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Nutrition transition, overweight and obesity among rural-to-urban migrant women in Kenya

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Abstract

Objective: To assess the effect of rural-to-urban migration on nutrition transition and overweight/obesity risk among women in Kenya.

Design: Secondary analysis of data from nationally representative cross-sectional samples. Outcome variables were women's BMI and nutrition transition. Nutrition transition was based on fifteen different household food groups and was adjusted for socio-economic and demographic characteristics. Stepwise backward multiple ordinal regression analysis was applied.

Setting: Kenya Demographic and Health Survey 2014.

Participants: Rural non-migrant, rural-to-urban migrant and urban non-migrant women aged 15–49 years (*n* 6171).

Results: Crude data analysis showed rural-to-urban migration to be associated with overweight/obesity risk and nutrition transition. After adjustment for household wealth, no significant differences between rural non-migrants and rural-to-urban migrants for overweight/obesity risk and household consumption of several food groups characteristic of nutrition transition (animal-source, fats and sweets) were observed. Regardless of wealth, migrants were less likely to consume main staples and legumes, and more likely to consume fruits and vegetables. Identified predictive factors of overweight/obesity among migrant women were age, duration of residence in urban area, marital status and household wealth.

Conclusions: Our analysis showed that nutrition transition and overweight/obesity risk among rural-to-urban migrants is apparent with increasing wealth in urban areas. Several predictive factors were identified characterising migrant women being at risk for overweight/obesity. Future research is needed which investigates in depth the association between rural-to-urban migration and wealth to address inequalities in diet and overweight/obesity in Kenya.

Keywords
Rural-to-urban migration
Urbanisation
Nutrition transition
Overweight
Obesity
Kenya

Overweight and obesity have become major global public health challenges. According to the WHO, in 2016 over 1·9 billion adults (18 years or older) were overweight, and of these over 650 million were obese[1]. Overweight and obesity are important risk factors for the development of non-communicable diseases such as CVD, type 2 diabetes mellitus, musculoskeletal disorders and several cancers[2]. These are responsible for millions of deaths and pose a significant financial burden on all health-care systems[3].

These epidemiological changes are stimulated by the nutrition transition. The nutrition transition reflects community and population shifts in dietary patterns typified by a reduction in fibre-rich foods such as coarse grains, legumes, fruits and vegetables, and an increase in animal-source products, oils, sugar and energy-dense refined foods[4]. Globalisation of the food distribution system, income growth and falling food prices, advances in technology and urbanisation have all been identified as key underlying drivers of this transition[5]. Urban food environments in low- and middle-income countries (LMIC) are increasingly seen as obesogenic environments[4,6].

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A major driver of the urbanisation in LMIC is internal rural-to-urban migration[7]. Due to the obesogenic environment in urban areas in LMIC, migration from the rural to urban areas has the potential to strongly stimulate national overweight and obesity levels. According to the dietary acculturation theory, when people migrate they adopt the cultural norms and practices of the host society[8].

Several studies of migration in LMIC have highlighted the association between rural-to-urban migration and increased overweight and obesity risk[9–13]. Furthermore, several studies have observed dietary change among migrant populations as they adopt a more fat-derived, energy-dense diet with lower dietary fibre[14–18]. In some studies, the changing dietary patterns also included increased fruit and vegetable intake when moving to urban areas[14,15]. Female rural-to-urban migrants appeared particularly vulnerable to increased BMI[12,14,19].

Urban growth rates have been much higher in Africa than any other region over the last 23 years. Urbanisation in sub-Saharan Africa (SSA) increased rapidly from 29 % in 1995 to 38 % in 2015, and is predicted to rise to 43 % in 2025[7]. A similar pattern has been observed in Kenya, an East African country which has an urban population growth rate of 4·3 % annually. About 19 % of Kenya's residents were living in urban areas in 2000, increasing to 31 % in 2010. Poverty and the lack of both development and job opportunities in rural areas are influential in rural-to-urban migration[20]. Rapid urbanisation in Kenya could be detrimental to health due to changes in diet as the nutrition transition appears to be present, especially in its urban areas[21]. Rural-to-urban migration therefore has the potential to fuel national overweight and obesity levels with the consequence that Kenya faces a double burden of malnutrition (i.e. both under- and overnutrition)[22]. Detailed knowledge about rural-to-urban migration and changes in diet and weight status is therefore important to better understand the impact of urbanisation on overweight and obesity and identify appropriate interventions to target this group in Kenya.

Few data sets exist in SSA generally, and Kenya specifically, that allow for such detailed study[23]. However, the Kenyan Demographic Health Survey (KDHS) offers this opportunity as it aimed to understand health and population trends and includes basic indicators of maternal and child health[24]. The KDHS 2014 permits exploration of the complex mechanisms between the nutrition transition and urbanisation.

