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RESEARCH ARTICLE

Hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi, Kenya

[version 1; peer review: 2 approved with reservations]

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V1 First published: 22 Sep 2021, 10:957
<https://doi.org/10.12688/f1000research.72937.1>
 Latest published: 22 Sep 2021, 10:957
<https://doi.org/10.12688/f1000research.72937.1>

Abstract

Background: Poor milk handling practices due to lack of knowledge or deliberate adulteration compromises the safety of milk and that of the consumer. With the increase of milk vending machines in informal settlements, the knowledge and practices of vendors concerning milk hygiene are critical in determining milk safety. The operation of milk vending machines is guided by strict regulations that aim at ensuring proper practices among milk handlers, but the level of implementation among milk vendors is questionable. This study sought to establish hygienic knowledge and handling practices of vendors operating milk vending machines in Nairobi's informal settlements of Kibra and Dagoretti North.

Methods: Using a cross-sectional study design, 37 milk vendors were interviewed at the study setting with the aid of questionnaires. Data was then recorded in datasheets and analyzed using frequencies, correlation, and t-test with the aid of Statistical Package for Social Sciences software.

Results: The mean percentage score for knowledge and practices was 68.83% and 54.05%, respectively. The knowledge and practices of vendors significantly improved with the increase in their level of education ($p=0.04$ and $p=0.02$). There was a significantly positive correlation between knowledge and practices ($r=0.626$, $p=0.000$).

Conclusions: There is a low level of hygienic knowledge and poor practices among vendors operating milk vending machines in the study area. The efforts by the regulator to ensure proper implementation of the regulations was also not sufficient. Training is required to improve the hygienic knowledge and practices of milk vending machine handlers in informal settlements. Frequent inspections should also be carried out in the informal settlements to ensure proper implementation of regulations on the operation of milk vending machines.

Keywords

Milk handlers, knowledge, practices, milk vending machines, hygiene

Open Peer Review**Approval Status** ? ?

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version 1	?	?
22 Sep 2021	view	view

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Competing interests: No competing interests were disclosed.

Grant information: The author(s) declared that no grants were involved in supporting this work.

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How to cite this article: Kevin H, Njue L and Abong G. **Hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi, Kenya [version 1; peer review: 2 approved with reservations]** F1000Research 2021, 10:957 <https://doi.org/10.12688/f1000research.72937.1>

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Introduction

In most developing countries, low incomes, weak government structures, and poor enforcement of regulations have led to the rapid growth of the informal sector. This sector has grown over time to being recognized as an important source of employment and contributes to the growth of the economy (Grace *et al.*, 2019). In terms of food safety, the informality of the informal sector is attributed to the ease of escaping systemic sanitary inspection resulting in retail practices being carried out under unhygienic conditions. Due to poor enforcement of regulations in the informal sector (Brown *et al.*, 2018), it has made it accessible to anyone, both the skilled and the unskilled, to engage in any form of retail business. This is risky when it comes to the retail of milk which requires a high level of consciousness and proper understanding and adherence to milk hygiene standards.

Post-harvest handling of milk plays a major role in determining milk safety (Godfrey, 2013). Milk handling practices entail the day-to-day activities that are carried out along the milk value chain, from production, during transportation, and at the retail stage. Unhygienic handling of milk is a leading cause of hazards in milk especially in developing countries (Grace, 2015). Studies have previously shown that milk safety is highly compromised at the retail point due to poor handling and storage practices (Alonso *et al.*, 2018). The knowledge of vendors on milk hygiene is critical in guiding their daily practices. A study assessing knowledge and practices of milk traders around Nairobi showed that only 30% of the respondents were aware of regulations on milk retail, 51% of them were not sure about some regulations while 19% of them said they are not aware of any existing regulations (Brown *et al.*, 2018).

Informal settlements tend to face extraordinary challenges when it comes to general hygiene, this is a result of inadequate resources and hygienically poor environmental surroundings that characterize these settlements (Grace *et al.*, 2019). The increase of milk vending machines in informal settlements raises concerns about the proper handling of the machines. Practices of milk vendors in these areas are critical in determining the safety of milk at the retail point, poor handling practices either due to lack of knowledge or negligence could result in post-pasteurization contamination of milk (Sadhu, 2018). Prolonged storage of milk in tanks at the retail points at temperatures that favor microbial growth could increase the bacterial load in milk hence affecting its safety (Paludetti *et al.*, 2018).

In Kenya, the dairy industry is regulated by the Kenya Dairy Board which is a state corporation under the ministry of agriculture and was established through an Act of Parliament, CAP 336 of the Laws of Kenya (Kenya Dairy Board [KDB], 2018). Kenya Dairy Board's regulatory mandate entails licensing, inspection, and surveillance of milk for both the local and export market. The Kenya Bureau of Standards on the other hand is responsible for assuring quality standards for milk and dairy products sold in the formal domestic market as per the

code of hygienic practice for milk and milk products KS1552:2016 (Kenya Bureau of Standards, 2016).

