**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 body-mass-index and nutrition transition. Nutrition transition was based on 15 different household food groups and was adjusted for socio-economic and demographic characteristics. Stepwise backward multiple ordinal regression analysis were applied.

*Setting:* Kenya Demographic and Health Survey 2014.

*Subjects:* 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 sourced, 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

**Introduction**

Overweight and obesity have become major global public health challenges. According to the World Health Organization (WHO), in 2016 over 1.9 billion adults (18 years and 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 (NCDs) such as cardiovascular disease, 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 healthcare 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-sourced 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 urbanization have all been identified as key underlying drivers of this transition(5). Urban food environments in low- and middle-income countries (LMICs) are increasingly seen as obesogenic environments(4; 6).

A major driver of the urbanization in LMICs is internal rural-to-urban migration(7). Due to the obesogenic environment in urban areas in LMICs, 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 LMICs have highlighted the association between rural-to-urban migration and increased overweight and obesity risk(9; 10; 11; 12; 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; 15; 16; 17; 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 body-mass index (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(20). A similar pattern has been observed in Kenya, an Eastern-African country which has an urban population growth rate of 4.3% annually. Around 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(21). Rapid urbanization 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 (22). 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 over-nutrition)(23). Detailed knowledge about rural-to-urban migration and changes in diet and weight status is therefore important to better understand the impact of urbanization 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(24). 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(25). The KDHS 2014 permits exploration of the complex mechanisms between the nutrition transition and urbanisation.

This study aimed to expand our knowledge on nutrition transition and population weight gain in Kenya in 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; 26; 27).

**Methods**

***Data sources and sampling strategies***

This 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(28). 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 1,612 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 (NASSEP) V frame. This frame is used by the Kenyan National Bureau of Statistics (KNBS) for conducting household surveys. The second stage involved the systematic sampling of households listed in each cluster. From each cluster 25 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(29).

The study population of this analysis comprised nationally representative cross-sectional weighted samples of 6171 non-pregnant women who have a 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(29).

***Study outcomes***

The outcome variables of the analysis were women’s body mass index (BMI) (kg/m2) and nutrition transition. The BMI was derived by dividing weight in kilograms by height squared. The BMI of female participants was then classified as normal weight (18.5-24.99 kg/m2), overweight (25.0–29.99 kg/m2), or obese (≥30.0 kg/m2)(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(29).

Nutrition transition was based on 15 of 16 available household food consumption categories. Each household was asked for the number of days a certain food was consumed in the past 7 days. These questions were developed by the World Food Programme to measure the household food consumption score(30). The selected household food consumption groups were as follows: cereals and grains (rice, pasta, bread, sorghum, millet, or maize); roots and tubers (potato, yam, cassava, normal sweet potatoes, taro, cooking banana/plantain or other tubers); pulses/nuts (beans, cowpeas, peanuts, lentils, soy, pigeon peas, other nuts); orange vegetable (carrots, red peppers, pumpkin, orange sweet potato); green leafy vegetable (sukuma wiki, spinach, broccoli, amaranth, cassava leaves, other dark green leaves); other vegetables (onion, tomatoes, cucumber, radishes, green beans, peas, lettuce); orange fruits (mango, paw paw, tree tomato); other fruits (banana, apple, lemon); meat (goat, beef, chicken, pork); organ meats (liver kidney, heart, or other organ meats); fish or shellfish (dried fish, canned tuna, or 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)(29).

Nutrition transition in this 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-sourced (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-migrant, 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)(21).The key independent variable of this 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 this 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(31). 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(32; 33; 34). 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(35; 36; 37), 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(29).

***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 odds ratios.

Multiple ordinal regression analysis was performed to measure the association between rural non-migrants, rural-to-urban migrants, and urban non-migrants for 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 (chi-square tests) were conducted. Predictive factors which were significantly associated with overweight/obesity risk (*p* <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.

