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Dietary, social, and environmental determinants of obesity in Kenyan women

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Abstract
Aim: To assess the determinants of overweight and obesity in Kenyan women considered to be undergoing the nutrition transition. *Methods:* A nationally representative sample of women ($n = 1008$) was randomly drawn. Weight, height, waist, and hip circumference were measured. A 24-hour dietary recall was conducted with each participant and a socio-demographic questionnaire completed. Data was analysed by age, education, location, and socioeconomic status. Risk for obesity was calculated while adjusting for age and location. *Results:* Overweight and obesity ($BMI \geq 25\,kg/m^2$) were highly prevalent in Kenya (43.3%). Urbanisation appears to be an important determinant of obesity since obesity was most prevalent in urban women in the high income group. Women in the high income group (7278 kJ) and in urban areas (7049 kJ) had the highest mean energy intakes. There were also significant urban/rural and income differences in the contribution of macronutrients to energy intake. Total fat intake was 34.5% of energy (E) in urban areas and 29.7% E in rural areas; while carbohydrates contributed 69.9% E in rural areas and 57.4% E in urban areas ($p < 0.0001$). Overweight was significantly more likely in the highest income group; among households where room density was low; electricity or gas was used for cooking; and households had own tap and/or own flush toilet. ***Conclusions:*** **This study suggests that urbanisation and its associated economic advancement as well as changes in dietary habits are among the most important determinants of overweight and obesity in Kenyan women.**

Key Words: *BMI, determinants, dietary intake, Kenya, obesity, overweight*

Introduction

It is widely accepted that the global prevalence of all the leading chronic non-communicable diseases (NCDs) such as heart disease and stroke, cancer, type 2 diabetes (T2D), and chronic respiratory diseases are increasing and will continue to do so in the next 20 years [1]. Forty-seven percent of the global burden of disease can be attributed to chronic NCDs. This is equivalent to about 60% of the annual 58 million deaths globally [2]. Although there appears to be no gender disparity associated with chronic NCDs since about half these deaths occur in women, it is of great concern to note that 80% of chronic NCD deaths occur in low and middle income countries. It is projected that without intervention, chronic NCD deaths will increase by 17% between 2005 and 2015 [2].

The increase in the prevalence of chronic NCDs in the developing world is largely attributed to the lifestyle changes associated with globalisation and urbanisation [3]. Among others these changes include adopting behaviours such as unhealthy eating habits. This is defined as a high energy intake together with high intakes of total fat, saturated fat, refined carbohydrate, and added sugars and low intakes of fibre, fruits, and vegetables; and has been classified as

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a typical "Western diet". This process has been described by many as the nutrition transition [4]. Associated with unhealthy eating habits are a sedentary lifestyle. These behaviours comprise the risk factors for the development of overweight and obesity in both children and adults. Studies from populations throughout the world have demonstrated a strong association of obesity with chronic NCDs, especially T2D and cardiovascular diseases [4,5]. Thus these risk factors ultimately result in the increased mortality, morbidity, and impaired functioning associated with chronic NCDs [6].

With increased urbanisation in developing countries, including those in sub-Saharan Africa, traditional diets are rapidly being displaced by the Western diet providing further evidence that the nutrition transition is in full swing on the African continent. While underweight is still prevalent in many sub-Saharan African countries, the prevalence of overweight is already a problem of significance in many developing countries [7–10]. The 2008–2009 Demographic Health Survey (DHS) reports that while 12.3% of women aged 15–49 years in Kenya are underweight [body mass index (BMI) $< 18.5\,kg/m^2$], 25.1% of women are overweight or obese (BMI $\geq 25\,kg/m^2$) [11]. Similar results are reported in South Africa, where 16% of 13 year olds are either overweight or obese (BMI $\geq 25\,kg/m^2$) and this increases to 26.4 % in 19 year olds and to 56% in urban black women [12,13]. In other sub-Saharan African countries such as Uganda and Ghana, the prevalence of overweight in women is already above 30% in urban areas and nearly half that in rural areas, a clear indication that these countries have already entered the nutrition transition [13].

There is an abundance of literature available documenting the consequences of obesity, not only in high income countries but also in the developing world [14–16]. It has been predicted that in the next decade obesity-related chronic diseases such as T2D will rapidly escalate in developing countries, including those in sub-Saharan Africa [14,15]. The costs related to treating the disease will be exorbitant and will add to the disease burden of countries already saddled with inadequate health resources.

The primary objective of this study was to determine the nutritional status of women in Kenya and to assess the relationship of diet, demographic and socioeconomic factors on their current weight status, since no published data in this regard are available for Kenya. Furthermore, such data are essential for health policymakers to have a better understanding of the possible determinants of excessive weight gain.

Materials and methods

Study population and sampling

In Kenya, 1050 women aged 15–60 years were randomly selected proportionally according to urban/rural classifications from four primary regions (Meru, Kisumu, Nakuru, and Nairobi) by the Kenya Central Bureau of Statistics (CBS).These regions were subdivided and stratified according to socio-economic classes to provide sub regions. Enumerator areas (EAs) were then randomly selected from the different sub-regions. Fifteen households (HH) were randomly selected from each EA by the CBS. The primary female responsible for food preparation in each household was then interviewed at her home. Anthropometric and dietary data was obtained from each participant. The final sample included 1008 women.