The wide usage of milk vending machines has necessitated legislation on their operation, this is aimed at standardizing vendors' operations to ensure the safety and suitability of milk from the vending machines. These regulations are aimed at addressing the possibility of quality breaches by milk vending machine handlers, which may include the use of sub-standard milk dispensers, stocking of raw instead of pasteurized milk, breaking the cold chain during storage of milk, poor location of the dispensers, limited skills by the operators as well as poor hygiene standards (Raposo *et al.*, 2015). Despite the existence of these regulations, there have been constant breaches from the operating standards of milk vending machines by handlers.

This study sought to establish the hygienic knowledge and practices of vendors handling automatic milk dispensing machines in Kibra and Dagoretti North informal settlements of Nairobi, Kenya.

Methods

Study site

The study was carried out in the informal settlements of Nairobi County, Kenya. Nairobi serves as the capital city of Kenya and has 17 sub-counties with a population of over four million people according to the 2019 census report (Kenya National Bureau of Statistics, 2019). The majority of these people are low-income earners who live in informal settlements distributed across these sub-counties. Two sub-counties were purposively selected for this study, which include Kibra and Dagoretti North. The areas were purposively chosen since they contain some of the largest informal settlements in the county with a high population density.

Figure 1 shows the locations of Kibra and Dagoretti North. Kibra is located to the southwest of the city of Nairobi, it is approximately 12.1km² and has a population of around 178,000 people. Dagoretti North is located to the west of Nairobi city, it is approximately 29 km² with a population of around 181,000 people. These two regions have areas characterized by unplanned settlements, poor quality of housing, inadequate access to safe water and sanitation, and poor drainage systems among others.

Research design

A cross-sectional design was used to carry out the study. This design was appropriate for the study since it made it possible to estimate the extent of the outcome of interest which, in this case, is the level of hygienic knowledge and practices of vendors and also enabled the assessment of many study outcomes within a reasonable time (Kesmodel, 2018).

Study setting

The informal settlements of Kibra and Dagoretti North represent the setting where the study was conducted. In Kibra, four wards were purposively selected for the study, these include Makina, Laini Saba, Lindi, and Sarang'ombe. In Dagoretti

Figure 1. Location of Kibra and Dagoretti North in Nairobi County (RCMRD).

North, two wards were purposively selected, which include Kawangware and Gatina wards. These areas are characterized majorly by informal settlements and structures along which milk vending machines are stationed. The vending machines are randomly distributed in the areas without any specific order.

Study population

The study population comprised of all milk handlers operating milk vending machines located in the informal areas of Kibera and Dagoretti North. A pre-visit was conducted at the study setting to establish the total number of milk vending machine handlers available and in operation. A representative from the Kenya Dairy Board, a regulatory body in the dairy industry, also formed part of the study population, the representative officer was invited to participate in the study through a formal request to the regulatory institution.

Sample size

An exhaustive sampling of the available milk vending machine handlers was carried out in the study areas, a total of 37 milk vendors operating milk vending machines were identified, 20 of them were from Dagoretti North while 17 from Kibera. All the vendors identified were included in the study.

Sampling procedure

The sampling of milk vending machine handlers for interviews was conducted within a period of one month, in October 2020; this began with Dagoretti North then followed by Kibera. Respondents were physically invited for the interviews through one-on-one engagement by explaining the nature and purpose of the interview. The interviews were conducted daily at the respondents' milk vending machine premises with informed consent obtained from the vendors before an interview by explaining to them the objectives of the study and assuring them of the confidentiality of their data. All the available milk vending machine handlers within the study setting were interviewed individually using semi-structured questionnaires with every interview taking roughly 20 minutes to 30 minutes.

Data collection

Interviews were conducted by the corresponding author at the study site after undertaking relevant training on conducting research interviews. A questionnaire containing 26 questions was first pilot tested on a sample of the respondents and modified according to the observations from the pilot test before the actual interview. Vendors were interviewed on a face-to-face basis to validate the accuracy of the responses, with the interviews

being conducted either in English or Swahili (through translation) using semi-structured questionnaires. The questionnaire was divided into three sections with the first part of it capturing the socio-demographic characteristics of the respondents with details about their gender, age, and level of education. The second part entailed 15 questions with the choices of True, False, and Don't Know to assess the hygiene knowledge of the respondents. The third part of the questionnaire had 21 questions covering the practices of handlers with choices of Yes, No, or a structured answer which the interviewer interpreted to be either the right or wrong practice. A copy of the questionnaire can be found in the *Extended data*. A representative from the Kenya Dairy Board was also interviewed separately at the institution's premises following official appointment request to conduct the interview by the corresponding author. The officer was interviewed on a one-on-one basis on measures the institution is putting in place to ensure that regulations governing the operation of milk vending machines are adhered to. A copy of the questionnaire can be found in the *Underlying data* (in the "Holi Regulator's Questionnaire.docx" which also contains the answers). No follow-ups were conducted after the interviews.

