# Food insecurity as a risk factor for Ebola-related outcomes in Kono District, Sierra Leone: a cross-sectional study

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## Introduction

- Despite more than 33 documented outbreaks of Ebola virus disease (EVD) since 1976, the complex biosocial processes that are associated both with the spread of the virus and with disease outcomes are poorly understood.[1]
- During the rainy season in Sierra Leone, 45% of the population, or 2.5 million people, have not had access to sufficient food, and the majority of people (52%) have had to borrow money to buy food.[2]
- The World Food Programme estimated that the 2013-2016 Ebola outbreak pushed approximately 750,000 people into a state of food insecurity.[3]
- As malnutrition is associated with greater susceptibility to infectious diseases,[4] food insecurity may predict Ebola-related outcomes such as Ebola virus disease (EVD) and mortality.
- Without a robust protective immune response, Ebola-infected persons have higher viral loads and a greater likelihood of death.[5]
- Food insecurity and poor nutrition are associated with higher risks of HIV, tuberculosis, malaria, sexually transmitted infections, and non-communicable diseases,[6-8] and poorer health outcomes among those affected, including higher mortality and worse immunologic and virologic outcomes in HIV.[9]
- To date, no study has examined the association between food insecurity and Ebola-related outcomes.

## Project Goals

Given the dearth of data regarding nutrition and Ebola-related outcomes, we sought to test the following hypothesis: Food insecurity was associated with the risk of exposure to EVD, having EVD or EVD-related mortality.

## Materials and Methods

- We conducted a cross-sectional study in the communities of Sukudu and Ndogboya in Kono District, Sierra Leone, from November 2015 to September 2016.
- Sukudu and Ndogboya experienced Ebola outbreaks in December of 2014 and January of 2015, and both are rural communities with approximately 800 and 1,200 inhabitants, respectively.
- We enrolled persons who were determined to have had an exposure to Ebola virus.
- Exposure to Ebola virus was inferred based on indirect or direct contact with an EVD case, or living in a house or sharing a toilet with an EVD case.
- To assess for potential differences in food insecurity among community members, we also enrolled a random sample of unexposed persons.
- Participants were interviewed to obtain their age, gender, occupation, educational level, head of pot group, and food insecurity level.
- Food insecurity was our primary explanatory variable and assessed using the Household Food Insecurity Access Scale (HFIAS), a nine-item scale well validated across Africa.[11]
- Food insecurity data was collected at the pot level in both communities. A pot represents a relationship structure inside each household, where participants gather to eat.
- We asked the head of a pot group to report his or her food insecurity in the month before the Ebola outbreak occurred in the community. Each participant was assigned to a pot group.
- Our outcome variables were exposure to EVD, having EVD and EVD-related death.
- We obtained a list of EVD survivors and confirmed and probable dead cases from the DERC. These EVD cases were confirmed by interviews. In cases where confirmed or probable EVD cases had died, we interviewed household members to obtain data.
- We analyzed the relationship between food insecurity and risk of exposure to EVD, having EVD, and EVD-related mortality, using cluster-adjusted logistic regression models.
- We dichotomized the food insecurity variable into food security (none, mild) and food insecurity (moderate, severe) based on categories of a standard algorithm.[11]
- Covariates with a p-value $\leq 0.2$ in bivariate analysis were included in adjusted models. Age and gender were considered epidemiological confounders and included in adjusted analyses irrespective of their bivariate associations.
- The analyses were performed in STATA/IC 14.1.

## Results and Outcomes

- We interviewed 423 persons.
- These participants had a mean age of 29.2 years (SD+/-17.6).
- The majority were men (56%) and worked outdoors (62%).
- Three-quarters (75%) completed primary school or less.
- One-third (33%) were head of a pot group, and most (88%) were categorized as food insecure.
- These participants lived among 123 pot groups in 83 households.
- Of the 423 participants, 326 (77%) exposed persons lived among 80 pot groups in 53 households.
- Of these 80 heads of pot groups, 23 (29%) developed EVD, and 12 (52%) of these EVD cases died.
- Two hundred eighty-four (87%) exposed persons were food insecure, and 57 (20%) of them developed EVD.
- Of the 57 EVD cases who were food insecure, 44 (77%) died.
- In total, 61 (19%) developed EVD, and 45 (74%) of these EVD cases died.