The present study aimed to expand our knowledge on nutrition transition and population weight gain in Kenya in the context of urbanisation by assessing the effect of rural-to-urban migration on dietary changes and overweight/obesity risk, and by identifying demographic and socio-economic factors which are associated with overweight/obesity risk among rural-to-urban migrants. The study focused on female rural-to-urban migrants as both migrant and non-migrant literature in SSA observed high levels of overweight and obesity among women[15,25,26].

Methods

Data sources and sampling strategies

The present study used data from the Demographic and Health Surveys (DHS) Program. The DHS are nationally representative, repeated cross-sectional household surveys which are standardised to enable cross-country comparisons[27]. The 2014 KDHS was designed to produce representative estimates for most of the survey indicators at the national level, for urban and rural areas separately, at the regional level, and for selected indicators at the county level. The sample was designed to have 40 300 households from 1612 clusters spread across the country, with 995 clusters in rural areas and 617 in urban areas. Samples were selected independently in each sampling stratum, using a two-stage sample design. In the first stage, all clusters were selected with equal probability from the National Sample Survey and Evaluation Program V frame. This frame is used by the Kenyan National Bureau of Statistics for conducting household surveys. The second stage involved the systematic sampling of households listed in each cluster. From each cluster twenty-five households were selected. The objective of the second stage of sampling was to ensure adequate numbers of completed individual interviews in order to provide estimates for key indicators with the acceptable precision. All men and women aged 15–59 and 15–49 years, respectively, in the randomly selected households (men in half of the households) were eligible to participate in the survey[28].

The study population for the current analysis comprised a nationally representative cross-sectional weighted sample of 6171 non-pregnant women who have complete anthropometry data. We limited our analysis to non-pregnant women in order to avoid biasing the results, as pregnant women are likely to weigh more than their normal weight. The data collection occurred between May and October 2014. Additional information on the data source and methodology is described elsewhere[28].

Study outcomes

The outcome variables of the analysis were women's BMI (kg/m^2) and nutrition transition. BMI was derived by dividing weight in kilograms by the square of height in metres. The BMI of female participants was then classified as normal weight (18·5–24·99 kg/m^2), overweight (25·0–29·99 kg/m^2) or obese (≥30·0 kg/m^2)[1]. In the KDHS, height and weight were measured objectively by trained field technicians using standard techniques. Weight measurements were taken using an electronic scale (SECA scale), while standing height measurements were taken using height/length (Shorr) boards[28].

Public Health Nutrition

Nutrition transition was based on fifteen of sixteen available household food consumption categories. Each household was asked for the number of days a certain food was consumed in the past 7 d. These questions were developed by the World Food Programme to measure the household food consumption score[29]. The selected household food consumption groups were as follows: cereals and grains (rice, pasta, bread, sorghum, millet, maize); roots and tubers (potato, yam, cassava, normal sweet potatoes, taro, cooking banana/plantain, other tubers); pulses/nuts (beans, cowpeas, peanuts, lentils, soy, pigeon peas, other nuts); orange vegetable (carrots, red peppers, pumpkin, orange sweet potato); green leafy vegetables (*sukuma wiki*, spinach, broccoli, amaranth, cassava leaves, other dark green leaves); other vegetables (onion, tomatoes, cucumber, radishes, green beans, peas, lettuce); orange fruits (mango, pawpaw, tree tomato); other fruits (banana, apple, lemon); meat (goat, beef, chicken, pork); organ meats (liver, kidney, heart, other organ meats); fish or shellfish (dried fish, canned tuna, other seafood); eggs; milk and other dairy products (yoghurt, cheese); fats (oil, fat and butter); and sugar (sugar or sweet things such as honey, jam, cakes, candy, biscuits, pastries, sugary drinks)[28].

Nutrition transition in the current analysis is taken to mean rural-to-urban migrants having a lower intake of main staples, legumes, fruits and vegetables (cereals and grains, roots and tubers, pulses/nuts, and all vegetable and fruit groups), and a higher intake of animal-source foods (meat, organ meats, fish or shellfish, eggs, milk and other dairy products), fats, and sugary energy-dense foods and beverages (sweets), compared with rural non-migrants, while having a similar intake to urban non-migrants.

