,
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16 123 with a combined overweight/obesity prevalence of 37.2% among urban women compared to
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18 124 19% of rural women (16). The study however noted regional differences, with rural women in
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21 125 Latin America, the Middle East, and North Africa having much higher increases in the
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23 126 prevalence of overweight/obesity compared to their urban counterparts. Conversely, in
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26 127 different multi-country analysis, overweight was increasing more quickly in urban areas than in
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28 128 rural areas of lower-income countries such as Bangladesh and Uganda, but increasing more
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31 129 quickly in rural areas compared to urban areas of upper-middle-income countries, such as
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33 130 Jordan and Peru (17).

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40 132 The trend observed above may be attributable to an increased intake of energy-dense foods
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42 133 that are high in fat; and an increase in physical inactivity due to the increasing sedentary nature
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44 134 of many occupations, increased use of motorized transportation, and urbanization (1, 18-20).
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47 135 Increasingly, sedentary lifestyles and high consumption of energy dense diets account for the
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50 136 increasing burden of overweight and obesity in urban settings of low and middle-income
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52 137 countries (LMIC) (21-23). Various other studies have argued that the association between urban
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55 138 residence and obesity in LMICs is driven largely by higher individual- and community-level
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57 139 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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9 142 example, lower SES populations in some of these countries now have higher prevalence of
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11 143 overweight, mimicking long-standing associations between low SES and poorer health in LMICs
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13 144 (4, 24-26). This changing trend is particularly widespread among the urban population. A study
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16 145 in urban poor settlements in Nairobi, Kenya confirmed high levels of overweight and obesity
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18 146 among women (27). Another study using data from 7 African countries showed that the
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21 147 increase in overweight and obesity was higher among the poorest urban dwellers compared to
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23 148 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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37 153 overweight and obesity in this study across several countries in the region, is a critical step in
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39 154 the provision of insights into the extent of the problem over time, especially in urban settings,
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41 155 which is needed to inform policy and program interventions to address the challenge in urban
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44 156 Africa.
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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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56 160 together in their analyses (2, 13), analysed overweight and obesity together (26), or used one
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3 161 data point (29). These attempts may mask the seriousness of the problem in urban settings and
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6 162 the important differences in the trends and prevalence of overweight and obesity over time.
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9 163 Also, the presentation of the results in some of these studies makes it difficult for policy makers
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11 164 to appreciate the extent of the problem. The present study elucidates the prevalence and time
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13 165 trends in overweight and obesity separately, and presents the results in a way that makes it
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16 166 easier for policy makers to understand the extent of the problem in urban settings.
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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.

198

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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3 201 and Housing Census data of the respective countries. The clusters are then selected using
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6 202 systematic sampling with probability proportional to size. A household listing operation is then
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9 203 conducted in all the selected clusters to provide a sampling frame for the second stage
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11 204 selection of households. The second stage of selection involves the systematic sampling of
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13 205 households listed in each cluster. The primary objective of the second stage of selection is to
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16 206 ensure adequate numbers of completed individual interviews to provide estimates for key
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18 207 indicators with acceptable precision (31). We limited our analyses to adult non-pregnant
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21 208 women of reproductive age, 15–49 years in all countries. This is because pregnant women
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23 209 naturally gain weight during the course of their pregnancy, including them in the analysis may
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26 210 present a misleading picture about the issue of overweight and obesity among women. Since
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28 211 the earlier DHS surveys collected anthropometry data on only those women who had children
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31 212 aged 0–5 years (26, 32), we further restricted our main analyses to this subgroup. For the total
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33 213 of 224,940 urban women who met eligibility criteria, anthropometric data were available for
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36 214 191,836 (85.3 %).

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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.

