Regional Variation and Socioeconomic Inequalities in Obesity Prevalence Among Non-pregnant Women in Chad: Evidence From Three Waves of Chad Demographic and Health Surveys

Gebretsadik Shibre
Department of Reproductive, Family and Population Health, School of Public Health, Addis Ababa University, Addis Ababa, Ethiopia

Betregiorgis Hailu Zegeye (betregiorgiszegeye27@gmail.com)
Shewarobit Field Office, HaSET Maternal and Child Health Research Program, Shewarobit, Ethiopia

Gashaw Woldeamanuiel Garedew
Department of Medicine, College of Health Science, Wolkitie University, Wolkitie, Ethiopia

Wassie Negash
Department of Public Health, College of Health Science, Debre Berhan University, Debre Berhan, Ethiopia

Gorems Lemma
Chacha Health Center, Angolela Tera Health Office, Debre Berhan, Ethiopia

Mitku Taderegew Mamo
Department of Medicine, College of Health Science, Wolkitie University, Wolkitie, Ethiopia

Research article

Keywords: Geographic, socioeconomic, inequality, Obesity, Chad, DHS

Posted Date: August 27th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-54071/v1

Abstract

Background: While the prevalence of obesity is increasing worldwide, the growing rates of overweight and obesity in developing countries are alarming. Obesity is widely recognized as a risk factor for non-communicable diseases (NCDs), including diabetes, cancer and cardiovascular diseases. Available evidence on whether obesity has been more prevalent among higher or lower socioeconomic groups, across regions and urban-rural women's are inconsistent. This study examined socioeconomic, urban-rural and sub-national regional inequalities in obesity among non-pregnant women in Chad.

Method: Using cross-sectional data from Demographic and Health Surveys (DHS) from Chad conducted between 1996 and 2014, we used the World Health Organization Health Equity Assessment Toolkit to analyze the socio-economic and regional inequalities in obesity prevalence among non-pregnant women aged 15-49 years. Inequalities are assessed using socioeconomic and demographic indicators such as wealth index, education level and place of residence. We presented inequalities using both simple and complex summary measures, namely Difference (D), Population Attributable Risk (PAR), Population Attributable Fraction (PAF) and Ratio (R).

Results: Though constant pattern overtime, both wealth-driven and place of residence inequality were observed in all three surveys by Difference measure and in the first and last surveys by Ratio measure. Similarly, including the recent survey (D=-2.80%, 95% CI:-4.15, -1.45, R= 0.37%, 95% CI: 0.23, 0.50) absolute (in 1996 & 2014 survey) and relative (in all three surveys) educational status inequality with constant pattern were observed. Substantial absolute (PAR=-2.2%, 95% CI: -3.21, -1.34) and relative (PAF= -91.9%, 95% CI: -129.58, -54.29) regional inequality was observed with increasing and constant pattern by simple (D) and complex (PAR, PAF) measures.

Conclusion: Both socioeconomic and area-based obesity inequalities disfavoring women in the higher socioeconomic status and residing in urban areas. Prevention of obesity prevalence should be government and stakeholders' priority through organizing the evidence, health promotion and prevention interventions for at risk population and general population.

Introduction

Globally, obesity remains one of the major threats to public health. The emerging burden of chronic non-communicable diseases (NCDs), particularly cardiovascular disease (CVD), diabetes and obesity, threatens the gains in life expectancy made by combating infectious diseases (1, 2). In the African region, where many of these diseases have long been considered "diseases of affluence", obesity is becoming increasingly prevalent (3, 4). Vulnerable populations are experiencing high double-burdens of infectious and chronic diseases and the emerging burden of obesity in sub-Saharan Africa if not appropriately addressed, in the next decades, will create new challenges to health systems and threaten global economic development of African countries (5, 6).

Recent estimates from the World Health Organization suggest that NCDs kill near 45 million people each year, representing 70 percent of all deaths globally (7). In Africa, over 115 million people suffer from obesity-related problems and the rates are climbing faster than in just about anywhere else in the world (8). Available evidence suggests that obesity, together with excessive consumption of fat and salt, are risk factors for occurrence of chronic problems such as cancer, chronic kidney disease, diabetes, stroke and heart disease (9). Furthermore, it is well-established that obesity has a detrimental effect on reproductive physiology as it reduces fertility and increase the risk of adverse outcomes for mother and child. Interest for NCDs surveillance had mostly remained the concern of developed countries until the 1990s, when it became evident that the greatest impact of NCDs would be in low- and middle-income countries (LMICs). The 53rd World Health Assembly adopted the "Global strategy for prevention and control of non-communicable diseases" (10). The resolution positioned surveillance as a key objective of a global strategy, by stressing the need for mapping emerging NCDs epidemics and their determinants with particular reference to poor and disadvantaged populations, in order to provide guidance for policy, legislative and financial measures related to the development of an environment supportive of control(10). The WHO has also adopted a

strategy to be implemented by nations worldwide (11) to halt the issue. The strategy put an emphasis on stakeholders' role in working together to address the health impact (12). As primary prevention, the adoption and implementation of strategies at individual, societal and institutional levels are necessary to effectively prevent obesity and the associated health burdens (13).