Data collection

Prior to entering the field, two dieticians with experience in dietary and anthropometric surveys provided a rigorous 3-day training programme to nine fieldworkers, each of whom had a basic nutrition qualification. Training was conducted as per the training manual that was developed for this purpose. In order to ensure quality of the data collected, dietary training included the use of life-size portion sizes and food photographs. A pilot study was first undertaken on 20 participants in order to ensure that the fieldworkers were providing accurate and reliable data. During the survey, questionnaires were checked on a daily basis by field team managers together with the two dieticians in order to correct any errors immediately. To further ensure quality of the data supervisors conducted quality checks on the fieldworkers throughout the study. Furthermore, stringent data cleaning procedures were followed before data analysis commenced.

A socio-demographic questionnaire was used to determine factors which are known to impact on nutritional status. These included age, marital status, level of education, employment, type of residence, and location (urban/rural) of the women in the sample.

Anthropometry

The participants were measured in their own homes according to standard anthropometric procedures, wearing light clothing [17]. Height was measured without shoes to the nearest 0.5 cm using a stadiometer with a wooden head board. Weight was calculated on a Lotus digital scale to the nearest 0.05 kg. The waist measurement was taken around the narrowest part of the middle, while the hip measurement was taken around the broadest part of the hips. BMI was calculated as kg/m^2.

Dietary data collection

Dietary data was collected by means of a structured, pre-coded 24-hour recall questionnaire which had been validated in an earlier study against biomarkers [18]. Due to the study being in an African context and because of the similarities in many foods this questionnaire was chosen since it had previously been used in the National Food Consumption Survey in South Africa [19].

Each participant was required to report on all the foods and drinks consumed during the previous 24 hours. Probing allowed the interviewer to obtain information on forgotten foods. In order to facilitate the estimation of portion sizes, various dietary aides were used, namely a dietary assessment kit comprising photographs of common South African foods as well as life-size drawings and generic food models. Photographs of commonly eaten Kenyan foods were added by local Kenyan nutritionists. The generic drawings and three-dimensional models had previously been tested against real food portions [20].

Although it would have been ideal to repeat all the dietary interviews, this would have been superfluous since repeatability of a random 10% of the sample ($n = 104$) showed no significant mean differences in energy, macro-, and micronutrients (except vitamin D), thereby suggesting that one recall was sufficient.

Data management and statistical analysis

Dietary data was analysed using FoodFinder, a software product developed by the Medial Research Council of South Africa [21]. The most commonly eaten Kenyan foods were added to the South African tables from Kenyan National Food Composition Tables [22]. All data were analysed in terms of location, age, level of education and socioeconomic status (as by census categories). Because of the relationship between BMI with age and with location, risk for overweight was calculated by standardising for age and location. Anthropometric data were categorised according to BMI cut-off points in terms of underweight ($BMI < 18.5\,kg/m^2$), normal weight ($BMI = 18.5–24.9\,kg/m^2$), overweight ($25–29.9\,kg/m^2$)and obesity ($BMI \geq 30\,kg/m^2$) [17]. Basic measures of central tendency and dispersion were determined using the SAS programme. While differences between mean values were calculated using the Bonferroni multiple comparison test, differences in categorical data were calculated using the Chi-square test.

Results

Table I provides a summary of the nutritional status of Kenyan women. While their overall mean BMI was $25.2\,kg/m^2$, 43.3% were overweight and obese and only 4.6% of women were underweight. Furthermore, Table I clearly shows that demographic factors play a role in their nutritional status. There were significant differences in mean BMI between urban and rural women (Bonferroni, $p < 0.05$). Urban women had significantly higher mean BMI (25.6 vs. $24.2\,kg/m^2$), waist (80.8 vs. 78.9 cm) and hip measurements (102.1 vs. 98.6 cm) compared to rural women. A similar pattern was shown between the categories of BMI (Chi-square $p < 0.001$). Sixteen percent of urban women were obese and 47.8% had a BMI over $25\,kg/m^2$ compared with 10.3% and 32.3% of rural women, respectively. Abdominal obesity was also more prevalent in urban women compared to rural women (26.5% vs. 16.4%)

Socioeconomic factors also appeared to play a role in nutritional status since there were significant differences in anthropometry between different income categories (Table I). The upper income group had significantly higher mean BMI ($27.3\,kg/m^2$), waist $\geq$ 88 cm (82.7 cm) and hip (105 cm) measurements compared with the middle ($25.6\,kg/m^2$; 80.8 cm and 102.3 cm) and lowest income groups ($23.9\,kg/m^2$; 78.8 cm and 98.1 cm), respectively. Abdominal obesity was prevalent in 26% of upper and middle income groups compared to 18.4% in the lower income group.