222 Variables

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

235

236 Analytical strategy

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

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3 243 account the complex survey design (CSD) of DHS within the *svyset* and *svy* procedures in STATA.
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6 244 In STATA, this is achieved with the “subpop” in *svy* procedures. In the third step, we examined
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9 245 statistical significance of the trends of overweight and obesity. To achieve this, we performed a
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11 246 multinomial logistic regression with time (year of survey) as the key independent variable using
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13 247 BMI<25 kg/m² category as the base outcome and taking into account the CSD. While in steps 1
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16 248 and 2 the time point data sets were treated independently, we pooled the data sets for trend
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18 249 analyses. To account for sampling weight, the weight in the pooled data was divided by the
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21 250 number of surveys available for the respective countries.
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262 **Results**

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

269

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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4	Rwanda	2000	2005	2010	2014	---	
5						---	
6	Samples	1,528	1,524	1,112	1,604	---	5,768
7						---	
8	Tanzania	1991	1996	2004	2009	---	
9						---	
10	Samples	1,128	1,247	1,336	1,404	---	5115
11						---	
12	Uganda	1995	2000	2006	2011	---	
13						---	
14	Samples	1,462	1,510	826	1,539	---	4,593
15						---	
16	Zimbabwe	1994	1999	2005	2010	---	
17						---	
18	Samples	508	1,685	1,298	1,500	---	4,991
19					---	---	
20	Senegal	1993	2005	2010		---	
21					---	---	
22	Samples	1,683	3,180	3,373		---	8,236
23					---	---	
24	Ivory Coast	1994	1998	2011		---	
25					---	---	
26	Samples	1,470	1,040	2,344		---	4,854
27					---	---	
28	Cameroon	1998	2004	2011		---	
29					---	---	
30	Samples	838	2,819	4,161		---	7,818
31					---	---	
32	Ethiopia	2000	2005	2011		---	
33					---	---	
34	Samples	1,550	1,299	1,817		---	4,666
35					---	---	
36	Guinea	1999	2005	2012		---	
37					---	---	
38	Samples	1,415	1,263	1,818		---	4,496
39					---	---	
40	Lesotho	2004	2009	2014		---	
41					---	---	
42	Samples	640	648	761		---	2,049
43					---	---	
44	Madagascar	1997	2003	2008		---	
45					---	---	
46	Samples	722	2,708	2,079		---	5,509
47					---	---	
48	Mozambique	1997	2003	2011		---	
49					---	---	
50	Samples	949	3,320	3,308		---	7,577
51					---	---	
52	Nigeria	2003	2008	2013		---	
53					---	---	
54	Samples	1,831	6,659	8,976		---	17,466
55					---	---	
56	Namibia	1992	2006	2013		---	
57					---	---	
58	Samples	1,090	1,854	2,142		---	5,086
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Chad	1996	2004	2014	---	---	
Samples	2,443	2,112	3,396	---	---	7,951
Total sample						191,836

270

271 Table 2 provides period estimates and trends in overweight and obesity in 13 countries with 4
 272 or more data points. These surveys cover periods between 14 years in Rwanda and 21 years in
 273 Ghana, Kenya and Zambia. The earliest data points in these countries were in the 1990s and the
 274 latest are after 2010. Across all 13 countries, levels of overweight reached or exceeded 20%
 275 only in Egypt (36%) and Zimbabwe (28%) in the 1990s surveys. Obesity reached a double digit
 276 of 10% or more only in Egypt (34%), and Zimbabwe (13%). In all the other countries,
 277 overweight was under 20% and obesity was under 10%. In the latest surveys conducted since
 278 2010 in these countries, overweight exceeded 20% in all countries except Burkina Faso and
 279 Malawi where the prevalence was around 16%. The increase overtime was not also statistically
 280 significant in these two countries. In 4 countries, the prevalence of overweight exceeded 30%
 281 (Egypt (44%), Niger (32%), Rwanda (31%) and Ghana (30%)). Obesity exceeded 10% in all
 282 countries in the 2010s surveys with Egypt (39%) and Ghana (22%) leading in levels of obesity.
 283 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						<i>p</i>	Nature of trend
Ghana	1993	1998	2003	2008	2014		
<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		