While studies have reported associations of obesity with socioeconomic factors among the general population in Chad by assessing either the overall prevalence and the associated potential risk factors or the trend (12, 14). There is a dearth of studies examining inequalities in obesity prevalence, and assessing how social structures and processes are critical for equity in achieving healthy weight. Yaya et al showed that the prevalence of obesity among women in Chad was 2.3% in 2014 (14) However, such aggregated analyses are not enough to get a clear picture of obesity in the country. Specific evidence from different dimensions of subpopulation within the country in obesity prevalence is important to plan targeted obesity prevention and health promotion intervention and develop policies that can reduce health inequities while improving health for all. There was previous attempt on socio-economic inequality prevalence of obesity (9) that assessed only wealth and education status inequality or it lack evidence on area-based inequality and no information about inequality trends in Chad. This study aimed to address the evidence gap in socioeconomic-related and area-based inequalities in obesity among non-pregnant women in Chad. This paper addressed two research questions: (i) what is the extent of both socioeconomic and area-based inequalities in obesity prevalence among non-pregnant women in Chad and (ii) how were the trends of both socioeconomic and area-based inequalities in obesity prevalence among non-pregnant women in Chad between 1996 and 2014?

Method

Data

We used cross-sectional data from Demographic and Health Surveys (DHSs) from Chad conducted between 1996 and 2014. DHS surveys are nationally representative that collect information on a wide range of public health related topics such as anthropometric, demographic, socioeconomic, family planning and domestic violence to name a few. They were implemented in Chad with the financial and technical assistance by ICF International provisioned through the USAID-funded MEASURE DHS program.

Selection of variables

Inequality in the prevalence of obesity was measured for four equity stratifiers. Economic status was proxied through a wealth index in the DHS computed using household assets and ownerships following the methodology explained here (15) and was classified in to poorest, poor, middle, rich and richest. The wealth index was computed for each of the four surveys conducted in Chad using principal component analysis (PCA) and is deemed comparable across the survey years. Maternal educational status was classified as no-education, primary education, and secondary education, place of residence as urban vs. rural and sub-national region.

Data analysis

The latest version of the WHO's HEAT software was adopted for the analysis (16). In the software, datasets were analyzed and disaggregated by the five equity stratifiers-economic status, education, place of residence and region were presented through four out of the 15 commonly used summary measures of health inequality (17). We disaggregated obesity prevalence by the four equity stratifies as sex does not apply to our analysis: economic status, educational status, place of residence, and sub-national regions. In addition to disaggregation, we computed summary measures of inequality. Out of the 15 summary measures available in the software, we chose to use four, namely Difference, Population and Attributable Risk (PAR), Population Attributable Fraction (PAF) and Ratio (R) due to their application for all dimension of inequality. Both simple and complex summary measures were calculated for each equity stratifiers to better understand inequality involved in the occurrence of obesity (16–19). The Difference and Ratio are simple measures of health inequality, whereas the PAR and PAF

are complex measures (16, 17). While simple measures of health inequality are suitable for pairwise comparison of a health indicator of interest, they do not account for the subpopulations in the middle when applied to an equity stratifier with more than two categories, such as wealth index. This issue is avoided by the adoption of complex measures, whereby estimates are based on the sizes of all categories of a particular dimension of inequality (17).

As step-by-step procedures for the calculation of each summary measure included in the health equity database are discussed in detail in the HEAT software technical notes (16) and the WHO handbook on the health inequality monitoring (17), only a brief summary is offered here. Summary for education and economic status dimensions of inequality, Difference was calculated as obesity prevalence in the poorest group minus and in the richest group. Summary of the Difference in prevalence between the uneducated group and the group that has acquired at least secondary education was conducted. Similarly, for the place of residence, Difference pertains to that between rural and urban populations, whereas that for the sub-national regions pertains to the Difference between regions with the highest and the lowest obesity prevalence was executed. PAR and PAF were computed as the difference between the estimate for the reference subgroup yref and the national average of obesity, μ, as indicated below.

PAR/PAF: yref-μ (1)

In this study, yref refers to rural setting to estimate obesity inequality for a place of residence, to secondary education and richest sub-groups to estimate, respectively, education and economic-based differences in obesity. For the dimension of inequity at sub-national regional level, yref refers to a sub-national region with the lowest estimate of obesity prevalence. Zero indicates absence of inequality and the greater absolute value of PAR/PAR indicates a higher level of inequality.

As a measure of statistical significance, 95% Uncertainty Intervals (UI) were computed around point estimates. While interpreting inequality existence, Difference and PAR lower and upper bounds of UI shall not entail zero. R inequality exists if UIs do not involve one. In the case of inequality trend interpretation, UIs of the summary measures for different survey years shall not overlap to conclude a change in inequality over time. To facilitate the assessment of the quality of the evidence contained in study, we followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (20).

Ethical Consideration

We did the analyses using publicly available data from demographic health surveys. Ethical procedures were the responsibility of the institutions that commissioned, funded, or managed the surveys. All DHS surveys are approved by ICF international as well as an Institutional Review Board (IRB) in respective country to ensure that the protocols are in compliance with the U.S. Department of Health and Human Services regulations for the protection of human subjects.

Results

A total of 16, 516 population were involved in this study in 1996, 2004 and 2014 surveys. Of them 12,881 (77.9%) and 3,140 (19%) were rural residents and from wealth quintile 1 subgroups respectively. regarding educational status, about 10892 (65.9%) and 3386(20.5%) participants were among the no educated and primary school subpopulations respectively. the national prevalence of obesity among non-pregnant women was 0.8, 1.6 and 2.4 percentage point in 1996, 2004 and 2014 respectively. Obesity prevalence among non-pregnant women was dissimilar across socio-economic and area-based subgroups in Chad over the last 18 years.

The result shows prevalence of obesity was significantly higher among wealth quintile 5 and four respectively as compared to other three wealth quintiles. For instance, the prevalence among quintile 5 was 3.6, 5.2 and 7.3 percentage point in 1996, 2004 and 2014 respectively. Whereas, among quintile 1 for example, it was 0, 0.9 and 1.1 percentage point in same survey years respectively (Fig. 1).