Dietary differences were also significant between urban and rural participants (Table II). The overall mean energy intake of Kenyan women was 6966.3 kJ (Table II). Although the results show that there were no significant differences in total energy intake between urban and rural women, there were significant differences in macronutrient intake. Urban women had significantly higher mean fat intakes (65.8 g vs. 53.9 g); and saturated fat (22 g vs. 17.2 g) and cholesterol intakes (181.1 g vs. 146 g) than rural women; while rural women had significantly higher intakes of carbohydrate (250.9 g vs. 223.1 g) and polyunsaturated: saturated ratio (1.11 g vs. 0.99 g). Although rural women had higher total protein intakes compared to urban women (45.8 g vs. 41.0 g), urban women had higher animal protein intakes than rural women (11.1 vs. 7.8 g) (results not presented). It was also interesting to note that there

Table I. Anthropometric data of Kenyan women by area and income (age standardised).

	Area		Income			
Anthropometric Measures	Rural (291)	Urban (715)	Upper (N = 55)	Middle (N = 635)	Low (N = 316)	All (1006)
BMI, mean kg/m^2	24.2^B	25.6^A	27.3^A	25.6^B	23.9^C	25.2
SE	0.43	0.26	0.90	0.31	0.35	0.22
95% CI)	23.2–25.1	25.0–26.1	25.5–29.1	25.0–26.2	23.2–24.6	24.7–25.6
% BMI < 18.5 kg/m^2	7.9	3.2	–	3.1	8.2	4.6
95% CI	3.3–12.5	1.6–4.9	–	1.7–4.6	3.9–12.5	2.9–6.3
18.5 <= % BMI <25	59.8	49.0	32.7	49.9	59.8	52.1
95% CI	50.8–68.8	44.9–53.0	20.0–45.5	45.1–54.8	53.0–66.6	48.4–55.8
25 <= BMI <30	22.0	32.0	50.9	29.9	23.7	29.1
95% CI	14.7–29.2	28.6–35.5	48.0–53.8	26.5–33.3	17.6–29.9	26.0–32.2
%BMI >= 30 kg/m^2	10.3	15.8	16.4	17.0	8.2	14.2
95% CI	5.9–14.7	12.4–19.2	2.7–30.0	13.3–20.7	4.9–11.6	11.5–16.9
%BMI >= 25 kg/m^2	32.3	47.8	67.3	46.9	32.0	43.3
95% CI	22.0–42.6	43.9–51.8	54.5–80.0	41.7–52.1	25.2–38.7	39.5–47.2
WC mean (cm)	78.9^B	80.8^A	82.7^A	80.8^{AB}	78.8^B	80.2
SE	0.84	0.53	2.67	0.62	0.90	0.45
95% CI	77.0–80.7	79.7–81.9	77.3–88.1	79.5–82.0	76.9–80.6	79.3–81.1
%Waist >= 88 cm	16.4	26.5	25.9	26.0	18.4	23.6
95% CI	10.2–22.6	22.5–30.5	4.0–47.8	21.7–30.3	11.9–24.9	20.4–26.8
HC mean (cm)	98.6^B	102.1^A	105.0^A	102.3^A	98.1^B	101.1
SE	1.02	0.54	1.29	0.66	0.94	0.48
95% CI	96.3	101.0	102.5–107.6	100.9–103.6	96.2–100.0	100.2
	100.8	103.2				102.1
WHR mean	0.80	0.79	0.79	0.79	0.80	0.79
SE	0.004	0.004	0.03	0.003	0.005	0.003
95% CI	0.79–.81	0.78–.80	0.74–0.84	0.78–0.80	0.79–0.81	0.79–.80
%WHR >= 0.85	20.4	17.7	24.1	16.4	21.7	18.5
95% CI	16.1–24.8	14.6–20.9	0.0–51.1	14.0–18.8	16.4–27.1	16.0–21.0
Chi-square*	P<0.0001		P<0.0001			
Chi-square**	P<0.0001		P<0.0001			
Chi-square#	P<0.0009		P<0.0374			
Chi-square##	P<0.3269		P<0.0830			

BMI, body mass index; WC, weight circumference; HC, hip circumference; WHR, waist hip ratio; SE, standard error of the mean; CI, confidence interval.
[A,B and C] Different symbols indicate which BMI means, waist circumference, hip circumference and waist-hip-ratio (comparing age groups and urban and rural areas) are significantly different, Bonferroni multiple comparison test, $p < 0.05$
*Chi-square p-value testing for relationship, between BMI grouping (4 groups) & urban/rural and income, respectively;
**Chi-square value for testing for relationship, between BMI grouping (BMI < 25, BMI >= 25) & urban/rural & income, respectively.
#Chi-square p-value for testing for relationship between % waist < 88 cm/% waist >= 88 cm and urban/rural & income group, respectively.
##Chi-square p-value for testing for relationship between % waist-hip ratio <0.85/%waist-hip ratio >= 0.85 and urban/rural and income group, respectively.

Table II. Macronutrient intake of Kenyan women by age and urban/rural domains.

