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An analysis of the contribution of the informal milk market to nutrition in Kenya

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Abstract

Background The dairy sector in Kenya is an important part of the agricultural GDP of the country. Its legal framework was reformed in 2004 to address the economic importance that the informal sector (i.e. trading on raw milk) had for smallholders' producers. However, this reform was accused of being a pro-poor policy instead of focusing on the development of the formal dairy sector. In recent years, there has been pressure to go back to the pre-2004 regulatory system and to illegalize the raw milk trade. An aspect that has been absent from the discussion is the contribution that the informal market has to households' nutrition. The contribution of this paper is to address this shortcoming using the most recent Kenya Integrated Household Budget Survey for 2015–16.

Results The results indicate that the rural annual milk consumption (70.2 L) surpasses that of urban areas (68.8 L). These values are different to those found in the literature. County consumption varies depending on the availability of milk, which appears associated to the production capacity and the climate of the region. However, regardless of the region unpacked milk is the most consumed dairy item representing 72 per cent of the total countrywide; 84 per cent of the rural total and 55 per cent of the urban area.

Conclusions The results indicate that the sector provides significant nutrition especially to poor economic groups. Therefore, attempting to ban the informal sector would have negative consequences for Kenya's food security, impacting mostly on the nutritional security of low-income households. In addition, the nutritional aspects that the informal dairy sector provides need to be considered alongside the economic ones in future debates regarding regulatory reforms of the sector.

Keywords Informal milk market, Nutrition, Kenya, Developing countries

Introduction

Kenya suffers from food insecurity due to several intertwined reasons such as climate change and poverty. As noted by FEWS NET [9], climate change poses one of the biggest challenges for food security, for instance, in 2019 the country suffered from a delayed rainy season that led to water scarcity and affected the agricultural sector causing food shortages, decreasing dietary diversity and amplifying malnutrition problems. The most vulnerable households in crisis reduced their meals to one per day with maize, beans, oil and sugar as the key staples (FEWS [9]).

Agriculture in Kenya is an important sector that contributes to 24 per cent of the Gross Domestic Product (GDP) and the dairy sector, which is the focus of this paper, represented in 2014 14 per cent of the agricultural GDP [19, 26].

The experiences of the Kenyan dairy sector are interesting for developing countries and particularly for sub-Saharan African countries because of its treatment of the informal market. Thus, the legal framework of the

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Kenyan dairy sector was reformed at the beginning of 2004. The reform was focused on the economic importance that the informal sector had for smallholders' producers. It fomented the revision of policies to decriminalize their activities and encourage their registration with the respective authorities [15]. Before then, milk regulation was focused on large-scale production that only represented the minority of the dairy sector. However, the reform was accused of being a pro-poor policy that empowered more the informal sector rather than focusing on the development of the formal one [14]. In recent years, due to lobbying power from the private sector, there has been pressure to go back to the pre-2004 regulatory system that illegalizes the trade of raw milk [23].[1]

The contributions of this paper are focused on the input that the informal sector has in the consumption of milk in Kenya. This is an interesting area because as pointed out by FAO [5], there are conflicting estimations of annual per capita milk consumption in Kenya. The existing estimates are based on the apparent consumption (i.e. supply divided by population) not on household data. In this context, a contribution of this paper is to provide estimates for the entire country and broken down by rural and urban areas using the 2015–16 Kenya Integrated Household Budget Survey (KIHBS) (Kenya National Bureau of Statistics, [18]).

A second contribution of the paper is to estimate the importance that the informal dairy market has on households' nutrition particularly to those in a poor economic situation. It should be noted that this is an aspect that has not been explicitly considered in the discussions about the reform of the Kenyan dairy sector (past and present). This has been done combining the 2015–2016 KIHBS with the newly published nutritional tables, i.e. Kenyan Food Composition Tables [7], which allowed not only to estimate the contribution of milk, but also the nutritional significance of milk within the diet.

The structure of the paper is as follows: it starts with two reviews—one on milk, food security and nutrition and another on the Kenya's estimations of milk consumption. Next, the data and methods used on the paper are presented, followed by the results and their discussion. Finally, conclusions and some implications are presented.

Milk, food security and nutrition

The purpose of this literature review is to address the following topics: milk consumption and its relationship with food security and nutrition.

[1] A relatively recent review of the informal dairy supply chain in Kenya can be found in Zavala-Nacul and Revoredo-Giha (2022).

Impact of milk on food security

Food security has four dimensions or pillars that are access, availability, utilization and stability (which is satisfied if the other three dimensions are satisfied). Milk plays an important role in each of them. For access, it represents an affordable source of food that provides jobs and income improving the purchasing power of the households. For availability, milk is a nutrient-rich food that can be found even in remote locations [4, 6]. For utilization, milk contributes to nutritional security and helps in diet diversification [31]. For stability, the promotion of stable dairy systems that can manage climate extremities can be a coping mechanism for food insecure populations [4, 6].

Access is directly linked to the affordability of food products and the purchasing power of the household. Dairy is a source of livelihood for smallholders providing income and employment to them [4]. Cash income can be obtained from different points of the dairy supply chain [20]. This income can be directly related to the sales of the product or services or indirectly to the creation of jobs along the value chain. The cash can be used to acquire staple foods and aides in making the diet more diverse [20]. Dairy in Kenya especially from the informal sector can also be bought in accordance with the daily monetary allowance the households have. In this way, even in days that they have budgetary constraints they still can afford little milk quantities [29].

Availability is linked to local production and distribution. Most developing countries, like Kenya, have weak market structures and supply chain systems that complicate the movement of food products from one region to the other. However, the production of milk tends to be regionalized bringing the producers and consumers geographically close and facilitating the availability of milk even in remote regions [25]. Smith et al. [31] established that in times of crisis, dairy cattle can move if relocation is required proving a moving source of food.

In the case of utilization, milk consumption supports growth and development. It is a source of key macronutrients and critical micronutrients in a bioavailable matrix, for instance, vitamin A, B complex, iron, zinc, riboflavin, magnesium, phosphorus, potassium and calcium. It also provides high-quality linoleic acid and a-linoleic fatty acids that aid in the development of the nervous system [11, 24].

Impact of milk in nutrition

Milk is a complex food matrix that is nutritionally dense and provides high-quality protein and a wide range of macro and micronutrients. It has a relevant role in human's diet due to its affordability and its nutritional value especially in the poorest and more food insecure

sectors of the population with starchy based diets [3, 4]. According to Smith et al. [31], the consumption of milk can contribute to achieve dietary adequacy and prevent undernutrition.

The role of milk is pivotal to achieve dietary adequacy, especially for children. Thus, children from 6 months to 5 years that have moderate malnutrition and start a diet with sufficient milk have a positive effect on linear growth, bone health and weight gain. This stage of development is one of the most important as it will have repercussions throughout the individual's life [4].

Micronutrient deficiency and substandard energy ingestion are common in populations with low dietary diversity. For instance, stunting is associated with poor maternal nutrition, regular consumption of a poor diet and suffering from infections and parasites during the early life years [4]. Milk plays a key role in alleviating this condition. First, it is the primary source of protein for pregnant and lactating women in Kenya [35]. Second, in children and adolescent's diet, it is linked to increase of bone content, enhance the uptake of amino acids in bone tissue, promote linear growth and reduce protein deficiency [11, 24]. It is interesting to note that those areas (see Fig. 1) with high food insecurity corresponds to pastoralists and arid area with low milk consumption and production (FEWS [9]).

One of the main nutritional advantages that milk has is that it does not contain nutritional inhibitors that affect mineral availability like phytates. For this reason, it is a good vector for fat-soluble vitamins and bioactive compounds like phospholipids [4]. Two of the main micronutrients that milk provides are calcium and vitamin B12. Calcium is associated with bone development, the rigidity of the skeleton and the prevention of osteoporosis (FAO/WHO, [8]). Vitamin B12 or cobalamin is mainly linked to the consumption of animal source food. According to Williams et al. [35], B12 deficiencies have metabolic consequences for all group ages with children being the most affected by having impaired development and poor academic performance.

Milk consumption in Kenya

FAO report about the development of the Kenya's dairy sector [5] noted that there are conflicting estimations of annual per capita milk consumption in Kenya. The FAO report indicates that the Kenya Dairy Master Plan (KDMP) report, prepared by the Danish International Development Agency for Kenya's Ministry of Livestock Development in 1991, estimated the annual per capita consumption of marketed milk at 125 kg in urban and 19 kg in rural areas.