- There was no association between food insecurity and exposure to EVD (**Table 1**).
- Compared to those who were food secure, the adjusted odds of having EVD were 2.1-fold higher for participants who were food insecure, but the association was not statistically significant (95% CI, 0.62-9.23) (**Table 2**).
- EVD cases who were food insecure had a 18.3-fold higher odds of dying than EVD cases who were food secure (95% CI, 1.27-261.57) (**Table 3**).

- EVD cases who were not head of pot group had a 8.33-fold higher odds of dying than EVD cases who were head of pot group (95% CI, 1.87-33.33) (**Table 3**).
- Additional analyses among participants from Ndogboya showed that heads of pot groups were more likely to be food secure (OR, 3.03; 95% CI, 1.09-9.89) (data not shown).

**Table 1.** Risk of exposure to Ebola virus disease (n=423)*

| Characteristics | OR | 95% CI | AOR | 95% CI |
|---|---|---|---|---|
| **Age** | 0.98 | 0.97-0.99 | 0.99 | 0.98-1.01 |
| **Gender (Female)** | 1.21 | 0.75-1.93 | 0.99 | 0.59-1.65 |
| **Occupation (Works outdoors)** | 0.56 | 0.32-0.99 | 0.98 | 0.47-2.07 |
| **Education (Middle school or above)** | 0.61 | 0.37-1.00 | 0.65 | 0.41-1.04 |
| **Not head of pot group** | 2.63 | 1.59-3.85 | **2.29** | **1.37-3.85** |
| **Food insecure** | 0.78 | 0.26-2.35 | 0.76 | 0.29-2.02 |

**Table 2.** Risk of Ebola virus disease (n=326)*

| Characteristics | OR | 95% CI | AOR | 95% CI |
|---|---|---|---|---|
| **Age** | 1.03 | 1.01-1.05 | **1.03** | **1.00-1.05** |
| **Gender (Female)** | 0.83 | 0.48-1.43 | 0.94 | 0.52-1.69 |
| **Occupation (Works outdoors)** | 2.22 | 1.25-3.96 | 1.12 | 0.42-2.99 |
| **Education (Middle school or above)** | 1.86 | 1.00-3.45 | 1.48 | 0.82-2.66 |
| **Not head of pot group** | 0.58 | 0.29-1.15 | | |
| **Food insecure** | 2.39 | 0.62-9.23 | 2.05 | 0.57-7.40 |

**Table 3.** Risk of Ebola virus disease-related mortality (n=61)*

| Characteristics | OR | 95% CI | AOR | 95% CI |
|---|---|---|---|---|
| **Age** | 1.00 | 0.97-1.03 | 1.01 | 0.96-1.06 |
| **Gender (Female)** | 0.86 | 0.31-2.34 | 0.43 | 0.11-1.77 |
| **Occupation (Works outdoors)** | 0.57 | 0.12-2.78 | | |
| **Education (Middle school or above)** | 1.10 | 0.36-3.34 | | |
| **Not head of pot group** | 5.88 | 1.30-25.00 | **8.33** | **1.87-33.33** |
| **Food insecure** | 10.15 | 0.91-113.06 | **18.25** | **1.27-261.57** |

*bold indicates that the p-value was statistically significant

## Conclusions

- This is the first study to demonstrate a potential relationship between food insecurity in the month prior to the Ebola outbreak and EVD-related outcomes.
- There was no association between food insecurity and exposure to EVD or having EVD, though food insecure individuals had over two times the odds of having EVD.
- Food insecurity was a strong risk factor for EVD-related mortality.
- High levels of food insecurity were found among EVD cases who died and community members, suggesting that this modifiable risk factor may be a target for interventions among persons with EVD, or in communities with epidemic Ebola transmission, respectively.
- Larger studies need to be conduct to confirm these findings.
- Our findings extend previous research by suggesting that food insecurity and malnutrition may be critically important to survival in the context of emerging infectious diseases.
- Broader interventions to improve food security are needed in Sierra Leone because those who are food insecure during the next Ebola outbreak may be at higher risk of poor Ebola-related outcomes.

## Future Goals

- We plan to collect these data in an additional village in Kono District so that our findings are strengthened.
- We are collecting data on current food insecurity so that we test the following hypotheses:

– Food insecurity disproportionally affected Ebola-affected households after the Ebola outbreak as compared to unaffected households,
– Food insecurity is worse in households where at least one working family member died of Ebola virus disease as compared to households where there was at least one Ebola survivor and no Ebola-related deaths.

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