	Area		Age				
Macronutrients	Rural ($n=292$)	Urban ($n=715$)	15–25 y ($n=233$)	25–34 y ($n=395$)	35–44 y ($n=228$)	45+y ($n=151$)	All ($n=1007$)
Energy, mean kJ (SE, 95% CI)	6761.9 (184.9, 6354.9–7168.9)	7049.8 (129.8, 6785.9–7313.6)	6673.3 (192.8, 6284.9–7061.6)[a,b]	7200.0 (134.9, 6928.3–7471.7)[a]	7202.3 (190.9, 6817.8–7586.7)[a]	6450.8 (264.1, 5918.9–6982.7)[b]	6966.3 (106.6, 6751.6–7180.9)
Carbohydrate, mean g (SE, 95% CI)	250.9 (9.74, 229.4–272.3)[a]	223.1 (5.02, 212.8–233.3)[b]	216.1 (5.79, 204.5–227.8)	237.9 (5.37, 227.1–248.8)	231.7 (8.00, 215.6–247.8)	235.5 (13.03, 209.3–261.7)	231.1 (4.6, 221.9–240.3)
Protein, mean g (SE, 95% CI)	45.8 (2.27, 40.8–50.8)[a]	41.0 (0.98, 39.0–43.0)[b]	40.0 (1.64, 36.7–43.3)	42.3 (1.12, 40.0–44.6)	43.6 (2.20, 39.1–48.0)	44.6 (2.83, 38.9–50.3)	42.4 (0.96, 40.5–44.3)
Total fat, mean g (SE, 95% CI)	53.9 (2.74, 47.9–60.0)[b]	65.8 (1.92, 61.9–69.7)[a]	60.0 (3.1, 53.8–66.3)[a,b]	65.8 (1.80, 62.1–69.4)[a]	63.2 (2.87, 57.4–69.0)[a,b]	55.5 (3.54, 48.4–62.7)[b]	62.3 (1.57, 59.2–65.5)
SFA, mean g (SE, 95% CI)	17.2 (0.96, 15.1–19.3)[b]	22.0 (0.80, 20.4–23.7)[a]	20.5 (1.42, 17.6–23.3)[a,b]	21.5 (0.71, 20.0–22.9)[a]	21.3 (1.16, 18.9–23.6)[a]	17.7 (1.36, 14.9–20.4)[b]	20.6 (0.64, 19.3–21.9)
PS, ratio-g (SE, 95% CI)	1.11 (0.06, 0.97–1.25)[a]	0.99 (0.04, 0.91–1.07)[b]	1.07 (0.05, 0.96–1.18)[a]	1.02 (0.04, 0.93–1.11)[a,b]	0.90 (0.05, 0.80–0.99)[b]	1.15 (0.08, 0.99–1.30)[a]	1.02 (0.03, 0.96–1.09)
Cholesterol, mg (SE, 95% CI)	146.0 (12.78, 117.8–174.1)[b]	181.1 (7.21, 166.4–195.7)[a]	181.7 (14.43, 152.6–210.8)	184.1 (9.32, 165.4–202.9)	153.6 (9.93, 133.6–173.6)	145.7 (15.60, 114.3–177.1)	170.9 (6.30, 158.2–183.6)
Added sugar, g (SE, 95% CI	31.0 (2.26, 26.0–35.9)	31.1 (1.20, 28.7–33.6)	30.3 (1.63, 27.0–33.6)	33.1 (1.37, 30.4–35.9)	31.2 (2.20, 26.8–35.7)	26.8 (2.61, 21.5–32.0)	31.1 (1.08, 28.9–33.3)

kJ, kilojoules; SFA, saturated fatty acids; PS, polyunsaturated; SE, standard error of the mean; CI, confidence interval.
[a,b,c]Different symbols indicate values that are significantly different comparing age groups and rural areas of residence. Bonferroni multiple comparison test, $p < 0.05$.

was no significant difference in added sugar intake between urban and rural women,

Age didn't appear to have much of an effect on macronutrient distribution since there were no significant differences in carbohydrate, protein, cholesterol, and added sugar intake between various age categories. However, older women tended to have significantly lower mean energy, total fat and saturated fat intakes.

Income on the other hand had a significant impact on dietary intake (Table III). Women in the upper income group had significantly higher intakes of energy (7278 kJ vs. 6374 kJ) and fats (72.6 g vs. 52.1 g) compared to those in the lower income groups. However, although there was no significant difference in protein intake between upper and low income groups (49.7 g vs. 44.9 g) there was a significant difference between upper and middle income groups (49.7 g vs. 40.5 g). Similar results were obtained when comparing different education categories (Table III), where individuals with a higher level of education had significantly higher intakes of energy, fat, and cholesterol compared to those with a lower level of education. There were however no significant differences in protein, carbohydrate, and added sugar intake across education categories.

The most commonly eaten food items in decreasing order of percent respondents who consumed the item in the previous 24 hours (results not presented in this paper) were tea (94%), sugar (88%), cows milk (87%), cooking fat (73%), maize porridge (68%), kale (47%), white bread (46%), brick margarine (39%), beef gravy (28%), rice (28%), maize with beans (26%), bananas (24%), vegetable oil (20%), and cabbage (19.3%).