Research tools used to collect the data include questionnaires for conducting interviews, pencils, and erasers for recording feedback from respondents on copies of the questionnaires by the corresponding author, datasheets, a camera for taking photos of the study area and the nature of its surroundings, and a stationery bag to store the data collection materials. Results from the interviews were then recorded on a datasheet for analysis. This data was stored in sealed envelopes under lock and key for security purposes and labeled "confidential," only to be opened during analysis.

Data analysis

Data was analyzed using Statistical Package for Social Sciences software (IBM SPSS v25). Each study question was classified and assigned points, responses on questions assessing the hygiene knowledge of respondents were categorized as either correct or incorrect. For every correct answer, one point was awarded while an incorrect response was awarded zero points. On questions assessing the hygiene practice of respondents, one point was awarded for the right practice while a bad practice was awarded zero points. All the scores for handling knowledge and practices of respondents were tallied and calculated as a percentage. Individual scores for questions on knowledge and practices were summarized using frequencies and descriptive statistics. Pearson's correlation coefficient was used to establish an association between knowledge and practices of respondents. Scores above 75% were considered to be indicative of high knowledge and good practice with statistical significance set at $p < 0.05$. Responses from the Kenya Dairy Board's representative were assessed based on the milk vending machine quality manual from the institution and presented descriptively by stating the regulatory measures being put in place and the existing gaps.

Potential sources of bias were addressed by involving the participating authors to independently interpret the data for

comparison and verifying the findings with other similar data sources supporting the findings. The findings and conclusions were also shared with peers for review.

Ethical approval

This study was approved by the National Commission for Science, Technology and Innovation of Kenya under license number: NACOSTI/P/20/5347

Consent from participants

Before every interview, respondents were informed that the interview was for research purposes and were asked to sign a consent form indicating the purpose and confidentiality of the data.

Results

Demographic characteristics of milk vending machine handlers

Out of 37 milk vendors who were enrolled in the study as respondents, 56.8% were male and 43.2% were female. Out of the total male respondents, 61.9% were from Dagoretti North while 38.1% from Kibra. Out of the total female respondents, 43.8% were from Dagoretti North while 56.2% of them from Kibra. From these respondents, the youngest was 20 years and the oldest 45 was years with their mean age being 26 years. There was no significant difference ($p=0.51$) between the ages of males and that of females. In Kibra, the mean age of the respondents was 26.18 while in Dagoretti North it was 26.05, the difference in the average age of the two study areas was, however, not significant ($p=0.95$).

The majority of the respondents (64.9%) had attained secondary education with only 21.6% having tertiary education and 13.5% primary education. In Dagoretti North, 5% of the respondents had primary education, 70% secondary education, and 25% with tertiary education. In Kibra, those with primary education were 23.6%, 58.8% having secondary education, and 17.6% tertiary education (Table 1).

Out of the total percentage of males (56.8%), 28.6% had attained tertiary education, and 66.6% had secondary education, while only 4.8% had primary education. Among the females (43.2%), 12.5% had attained tertiary education, 62.5% had secondary education, and 25% had primary education (Table 2). Differences in the level of education between males and females as calculated using Fisher's exact test was however not significant ($p=0.2$).

Hygiene knowledge of milk vending machine handlers

Table 3 shows hygiene knowledge responses by milk vending machine handlers for this study. Milk vending machine handlers had a low level of knowledge on milk hygiene with a mean percentage score of 68.83 ± 11.2 . Male respondents registered a higher knowledge score of 68.88 ± 11.02 compared to females with 68.74 ± 11.86 , but the difference was not statistically significant ($p=0.97$). The mean percentage score of vendors' knowledge in Dagoretti North was 72.66 ± 11.2 while in Kibra it was 64.31 ± 9.7 with the difference being significant ($p=0.02$). Milk hygiene knowledge scores increased with

Table 1. Level of education with the area of study of milk vendors in the informal settlements of Nairobi.

Area of study	Level of education (% Respondent)			Total % Respondent
	Primary	Secondary	Tertiary	
Dagoretti North	5.0	70.0	25.0	100
Kibra	23.6	58.8	17.06	100
Total	13.5	64.9	21.6	100

Table 2. Level of education with the gender of milk vendors in the informal settlements of Nairobi.

Level of education	Gender (% Respondent)		Total % Level of education
	Male	Female	
Primary	4.8	25.0	13.5
Secondary	66.6	62.5	64.9
Tertiary	28.6	12.5	21.6
Total	56.8	43.2	100.0

Table 3. Hygiene knowledge responses by milk vending machine handlers (N=37).