Key independent variable

In the DHS, urban areas are defined as large cities (capital cities and cities with over 1 million population), small cities (population between 50 000 and 1 million) and towns (other urban areas)[20]. The key independent variable of the current analysis is migration status. The 2014 KDHS does not contain direct questions on the migration status of respondents. However, there are questions on place of residence during childhood, previous place of residence, current place of residence, duration of stay in current residence, and type of previous and current places of residence (rural or urban; city, town or countryside). To be classed as a rural-to-urban migrant in the analysis, the respondent had to have previously lived in the countryside during their childhood (until their 12th birth year) and before they moved to their current location of residency. At the time of measurement the respondent had to reside in an urban area[30]. Respondents were considered 'urban non-migrants' and 'rural non-migrants' if they responded 'always' to the question on duration of stay in current residence. Similar classifications for migration status have been used in previous research in SSA context[31–33]. A proportion of non-migrants (2·7 % of rural-non-migrants and 38·6 % of urban non-migrants) did, however, have their place of birth in a different geographical area (rural or urban) from their current residence.

Socio-economic and demographic variables

The differences in household food consumption and BMI status between rural non-migrants, rural-to-urban migrants and urban non-migrants were adjusted for socio-economic and demographic characteristics. This was done to explore which characteristics modify the association between nutrition transition and migration status. Based on the dietary acculturation model by Satia-Abouta *et al.*[8], the following characteristics selected for adjustment were: women's age, women's employment, women's education, women's religion, women's ethnicity, marital status, household number of children under 5 years of age and household wealth.

Based on availability in the KDHS, and non-migrant literature in Kenya and SSA[34–36], potential predictive factors of overweight and obesity risk among rural-to-urban migrant women were selected. These factors included women's age, women's employment, women's education, marital status, household number of children under 5 years of age and household wealth. Duration of residence in the urban area was also included to gain more detail on the effect of prolonged exposure to urban areas on overweight/obesity risk. In the DHS, household wealth is a composite measure of a household's cumulative living standard. Additional detail on the construction of household wealth in the KDHS is described elsewhere[28].

Statistical analysis

Descriptive statistics were used to summarize BMI status, nutrition transition and the socio-economic and demographic characteristics of the rural non-migrants, rural-to-urban migrants and urban non-migrants. Nutrition transition is presented in average days per week and OR.

Multiple ordinal regression analysis was performed to measure the association of rural non-migrants, rural-to-urban migrants and urban non-migrants with overweight/obesity risk and household food consumption. A stepwise backward technique was used to adjust for socio-economic and demographic characteristics. For the identification of demographic and socio-economic factors associated with overweight and obesity among rural-to-urban migrant women, bivariate analyses (χ^2 tests) were conducted. Predictive factors which were significantly associated with overweight/obesity risk ($P < 0{\cdot}10$) were assessed for collinearity using Pearson's correlation coefficient. Finally, a stepwise backward ordinal regression analysis was performed to assess the association between the selected predictive factors and weight status among rural-to-urban migrant women.

Table 1 Descriptive analysis of respondents' characteristics by migration status: women aged 15–49 years (*n* 6171), Kenya Demographic and Health Survey 2014

	Rural non-migrants (*n* 2915; 47·2 %)		Rural-to-urban migrants (*n* 2269; 36·8 %)		Urban non-migrants (*n* 987; 16·0 %)	
Characteristic	*n**	%	*n**	%	*n**	%
BMI status						
Healthy weight (18·5–24·99 kg/m^2)	1890	78·8	1133	54·5	517	60·4
Overweight (25·0–29·99 kg/m^2)	378	15·8	624	30·0	222	25·9
Obese (≥30·0 kg/m^2)	130	5·4	322	15·5	117	13·7
Total	2398		2079		856	
Women's age (years)						
15–29	2021	69·3	1286	56·7	664	67·3
30–39	510	17·5	690	30·4	189	19·2
40–49	384	13·2	293	12·9	133	13·5
Total	2915		2269		986	
Women's employment status						
Not working	1545	53·0	607	26·8	446	45·2
Self-employment	442	15·2	118	5·2	67	6·8
Employed, any cash	868	29·8	1522	67·1	469	47·6
Employed, in kind only	58	2·0	20	0·9	4	0·4
Total	2913		2267		986	
Women's education						
No education	330	11·3	66	2·9	54	5·5
Primary	1573	54·0	1025	45·2	345	34·9
Secondary or higher	1012	34·7	1177	51·9	588	59·6
Total	2915		2268		987	
Marital status						
Never married	1676	57·5	563	2·8	490	49·6
Married/living together	953	32·7	1399	61·7	385	39·0
Divorced/separated/widowed	286	9·8	307	13·5	112	11·4
Total	2915		2269		987	
Number of children under 5 years in household						
0	1160	39·8	867	38·2	480	48·7
1	963	33·0	939	41·4	346	35·1
2	528	18·1	396	17·5	109	11·0
≥3	264	9·2	66	2·9	51	5·2
Total	2915		2268		986	
Religion						
Roman Catholic	2038	71·4	1685	74·9	606	62·1
Protestant/other Christian	595	20·8	483	21·5	218	22·3
Muslim	222	7·8	82	3·6	152	15·6
Total	2855		2250		976	
Ethnicity						
Kikuyu	393	13·5	672	29·6	277	28·0
Kalenjin	592	20·3	191	8·4	76	7·7
Kamba	391	13·4	377	16·6	65	6·6
Luhya	355	12·2	340	15·0	129	13·1
Luo	151	5·2	198	8·7	164	16·7
Mijikenda/Swahili	142	4·8	73	3·2	55	5·6
Somali	108	3·7	19	0·9	67	6·8
Other	783	26·9	399	17·6	153	15·5
Total	2915		2269		986	
Household wealth quintile						
Poorest	831	28·5	98	4·3	81	8·2
Poorer	741	25·4	164	7·2	98	9·9
Middle	770	26·4	215	9·5	88	8·9
Richer	438	15·0	617	27·2	212	21·5
Richest	135	4·7	1175	51·8	508	51·5
Total	2915		2269		987	