When expressed as a percentage of total energy intake, macronutrient intakes varied significantly in many instances (Table IV). Carbohydrates comprised a larger proportion of the diets of rural women (69.9% vs. 57.4%) while animal protein (2.7% vs. 1.9%), total fat (34.5% vs. 29.7%), and saturated fat intakes (11.6% vs. 9.6%) comprised a significantly larger proportion of the diets of urban women. Similarly animal protein (5.1% vs. 2.3% and 2.3%) and fat (36.7 vs. 34.2% and 30.3%) contributed a larger proportion of the diets of women in the upper income group, while carbohydrates (53.6% and 58.5% vs. 67.2%) comprised a larger proportion of the diets of women in the lower income groups.

Table V provides the odds ratios for various socioeconomic factors that influence the BMI of Kenyan women. Women were significantly more likely to be overweight or obese if they had a higher level of education, were in the high income group and lived in a household where there was a low room density; a tap and flush toilet in the home; and electricity or gas was used for cooking. They were significantly less likely to be overweight if they were in the low income group and did not own a stove; a freezer; a radio/television; or vehicle. Conversely women were significantly more likely to be underweight if they lived in female headed households, had a low level of education and a low income as well as not owning a telephone. Underweight was significantly more likely in female-headed households; with a low level of education, low income; and no telephone in the house.

Discussion

This study clearly illustrated the nutritional status of women in Kenya. While underweight is still prevalent, overweight and obesity are far more prevalent in women in this country. Furthermore the results of this study suggest that urbanisation and its associated economic advancement are among the most important determinants of overweight and obesity in Kenyan women since obesity was more prevalent in urban areas and in women of the higher income bracket. These findings are in line with those of other sub-Saharan Africa studies [7,8,12]. In addition, abdominal obesity was present in nearly one out of four women in the study and was significantly higher in women in urban areas. Abdominal obesity has been associated with an urban lifestyle and is a common cause of insulin resistance which leads to impaired glucose tolerance and eventually T2D [8,14]. This could in part explain the increasing prevalence of T2D and cardiovascular diseases reported in sub-Saharan Africa [8,9].

Anthropometric and dietary results showed that the nutrition transition is clearly underway in the women studied. This was illustrated by the significantly higher levels of overweight and obesity in the urban women combined with the significant differences in dietary intake and macronutrient distribution namely increased energy, fat, and saturated fat intakes, in the urban group.

The fact that the weight status (BMI) of Kenyan women followed a socioeconomic gradient; being highest in upper income women and lowest in the lower socioeconomic category is an interesting feature since it is in direct contrast to the USA where the socioeconomic gradient is reversed and lower income women have the highest rates of overweight [23]. Two studies in the USA have shown a significant association between food insecurity and overweight in women, particularly in minority groups [24,25]. This association may appear to be contradictory in

Table III. Macronutrient intake of Kenyan women by income and level of education.