Hygiene knowledge questions	With knowledge (%)	Without knowledge (%)
1. Only pasteurized milk should be stored and sold from the vending machine.	89.2	10.8
2. Pasteurized milk is safe for consumption and cannot be contaminated by microorganisms.	0	100
3. Milk storage facilities should always be cleaned and disinfected before and after use.	100	0
4. Any detergent and disinfectant can be used to clean milk storage equipment.	24.3	75.7
5. Water used for cleaning/rinsing vending machines should be one that is safe for drinking.	100	0
6. Milk should be handled in a manner that minimizes contamination.	100	0
7. Milk vendors should undergo medical checkups to ensure they are free from contagious diseases.	43.2	56.8
8. Milk vending machines should only be purchased from licensed suppliers.	75.7	24.3
9. Milk suppliers should be licensed and their vehicles authorized to transport milk.	91.9	8.1
10. Milk storage containers, tanks, and cans can be used to store other liquid material.	81.1	18.9
11. Milk vending machines should only be placed in a clean, well lit and ventilated environment.	100	0
12. Milk can be stored at any temperature in the vending machine.	64.9	35.1
13. Milk can be kept in the vending machines for more than 24 hours.	43.2	56.8
14. Every milk vendor and the vending machine should be registered and licensed.	83.8	16.2
15. There are laws and regulations that guide the selling of milk using milk vending machines.	35.1	64.9

the level of education; vendors with college education showed a high hygiene knowledge on milk handling (76.67 ± 11.8), followed by those with secondary education (67.78 ± 10.5), and lastly those with primary education (61.33 ± 7.3), with the difference in their knowledge scores being significant ($p=0.04$ and $F=3.632$).

The majority of the respondents (89.25%) correctly answered that only pasteurized milk should be stored and sold from the vending machines with all the respondents (100%) not knowing that pasteurized milk, despite being safe for consumption, can be contaminated by microorganisms. More than half (75.7%) of the respondents thought that any detergent and disinfectant can be used to clean milk vending machines with 100% of them believing that water used for cleaning milk vending machines should be one that is also safe for drinking. Additionally,

only 43.2% of the respondents believed that milk vendors should undergo medical checkups to ensure they are free from contagious diseases. About 75.7% of the vendors believed that milk should only be purchased from licensed suppliers. The majority of the respondents (81.1%) believed that milk storage containers should not be used to store other liquid materials. About 35.1% of vendors believed that milk can be stored in the vending machines at any temperature while 56.8% of them stated that milk can be kept in the vending machines for more than 24 hours. More than half of the respondents (64.9%) did not know that there are laws and regulations that guide the selling of milk using milk vending machines.

Practices of milk vending machine handlers

Table 4 shows vendor practices responses by milk vending machine handlers for this study. Milk vending machine handlers

Table 4. Vendor practices responses by milk vending machine handlers (N=37).

Vendor practices questions	Appropriate practice (%)	Inappropriate practice (%)
1. Which type of milk do you sell from the vending machine?	91.9	8.1
2. Do you use cleaning and disinfecting agents while cleaning milk vending machines?	83.8	16.2
3. If yes in Q2, are the detergents used for cleaning food grade?	0	100
4. Do you have adequate clean water for cleaning milk vending machines?	94.6	5.4
5. Where is the source of water used for cleaning the vending machines?	86.5	13.5
6. How many times is the milk vending machine cleaned in a day?	78.4	21.6
7. Do you clean the vending machines before every instance of refilling?	97.3	2.7
8. If yes in Q5, do you keep daily cleaning and sanitation records?	8.1	91.9
9. Does the vending machine have a temperature monitoring and displaying device?	78.4	21.6
10. If yes in Q6, at what temperature is the milk usually stored while in the vending machines?	51.4	48.6
11. Do you keep monitoring records (checklist) of the daily temperature fluctuations in the vending machine?	0	100
12. Is the vending machine maintained and calibrated periodically?	16.2	83.8
13. If yes in Q12, do you have or keep maintenance and calibration records?	2.7	97.3
14. Is milk usually transferred directly from the supplier's original container to the dispenser?	29.7	70.3
15. How long does the milk stay in the vending machine?	73	27
16. Is there any open dumpsite or waste drainage system near the location of the vending machine?	81.1	18.9
17. Are your milk suppliers licensed?	81.1	18.9
18. Have you undertaken any medical tests on contagious diseases such as influenza, tuberculosis, etc.?	18.9	81.1
19. Have you been trained in handling and operating milk vending machines?	35.1	64.9
20. Do you have a valid operational license?	81.1	18.9
21. Is your premise usually inspected periodically?	45.9	54.1

in the current study demonstrated poor milk handling practices with a mean percentage score of 54.05 ± 11.5 . Male respondents demonstrated better practices (54.20 ± 12.5) as compared to female respondents (53.87 ± 10.5), but the difference was not significant ($p=0.93$). The mean percentage score of vendors' practices in Dagoretti North was 54.52 ± 11.2 while in Kibra it was 53.50 ± 12.2 ; the difference was, however, not significant ($p=0.79$). Milk safety practices increased with the level of education; respondents with tertiary education showed better practices (61.9 ± 11.9) as compared to those with secondary education (53.57 ± 11.3) and primary education (43.8 ± 8.5), with their mean score difference being quite significant ($p=0.02$ and $F=4.641$).