*Weighted.

The analysis was completed in the statistical software package Stata version 14, with svyset commands to apply inverse probability weights which account for oversampling of urban primary sampling units and stratification by district. Throughout the analysis, means, SD, OR, 95 % CI and *P* values are reported.

Results

Descriptive analysis

Table 1 presents BMI status and socio-economic and demographic characteristics of 6171 (weighted total) rural-non-migrant, rural-to-urban migrant and urban

Table 2 Descriptive analysis of household food group consumption by migration status among women aged 15–49 years (*n* 6171), Kenya Demographic and Health Survey 2014

	Rural non-migrants		Rural-to-urban migrants		Urban non-migrants	
Food group	Mean*	SE	Mean*	SE	Mean*	SE
Main staples and legumes						
Cereals, grains	6·13	0·05	5·75	0·08	5·92	0·10
Roots, tubers	1·83	0·06	1·92	0·07	1·98	0·11
Pulses, nuts	2·80	0·08	2·06	0·06	2·44	0·11
Vegetables						
Orange vegetables	0·87	0·06	2·09	0·12	1·76	0·14
Green vegetables	4·09	0·08	4·45	0·09	4·20	0·14
Other vegetables	4·54	0·08	6·11	0·06	5·80	0·09
Fruits						
Orange fruits	0·81	0·05	1·72	0·09	1·58	0·13
Other fruits	1·07	0·05	2·51	0·10	2·40	0·16
Animal-source foods						
Meat	0·86	0·04	1·55	0·07	1·55	0·10
Organ meats	0·11	0·02	0·18	0·03	0·23	0·04
Fish or shellfish	0·63	0·06	0·67	0·04	0·89	0·08
Eggs	0·72	0·04	1·40	0·07	1·39	0·09
Milk and other dairy products	4·22	0·09	4·35	0·11	4·35	0·11
Oil, fat and butter						
Fats	6·08	0·05	6·52	0·06	6·44	0·10
Sugary foods and beverages						
Sweets	5·62	0·07	6·00	0·09	5·85	0·15

*Weighted average days per week.

non-migrant women. In total, 2269 (36·8 %) women were identified as rural-to-urban migrants, 2915 (47·2 %) as rural non-migrants and 987 (16·0 %) as urban non-migrants (Table 1). Of the rural non-migrants, 16 % and 5 % were measured as being overweight and having obesity, respectively, against 30 % and 16 % of rural-to-urban migrants. Of the urban non-migrants, 26 % and 14 % were overweight and obese, respectively. A little over half (57 %) of the rural-to-urban migrant women were aged 15–29 years, while 62 % were married or living together. Only 5 % of the female rural non-migrants were in the richest household wealth quintile, compared with 52 % of the female rural-to-urban migrants and 51 % of the female urban non-migrants.

Table 2 provides a description of weekly household food group consumption per migration status in average days per week. Rural-to-urban migrants had lower average number of days per week consumption of cereals and grains and pulses/nuts compared with rural non-migrants (mean (SE): 5·75 (0·08) *v.* 6·13 (0·05) for cereals and grains; 2·06 (0·06) *v.* 2·80 (0·08) for pulses/nuts). Additionally, migrants had a higher average daily consumption per week for all fruit and vegetable groups compared with rural non-migrants. Migrants also consumed higher weekly averages (mean (SE)) for the animal-source food products meat (1·55 (0·07) *v.* 0·86 (0·04)) and eggs (1·40 (0·07) *v.* 0·72 (0·04)), fats (6·52 (0·06) *v.* 6·08 (0·05)) and sweets (6·00 (0·09) *v.* 5·62 (0·07)) compared with rural non-migrants. Compared with urban non-migrants, rural-to-urban migrants consumed more fruits, vegetables and sweets; and less animal-source food products meats, fish or shellfish, and dairy products.