	Income			Level of education					
	Upper ($n=55$)	Middle ($n=635$)	Low ($n=317$)	None ($n=51$)	Some PS+ ($n=414$)	Some HS++ ($n=146$)	Matric ($n=231$)	College ($n=165$)	All ($n=1007$)
Energy, mean kJ (SE, 95% CI)	7278.0 (192.0, 6892.4–7663.6)^{a}	7235.1 (138.5, 6956.1–7514.2)^{a}	6373.7 (152.0, 6067.5–6679.8)^{b}	5899.1 (342.8, 5208.7–6589.4)^{b}	6729.6 (131.5, 6464.8–6994.4)^{a,b}	7075.2 (262.8, 6545.8–7604.5)^{a}	7404.4 (198.7, 7004.2–7804.7)^{a}	7180.2 (185.8, 6806.0–7554.5)^{a}	6966.3 (106.6, 6751.6–7180.9)
Carbohydrate, mean g (SE, 95% CI)	216.8 (18.71, 179.2–254.4)	234.0 (6.01, 221.9–246.1)	227.8 (7.89, 211.9–243.7)	227.3 (19.3, 188.5–266.1)	229.0 (6.04, 216.8–241.1)	240.0 (10.47, 218.9–261.1)	236.3 (7.15, 221.9–250.7)	222.7 (9.12, 204.3–241.0)	231.1 (4.6, 221.9–240.3)
Protein, mean g (SE, 95% CI)	49.7 (2.90, 43.8–55.5)^{a}	40.5 (0.96, 38.6–42.4)^{b}	44.9^{AB} (2.30, 40.3–49.6)	42.6 (4.81, 32.9–52.3)	42.6 (1.49, 39.6–45.6)	40.4 (1.88, 36.6–44.2)	42.4 (1.42, 39.5–45.2)	43.7 (1.97, 39.7–47.7)	42.4 (0.96, 40.5–44.3)
Total fat, mean g (SE, 95% CI)	72.6 (3.54, 65.5–79.7)^{a}	66.5 (1.89, 62.7–70.3)^{a}	52.1 (2.20, 47.7–56.5)^{b}	46.8 (4.38, 38.0–55.6)^{b}	57.1 (1.81, 53.5–60.8)^{a,b}	63.9 (2.67, 58.5–69.2)^{a}	69.2 (2.34, 64.4–73.9)^{a}	69.2 (2.33, 64.5–73.9)^{a}	62.3 (1.57, 59.2–65.5)
SFA, mean g (SE, 95% CI)	21.6 (1.52, 18.6–24.7)^{a}	22.4 (0.79, 20.8–24.0)^{a}	16.8 (0.97, 14.9–18.8)^{b}	14.2 (1.34, 11.5–16.9)^{c}	18.7 (0.82, 17.0–20.3)^{b,c}	21.2 (0.97, 19.3–23.2)^{a,b}	23.9 (0.93, 22.0–25.8)^{a}	22.4 (1.12, 20.1–24.6)^{a,b}	20.6 (0.64, 19.3–21.9)
PS ratio, g (SE, 95% CI)	1.34 (0.05, 1.24–1.43)^{a}	0.94 (0.03, 0.87–1.01)^{b}	1.14 (0.08, 0.97–1.30)^{b}	1.22 (0.12, 0.98–1.46)^{a}	1.07 (0.05, 0.97–1.17)^{a,b,c}	0.98 (0.05, 0.89–1.08)^{b,c}	0.86 (0.05, 0.76–0.96)^{c}	1.12 (0.09, 0.94–1.30)^{a,b}	1.02 (0.03, 0.96–1.09)
Cholesterol, mg (SE, 95% CI)	183.6 (16.43, 150.6–216.6)	179.3 (8.16, 162.9–195.8)	151.8 (12.32, 127.0–176.6)	99.7 (13.3, 73.1–126.8)^{b}	157.5 (9.13, 139.1–175.8)^{a,b}	165.9 (15.00, 135.7–196.1)^{a}	187.5 (11.9, 163.6–211.4)^{a}	207.7 (15.6, 176.3–239.0)^{a}	170.9 (6.30, 158.2–183.6)
Added sugar, g (SE, 95% CI)	28.0 (5.42, 17.1–38.9)	33.3 (1.08, 31.2–35.5)	27.2 (2.45, 22.2–32.1)	22.6 (4.10, 14.4–30.9)	30.5 (2.02, 26.4–34.6)	32.1 (2.45, 27.2–37.1)	32.3 (1.47, 29.4–35.3)	32.5 (2.91, 26.7–38.4)	31.1 (1.08, 28.9–33.3)

CI, confidence interval; HS+ +, some years of high school; Matric, completed high school; PS, polyunsaturated; PS+, some years of primary school; SE, standard error of the mean; SFA, saturated fatty acids.

^{a,b,c}Different symbols indicate values that are significantly different comparing income groups and level of education. Bonferroni multiple comparison test, $p < 0.05$.

Table IV. Macronutrient intake of Kenyan women by location income, expressed as a percentage of total energy intake.

Macronutrients (% of energy)	Area		Income			
	Rural (292)	Urban (715)	Upper ($n=55$)	Middle ($n=635$)	Low ($n=317$)	All (1007)
Protein (SE, 95% CI)	11.8 (0.87, 9.9–13.7)[a]	9.8 (0.21, 9.4–10.3)[b]	11.4 (1.04, 9.3–13.5)[a]	9.5 (0.17, 9.2–9.9)[b]	12.1 (0.88, 10.3–13.8)[a]	10.4 (0.29, 9.8–11.0)
Animal Protein (SE, 95% CI)	1.9 (0.23, 1.4–2.4)[b]	2.7 (0.18, 2.3–3.1)[a]	5.1 (1.41, 2.2–7.9)[a]	2.3 (0.15, 2.0–2.6)[b]	2.3 (0.26, 1.7–2.8)[b]	2.4 (0.15, 2.2–2.7)
Carbohydrate (SE, 95% CI)	69.9 (4.73, 59.5–80.3)[a]	57.4 (0.81, 55.7–59.0)[b]	53.6 (2.89, 47.8–59.4)[b]	58.5 (0.98, 56.6–60.5)[b]	67.2 (4.55, 58.1–76.4)[a]	61.0 (1.50, 58.0–64.0)
Added sugar (SE, 95% CI)	7.9 (0.52, 6.8–9.1)	7.4 (0.23, 7.0–7.9)	6.5 (0.91, 4.7–8.3)	7.9 (0.29, 7.3–8.5)	7.2 (0.65, 5.9–8.5)	7.6 (0.22, 7.1–8.0)
Fat (SE, 95% CI)	29.7 (0.84, 27.9–31.6)[b]	34.5 (0.56, 33.3–35.6)[a]	36.7 (1.74, 33.2–40.2)[a]	34.2 (0.63, 32.9–35.5)[a]	30.3 (0.84, 28.6–32.0)[b]	33.1 (0.46, 32.2–34.0)
SFA (SE, 95% CI	9.6 (0.34, 8.8–10.3)[b]	11.6 (0.28, 11.0–12.1)[a]	11.0 (0.70, 9.6–12.4)[a,b]	11.6 (0.30, 11.0–12.2)[a]	9.8 (0.39, 9.0–10.6)[b]	11.0 (0.22, 10.5 = 11.4)

CI, confidence interval; PS, polyunsaturated; SE, standard error of the mean; SFA, saturated fatty acids.
[a,b,c]Different symbols indicate values that are significantly different comparing age groups and urban and rural areas of residence. Bonferroni multiple comparison test, $p < 0.05$.

that women with poor food security would be expected to have a reduced food intake and hence less probability of being overweight.

