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DESCRIPTIVE ANALYSIS OF SELENIUM CONTENT OF COMMON FOODS EATEN BY EBOLA SURVIVORS IN BENI, NORTH –KIVU, D.R.C.

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ABSTRACT

Selenium, a mineral present in food, has been demonstrated to assist a number of bodily processes, including the maintenance of strong muscles and an effective immune system. It may also slow the spread of some viruses and control blood coagulation. As a result, it might contribute to the fight against the Ebola virus infection. This descriptive case-control study examined how the lack of selenium affected people's susceptibility to the Ebola virus in Beni, North Kivu, Democratic Republic of the Congo. 95 Ebola virus survivors and 95 uninfected contact people were randomly chosen to provide data. Adults in both research groups reported eating beans, plantains, potatoes, vegetables, cassava leaves, fish, meat, ugali made from cassava and maize flours, sweet potatoes, and rice throughout the course of the year. According to the investigation, the amounts of selenium in corn flour, red sorghum, soy, squash, peanuts, tomatoes, plantains, and ginger were below the recommended levels. Amaranth, white rice, sweet potatoes, green beans, cassava, cassava leaf, eggs, meat, fish, raw egg plant, ndakala, garlic, and cauliflower were among the foods with normal selenium levels. Non-infected consumed more maize flour, red sorghum, soy, peanuts, amaranth, white rice, sweet potatoes, green beans, and cassava as compared to Ebola survivors. It was discovered that non-infected consumed more beef, eggs, and tomatoes than survivors.

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INTRODUCTION

Although it does not happen frequently, the Ebolavirus sickness is deadly. People from several nations have been impacted by Ebola since the first human case was discovered in the Democratic Republic of Congo (DRC), Ebola River in 1976[https://www.cdc.gov /vhf/ebola/history/distribution-map.html.]. Since then, the DRC has had the greatest number of disease outbreaks, with the Ebola Zaire strain accounting for the majority of fatalities (50 to 90%). One of the major Ebola outbreaks in DRC was recently reported in the North Kivu (August 2018 to June 2019) [Lacroix, 2018]. Although it was the tenth wave, the epidemic in North Kivu was the biggest seen in the DRC. When an organism unintentionally comes into contact with an infected animal, whether it's alive or dead, it contracts the zoonotic disease Ebola virus [Pourrut]. When a zoonotic spillover develops, it becomes a health problem when combined with other epidemiological, ecological, behavioral, and human-related factors that determine exposure to pathogens and increase susceptibility to some kinds of infection, like culture and diet ([Rodriguez-Morales, 2014]. Micronutrients are needed in very little amounts, yet they serve as the building blocks for strong immune systems, healthy bones, brains, and bodies [Oshin, 2019].

Iron, iodine, zinc, selenium, fluorine, calcium, and vitamins A, B6, B12, B1, B2, and B3 are a few of the critical micronutrients required by the body [World Health, 2019]. Due to its usefulness in maintaining healthy immunological, endocrine, and cardiovascular systems, selenium is highly valued [Jillian, 2019]. Selenium supports bodily functions include DNA synthesis, thyroid hormone metabolism, immunity against infections, and reproduction. The presence of selenium in the body leads to growth, healthy muscular function, the immune system, and reproductive organs. It also lessens the toxicity levels of some toxic substances, such as mercury, and has been demonstrated to slow the spread of viruses like the flu, HIV, and Ebola [Boaz Otieno, 2013]. Selenium is mostly found in plant-based foods, and the levels found in them correspond to the levels found in the surrounding soils. Selenium is found in grains like bread, cereal, and pasta, which makes it simple for a person to consume part of the required levels of selenium [Xie, 2021]. A coagulant has been utilized as supportive therapy for Ebola patients to prevent blood loss and increase survival chances because the disease is one of the hemorrhagic fevers. Selenium helps Ebola patients control blood coagulation and may help with coagulopathy caused by the hemorrhagic disease [Taylor].