The KDMP report indicated that districts with high per capita milk production also have high per capita home milk consumption. The study also showed that the quantities consumed increase as incomes increase.

A 2002 Smallholder Dairy (Research and Development) Project (SDP) study (ILRI, [13]) estimated monthly per capita dairy consumption in Nairobi, Nakuru urban and Nakuru rural of being 4.8, 4.6 and 4.2 L, respectively. This translates into annual per capita consumption of 57.6, 55.2 and 50.4 L, respectively.

Another SDP study (2004) (ILRI, [13]) estimated that milk consumption levels in Kenya are among the highest in the developing world, with an average of 100 kg/year per capita. Note that Kiambi et al. [19] do not provide new figures but cites an SDP study (ILRI, [13]) where milk intake was estimated to be highest in the urban centres at 125 L per capita (Fig. 2).

For Kenya, Omore et al. [27] estimated the per capita consumption by 145 L, while FAO [5] stated it was of 100 kg, and Rademaker et al. [28] declared that the yearly consumption accounted for 110 L. It is important to highlight that these estimations are based on availability and not on demand.

Milk consumption among sectors is not homogenous; there are discrepancies among rural and urban households as well as between different income levels. According to Njarui et al. [24] and Alonso et al. [1], urban populations consume more milk when compared to rural ones and low-income communities drink below the recommended levels. Njarui et al. [24] and FAO [5] mention that there are also differences among regions. According to these publications, the districts that have higher milk production have a high milk consumption. While pastoralist populations only can produce small quantities of milk that are aimed to be consumed by the household, communities with a mixed crop–livestock system tend to have better yields and can produce milk with the double purpose of household consumption and commercialization.

In terms of the characteristics of the demand, milk demand was estimated to be price inelastic so even if the prices increase, there is a willingness to buy it [1]. Urban and peri-urban milk consumption increases with the expansion of urbanization, rising of the middle class and access to more added value products [28].

With regard to the informal market, Kaitibie et al. [15] indicate that consumers buy in the informal market for diverse reasons: price, i.e. milk sold raw or unprocessed is cheaper than process milk besides the vast majority (96 per cent) boils the milk prior to their consumption, access, consumers in the remote location have limited access to processed products so they buy in local informal markets; quantity that can be bought. Consumers especially those with a constrained

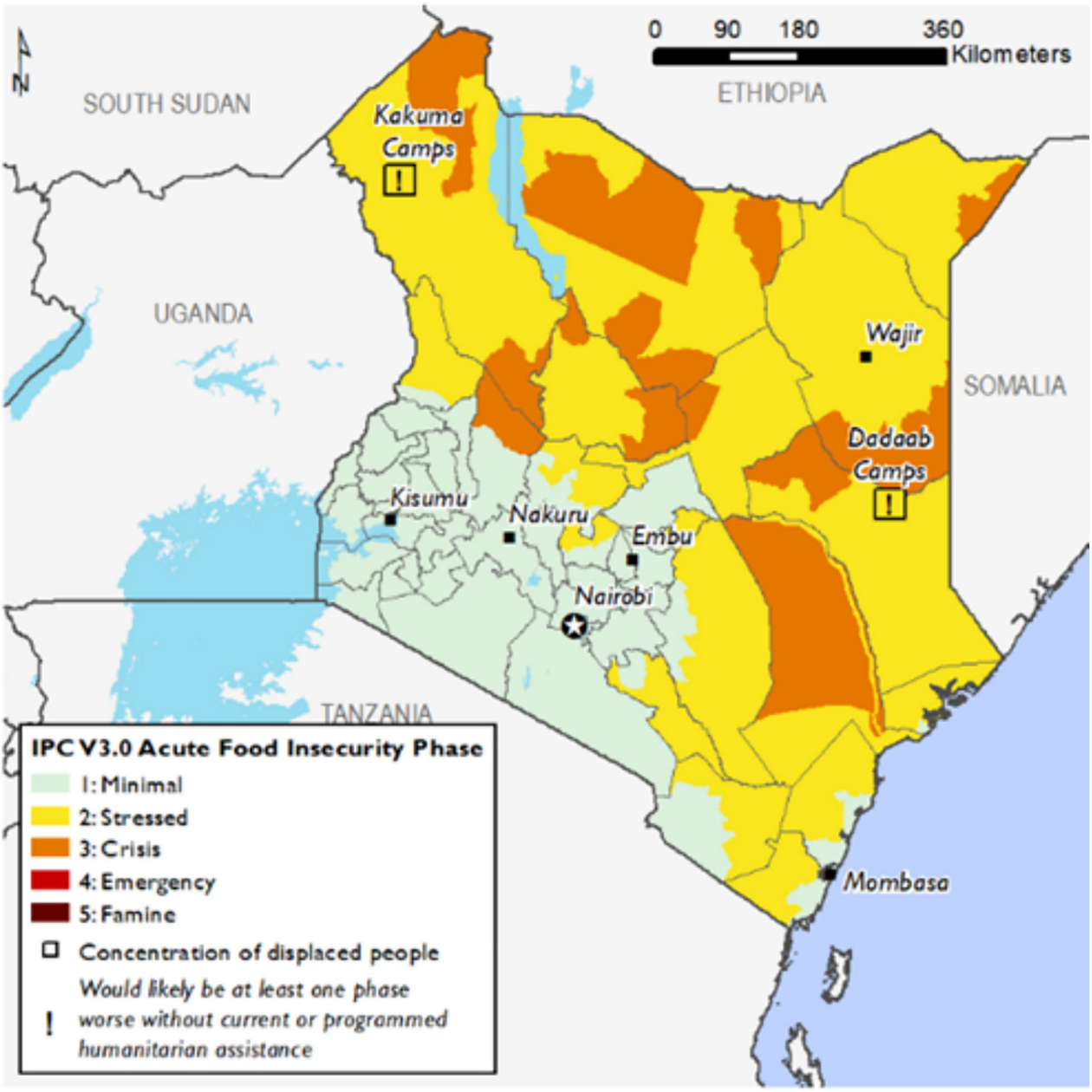

Fig. 1 Kenya—food insecurity areas (June to September 2019). Source: FEWS, 2019

food budget can decide the amount they can afford and negotiate a price [15, 24, 30].

Methods

This section describes the data used in the estimations as well as the methods used.

Data

The data used in this paper came from the Kenya Integrated Household Budget Survey of 2015–2016 (KIHBS). This survey was used to understand the importance of dairy and its selling points. Additionally, the Kenyan Food Composition Tables (KFCT) [7] were used to estimate the nutritional impact that each food groups have in the diet.

The focus point was given to fresh-unpacked and packed milk consumption and the impact in nutrition they have. To do so, the information was analysed for countrywide, then by rural and urban areas and by economic tertiles.

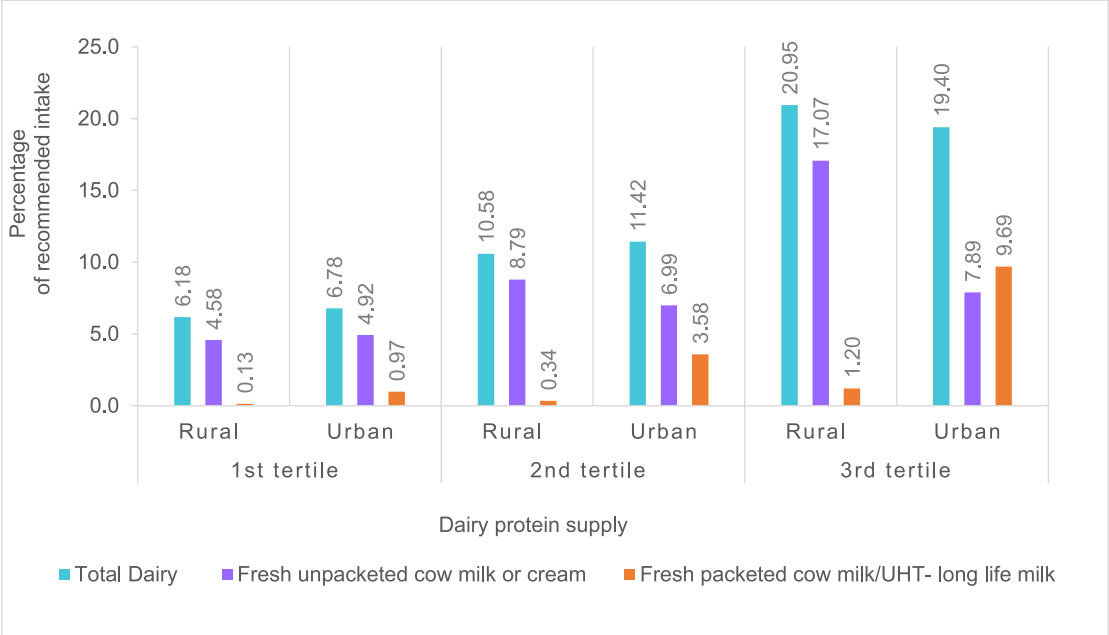

Fig. 2 Percentage of protein that dairy, unpacked and packed milk represent from the recommended values per tertiles. Source: Own elaboration based on KIBHS data