The analysis was completed in Stata v14, with svyset commands to apply inverse probability weights which account for oversampling of urban primary sampling units (PSUs) and stratification by district. Throughout the analysis, means, standard deviations (SDs), odds ratios (ORs), 95% confidence intervals (CIs), 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 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 or obesity respectively, against 30 % and 16% of rural-to-urban migrants. Of the urban non-migrants, 23% and 18% were overweight and obese respectively. A little over half (57%) of the rural-to-urban migrant women were aged 15-29, while 62% were married or living together. Only 5% of the female rural non-migrants were in the richest household wealth quintile, compared to 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 (5.75 (0.08) vs. 6.13 (0.05) for cereals and grains and 2.06 (0.06) vs. 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 for animal-sourced food products meat (1.55 (0.07) vs 0.86 (0.04)), eggs (1.40 (0.07) vs. 0.72 (0.04)), fats (6.52 (0.06) vs. 6.08 (0.05)), and sweets (6.00 (0.09) vs. 5.6 (0.07)) compared to rural non-migrants. Compared with urban non-migrants rural-to-urban migrants consumed more fruits, vegetables and sweets; and less animal-sourced products meats, fish or seashell seafood, 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, there was 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 to rural non-migrants, migrants were less likely to consume cereals and grains (OR 0.62, 95% CI 0.50-0.76) and pluses/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-sourced 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 (OR 1.42, 95% CI 1.12-1.80) vegetables. The only food group they were less likely to consume were pulses/nuts (OR 0.79, 95% CI 0.65-0.96).

Some food consumption changes were only significant 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-sourced 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 (OR 2.04, 95% CI 1.32-3.15) were significantly associated with overweight or obese compared to 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 obese compared to migrant women who had lived in an urban area for less than five 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 to migrant women in the poorest wealth quintiles, 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 this 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 less likely to consume main staples and pulses/nuts (and thus fibre), and more likely to consume animal-sourced 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 this 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 et al. which showed that in Kenya the wealthier rural households had higher risks of overweight than urban households(38). This also accounted for nutrition transition as differences for most animal sourced groups, fats and sweets became non-significant between rural non-migrants and rural-to-urban migrants. This suggests that animal-sourced 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 to the lower income group (39). Several systematic reviews show that high SES individuals and households (assessed through education, income, assets, occupation or composite indicators) in LMICs tend to consume more energy and saturated fats than the lower SES groups (40; 41). 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(42). 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 socio-cultural 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. (2011) and Unwin et al. (2010) as fruit and vegetable intakes showed an increasing trend from rural to migrant to urban(14; 15). After adjustment for household wealth, these associations remained significant suggesting that overall, fruits and vegetables are more accessible to migrants in urban areas compared to 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(43). 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(23). Vegetable consumption in Kenya is particularly high in urban areas compared to other SSA countries(44). 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 food in urban markets, and the availability of storage facilities(44).

The second aim of this 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 being 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(45). 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 (39)). Other literature reviewing the association between SES and obesity among non-migrants in LMICs confirms this. A review, showed that the size of the association between urban residence and BMI in LMICs 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(46). 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(47). In this 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 migrants in Kenya to move to urban areas is to escape rural poverty(21). After arrival, a large group faces unemployment, especially in the case for women which could make them end up residing in slums as they cannot afford rent(48). This suggests that the sample represented in the KDHS is not covering a proportion of the migrants. The results of this 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 to migrant women who had lived in an urban area for less than five 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(49; 50; 51). 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 food 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 (52).

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(53; 54; 55). Potential explanations provided were socio-cultural perception about fatness being associated with beauty, and husbands and wives eating ready-to-eat-food 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 are 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 this study only reflected 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 as important in the development of obesity as they are easily available and make a major contribution to the diet of many living in SSA(42; 56). In addition, food consumption was measured per household(31); 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(12). While these limitations are important to consider for future studies, the wide array of food groups included in this 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 an important indicator for food consumption. When people’s income is low, they may resort to obesogenic dietary behaviour such as the consumption of street food and cheap energy dense food products to satisfy their hunger(57). 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(58). The KDHS 2014 has classified these areas as rural areas(31). Rural-to-urban migrants in this 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(59; 60).

**Conclusion**

Despite its limitations, this 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-sourced and energy-dense food groups and overweight/obesity risk 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 of 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 context of the rapid urbanisation, the association between rural-to-urban migration and household wealth must be better understood.

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**Table 1.** Descriptive analysis of respondents' characteristics by migration status