It is anticipated that supplementing with more selenium can lessen the patient's exposure to the harmful consequences of the Ebola virus. In a paper published in 2014, Lyon proposed a paradigm for treating Ebola virus infection utilizing sodium selenite or selenium selenite. He proposed that proper usage of the micronutrient could decrease Ebola mortality and expedite recovery [Lyons, 2014]. Selenium supplements could be added to the diet to boost defenses against infection and the immune system [Hiffler, 2020]. On the other hand, it is anticipated that a selenium deficit will raise the chance of death [Taylor]. Numerous viral infections have been demonstrated to develop and worsen more quickly when selenium levels are low [Ligowe, 2020]. Additionally, it has been demonstrated that selenium deficiency can cause normally benign viruses to become dangerous to the host [Beck, 2003]. If the Ebola virus contains a gene with high selenium requirements, this may be viewed as a factor contributing to the pathogenicity of certain viral strains [Taylor]. Infection with EVD is likely to increase the need for selenium, which could result in a deficit, cell membrane damage, and severe lipid peroxidation. Consequently, viruses multiply more quickly in cells with low selenium levels [Taylor]. Hemorrhagic symptoms won't appear as a result of this for a very long time [Taylor].

The amount of selenium consumed daily in EVD-endemic areas is quite low (23 g) [Abd-ElMoemen, 2016]. Utilizing epidemiological data from a study of endemic and non-endemic Keshan disease areas, the recommended daily intake of selenium for people was calculated. According to the study, adults who consumed more than 13.3 or 19.1 mg of selenium per day, respectively, for females and men, were more likely to have Keshan illnesses than those who consumed lower levels of the mineral [Yang]. Thus, a 55 microgram Recommended Daily Allowance (RDA) for both men and women over the age of 19 was estimated. It was discovered that pregnant women and nursing mothers needed 60 and 70 mcg of iron daily, respectively. Although 400 micrograms per day was the Upper Limit (UL) that was deemed reasonable as more would injure the body, these groups were not forced to take it [Mistry]. Because of the region's history of natural disasters, armed warfare, and political unrest, its citizens frequently struggle to purchase food, which is frequently unavailable or inaccessible. The occupants don't receive enough food to consume that will satisfy their demands for energy and to support children's growth. Due to the fact that the number of people experiencing food insecurity has doubled since 2017, this nation is also the second most affected by the global food crisis [Peters, 2022]. The DRC as a whole is in a situation where the populace cannot consume enough selenium every day and where selenium insufficiency is still under-reported and may require emergency supplementation. As a result, selenium, which is inexpensive and easily accessible, could easily reduce mortality because it exhibits EVD-like coagulopathy symptoms. These circumstances made it necessary to assess the requirement for determining the amounts of selenium for the local population—something that had not before been done. By identifying the typical food types consumed by recovered patients and people who were not infected with the Ebola virus disease in the study region, the main goal was to investigate the function of selenium deficient vulnerability to the Ebolavirus disease in Beni, North Kivu. determining the selenium content of typical meals consumed in the area by both recovered and uninfected research participants.

METHODS

Study Design: A treatment and control group were included in this case control research. Controls served as the cases' point of contact when they were infected, while cases were EVD survivors. Only those meeting the conditions for inclusion were randomized into the study for both case and control groups. Case group: Using a simple random sample method of randomization, 95 members were added to the group, giving every member of the population an equal chance of participation. The randomization procedure made use of the Fisher and Yates random number table [Toutenburg, 1963]. Those who are listed in the database of the EVD survivors' association made up this sample.

Sampling procedure and selection: Participants from the case group helped identify the individuals they had contact with while ill for the control group. Using the Fisher and Yates randomization table, the selected individuals were then randomly assigned to the study [Toutenburg, 1963]. The province of North Kivu in the northeastern region of the DRC served as the study's location. There are about a million people living in the area, which has a high population density (ACAPS, 2018). North Kivu is divided into six territories: Nyiragongo, Lubero, Beni, Masisi, Walikale, and Rutshuru. As of the time of writing, transmission to other places was likely and there were reported cases in the Beni area, where our main focus is. On the western edge of Virunga National Park is the city of Beni.

Study Population: Residents of the North Kivu, Beni area who live there made up the study population; table 2 shows a summary of their population distribution. Those who had contracted EVD but had since recovered were included in the treatment/cases group. The EVD survivors' association currently has these patients listed as members. Prior research demonstrating the persistence of the virus long after the patients have recovered supports the use of EVD recovered patients [Deen, 2015]. Patients who were found to be on the contact lists of the infected individuals and those who were thought to have contracted the virus made up the control group. Following up on people who had close physical contact with an infected during the infection timeframe, those who resided with them, visitors, people in houses of worship and other settings where the sick congregated, and people who, in the event of death, handled the body until burial were all part of the contact tracing process [World Health, 2019].