The KIHBS for the period 2015–2016 is the eighth-household budget survey conducted in Kenya, the first was produced in 1981/82 and the previous before the 2015–2015 survey was for the period 2005/2006. The survey 2015–2016 was conducted in a period of 12 months from the 1 of September in 2015 to the 31 of august in 2016 by the Kenya National Bureau of Statistics and comprised 21,773 households (of which 58.8 per cent was rural and the remaining 41.2 per cent). This survey was funded by the World Bank and the Government of Kenya to obtain a series of socio-economic indicators of consumption patterns at a household level in all counties to have national, rural and urban representation and to evaluate the implementation of different initiatives.

The KFCT provided a way to understand the intrinsic nutrient quality of foods. The original tables were developed in 1993 and by 2018 an update was done to reflect the changes that the food system had undergone in the 25-year gap. For this update, 509 raw and cooked foods and 142 mixed ingredient recipes were considered. These foods were divided into food groups and presented in alphabetical order. The Kenyan Food Composition Tables follow international guidelines from FAO-UN International Network of Food Data System. The Tables include information about energy, micronutrients, vitamins, minerals, cholesterol, phytates and oxalates, amino acids and fatty acids.

It is important to highlight that consumption in the KIHBS presents the same limitations for nutritional analysis observed in other household surveys. The main issue is that consumption is considered at the household level and does not provide intra-household allocation. Another limitation is that all the food reported is considered as homogeneous in terms of safety and quality and that these conditions are matching the ones reported in the KFCT. The final limitation is it considers that food utilization (e.g., preparation, storage) in the households is adequate and all the macro and micronutrients are maintained during the preparation of the meals. Regardless of the limitations mentioned, the survey can provide a general picture of the relevance of milk and dairy to the nutritional status of the household that is better from that inferred from apparent consumption estimates.

As regards the KFCT main limitation, this is that the food information considered is calculated based on samples or literature review. This information may vary when different cooking conditions and techniques are used, for instance, fat in deep-fried food that can be overestimated, or vitamin loss may occur.

Methodology

This section presents first, how the dairy and milk consumption was estimated for each of the population groups chosen; it is followed by the calculation of the food consumption and nutrient intakes; and the diverse nutritional indicators associated with them; finally, the method used to understand the relevance that each selling point has on milk purchases is presented.

Dairy and milk consumption

Annual dairy consumption was obtained by calculating the weighted (the survey contains weight for each household so it is possible to infer population numbers) average of consumption, as Eq. (1) shows, first countrywide and then considering a disaggregation between rural and urban areas. Total dairy consumption is the sum of the fractions between the population of counties in rural areas (Cr) and urban areas (Cu) divided by the total population (Ct) and multiplying by the average dairy consumption in rural and urban areas, respectively, ($\overline{\text{Dr}}$ and $\overline{\text{Du}}$) as shown in the formula. To further illustrate the ingestion of dairy in different regions, the annual weighted average of dairy consumption per capita was computed by county:

$$\text{Total dairy consumption} = \frac{\sum \text{Cr}}{\sum \text{Ct}}\overline{\text{Dr}} + \frac{\sum \text{Cu}}{\sum \text{Ct}}\overline{\text{Du}} \quad (1)$$

The milk categories considered in the KIHBS were fresh-unpacked cow milk or cream, fresh packed cow milk, fresh flavoured packed cow milk, UHT long-life milk, goat milk and camel milk, and the weighted annual averages were used considering the same population divisions mention before. Then, the percentage that each product represented in the total dairy category was plotted for countrywide, rural and urban populations. Finally, the annual weighted per capita consumption of fresh unpacked and packed milk was calculated for each income tertile of the rural and urban areas.

Estimation of food and nutrient consumption

Household food consumption recorded in KIHBS was divided into 21 different food groups shown in Table 1. These groups were created considering the nutritional composition and to portray a realistic approximation of an average daily diet for the Kenyan population. Average consumption values were obtained for each category and then were converted into per-capita and daily basis. Additionally, consumption data were arranged in groups: countrywide, rural and urban areas and then within tertiles per rural and urban.

In order to get the macro and micronutrient compositions for each of the food groups, the KFCT were used. These tables were grouped in the same 21 categories mention before (i.e. Table 1), and the average values for each nutrient was obtained. This segmentation shows the impact each food group has on different nutrient intakes. However, a limitation found was that in some cases the average inflates the nutritional values. This situation was particularly found for 2 categories of meat/egg and dairy. For this reason, the food components in these two categories were weighted prior to their consideration in the total.

Table 1 Household food categories

Food categories			
1	Millet and minor cereals	12	Fish and seafood
2	Rice	13	Dairy products
3	Maize	14	Oils and fats
4	Wheat	15	Fruits
5	Fortified flour	16	All vegetables
6	Breakfast cereals	17	Sugary products
7	Pulses and nuts	18	Spices and miscellaneous
8	Bread and cakes	19	Coffee, tea and cocoa
9	Pasta	20	Soft drinks and juices
10	Roots and tubers	21	Other dishes
11	Meat and eggs		

Source: Own elaboration based on KIHBS data

Nutritional indicators

To estimate the impact that dairy and cow´s milk have on the diet several indicators were used. First, the energy, protein and fat supply from the consumption were calculated for countrywide, rural and urban areas by multiplying the consumption of the dairy products by their nutritional values from the KFCT. Then, the households were divided into income tertiles to obtain the percentage that diary, fresh-unpacked and packed milk represent in their total diet.

In addition, mean adequacy ratios (MAR) were calculated as indicators of nutritional quality and dietary diversity for each tertile of the rural and urban population. These indicators measure the overall nutritional adequacy of a population based on an individual's diet using the recommended intakes for a selected group of nutrients. They have also been associated positively with other health indicators [12, 34]. One of the main advantages of this method is that it allows the evaluation of the overall nutritional adequacy rather than just focusing on one nutrient providing a more realistic indication of dietary quality [12].

In order to calculate the MAR, it was necessary to select the nutrients and know the recommended intakes. The seven selected nutrients, shown in Table 2, were based on the report by FAO on milk and dairy products (2013). As mentioned in the INDDEX Project [12], MAR can only provide a general picture of the adequacy of the diet, but does not reflect which micronutrients are over or under-consumed.

The MAR is calculated by averaging the nutrient adequacy ratio of each of the selected nutrient as shown in Eq. (2). The nutrient adequacy ratio is the fraction

Table 2 Nutrients selected for the MARs

Nutrients	Units	Recommended values
Protein	(g)	50.0
Calcium	(mg)	800.0
Magnesium	(mg)	300.0
Selenium	(mcg)	70.0
Vitamin A	RE	800.0
Thiamine	(mg)	1.4
Riboflavin	(mg)	1.6
Vitamin B12	(mg)	1.0

Source: Codex Alimentarius Commission [2]

between the intake of a nutrient (Ci) and the recommended intake of that same nutrient (Ri). When the MAR percentage is 100, it represents that the diet has fulfilled these daily nutritional requirements. To prevent that the nutrients that are exceed disguised the nutrients that had a low intake, all the values are topped at 100 per cent [12, 34]:

$$\mathrm{MAR} = \frac{1}{8} \times \sum \frac{\mathrm{Ci}}{\mathrm{Ri}} \times 100 \quad (2)$$

Milk purchases by selling point

For fresh unpacked raw milk, the annual weighted average consumption per capita per origin in litres was calculated and the percentages that each selling point represent of the total quantity purchased was plotted for the countrywide, rural and urban population.