The pattern of obesity prevalence was different across economic subgroups. It was increasing from 1996 to 2004 and, then continued as constant till 2014 among quintile 1and quintile 2. On the other hand among quintile 5, it was constant from 1996 to 2004, and then it changed in to increasing till 2014. The pattern among quintile 3 and 4 was constant overtime (Table 1).

Table 1
Magnitude and trends of obesity among non-pregnant women in Chad from 1996–2014 using CDHS

Dimension of Inequality	Subgroup			1996		2004		2014	
				Estimate (95% CI)	**Pop^{n}**	**Estimate (95% CI)**	**Pop^{n}**	**Estimate (95% CI)**	**Pop^{n}**
Economic status	Quintile 1 (poorest)			0 (0, 0)	700	0.91 (0.31, 2.62)	538	1.10 (0.64, 1.87)	1902
	Quintile 2			0 (0, 0)	934	0.72 (0.22, 2.29)	658	0.78 (0.43, 1.44)	1786
	Quintile 3			0.10 (0.01, 0.73)	604	0.40 (0.11, 1.41)	586	0.88 (0.49, 1.56)	1818
	Quintile 4			1.02 (0.53, 1.95)	663	1.45 (0.59, 3.51)	630	1.57 (0.89, 2.76)	1929
	Quintile 5 (richest)			3.62 (2.59, 5.02)	646	5.26 (4.03, 6.85)	527	7.39 (6.31, 8.63)	2093
Education	No education			0.39 (0.26, 0.60)	2791	1.37 (0.95, 1.99)	2276	1.65 (1.32, 2.06)	5825
	Primary school			1.91 (1.25, 2.92)	646	2.58 (1.44, 4.57)	528	3.31 (2.29, 4.75)	2212
	Secondary school +			6.54 (3.56, 11.69)	110	2.93 (1.37, 6.17)	136	4.45 (3.32, 5.95)	1491
Place of residence	Rural			0.13 (0.04, 0.43)	2785	0.81 (0.47, 1.39)	2376	0.95 (0.70, 1.28)	7220
	Urban			3.52 (2.70, 4.59)	763	5.26 (4.08, 6.75)	564	7.25 (6.14, 8.55)	2308
Subnational region	01 batha	01 bar azoum	01 batha	0 (0, 0)	161	0.35 (0.07, 1.53)	138	2.92 (1.36, 6.14)	344
	02 b.e.t.	02 b. e. t.	02 borkou/tibesti	2.57 (0.26, 21.02)	23	0.89 (0.31, 2.49)	418	4.52 (2.42, 8.27)	42
	03 biltine	03 centre est	03 chari baguirmi	0 (0, 0)	107	1.03 (0.21, 4.89)	274	0.19 (0.02, 1.37)	379
	04 chari-baguirmi	04 chari baguirmi	04 guera	0.63 (0.14, 2.72)	408	2.18 (1.20, 3.95)	364	0.87 (0.28, 2.67)	524
	05 guara	05 logone occidental	05 hadjer-lamis	0.38 (0.05, 2.84)	161	2.09 (1.11, 3.88)	650	1.32 (0.45, 3.76)	621
	06 kanem	06 mayo kebbi	06 kanem	0.38 (0.05, 2.61)	161	2.31 (0.93, 5.60)	284	0.47 (0.16, 1.36)	365

07 lac	07 moyen chari	07 lac	0.82 (0.10, 6.05)	155	0.21 (0.03, 1.48)	347	0.48 (0.09, 2.41)	531
08 logone occidental	08 ouaddai est	08 logone occidental	1.30 (0.33, 4.94)	235	0.49 (0.12, 1.99)	251	4.72 (2.73, 8.04)	641
09 logone oriental	09 ndjamena	09 logone oriental	0.44 (0.17, 1.13)	279	5.55 (3.78, 8.09)	212	1.55 (0.72, 3.32)	943
10 mayo-kebbi	NA	10 mandoul	0.62 (0.31, 1.23)	397	NA	NA	1.86 (0.95, 3.60)	649
11 moyen chari	NA	11 mayo kebbi est	0.62 (0.31, 1.25)	393	NA	NA	0.62 (0.23, 1.61)	722
12 ouadda	NA	12 mayo kebbi ouest	0.53 (0.27, 1.04)	347	NA	NA	1.40 (0.63, 3.08)	531
13 salamat	NA	13 moyen chari	0.46 (0.05, 3.74)	132	NA	NA	5.09 (3.63, 7.10)	535
14 tandjila	NA	14 ouaddai	0 (0, 0)	288	NA	NA	0.42 (0.13, 1.34)	505
15 ndjamana	NA	15 salamat	4.54 (3.29, 6.23)	293	NA	NA	1.71 (0.67, 4.29)	172
NA	NA	16 tandjile	NA	NA	NA	NA	2.13 (1.00, 4.48)	574
NA	NA	17 wadi fira	NA	NA	NA	NA	0.55 (0.10, 2.80)	251
NA	NA	18 ndjamena	NA	NA	NA	NA	10.12(8.38, 12.19)	870
NA	NA	19 barh el gazal	NA	NA	NA	NA	1.54 (0.57, 4.10)	118
NA	NA	20 ennedi	NA	NA	NA	NA	1.78 (0.72, 4.34)	45
NA	NA	21 sila	NA	NA	NA	NA	0.31 (0.04, 2.16)	157

In 1996 survey, obesity prevalence among non-pregnant women was significantly higher among secondary school and above categories followed by primary school subgroups as compared to no educated. Nonetheless, no prevalence difference was observed across education subgroups in 2004 survey. Except in no educated subgroups; prevalence of obesity was significantly lower as compared to the rest two education subgroups, no difference was identified between primary and secondary school and above subgroups in 2014 survey (Fig. 2).