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<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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4	Overweight				---		
5	(%)	14.9	21.6	21.0	22.5	---	
6						p<.05	↗
7	(95% CI)	12.6, 17.4	18.4, 25.1	18.3, 23.9	19.1, 26.4	---	
8							
9	Obesity						
10	(%)	4.3	8.8	9.4	14.4	---	
11						p<.05	↗
12	(95% CI)	3.1, 5.8	6.9, 11.1	7.7, 11.4	11.7, 17.5	---	
13							
14	Malawi	1992	2000	2004	2010	---	
15							
16	Overweight						
17	(%)	15.8	15.9	15.4	16.4	---	
18						p>.05	→
19	(95% CI)	12.3, 20.0	13.1, 19.1	12.1, 19.5	12.7, 21.1	---	
20							
21	Obesity						
22	(%)	4.1	3.2	4.3	12.1	---	
23						P<.05	↗
24	(95% CI)	2.6, 6.4	2.0, 5.1	2.8, 6.7	8.2, 17.5	---	
25							
26	Niger	1992	1998	2006	2012	---	
27							
28	Overweight						
29	(%)	19.2	19.0	32.0	32.23	---	
30						p<.05	↗
31	(95% CI)	16.8, 22.0	15.5, 23.0	27.8, 36.6	28.5, 36.3	---	
32							
33	Obesity						
34	(%)	6.1	7.0	12.1	14.4	---	
35						p<.05	↗
36	(95% CI)	4.9, 7.6	5.2, 9.3	9.4, 15.4	11.7, 17.6	---	
37							
38	Rwanda	2000	2005	2010	2014	---	
39							
40	Overweight						
41	(%)	24.4	14.4	23.3	31.1	---	
42						p<.05	↗
43	(95% CI)	23.1, 25.6	11.0, 18.8	19.4, 27.6	26.5, 36.1	---	
44							
45	Obesity						
46	(%)	6.8	4.5	7.5	12.6	---	
47						p<.05	↗
48	(95% CI)	6.1, 7.3	2.6, 7.8	4.9, 11.4	10.0, 15.7	---	
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50	Tanzania	1991	1996	2004	2009	---	
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4	Overweight				---		
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6	(%)	14.1	20.5	18.9	21.0	p<.05	↗
7					---		
8	(95% CI)	11.1, 17.8	20.1, 20.9	18.5, 19.3	20.4, 22.2		
9					---		
10	Obesity						
11					---		
12	(%)	3.6	7.8	9.7	11.8	p<.05	↗
13					---		
14	(95% CI)	2.4, 5.3	7.2, 7.9	9.4, 10.1	11.1, 12.1		
15					---		
16	Uganda	1995	2000	2006	2011		
17							
18	Overweight						
19							
20	(%)	14.1	22.7	23.7	25.4	p<.05	↗
21							
22	(95% CI)	11.1, 17.8	18.9, 26.9	16.9, 32.2	20.0, 31.7		
23							
24	Obesity						
25							
26	(%)	5.6	5.5	10.0	11.4	p<.05*	↗
27							
28	(95% CI)	4.2, 7.6	4.0, 7.6	5.2, 18.3	7.8, 16.4		
29							
30	Zimbabwe	1994	1999	2005	2010		
31							
32	Overweight						
33							
34	(%)	28.2	23.1	25.1	26.5	p>.05	→
35							
36	(95% CI)	23.3, 33.7	21.0, 25.4	22.0, 28.5	23.5, 29.7		
37							
38	Obesity						
39							
40	(%)	12.7	11.5	10.3	18.5	p>.05	↗
41							
42	(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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285 Table 3 shows the results for the 11 countries with only three data points. The periods covered

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

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

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

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

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

Country				<i>p</i>	Nature of trend
Senegal	1993	2005	2010		
Overweight					
(%)	18.8	21.9	21.6	<i>p</i> >.05	→
(95% CI)	16.3, 21.6	17.0, 27.6	18.2, 25.4		
Obesity					
(%)	8.5	12.8	15.2	<i>p</i> <.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	<i>p</i> >.05	→
(95% CI)	16.1, 20.8	16.1, 21.7	21.4, 28.8		
Obesity					
(%)	6.9	9.0	11.8	<i>p</i> >.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	<i>p</i> >.05	→
(95% CI)	21.3, 28.3	23.8, 30.5	23.9, 29.3		
Obesity					
(%)	9.3	10.9	16.1	<i>p</i> >.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	<i>p</i> >.05	→
(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	↗
(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