Since the consumption of fresh-unpacked milk is more important for the poorest sections of the population, special attention was given to the first tertile of rural and urban populations. The selling points were divided into three markets as Table 3 shows. One limiting factor for this categorization is that some selling points could be participating in both types of markets, for instance, there are kiosks that operate with a license and are formal, but others do not hence they are informal. Since it is impossible to accurately separate these cases the category of others was created.

Results and discussion

The results are grouped into four parts: first, estimates of the per capita consumption of dairy products are reported at national, rural and urban and by income tertile. In addition, estimates of the share of fresh-unpacked and packed milk on the total milk consumption are presented. Second, estimates of the total dietary nutrient intake at a national level are considered; these are also broken down by the rural and urban groups and by income tertile group, being the first tertile the poorest one. Third, the contribution that dairy products, packed milk, and unpacked fresh milk have on the diet macro and micronutrients is presented and the MAR indicators are reported. Fourth, the relevance of the informal market is shown by main selling points of unpacked milk.

Table 3 Market and selling points

Market	Selling point
Informal market	Open market
	Other households
	Roadside/hawker
Formal market	Establishment/institution
	From stock
	Specialized shop
	Supermarket
Other	General shop
	Gift
	Kiosk
	Own produce
	Other

Source: KIHBS, 2015–16

Table 4 Kenya—weighted average annual per capita milk consumption of milk and dairy products

Group	Consumption	
	Dairy products (litres)	Milk (litres)
Countrywide	74.63	69.59
Rural	74.81	70.22
Urban	74.41	68.78

Source: Own elaboration based on KIHBS data

Dairy and milk consumption

All the information cited are in per capita terms. The estimated annual average dairy consumption for Kenya is 74.6 L. Rural and urban average consumption have less than a litre of difference between them as shown in Table 4. Milk consumption per capita was estimated in 69.6 L countrywide and once again the consumption in rural areas is higher than urban areas.

Detailed information on consumption per county (not presented here due to space limitations but available from the authors upon request) shows high variability with the highest dairy consumption being Nyeri and Bomet with values that surpass the 120 L per year; and the lowest consumption being in Turkana with only 19 L per year and Busia with 26 L. For rural areas, Kilifi and Busia are the lowest ones with annual dairy consumption

Table 5 Average annual per capita consumption of unpacked and packed milk countrywide and by economic tertile

Groups	Per capita consumption in litres	
	Unpacked cow milk /Fresh cream	Packed cow milk /UHT long-life milk
Countrywide	53.56	13.13
Rural	62.92	2.72
1st tertile	27.04	0.59
2nd tertile	52.00	1.57
3rd tertile	101.40	5.47
Urban	41.60	26.60
1st tertile	29.12	4.44
2nd tertile	41.60	16.28
3rd tertile	46.80	44.11

Source: Own elaboration based on KIHBS data

below 20 L per year. However, the lowest consumption of dairy is found in urban Turkana with less than 10 L of milk per year.

Cow´s milk is by far the most consumed product of the dairy category. Fresh-unpacked cow milk (unpacked milk, hereafter) represents 72 per cent of all the dairy consumed nationwide and packed/UHT long-life milk (packed milk, hereafter) adds another 17 per cent to the total dairy. For rural areas unpacked milk is even more relevant representing 84 per cent of the total dairy consumption while packed milk only provides 4 per cent. On the other hand, for urban areas packed and unpacked milk have a more even contribution with 36 per cent and 55 per cent, respectively.

Table 5 provides a more detailed depiction of the consumption of unpacked and packed milk considering annual per capita consumption in the different income tertiles of the rural and urban population. Unpacked milk is consumed the most in the third or richest tertile of the rural areas while packed milk is consumed the most in the third tertile of the urban areas. Nonetheless, in none of the tertiles packed milk is consumed more than unpacked milk showing the importance of unpacked milk for the country.

As mentioned, although dairy and milk consumption contribute to food security in Kenya [4], however, throughout the literature on the topic there is dissension towards the value of the annual milk consumed. Thus, according to ILRI [13], the annual per capita consumption of milk in Kenya was 145 L. FAO [5] established a differentiated consumption for rural (19 kg) vs urban areas (125 kg). Njarui et al. [24], mentions the same figures but with different units, and creates a further division, establishing that rural consumption is divided between those households that are producers (45 L) and those who are just consumers (19 L) and reiterates a consumption of 125 L for urban areas. The most recent data found in the KDB official webpage [17] stated that the annual average consumption of milk is 110 L. Yet, the results found are not aligned with any of these previous publications as the estimation of 70 L based on the 2015–2016 KIHBS (KNBS, [18]).

Additionally, there is also a contradiction with those reports that more consumption of dairy and milk is in urban areas than in rural. The findings of this study show that rural area on average consumed 1 L more than the urban counterpart. These differences could be attributed to the consideration of previous publications that apparent consumption from the supply side, rather than on the consumption from the demand side. Apparent consumption does not always considers waste or production losses. On the other hand, the estimation from demand side considers what the households actually consume making it a more accurate depiction of reality. However, it is important to highlight that per capita consumption must be taken with some reservations since the distribution of intra-household is uneven between men, women and children, as Roesel and Grace [29] and Kassie [16] stated there is a gender perspective in the milk supply chain that plays a key role not only in the way the system functions, but also in the way the food is allocated.

Estimation of food and nutrient consumption

As mentioned, the items consumed by the Kenyan population were divided into 21 categories. Table 6 shows the input of energy (i.e. metabolizable energy), macro and micronutrients that each of these categories provide to the diet for countrywide, and the totals for rural and urban areas. In addition, Tables 7 and 8 present the results for the first tertiles in rural and urban areas, i.e. the most disadvantaged groups.

On average, Kenyans consume daily 1838 kcal, 50 g of protein, 61 g of fat and 244 g of available carbohydrates. Energy consumption is similar for the rural and urban population with 1811 and 1864 kcal, respectively. In terms of macronutrients, the rural average diet has less protein (47 g) and fat (57 g) but more available carbohydrates (252 g). Urban population, on the other hand, consumes more protein (52 g) and fat (67 g) per day than the national average. These situations are different when compared to the first tertiles or the poorest sectors of the population. Rural first tertile only consumes 1008 kcal and has a daily protein intake of 24 g; while the urban tertile ingests daily only 1166 kcal and 38 g of protein. Both values are below the recommendations that are 2000 kcal and 50 g of protein per day. As is expected, maize is the