Inclusion and Exclusion Criteria: For inclusion in the study, respondents had to fulfill the following requirements. Patients who are listed with the EVD survivors' association and are between the ages of 18 and 65. EVD-exposed individuals who were not infected. In essence, these are the people who had contact with the diseased. The respondent had to have lived in the Beni region for six months prior to the study's start. Individuals who agree to take part in the study and finally, Cases of suspected EVD. The criteria for study exclusion were as follows: individuals who are under 18 and those who are over 65. individuals who have not joined the EVD survivors' association. Those who are not affected or who are not on the infected contact list. Those who declined to consent to research participation. six months prior to the start of the study, non-residents of the Beni area. Those who are infected with EVD actively.

Data Collection and Analysis: Using the following techniques, both qualitative and quantitative data were gathered. A questionnaire was created, and participants responded to inquiries about their socio-demographic status, livelihoods—including the amount of their land and the kinds of crops they grow—food sources and consumption, and lab food analysis reports. Participants in the study also consisted of healthcare professionals, lab technicians, and nutritionists who had interacted with EVD patients in Ebola treatment facilities were given the structured questionnaires. The interviews provided information on the main types of food that participants in this study consumed. The identified food categories' samples were kept in 250-gram Ziploc bags and transported in cool boxes (between 0 and 4 degrees Celsius) for processing. Twenty-three (23) widely consumed dishes in Beni were tested in this study. Food subsamples weighing 100 grams were packaged in marked polythene bags, shipped in refrigerators to the North Kivu Provincial Laboratories (AMI LABO), and kept there until cold. Atomic absorption spectrophotometry was used to determine the presence of Selenium in the sample. An elementary mass spectrometer serves as the detector. It comes from the Agilent brand and is a component of the 7500 series. It is a collision/reaction cell (H2O2, perchloric acid, 0.75 ml nitric acid, and 2.25 ml hydrochloric acid were mixed with each 100-gram food sample. The contents were carefully combined before being cooked for an hour at 80°C in an aluminum block. Following a brief cooling period, the sample was carefully reconstituted with 11.5 ml of pure water, and the combination was thoroughly stirred. AAS was used to measure and examine a portion of the sample for Selenium [21].

Ethics Statement: Following preliminary approval from the Ministry of Health and Agriculture, chosen respondents were informed of the study's purpose and implications, and both verbal and written consent was required to proceed. Any issues brought up by the participants were addressed, and the researcher gave them the assurance that the information they provided would be treated carefully, used solely for the study, and that their names wouldn't appear on the questionnaire. They were also given the assurance that the researcher would take good care of the data they had gathered.

RESULTS

Common Types of Foods Eaten by EVD Recovered Patients: Adults in both research groups reported eating beans, plantains, potatoes, vegetables, cassava leaves, fish, meat, ugali made from cassava and maize flours, sweet potatoes, and rice throughout the course of the year. Soya porridge, milk, bread, ugali, fish, veggies, and fruits were listed as common meals for kids. It is important to note that certain foods, such as yogurt, salmon, beans, caterpillars, potatoes, yams, and almonds, were frequently consumed by the non-survivors but infrequently consumed by the survivors. Table 3 lists the different food items together with the percentage of survivors and non-survivors who consumed each item. From the 95 survivors who were interviewed, 70% (66/95) said that adults in their houses ate at least two meals each day, whereas 22% (21/95) and 5.2% (5/95) said that adults in their households ate three and one meals, respectively. nearly half also stated that their children ate no less than three meals daily, compared to 38 percent (36/95), 10 percent (10/95), and 1 percent (1/95) who ate two, four, and one meal daily, respectively.