Overweight and obesity risk per migration status

Table 3 shows that rural-to-urban migrant women were at an increased risk of being overweight or obese in comparison with rural non-migrant women (OR = 3·10; 95 % CI 2·59, 3·72). Only after adjusting for household wealth was there no evidence of a significant difference for overweight/obesity risk between migrant women and rural non-migrant women.

Nutrition transition

For nutrition transition, the non-adjusted model (Table 3) shows that compared with rural non-migrants, migrants were less likely to consume cereals and grains (OR = 0·62; 95 % CI 0·50, 0·76) and pulses/nuts (OR = 0·65; 95 % CI 0·56, 0·76) and more likely to consume roots and tubers (OR = 1·18; 95 % CI 1·01, 1·38). Additionally, migrants were more likely to consume the animal-source products meat (OR = 2·45; 95 % CI 2·06, 2·93), organ meats (OR = 1·89; 95 % CI 1·38, 2·59), fish or shellfish (OR = 1·55; 95 % CI 1·26, 1·89) and eggs (OR = 2·92; 95 % CI 2·46, 3·45), fats (OR = 2·45, 95 % CI 1·87, 3·22) and sweets (OR = 1·63; 95 % CI 1·28, 2·07).

Migrants were also more likely to consume most fruits and vegetables. An increased likelihood was observed for orange fruits (OR = 2·75; 95 % CI 2·26, 3·33) and vegetables (OR = 3·22; 95 % CI 2·62, 3·96), other fruits (OR = 3·65; 95 % CI 3·03, 4·39) and vegetables (OR = 3·77; 95 % CI 3·13, 4·55), and green leafy vegetables (OR = 1·27; 95 % CI 1·07, 1·51). Compared with urban non-migrants, migrants were more likely to consume orange (OR = 1·28; 95 % CI 1·02, 1·60) and other

Table 3 Multiple ordinal regression model testing the association between overweight/obesity risk, nutrition transition and household migration status among women aged 15–49 years (*n* 6171), Kenya Demographic and Health Survey 2014

	Rural-to-urban migrants *v.* Rural non-migrants*		Rural-to-urban migrants *v.* Urban non-migrants*		Rural-to-urban migrants *v.* Rural non-migrants*		Rural-to-urban migrants *v.* Urban non-migrants*	
	OR	95 % CI	OR	95 % CI	OR†	95 % CI	OR†	95 % CI
BMI status								
Overweight/obesity	3·10	2·59, 3·72	1·12	0·90, 1·40	1·25	0·98, 1·59	0·87	0·67, 1·13
Food groups								
Main staples and legumes								
Cereals, grains	0·62	0·50, 0·76	0·79	0·60, 1·03	0·69	0·54, 0·88	0·75	0·56, 0·99
Roots, tubers	1·18	1·01, 1·38	0·99	0·80, 1·23	0·79	0·66, 0·96	0·91	0·72, 1·15
Pulses, nuts	0·65	0·56, 0·76	0·79	0·65, 0·96	0·51	0·41, 0·62	0·67	0·54, 0·83
Vegetables								
Orange vegetables	3·22	2·62, 3·96	1·28	1·02, 1·60	1·35	1·10, 1·67	1·13	0·88, 1·45
Green leafy vegetables	1·27	1·07, 1·51	1·16	0·96, 1·41	1·38	1·13, 1·68	1·10	0·87, 1·38
Other vegetables	3·77	3·13, 4·55	1·42	1·12, 1·80	1·39	1·09, 1·77	1·07	0·81, 1·40
Fruits								
Orange fruits	2·75	2·26, 3·33	1·15	0·91, 1·45	1·44	1·17, 1·78	1·17	0·92, 1·49
Other fruits	3·65	3·03, 4·39	1·17	0·91, 1·50	1·60	1·32, 1·95	1·13	0·86, 1·49
Animal-source foods								
Meat	2·45	2·06, 2·93	1·04	0·81, 1·33	1·02	0·84, 1·24	1·00	0·77, 1·33
Organ meats	1·89	1·38, 2·59	0·82	0·56, 1·18	0·96	0·67, 1·37	0·76	0·52, 1·12
Fish or shellfish	1·55	1·26, 1·89	0·82	0·67, 1·01	1·10	0·87, 1·40	1·08	0·84, 1·39
Eggs	2·92	2·46, 3·45	1·08	0·88, 1·32	1·14	0·93, 1·38	0·99	0·80, 1·23
Milk and other dairy products	1·09	0·92, 1·30	1·04	0·80, 1·34	0·85	0·69, 1·05	1·07	0·82, 1·40
Oil, fat and butter								
Fats	2·45	1·87, 3·22	1·18	0·82, 1·70	1·11	0·81, 1·51	0·96	0·65, 1·42
Sugary foods and beverages								
Sweets	1·63	1·28, 2·07	1·21	0·86, 1·70	1·03	0·77, 1·37	1·02	0·70, 1·48

*Reference category.
†Adjusted for socio-economic and demographic characteristics.