Table 6 Kenya—food and nutrient consumption countrywide

Food category	Nutrients												
	Energy	Protein	Fat	Carbs	Fibre	Ca	Mg	P	Zn	Se	Vit A	Vit B2	Vit B12
	kcal	g	g	g	g	mg	mg	mg	mg	mcg	RE	mg	mg
Millet and minor cereals	43.14	1.63	0.86	6.40	1.65	31.30	22.26	43.47	0.30	2.67	13.67	0.02	0.00
Rice	82.69	1.64	0.20	18.31	0.51	3.72	6.68	32.49	0.27	0.90	0.00	0.01	0.00
Maize	396.53	8.25	4.19	74.00	14.99	20.73	81.86	289.29	2.31	8.34	16.67	0.14	0.00
Wheat	51.30	1.75	0.32	9.45	1.81	5.24	16.18	34.01	0.37	5.87	0.06	0.02	0.00
Fortified flour	16.28	0.58	0.43	2.40	0.27	17.54	2.73	16.41	0.09	0.29	4.50	0.04	0.05
Breakfast cereals	1.55	0.04	0.01	0.31	0.03	0.08	0.25	0.81	0.00	0.08	0.06	0.00	0.00
Pulses and nuts	116.16	6.48	4.73	9.41	5.03	36.65	53.64	111.79	0.93	5.60	6.12	0.06	0.00
Bread and cakes	165.44	3.37	6.44	23.01	1.02	29.16	9.64	66.09	0.31	4.02	27.12	0.06	0.16
Pasta	4.58	0.17	0.02	0.92	0.04	0.27	0.46	2.00	0.01	0.16	0.00	0.00	0.00
Roots and tubers	101.61	1.84	0.29	21.27	3.26	19.18	17.67	45.83	0.39	0.57	78.97	0.04	0.00
Meat and eggs	63.94	7.07	3.86	0.26	0.01	5.91	5.61	78.99	1.07	6.51	628.37	0.15	3.28
Fish and seafood	8.23	1.44	0.24	0.03	0.00	9.39	2.16	21.19	0.09	2.36	2.22	0.01	0.31
Dairy	205.34	6.77	15.03	10.60	0.00	223.24	20.61	215.59	0.74	2.97	129.67	0.43	0.84
Oils and fats	193.36	0.05	21.46	0.03	0.00	1.18	0.16	1.51	0.01	0.05	264.06	0.00	0.06
Fruits	62.75	0.77	0.64	12.02	2.97	25.40	14.67	17.90	0.24	0.90	9.64	0.04	0.00
All vegetables	78.80	5.58	0.78	8.15	8.53	227.18	69.48	129.70	1.12	3.83	367.41	0.24	0.00
Sugary products	163.04	0.11	0.04	40.51	0.13	4.51	3.44	5.58	0.67	0.21	0.43	0.01	0.00
Spices and miscellaneous	11.65	0.37	0.32	1.39	0.88	25.65	7.26	23.13	0.11	0.40	10.92	0.01	0.00
Coffee, tea and cocoa	12.99	0.46	0.36	1.82	0.34	3.64	8.12	7.75	0.04	0.30	0.70	0.02	0.00
Soft drinks and juices	36.81	0.30	0.05	1.71	0.00	7.28	5.80	15.37	0.05	0.67	0.13	0.01	0.00
Other dishes	21.63	0.87	1.01	2.09	0.36	7.08	3.56	15.43	0.11	0.75	7.99	0.02	0.05
Total	1837.81	49.55	61.29	244.09	41.82	704.34	352.25	1174.32	9.27	47.46	1568.72	1.34	4.74
Rural areas	1811.91	47.36	56.71	251.52	44.84	664.86	366.42	1170.48	9.27	45.29	1257.09	1.23	3.28
Urban areas	1864.59	51.83	66.74	234.37	37.92	753.01	333.43	1171.59	9.22	49.14	1963.98	1.45	6.56

Source: Own elaboration based on KIHBS

Carbs. stands for carbohydrates, Ca for calcium, Mg for magnesium, P for phosphorus, Zn for zinc, Se for selenium, Vit A for vitamin A, Vit B2 for riboflavin and Vit B12 for cobalamin

most abundant food consumed and is the main source of energy and protein followed by the dairy for countrywide (Table 6).

For rural first tertile, as Table 7 shows, maize, sugary products and dairy account for the top three energy intake categories while maize, pulses and dairy are the main sources of protein. For the urban first tertile, Table 8 shows that maize is still the top source of dietary energy and protein supply. But oils and fats are the second main provider of calories follow by sugary products and dairy. For protein, this tertile has the same pattern as its rural counterpart.

Nutritional security focuses on the quality and diversity of the diet [31]. When the national average diet is analysed (Table 6), the results show that the Kenyan population has, in general, an adequate diet in terms of energy and protein intakes. This assertion is confirmed with a MAR score of 97.

As shown in Table 6, the country relies on maize as the prime source of energy and protein, while dairy represents 14 per cent of the total protein intake. This national estimation indicates to an extent that the country has nutritional security. Nonetheless, this perspective changes when the first tertiles of the rural and urban population are analysed.

The rural first tertile is the most food insecure. Their average diet has deficiencies in most of the macro and micronutrients. Consequently, they have the lowest MAR score with 55. Next, the urban first tertile presents a slightly better scenario with a MAR score of 65. For this tertile, milk specially unpacked milk has a relevant role providing around 10 per cent of the total dietary protein and approximately 25 per cent of the total calcium consumed.

Table 7 Kenya—food and nutrient consumption—rural areas first tertile

Food category	Nutrients												
	Energy	Protein	Fat	Carbs	Fibre	Ca	Mg	P	Zn	Se	Vit A	Vit B2	Vit B12
	kcal	g	g	g	g	mg	mg	mg	mg	mcg	RE	mg	mg
Millet and minor cereals	37.62	1.43	0.75	5.58	1.44	27.29	19.42	37.91	0.27	2.33	11.92	0.02	0.00
Rice	27.82	0.55	0.07	6.16	0.17	1.25	2.25	10.93	0.09	0.30	0.00	0.00	0.00
Maize	394.14	8.20	4.17	73.56	14.90	20.60	81.37	287.54	2.30	8.29	16.57	0.14	0.00
Wheat	16.13	0.55	0.10	2.97	0.57	1.65	5.09	10.69	0.12	1.85	0.02	0.01	0.00
Fortified flour	6.14	0.22	0.16	0.91	0.10	6.61	1.03	6.19	0.03	0.11	1.70	0.02	0.02
Breakfast cereals	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Pulses and nuts	74.78	4.17	3.05	6.06	3.24	23.60	34.54	71.97	0.60	3.60	3.94	0.04	0.00
Bread and cakes	24.27	0.49	0.94	3.38	0.15	4.28	1.41	9.70	0.05	0.59	3.98	0.01	0.02
Pasta	0.82	0.03	0.00	0.16	0.01	0.05	0.08	0.36	0.00	0.03	0.00	0.00	0.00
Roots and tubers	34.80	0.63	0.10	7.28	1.12	6.57	6.05	15.69	0.14	0.19	27.04	0.01	0.00
Meat and eggs	7.50	0.83	0.45	0.03	0.00	0.73	0.65	9.10	0.12	0.80	72.93	0.02	0.36
Fish and seafood	3.91	0.68	0.11	0.01	0.00	4.46	1.02	10.08	0.04	1.12	1.05	0.00	0.15
Dairy	99.63	3.09	7.65	4.54	0.00	101.69	9.48	96.76	0.31	1.23	65.80	0.19	0.39
Oils and fats	85.66	0.02	9.51	0.01	0.00	0.52	0.07	0.67	0.00	0.02	116.98	0.00	0.03
Fruits	18.90	0.23	0.19	3.62	0.90	7.65	4.42	5.39	0.07	0.27	2.90	0.01	0.00
All vegetables	34.89	2.47	0.34	3.61	3.77	100.59	30.76	57.43	0.49	1.70	162.68	0.11	0.00
Sugary products	116.21	0.08	0.03	28.88	0.09	3.22	2.45	3.98	0.48	0.15	0.31	0.01	0.00
Spices and miscellaneous	7.23	0.23	0.20	0.86	0.54	15.92	4.51	14.35	0.07	0.25	6.78	0.01	0.00
Coffee, tea and cocoa	6.27	0.22	0.17	0.88	0.17	1.76	3.92	3.74	0.02	0.15	0.34	0.01	0.00
Soft drinks and juices	5.60	0.05	0.01	0.26	0.00	1.11	0.88	2.34	0.01	0.10	0.02	0.00	0.00
Other dishes	5.19	0.21	0.24	0.50	0.09	1.70	0.85	3.70	0.03	0.18	1.92	0.00	0.01
Total	1007.52	24.39	28.25	149.26	27.25	331.25	210.26	658.53	5.24	23.26	496.89	0.61	0.98

Source: Own elaboration based on KIHBS

Carbs. stands for carbohydrates, Ca for calcium, Mg for magnesium, P for phosphorus, Zn for zinc, Se for selenium, Vit A for vitamin A, Vit B2 for riboflavin and Vit B12 for cobalamin

Nutritional indicators

As mentioned before dairy is relevant to the Kenyan diet. As per our calculations, dairy represents countrywide 11 per cent of the total dietary energy, 14 per cent of protein supply and 22 per cent of the total fat.

Unpacked milk is the biggest contributor to the category providing 9 per cent of the dietary protein supply countrywide. In rural areas, it accounts for 11 per cent of the dietary protein supply and 28 per cent of the dietary fat intake while for urban areas it represents 7 per cent and 15 per cent, respectively. Packed milk provides less than 1 per cent of the protein intake in rural areas, but it accounts for 6 per cent of the urban supply.

Tables 9 and 10 show the dietary relevance that dairy, in general, and fresh unpacked milk have for the population by tertile. Dairy represents from 10 to 14 per cent depending of the nutrient. Unpacked milk provides 9 per cent of the total protein for both first tertiles. Additionally, unpacked milk is also a source of calcium (Ca), vitamin A (Vit A) and vitamin B12 (Vit B12).