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

300

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

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

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3 313 **Discussion**
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6 314 We set out to investigate the prevalence and time trends in overweight and obesity between
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8 315 1991 and 2014 in 24 African countries. Primarily, we confirm that the prevalence of overweight
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10 316 and obesity among urban women has rapidly increased in the past two and a half decades. All
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12 317 24 countries included in our analyses experienced an increase in overweight and obesity over
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14 318 the time period under consideration. However, the increase was only statistically significant in
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16 319 17 of the 24 countries in the case of obesity and 13 out of the 24 for overweight. The changes
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18 320 over time were particularly noticeable among countries with 4 or more survey data points, in
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20 321 which case, all the 13 countries showed a statistically significant increase in obesity, while 10
21
22 322 showed significant increase for overweight during the period of the study. For countries with
23
24 323 three data points, only 4 of the 11 countries had a significant increase for overweight and 3 for
25
26 324 obesity. This suggests that length of time (number of data points) plays a role in understanding
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28 325 the changes in overweight and obesity over time. We also found that 18 of the 24 countries had
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30 326 an overweight prevalence above 20%, based on the most recent survey waves for the
31
32 327 respective countries. This was not the case in the earlier surveys where only 6 countries had an
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34 328 overweight prevalence of 20% or above. Four countries of the 24 had an obesity prevalence
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36 329 that was above 20%, with the prevalence in the rest ranging between 10% and 19% based on
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38 330 the latest surveys. However, in the earlier surveys, only one country had obesity prevalence of
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40 331 20% or more, while the rest had obesity rate ranging from 1 to 12%. This points to worsening
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42 332 phenomenon of obesity among urban women in the past two and half decades. Another key
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44 333 finding is that in most of the countries included in our analyses, obesity increased alongside
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46 334 overweight. This is not unexpected, as women who are overweight (also known as pre-obesity)
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3 335 are naturally likely to become obese if efforts are not made by such women to control their
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6 336 weight. Thus, addressing overweight may, to a larger extent curtail incidence of obesity.
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12 338 Focusing on individual countries, we found significant differences in overweight and obesity
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14 339 across the countries included in the analysis. For example, in the most recent surveys, Egypt has
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16
17 340 the highest prevalence of overweight (44%) and obesity (39%) by far, followed by Ghana with
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19 341 an overweight prevalence of 30% and obesity of 22%. Niger (32%) and Rwanda (31%) were two
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21 342 other countries with overweight prevalence of 30% and above. The results on Egypt are not
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23 343 surprising as the country was previously ranked among the countries in the world with the most
24
25 344 obese people (35). The results in Ghana are also consistent with previous findings (15). Egypt
26
27 345 and Ghana also experienced a significant increase in overweight and obesity in the past two and
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29 346 half decades. Obesity increased by 65% (7.7% to 22%) in Ghana and by 12% (34% to 39%) in
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31 347 Egypt. Similarly, increase in obesity doubled in Kenya, Benin, Niger, Rwanda, Ivory Coast and
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33 348 Uganda, while tripled in Zambia, Burkina Faso, Mali, Malawi and Tanzania. Thus, while the
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35 349 prevalence of obesity in the aforementioned countries may be considered lower than that of
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37 350 Egypt and Ghana, the increment overtime has been doubling or tripling in rates. This suggests
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39 351 that in the next decades, the obesity rates in these countries may catch up with Egypt and
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41 352 Ghana, which are currently leading in terms of the level of prevalence of both overweight and
42
43 353 obesity. However, overweight and obesity did not show any significant changes over time in
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45 354 Cameroon, Lesotho, Madagascar and Nigeria. Ethiopia and Madagascar had the lowest
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47 355 prevalence of both obesity and overweight. Similar findings were obtained in Ethiopia and