(OR = 1·42; 95 % CI 1·12, 1·80) vegetables. The only food group they were less likely to consume was pulses/nuts (OR = 0·79; 95 % CI 0·65, 0·96).

Some food consumption changes were significant only after adjustment for household wealth and other socio-economic and demographic covariates. Migrants were now less likely to consume roots/tubers (OR = 0·79; 95 % CI 0·66, 0·96) compared with rural non-migrants. There was no evidence of significant differences in consumption of most animal-source food groups (meat, organ meats and eggs), fats and sweets between rural-to-urban migrants and rural non-migrants. Regardless of wealth, migrants were less likely to consume pulses/nuts, and more likely to consume fruits and vegetables. Compared with urban non-migrants, migrants were less likely to consume cereals and grains (OR = 0·75; 95 % CI 0·56, 0·99) after adjustment for socio-economic and demographic characteristics. Women's ethnicity significantly modified this association.

Factors associated with overweight/obesity risk

Table 4 shows the results of the backward stepwise regression analysis. In the reduced model, several factors were associated with overweight/obesity risk. Being aged 30–39 years (OR = 1·70; 95 % CI 1·16, 2·50) and aged 40–49 years (OR = 2·04; 95 % CI 1·32, 3·15) were significantly associated with overweight or obese compared with being aged 15–29 years. Further, migrant women who had resided in an urban area for more than 10 years were more likely to be overweight or have obesity compared with migrant women who had lived in an urban area for less than 5 years (OR = 1·68; 95 % CI 1·21, 2·35). Migrant women who were married/living together had higher odds of being overweight or having obesity than migrant women who were never married (OR = 1·74; 95 % CI 1·20, 2·52). Household wealth was found to be the strongest predictive factor of being overweight or having obesity. Compared with migrant women in the poorest wealth quintile, migrant women who were in the richer and richest wealth quintiles had odds of 2·91 (95 % CI 1·82, 4·63) and 4·08 (95 % CI 2·58, 6·43), respectively, of being overweight or having obesity.

Discussion

The first aim of the present study was to assess nutrition transition and risk of overweight/obesity among rural-to-urban migrants, in comparison with rural and urban non-migrants. The analysis showed that rural-to-urban migration was associated with an increased the risk of overweight/obesity in women. In addition, rural-to-urban migrants showed signs of a nutrition transition as they were

Table 4 Multiple ordinal regression analysis between socio-economic and demographic predictive factors, overweight and obesity among rural-to-urban migrant women aged 15–49 years (*n* 2269), Kenya Demographic and Health Survey 2014

	Full model		Reduced model	
Predictive factor	OR	95 % CI	OR	95 % CI
Age (years)				
15–29	1·00	Ref.	1·00	Ref.
30–39	1·62	1·10, 2·39	1·70	1·16, 2·50
40–49	1·86	1·19, 2·91	2·04	1·32, 3·15
Duration of residence in urban area				
Between 0 and 5 years	1·00	Ref.	1·00	Ref.
Between 5 and 10 years	1·40	0·96, 2·05	1·34	0·92, 1·95
More than 10 years	1·67	1·20, 2·33	1·68	1·21, 2·35
Employment status				
Not working	1·00	Ref.	–*	–
Self-employed	1·46	0·88, 2·43	–	–
Employed, in-kind only	1·25	0·91, 1·72	–	–
Employed, any cash	1·26	0·68, 3·30	–	–
Marital status				
Never married	1·00	Ref.	1·00	Ref.
Married/living together	1·78	1·18, 2·68	1·74	1·20, 2·52
Widowed/divorced/separated	1·42	0·89, 2·26	1·46	0·92, 2·31
Household wealth				
Poorest	1·00	Ref.	1·00	Ref.
Poorer	1·17	0·71, 1·94	1·21	0·72, 2·01
Middle	1·60	0·97, 2·66	1·58	0·95, 2·63
Richer	2·76	1·73, 4·39	2·91	1·82, 4·63
Richest	3·85	2·45, 6·05	4·08	2·58, 6·43
Number of children under 5 years in household				
0	1·00	Ref.	–*	–
1	1·12	0·84, 1·50	–	–
2	0·76	0·48, 1·21	–	–
≥3	0·51	0·24, 1·12	–	–