For the rural first tertile, unpacked milk provides 22 per cent of Ca and 12 per cent of Vit A; for the urban counterpart, it represents 20 per cent of Ca and 8 per cent of Vit A. For vitamin B12, unpacked milk represents one third of the total consumption for the rural population and 16 per cent for the urban.

Comparably, Figs. 3 and 4 show the percentage that dairy and its subcategories provide of the recommended intakes, with unpacked milk representing 5 per cent of the protein and around 10 per cent of the Ca intake for both the rural and urban poorest.

According to FAO [4], milk provides worldwide around 134 kcal, 8 g of protein and 7.3 g of fat per capita per day. According to it, for Africa, it represents around 3 per cent of the energy and 6 per cent of the protein consume daily. The results found do not support these facts, with a national average that indicates that milk represents 10 per cent of the energy and 12 per cent of the dietary protein supply. Even in the first tertiles milk surpasses both reported figures. These results can be attributed to the

Table 8 Kenya—food and nutrient consumption—urban areas first tertile

Food category	Nutrients												
	Energy	Protein	Fat	Carbs	Fibre	Ca	Mg	P	Zn	Se	Vit A	Vit B2	Vit B12
	kcal	g	g	g	g	mg	mg	mg	mg	mcg	RE	mg	mg
Millet and minor cereals	23.89	0.91	0.48	3.54	0.91	17.33	12.33	24.07	0.17	1.48	7.57	0.01	0.00
Rice	60.19	1.20	0.14	13.33	0.37	2.71	4.86	23.64	0.19	0.65	0.00	0.01	0.00
Maize	334.40	6.96	3.53	62.41	12.64	17.48	69.03	243.96	1.95	7.03	14.06	0.12	0.00
Wheat	39.86	1.36	0.25	7.34	1.40	4.07	12.57	26.42	0.29	4.56	0.05	0.01	0.00
Fortified flour	10.49	0.37	0.28	1.55	0.17	11.30	1.76	10.58	0.06	0.19	2.90	0.03	0.03
Breakfast cereals	0.12	0.00	0.00	0.02	0.00	0.01	0.02	0.06	0.00	0.01	0.00	0.00	0.00
Pulses and nuts	72.07	4.02	2.94	5.84	3.12	22.74	33.28	69.36	0.58	3.47	3.80	0.04	0.00
Bread and cakes	82.21	1.67	3.20	11.44	0.51	14.49	4.79	32.85	0.15	2.00	13.48	0.03	0.08
Pasta	3.58	0.13	0.01	0.72	0.03	0.21	0.36	1.56	0.01	0.12	0.00	0.00	0.00
Roots and tubers	42.75	0.77	0.12	8.95	1.37	8.07	7.43	19.28	0.17	0.24	33.22	0.02	0.00
Meat and eggs	19.62	2.25	1.15	0.08	0.00	1.85	1.78	25.13	0.36	2.07	231.22	0.05	1.16
Fish and seafood	4.85	0.85	0.14	0.02	0.00	5.54	1.27	12.49	0.06	1.39	1.31	0.01	0.19
Dairy	106.51	3.39	7.97	5.24	0.00	109.46	10.18	106.67	0.36	1.49	68.32	0.21	0.42
Oils and fats	138.64	0.03	15.39	0.02	0.00	0.85	0.12	1.08	0.00	0.03	189.33	0.00	0.04
Fruits	25.53	0.32	0.26	4.89	1.21	10.33	5.97	7.28	0.10	0.37	3.92	0.02	0.00
All vegetables	45.51	3.22	0.45	4.71	4.92	131.22	40.13	74.92	0.65	2.21	212.22	0.14	0.00
Sugary products	110.59	0.07	0.03	27.48	0.09	3.06	2.33	3.79	0.46	0.15	0.29	0.01	0.00
Spices and miscellaneous	8.29	0.26	0.23	0.99	0.63	18.26	5.17	16.46	0.08	0.28	7.78	0.01	0.00
Coffee, tea and cocoa	8.20	0.29	0.23	1.15	0.22	2.30	5.13	4.90	0.03	0.19	0.44	0.02	0.00
Soft drinks and juices	9.26	0.07	0.01	0.43	0.00	1.83	1.46	3.87	0.01	0.17	0.03	0.00	0.00
Other dishes	19.44	0.78	0.91	1.88	0.33	6.36	3.20	13.87	0.10	0.68	7.18	0.02	0.04
Total	1166.00	28.94	37.71	162.01	27.93	389.48	223.17	722.24	5.77	28.78	797.13	0.74	1.96

Source: Own elaboration based on KIHBS

Carbs. stands for carbohydrates, Ca for calcium, Mg for magnesium, P for phosphorus, Zn for zinc, Se for selenium, Vit A for vitamin A, Vit B2 for riboflavin and Vit B12 for cobalamin

fact that Kenya has the highest milk consumption for the continent and that several initiatives have been taking place to promote and develop the dairy sector [5].

For the case of micronutrient, national, rural and urban averages are very similar (Table 6). But there is a clear difference with the first tertiles. For instance, vitamin A has a national value (1569 retinol equivalents) that is almost the triple when compared to the rural 1st tertile of 497 retinol equivalents and almost double when compared to the urban 1st tertile value of 797 retinol equivalents.

In the case of micronutrients, as shown the first tertiles of the population have a suboptimal consumption of energy and have micronutrient deficiencies. Their diets are rich in fibre and phytates that compromise the bioavailability of certain micronutrients like zinc [10]. Milk then has a crucial role since it is an affordable animal source food and a good source of calcium, selenium, magnesium, zinc, vitamin A and B complex [4, 11, 24].

Milk calcium comes in a highly bioavailable form that facilitates its absorption, provides around 10 per cent of the total consumed by the poorest, and has a direct beneficial impact on the dietary adequacy of vulnerable sectors of the population like children, lactating and menopause women (FAO/WHO, [8]).

Vitamin B12 is directly associated with the consumption of animal source food and milk contributes to approximately 30 per cent of the total intake. B12 deficiencies have metabolic affectation for all the population sectors causing pernicious anaemia [8, 31], but is particularly worrying in lactating women on rural areas having a negative cascade effect in the development of infants [35].

Milk quality and safety play a key role in its nutritional values [32]. As previously discussed, milk is mainly bought fresh and then is traditionally boiled prior to its consumption. However, many of the vitamins present in milk composition are thermolabile and if overboiled the nutrient value decreases [21]. Additionally, if unsafe milk

Table 9 Food and nutrient consumption—rural areas first tertile

Rural tertiles	Category	Nutrients															
		Protein		Ca		Mg		Se		Vit A		Thiamine		Vit B2		Vit B12	
		g	%	mg	%	mg	%	mcg	%	RE	%	mg	%	mg	%	mg	%
1	Total dairy	3.09	12.67	101.69	30.70	9.48	4.51	1.23	5.29	65.80	13.24	0.04	5.85	0.19	31.68	0.39	39.70
	Fresh unpacked cow milk or cream	2.29	9.39	71.66	21.63	6.72	3.20	1.00	4.28	56.48	11.37	0.01	2.23	0.14	23.35	0.30	30.17
	Packed cow milk	0.07	0.27	2.39	0.72	0.22	0.10	0.03	0.14	0.38	0.08	0.00	0.04	0.00	0.67	0.01	0.83
2	Total dairy	5.29	13.32	168.55	30.38	15.65	4.84	2.15	5.62	118.56	12.25	0.05	4.53	0.33	32.71	0.66	29.12
	Fresh unpacked cow milk or cream	4.40	11.07	137.61	24.80	12.90	3.99	1.91	5.00	108.46	11.20	0.03	2.88	0.27	26.75	0.57	25.18
	Packed cow milk	0.17	0.43	6.31	1.14	0.58	0.18	0.09	0.23	1.01	0.10	0.00	0.07	0.01	1.06	0.02	0.95
3	Total dairy	10.47	14.41	334.56	32.43	30.96	5.84	4.34	6.27	230.87	10.85	0.08	5.22	0.66	34.27	1.29	21.37
	Fresh unpacked cow milk or cream	8.53	11.74	267.11	25.89	25.04	4.72	3.71	5.35	210.54	9.90	0.06	3.44	0.53	27.40	1.10	18.24
	Packed cow milk	0.60	0.83	22.02	2.13	2.03	0.38	0.30	0.43	3.53	0.17	0.00	0.14	0.04	1.95	0.08	1.24
Recommended values		50.00		800.00		300.00		70.00		500.00		1.40		1.20		1.00	