With the exception of increasing pattern from 1996 to 2004 among no educated subgroups, the pattern of obesity prevalence among non-pregnant women was constant in other education subgroups and surveys (Table 1).

The result from this study also shows presence of significantly higher obesity prevalence among urban residents as compared to their counter parts from 1996 to 2014 (Fig. 3).

The pattern of obesity prevalence among rural residents was increasing from 1996 to 2004 and then, it continued as constant till 2014. However, among urban residents its pattern was constant overtime as presented in Table 2.

Table 2
Magnitude and trends of socio-economic and area-based inequality in obesity among non-pregnant women in Chad from 1996 to 2014.

Dimension		1996	2004	2014
	Measure	**%(95%CI)**	**%(95%CI)**	**%(95%CI)**
Economic status	D	-3.6 (-4.80, -2.43)	-4.35 (-6.04, -2.66)	-6.28 (-7.58, -4.99)
	PAF	0 (-85.55, 85.55)	0 (-77.87, 77.87)	0 (-27.89, 27.89)
	PAR	0 (-0.74, 0.74)	0 (-1.29, 1.29)	0 (-0.69, 0.69)
	R	0 (0, 0)	0.17 (-0.01, 0.36)	0.14 (0.06, 0.23)
Education	D	-6.14 (-10.00, -2.27)	-1.55 (-3.80, 0.68)	-2.80 (-4.15, -1.45)
	PAF	0 (-498.41, 498.41)	0 (-187.39, 187.39)	0 (-36.19, 36.19)
	PAR	0 (-4.32, 4.32)	0 (-3.12, 3.12)	0 (-0.89, 0.89)
	R	0.06 (0.01, 0.10)	0.46 (0.07, 0.85)	0.37 (0.23, 0.50)
Residence	D	-3.38 (-4.33, -2.44)	-4.44 (-5.82, -3.06)	-6.30 (-7.53, -5.07)
	PAF	0 (-58.53, 58.53)	0 (-71.94, 71.94)	0 (-24.44, 24.44)
	PAR	0 (-0.50, 0.50)	0 (-1.19, 1.19)	0 (-0.60, 0.60)
	R	0.03 (-0.00, 0.08)	0.15 (0.06, 0.24)	0.13 (0.08, 0.17)
Region	D	4.54 (3.10, 5.98)	5.34 (3.20, 7.47)	9.92 (7.99, 11.86)
	PAF	-100 (NA, NA)	-87.03 (-147.24, -26.81)	-91.93 (-129.58, -54.29)
	PAR	-0.86 (NA, NA)	-1.45 (-2.45, -0.44)	-2.27 (-3.21, -1.34)
	R	NA	25.70 (-24.39, 75.79)	50.66 (-47.59, 148.92)

Another main finding from the current study is dissimilarity in obesity prevalence across regions within the country in all three surveys. For instance, zero obesity prevalence was observed in 1996 survey in Batha, Biltine and Tandjila regions. Whereas in same survey, disproportionately higher prevalence of obesity was observed in B. E. T. next to Ndjamana region. On the other hand, in 2004 survey, the highest and lowest obesity prevalence was observed in Logone Oriental and Lac respectively (Table 1). Due to different regions in all three surveys, figuring out obesity prevalence pattern makes difficult in this study.

Magnitude and trends of Socio-economic and area based inequality

Table 2 shows existence of absolute and relative socio-economic and area-based inequality in obesity prevalence among non-pregnant women in Chad from 1996 to 2014.

Absolute wealth-driven inequality was observed in all three survey years by Difference measure. Furthermore, relative economic inequality was observed in the first (1996) and in the recent survey (2014) by Ratio measure. The pattern of economic inequality by Difference measure was constant overtime. However, no economic inequality was observed by complex measures (PAF, PAR) in all three surveys (Fig. 4).

Education based relative inequality in obesity prevalence was observed in all three surveys by Ratio measure. Whereas absolute educational status inequality in obesity prevalence was observed in 1996 and 2014 surveys only. Like economic

inequality, the complex measures (PAR, PAF) didn't indicate presence of education based inequality in all surveys. Its pattern was constant overtime as described in Table 2 by Ratio measure (Fig. 5).

Absolute place of residence inequality was demonstrated from 1996 to 2014 by Difference measure. Likewise, relative place of residence inequality also observed in 2004 and 2014 by Ratio measure. However, the complex measures didn't indicate inequality in all three surveys. The pattern of both absolute and relative place of residence inequality in obesity prevalence was constant overtime as presented by Difference and Ratio measures respectively (Fig. 6).

Running out the status of regional inequality in 1996 was not applicable. However, according to the next two surveys; 2004 and 2014 surveys, substantial absolute (D, PAR) and relative (PAF) subnational region inequality was identified in both of the surveys. The pattern of absolute inequality was increasing from 2004 to 2014 as described by Difference measure. Whereas constant pattern was observed by complex measures (PAF, PAR) (Table 2).

Discussion

The study sheds light on the extent and time-trend of socio-economic and living area-based inequalities in the obesity occurrence among non-pregnant women in Chad using the high-quality WHO health equity monitor database. The overall results showed the presence of marked inequalities in obesity prevalence favoring economically worse-off, uneducated and rural women. Mostly, the UIs of estimates in the adjacent survey years overlap and complicated interpretation of the inequality trends. However, the study confirmed an increasing trend of the inequalities across all equity stratifiers and between the first and the last rounds of surveys.