The majority of the respondents (91.9%) stated that the milk they sell using the vending machines was pasteurized, which is a practice that is compliant with the regulation. A good percentage of them (83.8%) confirmed that they use detergents while cleaning milk vending machines but none of them stated that the detergent was food grade, which is against the regulations. Most of the vendors (94.6%) stated that they can access adequate clean water for cleaning the milk vending machines. About 86.5% of the respondents said that they use tap water in cleaning the vending machines. Only 78.4% of them indicated that they clean the machines at least twice (morning and evening) daily with 21.6% of them only cleaning the vending machines once, which goes against the regulations.

More than half of the vending machines in the study (78.4%) displayed a temperature monitoring device; out of these, only 51.4% indicated that the milk was being stored at 0°C - 4°C while a big percentage of them (48.6%) being not sure about the temperature of storage or stored milk beyond 4°C against the regulation. None of the vendors kept temperature monitoring records of daily temperature fluctuations in the vending machine as per the regulations. Only 8.1% of them had some cleaning and sanitation records. The majority of the respondents in this study (70.3%) were not transferring milk directly from the supplier's original container to the dispenser as required. Regarding the duration for which milk is kept in the vending machines, only 73% of them stored milk in the machines for less than 24 hours as per the regulation with 27% of them not being compliant.

Only 18.9% of the respondents admitted to having undertaken medical tests for contagious diseases with 81.1% stating that they had not been medically examined to be free from contagious diseases. A good percentage of the respondents (64.9%) stated that they had not been trained for handling and operating milk vending machines and that they were relying on transferred knowledge on basic operations of the milk vending machines from the owners or previous operators. About 81.1% of the vending machine handlers had a valid operational license, however, 54.1% stated that their premises are not inspected periodically.

Relationship between hygiene knowledge and practices of milk vending machine handlers

There was a positive correlation between milk hygiene knowledge and practices in this study. From Pearson's

correlation analysis (Table 5), a strong positive correlation ($r=0.626$) existed between hygiene knowledge and practices, and it was highly significant ($p=0.000$).

The correlation between knowledge and practices of milk vending machine handlers is illustrated in Figure 2. The dots inside the tables represent knowledge and practices scores. From the distribution of the dots as illustrated, a close association between the scores on knowledge and practices is indicated by their alignment towards a possible line of best fit showing that the knowledge of vendors closely influenced their practices.

Figure 3 shows variations of the mean percentage scores for hygiene knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi. The green bars represent the variation in hygiene knowledge of handlers in Dagoretti North and Kibra; the blue bars represent variation in safety practices between handlers in the two study areas while the orange bar represents the overall hygiene knowledge and the red bar shows overall safety practices.

Role of regulators in ensuring vendor compliance to regulatory practices

A Kenya Dairy Board representative, a regulatory officer, interviewed in this study stated that the institution offers licensing for milk vending machines. However, the exact statistics of how many vending machines have been licensed within Nairobi County at the time of the study was not provided. The regulatory officer also admitted to the availability of unlicensed milk vending machines being used in the market and that they constitute those machines that had been fraudulently obtained. The officer also stated that the institution does not have a structured means of training vendors on the operation of milk vending machines but a published quality document on regulatory requirements that vendors are expected to adhere to exists. The officer confirmed that they usually conduct inspections on milk vending machines to establish vendors' operations and practices but that this has not been carried out intensively in the informal settlements, with the frequency of these inspections being described as routinely. According to the officer, measures taken on unlicensed vendors and those who do not comply with regulations include withdrawal of license and shutting down of business. The regulatory officer admitted to being aware of reported concerns on the quality of milk sold using milk vending machines. The officer, however, stated that Kenya Dairy Board has not yet

Table 5. Correlation between knowledge and practices of milk vending machine handlers (N=37).

Parameter % Score	Correlation	Parameter % Score	
		Knowledge	Practice
Knowledge	Pearson Correlation Sig. (2-tailed)	1	0.626 0.000
Practice	Pearson Correlation Sig. (2-tailed)	0.626 0.000	1

Figure 2. Correlation between knowledge and practices of milk vending machine handlers.

Figure 3. Mean percentage scores for vendor knowledge and practices.

begun carrying out regular and intensive surveillance tests to ascertain the safety of milk from milk vending machines and that the institution is in the process of building capacity to carry out these checks.