Source: Own elaboration based on KIBHS data

Table 10 Food and nutrient consumption—urban areas first tertile

Urban tertiles	Category	Nutrients															
		Protein		Ca		Mg		Se		Vit A		Thiamine		Vit B2		Vit B12	
		g	%	mg	%	mg	%	mcg	%	RE	%	mg	%	mg	%	mg	%
1	Total dairy	3.39	11.71	109.46	28.10	10.18	4.56	1.49	5.17	68.32	8.57	0.03	3.77	0.21	28.75	0.42	21.51
	Fresh unpacked cow milk or cream	2.46	8.51	77.07	19.79	7.23	3.24	1.07	3.72	60.75	7.62	0.02	2.24	0.15	20.70	0.32	16.28
	Packed cow milk	0.49	1.68	17.85	4.58	1.65	0.74	0.24	0.85	2.86	0.36	0.00	0.26	0.03	4.13	0.06	3.11
2	Total dairy	5.71	13.53	188.84	30.91	17.52	6.18	2.61	6.46	101.53	6.73	0.04	4.09	0.36	30.47	0.71	15.23
	Fresh unpacked cow milk or cream	3.50	8.28	109.43	17.91	10.26	3.62	1.52	3.76	86.25	5.72	0.02	2.54	0.22	18.43	0.45	9.69
	Packed cow milk	1.79	4.24	65.53	10.73	6.04	2.13	0.89	2.21	10.51	0.70	0.01	0.75	0.11	9.52	0.22	4.79
3	Total dairy	9.70	13.79	336.81	32.82	30.77	7.32	4.71	7.01	136.24	4.80	0.06	4.65	0.61	30.28	1.19	11.66
	Fresh unpacked cow milk or cream	3.95	5.61	123.55	12.04	11.58	2.75	1.72	2.56	97.38	3.43	0.03	1.95	0.24	12.15	0.51	5.02
	Packed cow milk	4.85	6.89	177.53	17.30	16.36	3.89	2.42	3.61	28.48	1.00	0.02	1.38	0.30	15.06	0.61	5.96
Recommended		50.00		800.00		300.00		70.00		500.00		1.40		1.20		1.00	

Source: Own elaboration based on KIBHS data

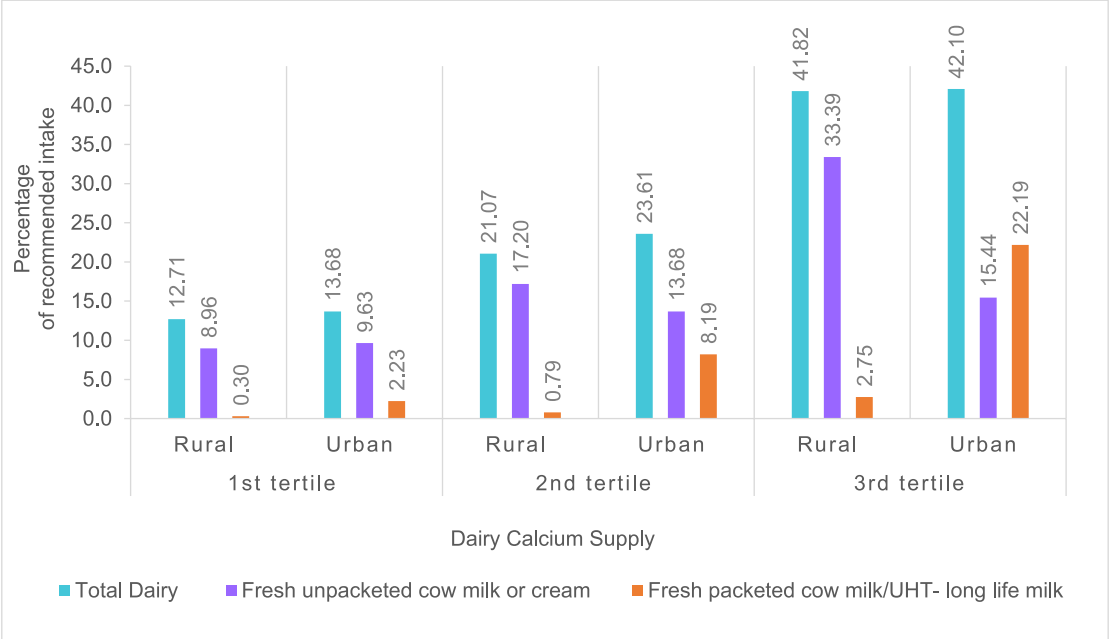

Fig. 3 Percentage of calcium that dairy, unpacked and packed milk represents from the recommended values by tertile. Source: Own elaboration based on KIBHS data

or food is consumed regularly intestinal infection and parasites become a health risk that further contributes to the lost and malabsorption of micronutrients increasing the malnutrition problems for the poorest sectors of the population [10, 29]. For this reason, milk safety plays a key role in nutritional and food security. The purchasing place of milk can be a decisive factor in its safety.

To finalize the dietary indicators, Table 11 shows the estimation of the MAR for the different segments of the population. There is a clear differentiation between the value obtained at a national level of 96.62 per cent that indicates that the Kenyan population fulfils almost all the require intakes of the selected nutrients and the first tertiles. Where the rural first tertile presents the lowest score with 54.93 followed by the urban tertile with 64.86. In general terms, the urban population has a better score than the rural.

Milk purchases by selling point

As previously mentioned, the consumption of fresh unpacked milk is incredibly important for the nutrition of the Kenyan population. Figure 5 shows the most important selling points countrywide and for rural and urban populations.

Roadside vendors and hawkers are the biggest selling point representing 38 per cent of the total purchases countrywide and 50 per cent of the rural. However, for the urban population, the commercialization with other households is more relevant, representing 20 per cent of the purchases, than the hawkers that account for 13 per cent.

To further understand the relevance of the informal sector in the consumption of fresh unpacked milk, Table 12 and Fig. 4 show a comparison of the litres bought in each type of market for the first tertiles of the population. As seen, the informal market provides 22 L of milk per year for the rural areas surpassing the combination of any other markets. This situation is replicated in the urban areas with 16 L purchase from the informal market compared to 2 L from the formal one. However, note that the Chi-square could not reject the null hypothesis that both distributions were the same.

Most authors highlight the importance that the informal market has on the dairy sector in Kenya [15, 33, 36].

In remote areas, the informal market is the only market that reaches the consumers, so the availability of products relies on it [29]. In rural areas, milk selling depends mainly on hawkers/roadside vendors. This situation could be attributed to the fact that small farmers in remote locations have limited options on how to access the market especially considering that milk is a perishable product.

Hawkers and roadside vendors can easily mobilize milk from one point to the other and bring the milk to the consumer [30]. Other households are the second selling point for the rural areas and the main point for the urban

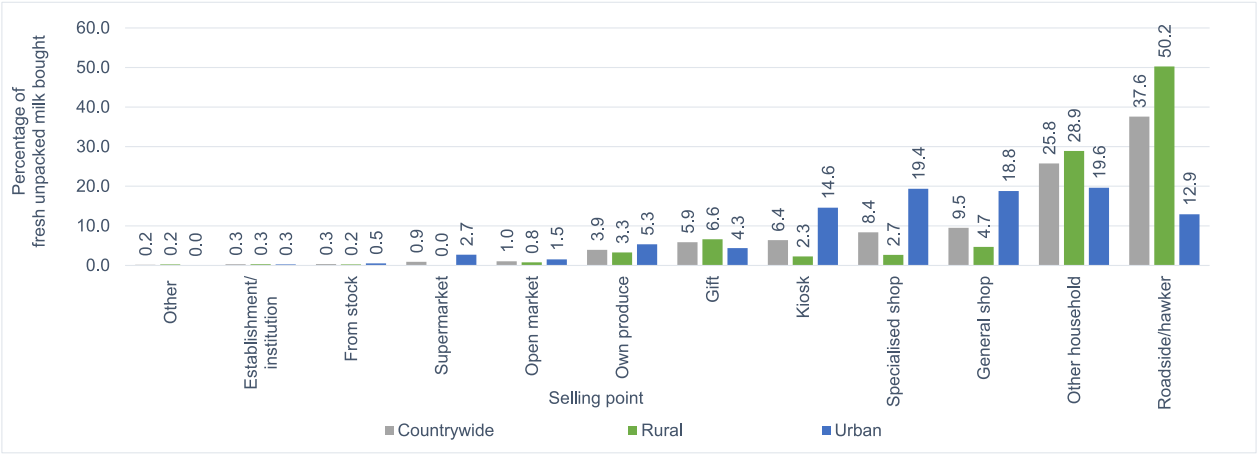

Fig. 4 Purchases of milk by selling point and countrywide, rural and urban areas. Source: Own elaboration from KIHBS

ones. As mentioned before, rural market infrastructure has deficiencies, therefore trade among neighbours facilitate access to products.