Ref., reference category.
*Not included in model.

less likely to consume main staples and pulses/nuts (and thus fibre), and more likely to consume animal-source products (e.g. meat and eggs) and energy-dense food products (e.g. fats and sweets), compared with rural non-migrants. It is noteworthy that migrants were more likely to consume fruits and vegetables as opposed to rural non-migrants. Compared with urban-non migrants, rural-to-urban migrants were less likely to consume pulses/nuts, and more likely to consume orange and other vegetables. No significant differences were observed for the other food group categories which suggests that, based on the current analysis, rural-to-urban migrants have adopted most of the urban diet.

However, after adjusting for household wealth there was no evidence of a significant association between rural non-migrants and rural-to-urban migrants for overweight/obesity risk. This result aligns with a recent study by Madise and Letamo which showed that the wealthier rural households in Kenya had higher risks of overweight than urban households[37]. This also accounted for nutrition transition as differences for most animal-source food groups, fats and sweets became non-significant between rural non-migrants and rural-to-urban migrants. This suggests that animal-source foods are not fully accessible to all socio-economic status (SES) groups within urban areas. It is consistent with other work in Kenya that showed women in the upper income group to have a significantly higher intake of fat compared with the lower income group[38]. Several systematic reviews show that high-SES individuals and households (assessed through education, income, assets, occupation or composite indicators) in LMIC tend to consume more energy and saturated fats than the lower-SES groups[39,40]. Further, differences for roots and tuber consumption became significant after adjustment for household wealth. A potential explanation for this could be the higher costs of traditional staple foods, in this case roots and tubers, in the urban areas, which are not accessible to lower-SES groups[41]. After adjustment for women's ethnicity specifically, a lower likelihood for cereal and grain consumption of migrants was observed in comparison with urban non-migrants. This result points to potentially an important role of sociocultural determinants of staple food consumption in urban areas, which merits further investigation.

Our study found rural-to-urban migrants were more likely to consume all fruits and vegetable groups. These findings for fruit and vegetable consumption agreed with the migrant studies by Bowen *et al.* and Unwin *et al.* as fruit and vegetable intakes showed an increasing trend from rural to migrant to urban[13,14]. After adjustment for

household wealth, these associations remained significant suggesting that overall, fruits and vegetables are more accessible to migrants in urban areas compared with rural non-migrants. This could be explained by increased household wealth which allows them to spend money on higher-value foods such as fresh fruits and vegetables other than staples[42]. For green leafy vegetables this might not come as a surprise, as Nairobi literature informed us that local collard greens (*sukuma wiki* in Kiswahili) are highly accessible in urban settings[22]. Vegetable consumption in Kenya is particularly high in urban areas compared with other SSA countries[43]. As the food categories contained a wide array of different food products, it is however difficult to determine what specifically the respondent consumed. Differences for vegetable consumption between migrants and urban non-migrants became non-significant after adjustment for socio-economic and demographic characteristics, emphasising that migrants adopt most of the urban dietary patterns post-migration. This could be due the availability of a wider range of foods in urban markets and the availability of storage facilities[43].

The second aim of the present study was to identify demographic and socio-economic factors which were associated with overweight/obesity risk among female rural-to-urban migrants. The analysis showed that the risk of being overweight or having obesity was higher in the older age groups, among migrant women resident in the urban area for more than 10 years, among the richer and richest household groups and among those married or living with a partner. Of all identified factors, belonging to the richer and richest group was seen to put rural-to-urban migrants at the highest risk of being overweight or having obesity. Similar results were found among internal rural-to-urban migrants from the Peru Migrant study, where migrants with a lower SES (defined by income) had lower odds of being overweight or having obesity[44]. These findings suggest that not only is urban living a strong risk factor for overweight/obesity among migrants, but household wealth plays a major role in this, something previously observed within Kenya[38]. Other literature reviewing the association between SES and obesity among non-migrants in LMIC confirms this. A review showed that the size of the association between urban residence and BMI in LMIC is reduced substantially after adjustment for SES (household wealth index), suggesting that much of the difference between urban and rural dwellers is driven by the socio-economic composition of the urban areas[45]. However, in the DHS, no identification of the migrant's residency within urban areas is possible. Urban areas are strongly heterogeneous environments, including urban slums, and the poorest migrants may therefore not have been included in the DHS analysis[46]. In the present study, rural-to-urban migrants were wealthier in comparison to rural non-migrants. As no reasons for migration to urban areas were provided in the KDHS, we can only speculate. A major reason for rural dwellers in Kenya to migrate to urban areas is to escape rural poverty[20]. After arrival, a large group faces unemployment, especially in the case of women, which could make them end up residing in slums as they cannot afford rent[47]. This suggests that the sample represented in the KDHS is not covering a proportion of the migrants. The results of our analysis should therefore be interpreted with caution.