Based on Difference as a measure of absolute health inequality, the economic status-based inequality assessment indicated that obesity burden is more pronounced among the economically better-off women in each of the three Chad DHS time points. For instance in the recent survey, the Difference measure − 6.2% (95% CI: -7.58, -4.99) indicates in addition to presence of absolute economic inequality in obesity, it also tell us obesity prevalence is higher by 6.2 percentage point among the richest subpopulation as compared to poorest subpopulation. Even if the pattern of absolute economic inequality is constant overtime, if we take and compare the 1996 and 2014 surveys, it has increasing sign. However, no inequality was observed by complex measures (PAR, PAF) in all three surveys. The reason for this might be due to complex measures taking accounts the weights of all subgroups and in this study there was nearly similar obesity prevalence distribution across all wealth quintile in all surveys except quintile 5, which had extremely higher prevalence as compared to quintile 1–4 (Table 1).

The study also revealed the existence of education-based disparity in the prevalence of obesity, more educated sub-groups are at higher risk by Difference measure in 1996 and 2014 and in all surveys by Ratio respectively. However, by complex measures (PAR and PAF) in all three surveys no education-based inequality exists. In terms of time trend based on the estimates of Ratio, the study indicated that constant pattern was observed in overtime. In terms of where the women live, the result revealed pro-urban concentration of the burden of obesity in all the survey years, and this urban-rural differential was constant overtime.

Overall, the visible socioeconomic and area-based inequalities in the prevalence of obesity persist over the 18 years. Such evidence is important for the community, policy makers, and concerned stakeholders to address the problem in different ways. It also helps policy makers and stakeholders to plan and design appropriate intervention for at higher risk of obesity population group. Finally, it is important to have prevention strategies and curb the problem through comprehensive approach to address the obesity inequality among all the social groups and this in turn helps to meet and achieve the SDG.

The findings indicated the occurrence of noticeable inequality in obesity prevalence disproportionately affected the advantaged subpopulations. This conclusion is compatible with the available body of evidence (21–23). Secondary education or more completed women are more vulnerable to obesity. This could be explained by the fact that educated persons are likely to be recruited to jobs that do not require physical mobility (23). However, the inequality of obesity to the disadvantage of the rich women in the present study was at odds with evidence reported from the US (24), where sizeable

obesity disparity existed to the disadvantage of the poor. An easy access to low-cost energy-rich foods to the relatively poorer communities in the US could differentially lead to increased body weight. The discordance in the findings might be justified by the difference in the approaches used in the two studies.

Major implication of this kind of finding is that relying on a single summary measure of inequality might not be enough to better understand an inequality (17). Simple summary measures such as Difference do not tell the whole story of inequality as they are restricted to just two extreme group of a sub-populations and ignore the sub-groups in the middle; this could lead to a conclusion that might be biased especially when there is a population shift in a subpopulation of interest over time (17).

The study has various strengths. First, the inequality analysis in this study was based on the WHO's high-quality health equity monitor database and this enhanced the quality of the evidence contained in this paper. Also, the study used the 2019 update of the database, so it was possible to capture the current obesity status from information obtained through the latest (2014) round of the CDHS. Secondly, using of different inequality summary measures in the study might have helped the researchers to exploit the nature of obesity inequality from diverse angles. In other way the imitations were, the study used nationally representative CDHS data, but this finding could not be generalized to areas below the sub-national regions. Also, the WHO equity monitor database does not age-disaggregated the obesity inequality and age should have been used as an equity stratifier to know specific age bracket obesity burden dominates the most. In addition, the study did not decompose the observed obesity inequality to underlying determinants and individual percentage contribution to the inequality of commonly risk factors remains unexplored.

Conclusions

The study showed both socioeconomic and area-based obesity inequalities disfavoring women in the higher socioeconomic status and residing in urban areas. Obesity prevalence inequality was recorded in all the survey years and across all the dimensions of inequality between the 1996 and 2014 CDHS, with constant inequality pattern over time though estimates of the PAR and PAF showed no inequality. Even though not applicable to run for 1996 survey and constant subnational region inequality was observed by PAF and PAR, it was increased from 2004 to 2014 by Difference measure. In terms of the sub-national regions, the highest burden of obesity prevalence was identified in Ndjamena in all surveys. Future studies need to go a step forward and estimate the influence of a multitude of determinants on the observed obesity inequality. Prevention of obesity prevalence should be government and stakeholders' priority through organizing the evidence, health promotion and prevention interventions for at risk population and general population. Stakeholders like health professionals, educators, and media need to support awareness of healthy lifestyle and balanced diets.

Abbreviations

CDHS
Burundi Demographic and health Survey; D:Difference; HEAT:Health Equity Assessment Toolkit; PAF:Population Attributable Fraction; PAR:Population Attributable Risk; PPS:Probability Proportional to Size; R:Ratio; WHO:World Health Organization; SDG:Sustainable Development Goal

Declarations

Acknowledgments

We acknowledge the WHO for making the HEAT software available to the public domain for free.

Authors' contributions

GS and BZ contributed to the conception and design of the study, analyzed and, interpreted the data, and prepared the first draft manuscript. GGW, WS, GL and MMT helped with data interpretation and critically reviewed the manuscript for its

intellectual content. BZ had the final responsibility to submit the manuscript for publication. All authors read and revised drafts of the paper and approved the final version.