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49 356 Madagascar in a recent study using the DHS data from 32 African countries (29).
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3 357 The increasing prevalence and trends of overweight and obesity in Africa may be attributed
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6 358 largely to rapid urbanization taking place in the continent and its associated nutritional
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9 359 transition. For example, in 2010, the share of the African urban population was about 36% and
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11 360 is projected to increase to 50% and 60% by 2030 and 2050 respectively (36). Using Ghana as a
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13 361 case in point, for the first time, the Ghana Population and Housing Census shows that a little
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16 362 over half (50.9%) of country's population live in urban areas compared to rural areas (37). The
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18 363 growing urbanization comes along with lifestyle changes such as decreased physical activity and
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21 364 increase supply of high caloric fast foods and sugar sweetened beverages (16, 38-40). Indeed,
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23 365 sedentary lifestyle and high consumption of energy dense diets are found to account for the
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26 366 increasing burden of overweight and obesity in urban settings of the low and middle income
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28 367 countries (LMIC) (21-23). The consequences of which, is increase in non-communicable
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31 368 diseases (NCDs), as there is substantial evidence that the risk of NCDs such as coronary heart
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33 369 disease, ischemic stroke and type 2 diabetes mellitus increases steadily with increasing body
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36 370 mass index (BMI) (3, 4, 40). In addition, an increased burden of disability-adjusted life years
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38 371 (DALYs) is associated with overweight and obesity (3). It is imperative that strategies be
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41 372 implemented to address the problem of overweight and obesity, thereby curbing associated
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43 373 NCD risk in urban Africa. Addressing the issue of overweight and obesity will be an important
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46 374 step towards curbing the surge of NCDs the continent is currently experiencing, which is likely
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49 375 to surpass the toll of sickness and death from infectious diseases by 2030 (41). This will further
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51 376 contribute greatly to the potential for African countries to achieve Sustainable Development
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53 377 Goals (SDG 3.4): reducing by one third premature mortality from non-communicable diseases
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56 378 through prevention, and treatment, and promote mental health and wellbeing by 2030 (42).
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3 379 In the light of the findings of our study and the literature discussed above, we particularly
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6 380 advocate for targeted interventions to address the incidence of overweight and obesity among
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9 381 urban dwelling women. Intervention strategies, described in the literature as ‘effective and
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11 382 essential’ (43) in addressing overweight and obesity in a developing country context include,
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13 383 policy interventions and inter-sectoral partnerships; addressing food system drivers of caloric
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16 384 over-consumption; and improving eating and physical activity environments in key community
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19 385 settings (43). It is believed that effective implementation of these strategies has the potential to
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21 386 curtail the incidence of overweight and obesity. It is important to recognize that large
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24 387 inequalities remain a major issue in many African countries, which may have a bearing on areas
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26 388 that ought to be prioritized and targeted for interventions. For example, in many African
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29 389 countries, it is common to see problems of undernutrition alongside increasing rates of
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31 390 overweight and obesity. This “dual burden” of undernutrition and obesity exists not only at
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34 391 country- or community-level, but all the way down to households (16, 44). Undernutrition
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36 392 persists as a significant problem (45) in many African countries, and interventions have been
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39 393 put in place to address it (46-48). However, the issue of overweight and obesity has not
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41 394 received adequate attention as yet in Africa (16, 48). More attention of policy makers and
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44 395 public health practitioners on ways to address the overweight and obesity epidemic, taking into
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46 396 account undernutrition is warranted.