Adults in their families ate at least two meals per day, according to 48% (46/95) of those who have not yet been exposed to the virus, compared to 31% (30/95), 14% (13/95), and 2% (2/95) who reported eating three, one, and four meals per day, respectively. Thirty-seven percent (35/95) of respondents said the kids in their households eat at least three meals each day, while one-third (33/95), 17% (16/95), and 1% (1/95) said they eat two, four, or five respectively. For members of the family in both research groups, breakfast and super were almost always consumed at the same time, but lunchtimes varied. 37 percent (35/95) and 56 percent (54/95) of the surviving and non-infected individuals, respectively, reported having family members there while 62% (59/95) and 44% (42/195) did not. People in all of the research groups concurred those various traditional foods, including chenille, yellow yams, yellow cassava, mushrooms, and pumpkins, had vanished. The key factors influencing the shift in the type of food consumed were mentioned as the rising expense of living, technology, warfare and instability, lifestyle modification, education, the influence of western culture, the broad range of foods, and civilization.

Selenium content of foods eaten by survivors and noninfected patients in Beni, North-Kivu: Table 1 lists the selenium levels in 23 laboratory-tested food samples together with the average predicted selenium levels and the percentage of people who survived and non-survivors who consumed each type of food. The amount of selenium per 100 grams of food sample as determined by the AMI laboratory is represented by selenium content (ug/100g). According to the investigation, the amounts of selenium in corn flour, red sorghum, soy, squash, peanuts, tomatoes, plantains, and ginger were below the recommended levels. Amaranth, white rice, sweet potatoes, green beans, cassava, cassava leaf, eggs, meat, fish, raw egg plant, ndakala, garlic, and cauliflower were among the foods with normal selenium levels. Non-survivors consumed more maize flour, red sorghum, soy, peanuts, amaranth, white rice, sweet potatoes, green beans, and cassava as compared to Ebola survivors. In contrast, survivors consumed more beef, eggs, and tomatoes than non-survivors did. There was no difference in the way they ate; plantains and cassava leaves were the prevalent meals found in both groups. Squash, raw eggplant, ndakala, garlic, ginger, and cauliflower are a few of the items that neither of the study participants recalled eating.

DISCUSSION

Common Types of Foods Eaten: The primary source of selenium in the body is food. In addition to vegetables, fish, meat, eggs, tomatoes, sweet potatoes, almonds, and rice, the main foods consumed by residents of North Kivu, Democratic Republic of the Congo, were cassava, plantains, and maize. Bread, ugali made from maize flour, fish, vegetables, and fruits made up the majority of children's diets. It appears that some items, such yogurt, beans, and almonds among others, were only found among Ebola non-survivors but not with the survivors. Only a small portion of survivors (5%), who typically ate two meals each day, only ate one meal per day. This contrasts with the non-survivors, who typically ate three meals a day on average, and those who occasionally ate as many as four. In addition, Barlow and company found that 13% of their research participants would skip meals five or more days a week, which is consistent with this study where 70% of the survivors' study participants ate two meals a day and 5.2% ate just one [Barlow, 2015]. In previous research, it was discovered that the main foods consumed by residents in north Kivu were rice, cassava, and maize [Katona, 2008]. Since the majority of participants in both study groups used these foods, this is comparable to what was found in that study. Other foods found by Barlow in 2015 and demonstrated in this study include plantains, pork, and potatoes [Barlow, 2015]. The variety of foods and eating habits in north Kivu cannot be described as complete or able to satisfy the dietary requirements of a healthy person. Rice, cassava, and maize make up the majority of the diet. This group rarely eats healthy meals including fish, eggs, meat, veggies, and fruits [Katona, 2008]. This shift was linked, among other things, to western civilization and the rising cost of life. According to a report by Barlow, the majority of the food consumed (74.37%) was cassava, followed by beans, potatoes, beef, bananas, and corn, with the remaining 1.74% going to other unidentified items [Barlow, 2015].

Selenium content of common foods eaten: The most popular food among both research groups had low levels of selenium, according to a check on the selenium content of the foods that study participants had previously indicated as their preferred sources of nutrition. Low quantities of selenium were found in a number of foods, including maize flour, soy, squash, peanuts, tomatoes, plantains, ginger, and red sorghum. Plantains and corn flour made from maize were popular foods in north Kivu, as was already mentioned. Other commonly consumed items, such as beef, rice, cassava, and cassava leaf, have typical levels of selenium. Raw eggplant, squash, cauliflower, ndakala, tilapia, and garlic were additional foods with normal selenium levels but were infrequently consumed by people in north Kivu. In affluent nations, much of the food consumed by individuals is high in selenium. This includes grains, bread, chicken, pork, eggs, and other foods. Previous research has revealed that foods consumed by people in impoverished nations, such grains, have significant levels of selenium [Berkelaar, 2015].