Discussion

Hygiene knowledge of milk handlers

The level of knowledge on hygiene among milk vending machine handlers in this study was relatively low at a mean percentage of 68.83. In comparison with similar studies (Mandefero & Yeshibelay, 2018), milk handlers had poor scores on overall food safety knowledge, personal hygiene, and temperature control. This is attributed to a lack of adequate training on milk hygiene knowledge among handlers. The level of hygiene knowledge among handlers in this study increased with increase in the level of education, this could be because one's general understanding of hygiene and possible compromises to food safety improves as one progresses with education, and these findings are in tandem with those of other studies (Blackmore *et al.*, 2015), which found the knowledge of handlers being influenced by the level of education. The belief that pasteurized milk is safe cannot be contaminated by micro-organisms alludes to a lack of enough knowledge on potential milk hazards among the respondents, a finding that is consistent with that of Lindahl *et al.* (2018) which revealed that only 9.1% of the respondents in that study believed that diseases can be transmitted by milk. In another study, Galičič *et al.* (2015) stated that one of the reasons milk vending machines have been highly embraced is the perception that the milk sold from these machines is of good quality and safe for consumption. While a majority of the vendors believe that milk storage facilities should always be kept clean using portable water, most of them do not know the type of detergents to use and could end up compromising the safety of the milk stored. While respondents understand that milk and milk vending machines should be purchased from licensed suppliers, however, the lack of awareness among vendors on the appropriate milk storage temperature is a major threat to milk safety. It is stated in the regulation that milk stored in the vending machine should be cooled and maintained at not higher than 4°C (KDB, 2018), and the control and monitoring of milk storage parameters such as temperature is critical in determining the level of microbial load in milk (O'Connell *et al.*, 2016). The majority of the milk handlers do not know that there are laws and regulations that guide the selling of milk using milk vending, which is a challenge that could be attributed to a lack of enough training and sensitization.

Practices of milk handlers

Milk safety is highly dependent on the handling practices of vendors, and several cases of milk contamination are attributed to poor handling practices (Angelidis *et al.*, 2016). Milk vending machine handlers in the current study demonstrated poor handling practices as indicated by the mean percentage score of 54.05. This finding is similar to other studies (Abunna *et al.*, 2019) which found the level of practices among milk vendors to be poor. The majority of the vendors in this study sold pasteurized milk via vending machines in line with the Regulatory Act on milk vending machines in Kenya (KDB, 2018). The finding, however, contrasts with that of another study by Abunna *et al.* (2019), which found out that 81.5% of the vendors sold raw

milk. Despite observing appropriate practices during cleaning of the vending machines, record keeping of routine hygiene and handling operations was a major challenge among handlers, which makes it hard for traceability in the event of safety concerns due to milk contamination (Ndambi *et al.*, 2020).

Vendors are required to routinely monitor temperature fluctuations and conduct periodic calibration of the vending machines while keeping these records as evidence during inspections. However, none of the vendors in this study kept monitoring and calibration records while some were not carrying out periodic monitoring and calibration. Efforts being put in place to reduce the possibility of cross-contamination in milk are not satisfactory, this is seen through the practice by 70.3% of the vendors storing milk in intermediate containers instead of transferring it directly from the supplier's container to the vending machine. The lack of practices among the majority of the vendors to undertake medical tests for contagious diseases puts the consumer at risk of contracting these diseases through contaminated milk. Despite the need for vendors to be trained before they are issued with a license (KDB, 2018), the majority of the vendors (64.9%) both with or without a license stated that they had not received any training and did not know that it existed, which is a drawback on the part of the regulator.

Impact of hygiene knowledge on practices of milk handlers

The level of practices among milk handlers increased with an increase in the level of education. This can be attributed to the increased hygiene knowledge among vendors, which is also influenced by education level, and has statistically been proven by the positive correlation between knowledge and practices of milk vending machine handlers in the current study. The overall poor milk handling practices can be attributed to a lack of training among a majority of the milk vending machine handlers as indicated in this study, which is a finding consistent with that of similar studies (Amentie *et al.*, 2016). The poor level of compliance with regulations by the milk vending machine handlers in this study can be attributed to the complexity of some regulatory standards that are seen to be either unclear to the vendors or out of touch with the reality of the informal settlements which are characterized by poor infrastructure and inadequate capital, therefore discouraging compliance (Blackmore *et al.*, 2015).

One limitation of this study is that it was not done over a longer follow up period to ascertain the exact impact of hygiene knowledge on practices of milk vending machine handlers. Another limitation is that some information obtained from the interviews on hygiene practices by respondents is prone to respondent bias since some may not have presented the true position on their milk handling practices due to personal fears hence compromising the authenticity of the study findings.

Conclusion

Milk vending machine handlers in the informal settlements of Nairobi have a low level of knowledge and poor practices on milk hygiene and safety and are not adequately adhering to regulations governing the operation of milk vending machines. This is attributed to a lack of proper training on milk hygiene and handling practices. While efforts are being put

in place by handlers to keep milk in good condition, critical omissions by vendors still threaten the safety of milk and consumers' health at large.

Vendors' awareness of milk hygiene and regulations relating to the operation of milk vending machines is inadequate especially in informal settlements. Increasing vendor awareness on matters of milk hygiene and correct practices through training and sensitization is crucial for improving regulatory compliance. Proposed changes to the Dairy Act should include routine inspections of milk vending machine premises in both the formal and informal settlements to assess the practices of vendors and possible gaps that exist, which could guide corrective actions. Penalties for non-compliance through poor practices by handlers should be strengthened but only after adequate training and corrective action measures have been provided to the vendors.