This paradox can be explained to a certain degree by the theory of behaviour proposed by Basiotis in the early nineties [26]. According to Basiotis, people who have a low income follow certain dietary behaviours when their income is reduced. Firstly, they buy less expensive foods and their range of choices becomes limited. Further decline in income may result in them eating less food so that there is still sufficient food for children in the household. The last stage occurs when there is insufficient food for children and overt hunger.

Another aspect to be considered is that poor people buy the least expensive foods which are gastronomically the most filling; the so called energy-dense foods [27]. As income available to buy food decreases, energy density correspondingly increases and this may translate into higher energy intakes and over-consumption. Energy-dense foods typically contain high quantities of fat, sugar, and/or starch such as fast foods, snacks and desserts; as opposed to low-energy dense foods which are higher in fibre and micronutrients, such as fruit and vegetables. It is theorised that people naturally select energy-dense foods during times of food shortage as a mechanism of survival. Similarly they may overeat or binge when food is available even when not necessitated by lean times [28]. The majority of food items consumed by the Kenyan participants were energy-dense foods such as maize, bread, rice, fats, and oils.

The finding that obesity was greatest in the highest income group in Kenya should be interpreted in the context of urbanisation and Westernisation of diet currently underway. In Kenya people have only recently been exposed to a Western diet as opposed to those in high income countries; in Kenya the demand and status of Western foods is still high and affordable mainly to those of higher income. Consequently, only those in the higher income group may currently be able to afford such food items. Westernisation of the Kenyan diet was shown in this study by the significantly higher intake of energy (kJ) intake and animal protein, fat, and saturated fat intake in the higher income and urban groups.

Another important factor to consider in terms of the nutrition transition is the fact that Kenya has the so-called double burden of disease. The prevalence of stunting and underweight in under-five children was 30.3% and 19.9%, respectively in the last Demographic and Health Survey [29], despite the high prevalence of overweight and obesity in adult women. Hence, the consequences of a poor quality diet can also be seen in children. Since stunting has been shown to be an independent risk factor for increased BMI with age the prevalence of overweight and obesity in women may only now be rearing its head [30].

Conclusion and recommendations

The results of this study clearly illustrate that urbanisation and its associated economic advancement as well as the resultant changes in dietary intake are among the most important determinants of overweight and obesity in Kenyan women. Increased prevalence of chronic non-communicable diseases as a result of obesity is imminent. As such the

Table V. Specific socioeconomic factors influencing BMI in Kenyan women, adjusted for age and locality.