49 **Strengths and limitations**

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52 398 The key strength of this study is the use of nationally representative data sets, thereby
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55 399 providing more robust estimates of the prevalence and trends of overweight and obesity in the
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58 400 respective countries. Further, height and weight as used in the calculation of BMI, was

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3 401 objectively measured by well-trained technicians, reducing possible misclassification of
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6 402 overweight and obesity. The study is also associated with some limitations. To maintain sample
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9 403 comparability over time, we had to limit our sample to women with children under 5 years old.
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11 404 This may, to some extent, affect the generalizability of the findings, as the sample may not be
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13 405 representative of the entire female population. Another limitation is the cross-sectional nature
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16 406 of the data. Because the surveys used in this analysis were conducted at different times across
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19 407 countries, we were unable to estimate the change in BMI across all countries for the entire
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21 408 survey period. Lack of uniformity in the definition of urban and rural settings may also affect
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23 409 the comparability of the findings across countries, since different countries have different
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26 410 definitions of what constitutes urban versus rural. Lastly, one methodological limitation is that
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29 411 we pooled the data to perform the trend analysis, which may lead to an overestimation of
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31 412 statistical power. To address this limitation, the weight in the pooled data was divided by the
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34 413 number of surveys available for the country.

35 36 37 414 **Conclusions**

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40 415 The study provided clear evidence of increase in overweight and obesity among women in the
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42 416 urban settings of all the countries included in the analysis, with the increase overtime being
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45 417 statistically significant in 17 of the 24 countries in the case of obesity and 13 out of the 24 for
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48 418 overweight. We have supported the finding that women dwelling in urban settings are prone
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50 419 to overweight and obesity. The prevalence of obesity increased more than two fold in most
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52 420 countries and more than three fold in others. The prevalence of obesity increased alongside
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55 421 overweight. These findings call for deliberate strategies and interventions by policy makers,
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58 422 politicians and health promotion experts, focusing on healthy diet, physical activity, weight

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3 423 reduction and maintenance strategies in African countries, particularly in urban areas to curb
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6 424 the growing proportion of unhealthy weight women of child bearing age in urban Africa.
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9 425 Strategies should include measures such as price reduction for healthy foods (e.g., fruits and
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11 426 vegetables) and promotion of physical activity. For future research, we suggest the conduct of
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13 427 longitudinal studies to systematically elucidate cumulative changes in individual's BMI over
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16 428 time. Longitudinal studies will also be able to ascertain the extent to which overweight can lead
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18 429 to mild-to-moderate obesity.
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11
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18 447 **Competing Interest**
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21 448 The authors have no competing interests to declare.
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31 451 **Data Sharing Statement**
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34 452 This study was a re-analysis of existing data that are publicly available from The DHS Program at
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36 453 <http://dhsprogram.com/publications/publication-fr221-dhs-final-reports.cfm>. Data are
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39 454 accessible free of charge upon a registration with the Demographic and Health Survey program
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42 455 (The DHS Program). The registration is done on the DHS website indicated above.
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45 456 **Authors' Contribution**
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48 457 DAA conceived and designed the study, interpreted the results, wrote the first draft of the
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51 458 manuscript, and contributed to revision of the manuscript. DAA and ZTD analysed the data. ZTD
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53 459 contributed to the drafting of the analytical strategy. ZTD, SM BM and ACE contributed to
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3 460 study design, data interpretation, and critical revision of the manuscript. All authors take
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6 461 responsibility of any issues that might arise from the publication of this manuscript.
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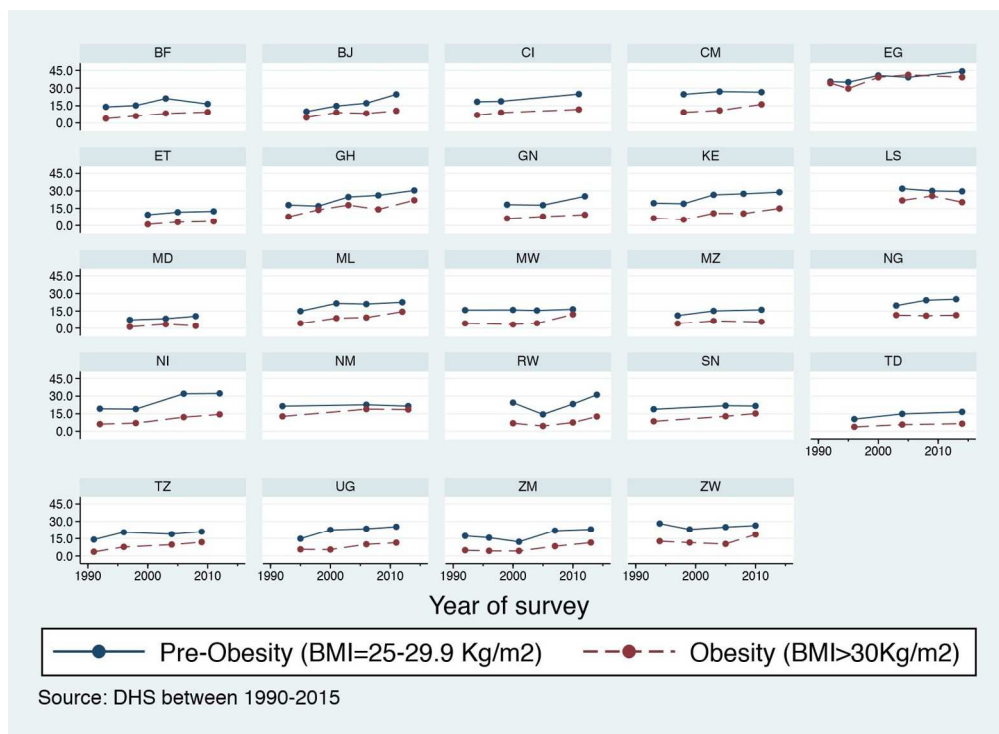
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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	9
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —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.