Funding

No funding was received for this work.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available in the WHO's HEAT version 3.1 [https://www.who.int/gho/health_ equity/assessment_toolkit/en/].

Ethics approval and consent to participate

Ethics approval was not required since the data is available to the public domain.

Consent for publication

Not applicable.

Competing interests

None.

References

1. Ford ND, Patel SA, Narayan KM. Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges. Annu Rev Public Health. 2017 Mar 20;38:145–164. doi: 10.1146/annurev-publhealth-031816-044604.
2. Sodjinou R, Agueh V, Fayomi B, Delisle H. Obesity and cardio-metabolic risk factors in urban adults of Benin: relationship with socio-economic status, urbanisation, and lifestyle patterns. BMC Public Health. 2008;8:84.
3. Crampin AC, Kayuni N, Amberbir A, Musicha C, Koole O, Tafatatha T, et al. Hypertension and diabetes in Africa: design and implementation of a large population-based study of burden and risk factors in rural and urban Malawi. Emerg Themes Epidemiol BioMed Central. 2016;13:3.
4. Wang H, Naghavi M, Allen C, Barber RM, Bhutta ZA, Carter A, et al. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980 to 2015: a systematic analysis for the Global Burden of Disease Study 2015. The Lancet. 2016;388:1459–544.
5. World Health Organization. Global Report on Diabetes. Isbn. 2016;978:88.
6. de-Graft Aikins A, Unwin N, Agyemang C, Allotey P, Campbell C, Arhinful D. Tackling Africa's chronic disease burden: from the local to the global. Glob. Health. 2010;6:5.
7. World Health Organization. Non-communicable diseases. 2018, Accessed on October 24, 2019. https://www.who.int/news-room/fact sheets/detail/noncommunicable-diseases.
8. World Health Organization. Controlling the global obesity epidemic. 2003, Accessed on October 24, 2019 https://www.who.int/nutrition/topics/obesity/en/.
9. Reys UM, Arndt MM, Victor CG. Socio-economic inequalities in the prevalence of of under-weight, over-weight and obesity prevalence among women aged 20–49 in low-and middle-income countries. International Journal of Obesity. 2020;44:609–16.
10. World Health Organization. Global strategy for the prevention and control of non-communicable diseases. Report by the Director-General, Fifty-third World Health Assembly. In. Edited by WHO. Geneva (Provisional agenda item 12.11; A53/14): WHO; 2000.

11. WHO. Global Strategy on Diet, Physical Activity and Health [internet]. Geneva: WHO; 2004. Available from: https://www.afro.who.int/sites/default/files/2017-06/NCD-Global_Strategy_Diet_Physical-Activity_health_2004.pdf.
12. Amugsi DA, Dimbuene ZT, Mberu B, Muthuri S, Ezeh AC. Prevalence and time trends in overweigh and obesity among yrban women: an nalysisi of of demographic and health surveys data from 24 African countries, 1991–2014. BMJ Open 2017;7.
13. WHO. Obesity and overweight [internet]. WHO fact sheet. 2018 [cited on Sep 16, 2019]. Available from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
14. Yaya S, Ekholuenetale M, Bishwajit G. Differentials in prevalence and correlates of metabolic risk factors of non-communicable diseases among women in Sub-Saharan Africa: Evidence from 33 countries. BMC Public Health. 2018;18:1168.
15. Rutstein SO, Johnson K. The DHS wealth index. http://www.measuredhs.com/pubs/pdf/CR6/CR6.pdf. Accessed on Oct 29, 2019.
16. Health Equity Assessment Toolkit (HEAT). Software for exploring and comparing health inequalities in countries. Built-in database edition. Version 3.1. Geneva, World Health Organization, 2019.
17. World Health Organization. Handbook on health inequality monitoring with a special focus on low and middle income countries. Geneva: World Health Organization; 2013. http://www.who.int/gho/health_equity/handbook/en/. Accessed 18 Sept 2019.
18. State of inequality: childhood immunization. Licence: CC BY-NC-SA 3.0 IGO. Geneva: World Health Organization; 2016.
19. Methodological issues in measuring health disparities. Keppel K, Pamuk E, Lynch J, Carter-Pokras O, Kim Insun, Mays V, Pearcy J, Schoenbach V, Weissman JS. Vital Health Stat 2. 2005 Jul; (141):1–16.
20. von Elm E, Altman DG, Stuart ME, Pocock J, Peter C, Gøtzsche, Jan P. Vandenbroucke, for the STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. Int J Surg.2014;1495–9. https://doi.org/10.1016/j.ijsu.2014.07.013.
21. Abrha S, Shiferaw S, Ahmed KY. Overweight and obesity and its socio-demographic correlates among urban Ethiopian women: evidence from the 2011 EDHS. BMC Public Health. 2016;16:636-.
22. Mekonnen T, Animaw W, Seyum Y. Overweight/obesity among adults in North-Western Ethiopia: a community-based cross sectional study. Archives of Public Health2018 2018/03/05;76(1):18.
23. Chowdhury MAB, Adnan MM. Hassan MZTrends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: a pooled analysis of five national cross-sectional. surveysBMJ Open. 2018;8:e018468. doi:10.1136/bmjopen-2017-018468.
24. Bilger M, Kruger EJ, Finkelstein EA. Measuring Socioeconomic Inequality in Obesity: Looking Beyond the Obesity Threshold. Health Econ. 2017;26:1052–66. doi:10.1002/hec.3383.