|  |  |  |  |
| --- | --- | --- | --- |
|  | Rural non-migrants | Rural-to-urban migrants | Urban non-migrants |
|  | n\* | % | n\* | % | n\* | % |
| Total number | 2,915 | 47.2 | 2,269 | 36.8 | 987 | 16.0 |
| Characteristics |  |  |  |  |  |  |
| BMI status |  |  |  |  |  |  |
| Healthy weight (18.5-25 kg/m2)Overweight (25-29.9 kg/m2)Obese (≥ 30.0 kg/m2)Total | 1,8903781302,398 | 78.815.85.4 | 1,1336243222,079 | 54.530.015.5 | 517222117856 | 60.425.913.7 |
| Women’s age |  |  |  |  |  |  |
| 15-2930-3940-49Total | 2,0215103842,915 | 69.317.513.2 | 1,2866902932,269 | 56.730.412.9 | 664 189133 986 | 67.3 19.2 13.5 |
| Women’s employment status |  |  |  |  |  |  |
| Not workingSelf-employmentEmployed, any cashEmployed, in kind onlyTotal | 1,545442868582,913 | 53.015.229.82.0 | 6071181,522202,267 | 26.85.267.10.9 | 446674694986 | 45.26.847.60.4 |
| Women’s education |  |  |  |  |  |  |
| No educationPrimarySecondary or higherTotal | 3301,5731,0122,915 | 11.354.034.7 | 661,0251,1772,268 | 2.945.251.9 | 54345588987 | 5.534.959.6 |
| Marital status |  |  |  |  |  |  |
| Never marriedMarried/living togetherDivorced/Separated/widowedTotal | 1,6769532862,915 | 57.532.79.8 | 5631,3993072,269 | 2.861.713.5 | 490385112987 | 49.639.011.4 |
| Number of children under 5 in household |  |  |  |  |  |  |
| 0123+Total | 1,1609635282642,915 | 39.833.018.19.2 | 867939396662,268 | 38.241.417.52.9 | 48034610951986 | 48.735.111.05.2 |
| Religion |  |  |  |  |  |  |
| Roman catholicProtestant/other ChristianMuslimTotal | 2,0385952222,855 | 71.420.87.8 | 1,685483822,250 | 74.921.53.6 | 606218152976 | 62.122.315.6 |
| Ethnicity |  |  |  |  |  |  |
| KikuyuKalenjinKambaLuhyaLuoMijikenda/swahiliSomaliOtherTotal | 3935923913551511421087832,915 | 13.520.313.412.25.24.83.726.9 | 67219137734019873193992,269 | 29.68.416.615.08.73.20.917.6 | 27776651291645567153986 | 28.07.76.613.116.75.66.815.5 |
| Household wealth quintiles |  |  |  |  |  |  |
| PoorestPoorerMiddleRicherRichestTotal | 8317417704381352,915 | 28.525.426.415.04.7 | 981642156171,1752,269 | 4.37.29.527.251.8 | 819888212508987 | 8.29.98.921.551.5 |
| \*Weighted  |

**Table 2***.* Descriptive analysis of household food group consumption by migration status

|  |  |  |  |
| --- | --- | --- | --- |
|  | Rural non-migrants | Rural-to-urban migrants | Urban non-migrants |
|  | Mean\* | SE | Mean\*  | SE | Mean\* | SE |
| Food groups |  |  |  |  |  |  |
| 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-sourced 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 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Rural-to-urban migrants vs Rural non-migrants\* | Rural-to-urban migrants vs. Urban non-migrants\* | Rural-to-urban migrants vs Rural non-migrants\* | Rural-to-urban migrants vs. 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-sourced |  |  |  |  |  |  |  |  |
| 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 |

**Table 3**. Multiple ordinal regression model testing the association between overweight/obesity risk, nutrition transition and household migration status

**Table 4.** Multiple ordinal regression analysis between socio-economic and demographic predictive factors, overweight and obesity among rural-to-urban migrant women

|  |  |  |
| --- | --- | --- |
|  | Full model | Reduced model |
|  | OR | 95% CI | OR | 95% CI |
| Predictive factors |  |  |  |  |
| Age |  |  |  |  |
| 15-2930-3940-49 | 11.621.86 | 1.10-2.391.19-2.91 | 11.702.04 | 1.16-2.501.32-3.15 |
| Duration of residence in urban area |  |  |  |  |
| Between 0 and 5 yearsBetween 5 and 10 yearsMore than 10 years | 11.401.67 | 0.96-2.051.20-2.33 | 11.341.68 | 0.92-1.951.21-2.35 |
| Employment status |  |  |  |  |
| Not workingSelf-employedEmployed, in-kind onlyEmployed, any cash | 11.461.251.26 | 10.88-2.430.91-1.720.68-3.30 |  | Not included in model |
| Marital status |  |  |  |  |
| Never marriedMarried/living togetherWidowed/divorced/separated | 11.781.42 | 1.18-2.680.89-2.26 | 11.741.46 | 1.20-2.520.92-2.31 |
| Household wealth |  |  |  |  |
| PoorestPoorerMiddleRicher Richest | 11.171.602.763.85 | 0.71-1.940.97-2.661.73-4.392.45-6.05 | 11.211.582.914.08 | 0.72-2.010.95-2.631.82-4.632.58-6.43 |
| Number of children under 5 in household |  |  |  |  |
| 0123+ | 1 1.12 0.76 0.51 | 0.84-1.50 0.48-1.21 0.24-1.12 |  | Not included in model |