The results also showed that migrant women who had resided in an urban area for more than 10 years were at a higher risk of overweight or having obesity compared with migrant women who had lived in an urban area for less than 5 years. Studies in India, Peru and Tanzania showed similar results as they observed a positive correlation between duration of residence and development of obesity among rural-to-urban migrants[48–50]. A potential explanation could be that as time passes, exposure to the urban environment and changing lifestyles may stimulate weight gain as the rural-to-urban migrants increase their energy intake, consume low-cost foods high in fat and sugar, and reduce their energy expenditure. There is evidence that longer times spent in urban areas are positively associated with fat intake[51].

Finally, marital status was found to be significantly associated with overweight/obesity. Women who were married and/or living together were more likely to be overweight or have obesity relative to women who had never been in union. Mixed results were observed in the non-migrant literature. While a Nairobi study did not observe a significant association between being married and overweight/obesity, other literature from national and urban Ghana and peri-urban Uganda indicated married women to be at a higher risk of being overweight or obese[52–54]. Potential explanations provided were sociocultural perception about fatness being associated with beauty, and husbands and wives eating ready-to-eat foods together. Further SSA context-specific research is needed which explores the mechanisms between rural migration, family composition and BMI status in depth.

Limitations of the study

There are some limitations intrinsic to the DHS data. As with all surveys of this type, their cross-sectional design precludes conclusions regarding causal processes. Information on the household food consumption groups collected in these surveys is potentially subject to reporting and recall bias. Importantly, there was no direct measure of rural-to-urban migration in the KDHS data. Rural-to-urban migration in the present study reflected only their childhood residence and migration between their current and previous place of residence. This classification does not account for migration experiences between their childhood place of residence and last migration, and may therefore limit the study's estimation of the migration effect. However, a clear distinction between migrants and non-migrants can still be made.

No food categories existed for energy-dense street foods, which are deemed important in the development of obesity as they are easily available and make a major contribution to the diet of many living in SSA[41,55]. In addition, food consumption was measured per household[30]; no distinctions could be made for the food consumption between women and men. This may bias the consumption among women as they could have reported what their husband and/or children consumed[11]. While these limitations are important to consider for future studies, the wide array of food groups included in the present analysis does provide sufficient detail to assess nutrition transition.

Even though wealth index measurement by the DHS reflects long-term wealth and provides inter-country comparison, it does not include household income and/or expenditure which is seen as an important indicator for food consumption. When people's income is low, they may resort to obesogenic dietary behaviours such as the consumption of street foods and cheap energy-dense food products to satisfy their hunger[56]. Lastly, many of the present rural areas have acquired characteristics previously mainly associated with urban areas, such as increased access to services and amenities associated with urban settlements, becoming so-called peri-urban areas[57]. The KDHS 2014 has classified these areas as rural areas[30]. Rural-to-urban migrants in the present study could have therefore migrated from areas where they were already more exposed to obesogenic urban lifestyles. This might be important to consider for future analysis as peri-urban areas seem to be a risk factor for overweight and obesity in SSA[58,59].

Conclusion

Despite its limitations, the current analysis expanded our knowledge on nutrition transition and predictive factors of overweight/obesity risk among rural-to-urban migrants in Kenya. The analysis showed that nutrition transition among rural-to-urban migrants is apparent as the consumption of main staples (including coarse grains) and legumes decreased, while both the consumption of animal-source and energy-dense food groups and the risk of overweight/obesity increased with wealth in urban areas. Migration to the urban areas also seemed to provide access to a more varied diet as migrants were more likely to consume fruits and vegetables. Several socio-economic and demographic risk factors of overweight/obesity among migrants were identified as well. These factors characterise migrant groups who could especially benefit from preventive interventions. The results indicate the need for longitudinal studies which investigate how changes in socio-economic and demographic characteristics influence changes in weight and dietary patterns over time. Additionally, to inform future interventions and policies, there is also a need for qualitative studies which explore in-depth environmental risk factors promoting nutrition transition among migrants while strongly considering social-cultural risk factors such as food traditions and body size perception. In particular, if we are to address inequalities in diet and overweight/obesity risk in the context of rapid urbanisation, the association between rural-to-urban migration and household wealth must be better understood.

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