Figures

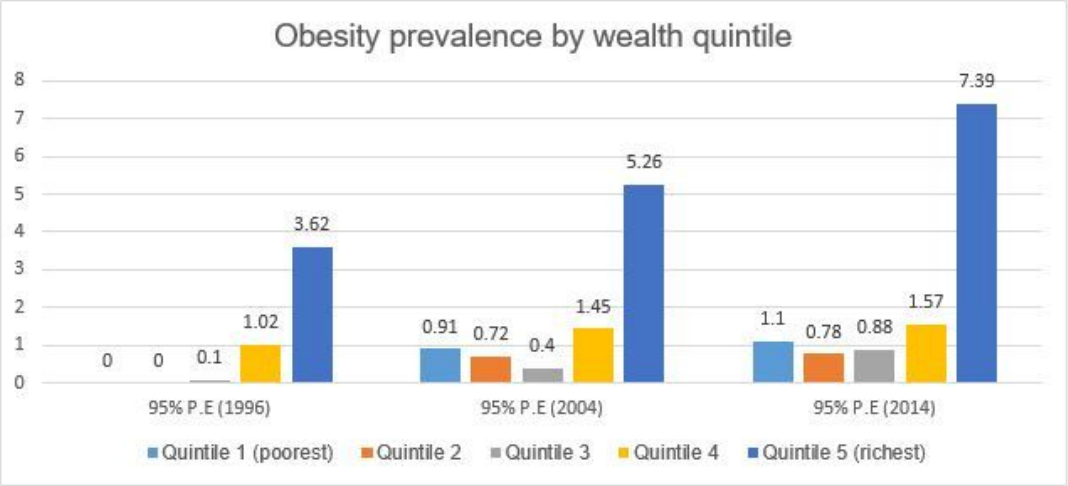

Figure 1

Magnitude and trends of obesity prevalence among non-pregnant women by wealth quintile in Chad from 1996 to 2014

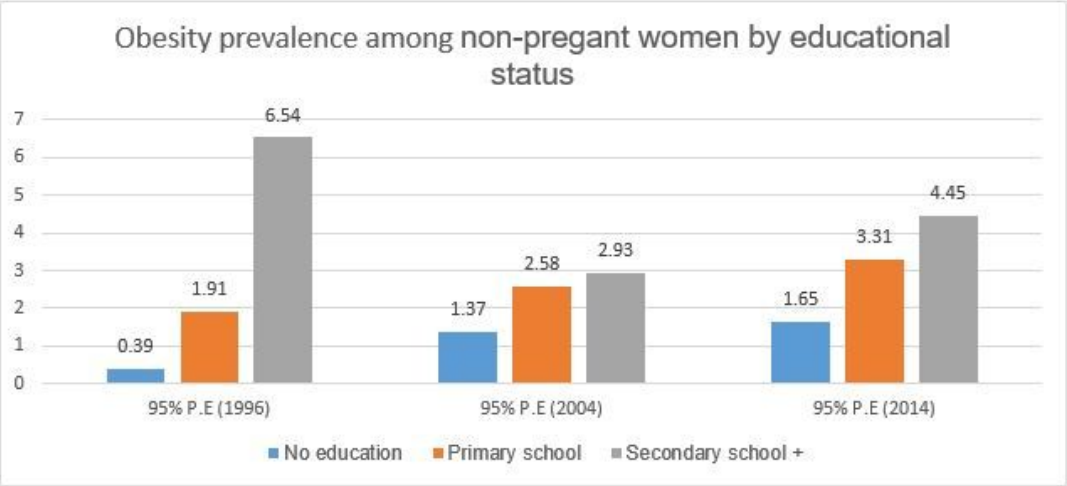

Figure 2

Magnitude and trends of obesity prevalence among non-pregnant women by educational status in Chad from 1996 to 2014

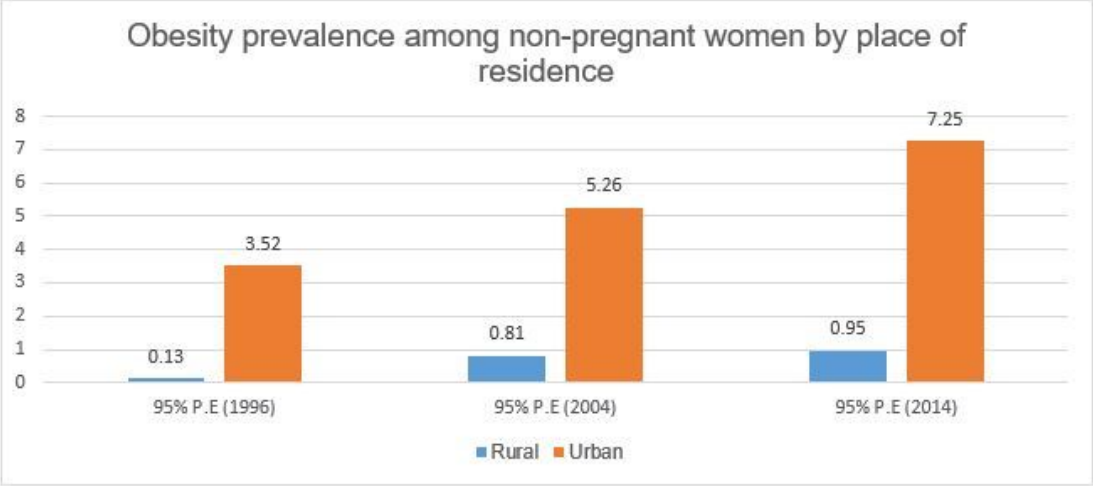

Figure 3

Magnitude and trends of obesity prevalence among non-pregnant women by place of residence in Chad from 1996 to 2014