Data availability

Underlying data

Zenodo: Data on hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi Kenya. <https://doi.org/10.5281/zenodo.5204466> (Holi, 2021a).

This project contains the following underlying data:

-Dataset (sav)

Zenodo: Questionnaire on hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi Kenya. <https://doi.org/10.5281/zenodo.5508163> (Holi, 2021b).

This project contains the following underlying data:

- Holi Regulator's Questionnaire.docx (a copy of the questionnaire for the regulator including the answers)

Extended data

Zenodo: Questionnaire on hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi Kenya. <https://doi.org/10.5281/zenodo.5508163> (Holi, 2021b).

This project contains the following extended data:

- Holi Knowledge and Practices Questionnaire.docx (a copy of the questionnaire for vendors)

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

Acknowledgment

The authors express gratitude to all the milk vending machine handlers who volunteered to take part in this study.

References

- Abunna F, Tasew N, Ragassa F, *et al.*: **Handling Practices, Quality and Safety of Milk along the Dairy Value Chains in Selected Sub Cities of Addis Ababa, Ethiopia.** *Biomed J Sci Tech Res.* 2019; **13**(1).
[Publisher Full Text](#)
- Alonso S, Muunda E, Ahlberg S, *et al.*: **Beyond food safety: Socio-economic effects of training informal dairy vendors in Kenya.** *Glob Food Sec.* 2018; **18**: 86–92.
[Reference Source](#)
- Amentie T, Guya M, Mekasha Y, *et al.*: **Milk postharvest handling practices across the supply chain in Eastern Ethiopia.** *J Adv Vet Ani Res.* 2016; **3**(2): 112–126.
[Publisher Full Text](#)
- Angelidis AS, Tsiota S, Pexara A, *et al.*: **The Microbiological Quality of Pasteurized Milk Sold By Automatic Vending Machines.** *Lett Appl Microbiol.* 2016; **62**(6): 472–479.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Blackmore E, Alonso S, Grace D: **Legitimising informal markets: A case study of the dairy sector in Kenya.** 2015.
[Reference Source](#)
- Brown LH, Alonso S, Lindahl J, *et al.*: **Regulatory Compliance in the Kenyan Dairy Sector: Awareness and Compliance among Farmers and Vendors.** IFPRI: International Food Policy Research Institute, 2018.
[Reference Source](#)
- Galicić A, Kanjec N, Kibiš A, *et al.*: **Consumer's attitude and manipulation of raw milk from milk vending machines.** *International Journal of Sanitary Engineering Research.* 2015; **9**(1).
[Reference Source](#)
- Godfrey K: **Milk Quality and On-Farm Factors Leading To Milk Spoilage In Bugaaki Sub County- Kyenjojo District.** 2013; 72.
[Reference Source](#)
- Grace D: **Food Safety in Low and Middle Income Countries.** *Int J Environ Res Public Health.* 2015; **12**(9): 10490–10507.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Grace D, Dipeolu M, Alonso S: **Improving food safety in the informal sector: Nine years later.** *Infect Ecol Epidemiol.* 2019; **9**(1): 1579613.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Holi K: **Data on hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi Kenya [Data set].** Zenodo. 2021a.
<http://www.doi.org/10.5281/zenodo.5204466>
- Holi K: **Questionnaire on hygienic knowledge and practices of milk vending machine handlers in the informal settlements of Nairobi Kenya.** Zenodo. 2021b.
<http://www.doi.org/10.5281/zenodo.5508163>
- KDB: **The Dairy Industry Regulations.** 2018; 114.
[Reference Source](#)
- KEBS: **Code of hygienic practice for milk and milk products/KS 1552: 2016—Full Catalogue Listing.** 2016.
[Reference Source](#)
- Kesmodel US: **Cross-sectional studies - what are they good for?** *Acta Obstet Gynecol Scand.* 2018; **97**(4): 388–393.
[PubMed Abstract](#) | [Publisher Full Text](#)
- KNBS: **Kenya National Bureau of Statistics—Humanitarian Data Exchange.** 2019.
[Reference Source](#)
- Lindahl JF, Deka RP, Asse R, *et al.*: **Hygiene knowledge, attitudes and practices among dairy value chain actors in Assam, north-east India and the impact of a training intervention.** *Infect Ecol Epidemiology.* 2018; **8**(1): 1555444.
[Publisher Full Text](#)
- Mandefero D, Yeshibelay G: **Assessment of community knowledge, attitude and practice on milk borne zoonoses disease in Debre- Birhan town, north Shewa, Ethiopia.** *J Public Health Epidemiol.* 2018; **10**(4): 123–131.
[Publisher Full Text](#)
- Ndambi A, Njiru R, van Knippenberg C, *et al.*: **A Review of Interventions and Parameters Used to Address Milk Quality in Eastern and Southern Africa.** *Food Control.* 2019; **116**: 107300.
- O'Connell A, Ruegg PL, Jordan K, *et al.*: **The effect of storage temperature and**

duration on the microbial quality of bulk tank milk. *J Dairy Sci.* 2016; **99**(5): 3367–3374.