The selenium levels in the frequently consumed foods for this investigation were, however, lower than what was often anticipated. The amount of selenium in the soil determines the amounts of selenium in foods, a phenomenon that this study did not investigate but which may have provided an explanation for the low levels of selenium in food ([World Health, 2019; Lopes, 2017). People in the Beni region depend on agriculture as a source of income, but this has been hampered by the instability brought on by attacks by rebel groups. People are compelled to abandon their farms and homes out of fear for their lives. The Food and Drug Administration (FDA) of industrialized nations like the United States of America has created a Daily Value (DV) index to help its residents determine their nutritional needs in relation to the foods they consume. This makes it possible to replenish those nutrients that they do not receive enough of in their everyday diet [Berkelaar, 2015]. Comparatively to foods with lower values, those with a DV more than 20% are thought to be particularly nutritious.

Table 1. Selenium contents in different foods

Food sample (100grams)	Selenium content (µg/100g)	Average expected selenium content (µg/100g)	Selenium content category	Proportion of survivors eating	Proportion of non-survivors eating
Corn flour	15	50 - 60	Low	33% (31/95)	36% (34/95)
Red sorghum flour	18	43	Low	0%	2% (2/95)
Squash	0.17	0.24	Low	-	-
Soy	8.3	8.8	Low	4% (4/95)	5% (5/95)
Peanut	8	19.6	Low	11% (10/95)	20% (19/95)
Amaranth	18.7	18.7	Normal	1% (1/95)	2% (2/95)
Raw white rice	15.1	15.1	Normal	5% (5/95)	8% (8/95)
Sweet potatoes	0.6	0.6	Normal	7% (7/95)	9% (9/95)
Green beans	0.3	0.3	Normal	51% (48/95)	55% (52/95)
Raw eggplant	0.2	0.2	Normal	-	-
Eggs	20	20	Normal	18% (17/95)	4% (4/95)
Beef	27	27	Normal	80% (76/95)	76% (72/95)
Ndakala	51	51	Normal	-	-
Tilapia	0.02	0.02	Normal	-	-
Tomato	0.40	1.1	Low	8% (8/95)	4% (4/95)
Plantain	0.20	2.3	Low	28% (27/95)	28% (27/95)
Garlic	0.98	0.98	Normal	-	-
Ginger	0.013	0.028	Low	-	-
Cassava	13	13	Normal	39% (37/95)	41% (39/95)
Cassava leaf	0.15	0.15	Normal	39% (37/95)	39% (37/95)
Cauliflower	10	10	Normal	-	-

When adopting agronomic decisions to increase levels consumed by people, selenium levels in foods that people eat are mostly dependent on its bioavailability in soil. The factors impacting the availability of selenium in the soil are important. Some of these variables include soil organic matter and PH [Liu, 2021], which when raised also raises the soil's selenium content. The main cause of selenium insufficiency is a poor diet, while the amount in the soil where food is grown may also play a role. People in the Beni region depend on agriculture as a form of income, but this has been hampered by the instability brought on by raids by rebel groups. People are compelled to abandon their farms and homes out of fear for their lives. 50% of the population is under the age of 15, making it the poorest region in the DRC. The analysis made it clear that plantains, maize, cassava, and rice were the main foods consumed by the study participants. In addition to the primary items, non-survivors also frequently ate yogurt, fish, beans, caterpillars, potatoes, yams, and almonds, which were less frequently observed among survivors. Additionally, the typical number of meals consumed daily by non-survivors was two and three. The main foods consumed by the two survivors, such as maize flour, peanuts, and plantains, were found lacking in selenium. Meat, cassava, and other commonly consumed meals also had normal selenium levels.

CONCLUSION

In conclusion, foods including maize flour, cassava, plantains, nuts, meat, vegetables, fish, sweet potatoes, and rice are frequently consumed by Ebola patients who have recovered from the disease. When compared to survivors, the bulk of non-infected ate fewer meals (3 meals per day), on average (2 meals per day). The non-infected may have had a stronger immune system as a result of this. Additionally, the survivors consumed a lot of things like yogurt, fish, beans, caterpillars, potatoes, yams, and nuts, some of which had high levels of selenium, which may have contributed to their increased susceptibility to the Ebola virus.

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