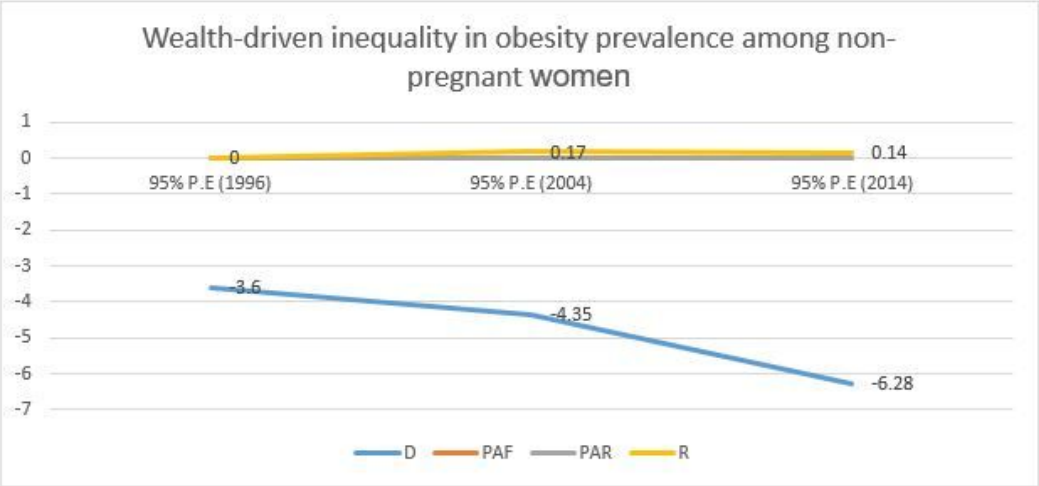

Figure 4

Magnitude and trends of wealth-driven inequality in obesity prevalence among non-pregnant women in Chad from 1996 to 2014

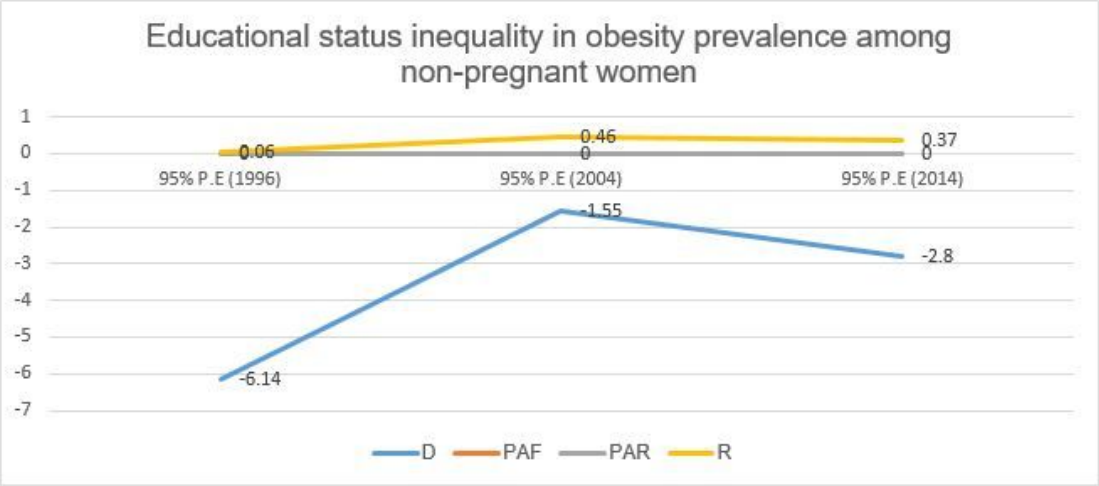

Figure 5

Magnitude and trends of educational status inequality in obesity prevalence among non-pregnant women in Chad from 1996 to 2014

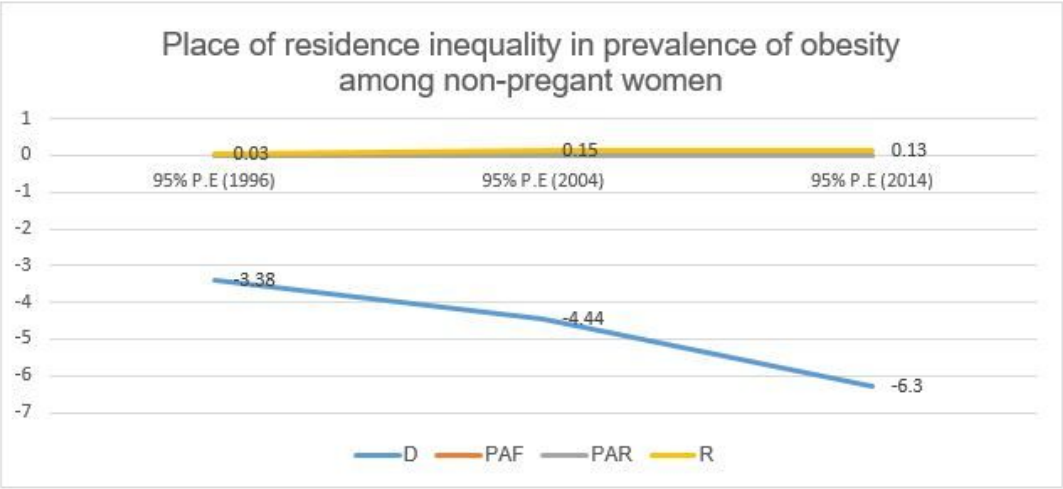

Figure 6

Magnitude and trends of place of residence inequality in obesity prevalence among non-pregnant women in Chad from 1996 to 2014