[PubMed Abstract](#) | [Publisher Full Text](#)

Paludetti LF, Jordan K, Kelly AL, *et al.*: **Evaluating the Effect of Storage Conditions on Milk Microbiological Quality and Composition.** *Irish J Agric Food Res.* 2018; **57**(1): 52–62.

[Publisher Full Text](#)

Raposo A, Carrascosa C, Pérez E, *et al.*: **Vending machines: Food safety and quality assessment focused on food handlers and the variables involved in the industry.** *Food Control.* 2015; **56**: 177–185.

[Publisher Full Text](#)

Sadhu SP: **Effect of cold chain interruptions on the shelf-life of fluid pasteurised skim milk at the consumer stage.** *Braz J Food Technol.* 2018; **21**.

[Publisher Full Text](#)

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Version 1

Reviewer Report 28 January 2022

<https://doi.org/10.5256/f1000research.76550.r115485>

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Puja Dudeja

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I congratulate the authors for undertaking research on this relevant topic. However, some observations are as under:

1. The sample size is very small. further, the authors have converted them into percentages.
2. The strength of correlation between knowledge and practice though significant is not strong. it is only a fair correlation and hence should not be commented upon.
3. Since the sample size is small the authors should restrict presenting their findings as descriptive statistics only and not apply statistical tests as done for analytical studies.
4. A line about milk-borne infections and its prevalence in the area of study would add value to the relevance of current work

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: food safety

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 06 January 2022

<https://doi.org/10.5256/f1000research.76550.r100363>

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Victor Kuri

School of Biological and Marine Sciences, University of Plymouth, Plymouth, UK

The manuscript reports an interview survey carried out on milk vending machine handlers in Kenya, which included some questions to probe knowledge on some specific aspects of the regulations, hygiene, and their understanding and practices.

It also includes a relation of an interview to an officer of a related board, and moves on to recommend changes on legislation.

Some aspects of the discussion don't seem to be evidence-based, and aspects of the protocol may not be fully reproducible.

Abstract - results:

"Knowledge and practices of vendors significantly improved with...."

They did not improve... a sub-sample received 'higher scores' than other.

In the study setting, authors state that: "The vending machines are randomly distributed in the areas without any specific order." ...

If no test for randomness was carried out, please remove this as it may be false, patterns of accessibility, transport, pockets of population transit or availability of location may have influenced distribution... an unknown order does not mean that there is no order.

What does an "exhaustive sampling" mean? it would be better to report the numbers available against the number of volunteers included.

Data collection: An interview to one officer may provide valid background information or knowledge, but no research data to be bundled with other data.

The resulting assessment may be suited for an opinion paper, but not as part of a the research report; the isolated statements of a handful of individuals (interviewee and author(s) providing appraisal) are not reproducible.

HK Question 2 is confusing...

Authors state that pasteurized milk, despite being safe for consumption, can be contaminated by microorganisms; The question state that "Pasteurized milk is safe for consumption AND cannot be contaminated by microorganisms"

Would term 'cannot' be always clearly discriminated from 'could not', 'should not', 'must not' or 'ought not to be' by the target sample cohort?

Also the link between both components of the question is problematic.

Are both premises necessary for the statement to be correct? What if there are no organisms but pasteurized milk is unsafe for consumption because there is a toxin or perhaps a physical risk by foreign body?

A suggestion is that results linked to this question are eliminated.

Table 4, Q 8... the reference to Q5 seems to be incorrect.

When describing Table 4, authors state:

"....that the detergent was food grade, which is against the regulations."

Review writing, as this seems to be incorrect. What precisely is against the regulations ?

Table 5. Not all information listed is relevant, remove table, relevant value already included within the text? Detail also could be integrated within Figure 2.

Figure 3 appears redundant. This could be best shown on a table or explained within the text.

Under last heading on result section, this is unclear:

"....vendors are expected to adhere to exists. "

Section labelled:

"Role of regulators in ensuring vendor compliance to regulatory practices"

Some of the information here fits better within the introduction, and will ideally use citations to mentioned regulations, laws, or KDB reports.

Other information could be used in the discussion to provide context and possibly to suggest explanations, linked to 'personal communication' citations. Otherwise, remove section, as this is not research data.

Discussion:

the variable: level of knowledge on hygiene is not clear enough to refer to it as a percentage. This is linked to a set survey... refer to the survey then.

Conclusion:

Some of this makes sense, but it is not related directly to the evidence presented or to the data obtained.

Personal and professional opinions have a place in technical literature, but this is mixed up with a research report, which is unacceptable.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Food Safety; Food Operation Management; Pathogen Control; Food Science; Food Product Development

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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