Factor	BMI < 18.5 kg/m^2 ($n = 46$) Odds Ratio (CI)	BMI < 25 kg/m^2 ($n = 570$) Odds Ratio (CI)	BMI ≥ 25 kg/m^2 ($n = 436$) Odds Ratio (CI)	BMI ≥ 30 kg/m^2 ($n = 413$) Odds Ratio (CI)
Gender of head of household is female	1.83 (1.02–3.25)[a]	1.00 (0.88–1.13)	1.01 (0.87–1.17)	0.82 (0.58–1.16)
Marital status is married/living together	0.57 (0.32–1.02)	1.05 (0.93–1.19)	0.95 (0.82–1.09)	1.28 (0.90–1.81)
Level of education				
Low (None or primary)	2.99 (1.50–5.96)[a]	1.11 (0.99–1.24)	0.88 (0.76–1.02)	0.79 (0.56–1.12)
High (complete secondary, tertiary)	0.48 (0.24–0.98)[a]	0.82 (0.73–0.92)[a]	1.26 (1.10–1.46)[a]	1.50 (1.10–2.06)[a]
Employed, seasonal or casual worker	0.90 (0.49–1.62)	0.90 (0.81–1.00)	1.14 (0.98–1.32)	1.27 (0.91–1.77)
Accommodation				
Roof is tin	0.67 (0.33–1.35)	1.18 (1.01–1.38)[a]	0.85 (0.73–0.99)[a]	0.83 (0.59–1.18)
Floor is brick/concrete	0.52 (0.26–1.04)	0.81 (0.72–0.91)[a]	1.41 (1.15–1.73)[a]	2.29 (1.35–3.86)[a]
Wall is brick/concrete	0.64 (0.35–1.16)	0.84 (0.76–0.94)[a]	1.29 (1.09–1.52)[a]	1.95 (1.30–2.93)[a]
Persons per room is 1 or 2	0.45 (0.26–0.78)[a]	0.88 (0.80–0.98)[a]	1.20 (1.03–1.41)[a]	1.45 (1.02–2.07)[a]
Cooking fuel				
Electricity or gas	0.22 (0.06–0.86)[a]	0.73 (0.61–0.86)[a]	1.35 (1.18–1.56)[a]	1.66 (1.21–2.27)[a]
Paraffin	0.86 (0.44–1.69)	1.01 (0.90–1.13)	0.98 (0.85–1.14)	0.96 (0.70–1.32)
Wood	2.00 (0.96–4.14)	1.21 (1.07–1.36)[a]	0.74 (0.60–0.91)[a]	0.62 (0.38–1.01)
Coal	1.51 (0.68–3.34)	1.10 (0.95–1.27)	0.86 (0.67–1.12)	0.64 (0.34–1.19)
Cook with paraffin	0.65 (0.34–1.24)	0.88 (0.79–0.98)[a]	1.20 (1.03–1.40)[a]	1.25 (0.88–1.77)
Cook with hotplate	0.26 (0.04–1.67)	0.82 (0.65–1.03)	1.20 (1.00–1.42)[a]	1.13 (0.75–1.72)
Water facilities				
Own tap	0.43 (0.18–1.02)	0.79 (0.69–0.91)[a]	1.28 (1.12–1.47)[a]	1.55 (1.15–2.11)[a]
Communal tap	0.77 (0.36–1.61)	1.14 (1.01–1.28)[a]	0.85 (0.73–0.98)[a]	0.89 (0.64–1.23)
River or well	1.71 (0.80–3.64)	1.14 (0.99–1.31)	0.80 (0.64–1.00)	0.53 (0.31–0.92)[a]
Sanitary facilities				
Flush toilet	0.48 (0.20–1.13)	0.77 (0.67–0.88)[a]	1.34 (1.16–1.54)[a]	1.80 (1.31–2.47)[a]
Pit	1.10 (0.56–2.13)	1.17 (1.03–1.31)[a]	0.83 (0.72–0.96)[a]	0.62 (0.45–0.85)[a]
No fridge or freezer	7.02 (0.90–55.12)	1.24 (1.03–1.49)[a]	0.82 (0.71–0.95)[a]	0.62 (0.45–0.86)[a]
No stove with oven	5.33 (0.88–32.44)	1.17 (0.98–1.41)	0.87 (0.74–1.02)	0.68 (0.48–0.96)[a]
No radio/tv	1.69 (0.81–3.51)	1.28 (1.13–1.45)[a]	0.62 (0.44–0.87)[a]	0.85 (0.46–1.56)
No telephone	2.71 (1.41–5.18)[a]	1.31 (1.18–1.45)[a]	0.69 (0.59–0.81)[a]	0.44 (0.30–0.65)[a]
No Vehicle	2.23 (0.57–8.82)	1.39 (1.09–1.76)[a]	0.77 (0.66–0.90)[a]	0.72 (0.50–1.04)
No home	1.45 (0.76–2.74)	1.04 (0.93–1.17)	0.94 (0.81–1.08)	0.97 (0.71–1.32)
Livestock				
No cattle or sheep	1.25 (0.70–2.22)	1.05 (0.94–1.18)	0.94 (0.81–1.08)	0.95 (0.70–1.30)
No chickens	0.87 (0.45–1.65)	0.95 (0.85–1.06)	1.07 (0.93–1.24)	1.04 (0.77–1.42)
Income				
Upper	–	0.70 (0.48–1.02)	1.27 (1.05–1.55)[a]	0.86 (0.46–1.63)
Mixed	0.56 (0.29–1.08)	0.95 (0.84–1.07)	1.07 (0.92–1.25)	1.62 (1.10–2.39)[a]
Low	2.22 (1.13–4.36)[a]	1.15 (1.01–1.30)[a]	0.82 (0.68–0.99)[a]	0.56 (0.35–0.89)[a]
Eat pot 1, 2, 3 people	1.43 (0.79–2.59)	1.09 (0.99–1.21)	0.89 (0.76–1.04)	0.96 (0.70–1.33)

Values are odd ratios (95% CI).
[a]Odds ratio is significant.

burden on the already extended health services is growing. Health policymakers need to recognise that further Westernisation of diet will exacerbate the prevalence of obesity among women. It is therefore essential for health policymakers in Kenya to consider implementation of effective overweight prevention strategies by advocating healthy diets and healthy lifestyles to all women. By targeting the younger population it would be possible to prevent a high prevalence of non-communicable chronic diseases in women in adulthood. Furthermore, stunting in childhood should be regarded of an early warning sign of later obesity, particularly in urban girls of higher socioeconomic class.

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NS and WP planned, took part in the study and wrote up the data for the article. JH Nel was responsible for data analyses and interpretation of data. DM and RA were jointly responsible for planning of the survey, training, fieldwork, and data entry. Article was seen by all authors.

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