In the case of urban areas, there is a difference in behaviour between the reported average and the first tertile. While for the average, other households, general and specialized shops are more important than the milk acquired from hawkers; but for the first tertile, this does not apply. The average behaviour could be attributed to the fact that farmers in urban and peri-urban areas tend to associate to increase their milk production and bargain power [19] and they are already located close to the consumer so there is no need to have hawkers as intermediaries.

For the specialized shop, its relevance could be associated with the convenience of their location and operating hours. Hawkers tend to operate early in the morning or late in the evening to avoid harassment from the authorities [19], this schedule might be conflicting with urban consumers and their lifestyle especially for the second and third tertiles. On the other hand, milk offered from the hawkers, that is the informal market, is generally cheaper than the one from the formal, since this tertile has the least affordability capacity, they are sensitive to price variations between the markets.

One of the biggest concerns associated with the informal sector is food safety. In general terms, the participants of this market have limited access to services and infrastructure, they operate without the support of the authorities and do not obey or comply with any food regulation [1]. These daring conditions increase the risks associated with milk handling and decrease the quality of the product [22]. Notwithstanding, as Roesel and Grace [29] mention, informal does not necessarily mean dangerous, nor formal means safe.

Table 11 MAR for the different sectors of the population

Population	MAR	Population	MAR
Countrywide	96.62		
Rural areas	95.55	Urban areas	97.24
1st tertile	54.93	1st tertile	64.86
2nd tertile	79.75	2nd tertile	81.33
3rd tertile	99.88	3rd tertile	98.77

Source: Own elaboration based on KIBHS data

Conclusions

The purpose of this paper has been to determine the relevance that milk consumption has on food security and nutrition in Kenya. The main focus was to understand the role that unpacked milk from the informal sector has on the nutritional security of the lowest income households.

The methodology used the 2015–2016 KIHBS to estimate the average annual dairy consumption by geographical region and within different economic groups; then, determine the percentage that unpacked milk represented from total dairy consumption and the main purchase points for it; follow by the evaluation of the nutritional impacts that milk had on the diet, combining the information from the KIHBS with the 2018 KFCT to estimate different nutritional indicators.

The estimated national average diet shows that the Kenyan population has a diverse food consumption that fulfils most of the micronutrient recommended intakes with a high MAR score for the 8 selected nutrients. However, when the population diets are analysed by tertile is clear that the first and poorest tertiles from rural and urban areas do not have the same variety or adequacy.

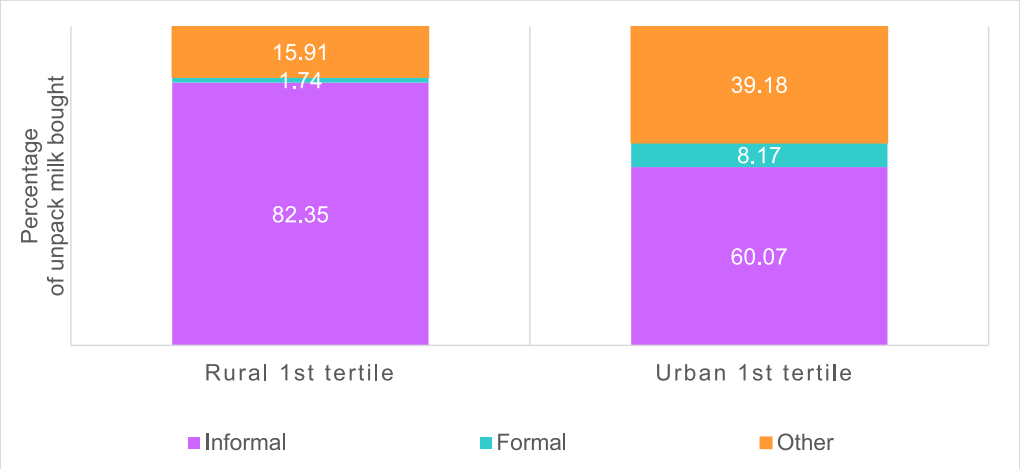

Fig. 5 Percentage of fresh unpacked milk that is purchased from the different markets by the first tertiles of the population. Source: Own elaboration from KIHBS

Table 12 Purchase points for annual per capita fresh unpacked consumed by the first tertile of the rural and urban population (litres)

Market	Selling point	Consumption of unpacked milk	
		Rural 1st tertile	Urban 1st tertile
Informal	Open market	0.23	0.45
	Other households	8.51	7.75
	Roadside/hawker	13.71	8.17
	Total	22.45	16.38
Formal	Establishment/institution	0.03	0.03
	From stock	0.08	0.13
	Specialized shop	0.36	1.89
	Supermarket	0.00	0.19
	Total	0.47	2.23
Other	Total	4.34	10.68

Source: Own elaboration from KIHBS

A Chi-square test (value = 2.32, with 6 degrees of freedom) cannot reject the hypothesis that both groups are the same

The rural first tertile has the worst MAR score consuming approximately half of the recommended energy, protein and micronutrients. This tertile has a maize-based diet that relies on unpacked milk as a source of animal protein representing 9.4 per cent of dietary supply, as well as a source of calcium (21.6 per cent of dietary supply), Vit B2 (23.4 per cent of dietary supply) and Vit B12 (30.17 per cent of dietary supply).

The urban first tertile has a slightly better MAR score and presents a more diversified diet when compared to the rural. Nonetheless, they also relied on unpacked milk to improve the intake of micronutrients like calcium (19.8 per cent of dietary supply), Vit B2 (20.7 per cent of dietary supply) and Vit B12 (16.3 per cent of dietary supply).

One of the main findings of this work was to establish the weighted national annual per capita consumption of dairy from the demand side of 74.6 L; indicating that there is a clear difference from the estimations done from apparent consumption reported in most of the literature revised. Interestingly, the rural annual milk consumption (70.2 L) surpasses that of urban areas (68.8 L).

The above consumption values are different to those from previous publications from Njarui et al. [24] and Alonso et al. [1]. County consumption varies depending on the availability of milk. Milk availability seems to be tied to the production capacity and the climate of the region. Consequently, arid and semi-arid counties (i.e. Busia and Turkana) that are categorized as more food insecure are the ones that consumed less compared to counties located in the central districts (i.e. Nyeri and Bomet) that have a humid climate and are the less food insecure.

Regardless of the region unpacked milk is the most consumed dairy item representing 72 per cent of the total countrywide; 84 per cent of the rural total and 55 per cent of the urban area.

The formal market has a small role in terms of the poorest tertiles consumption since fresh unpacked milk is mainly purchased in the informal market with roadside vendors/hawkers being the main selling point countrywide (37.6 per cent of the total). For the rural first tertile the informal market represents 82.4 per cent of the total unpacked milk purchased; for the urban, the informal sector represents slightly less with 60.1 per cent.

Finally, some policy recommendations that come from the above results include that attempting to ban the informal sector will have negative consequences for Kenya's food security, impacting mostly on the nutritional security of low-income households. In addition, the nutritional aspects that the informal dairy sector provides need to be considered alongside the economic ones in future debates regarding regulatory reforms of the sector.

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HZN designed the research, analysed the data and wrote the article. CRG designed the research, curated the data and edited the article.

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Declarations

Ethics approval and consent to participate
This is not relevant for the paper because it is based on a publicly available survey.

Consent for publication
The manuscript does not have personal information. It is based on an anonymized survey.

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There are no competing interests.

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