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Seasonal Changes in the Prevalence of Food Insecurity among Rural Households in East Ethiopia: A Longitudinal Panel Study

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Abstract

Background: Food insecurity has become a major public health problem affecting the general population worldwide. However, little has been known about its seasonal variation and correlates in low-income countries using advanced analysis to design time-oriented interventions.

Objective: To determine the seasonal changes in the prevalence of food insecurity in the wet and dry seasons among rural households in east Ethiopia.

Methods: A longitudinal study was conducted from August, 2011 to February, 2012 among mothers in rural and semi-urban households in east rural Ethiopia. Data were collected from 2,132 randomly selected households. Odds ratio along with 95% confidence interval was estimated to identify predictors of household food insecurity using a conditional fixed-effects logistic regression analysis.

Results: Nearly 45% [44.56%, 95% CI: (42.45%, 46.67%)] and 21.2% [95% CI: (19.4%, 22.9%)] of the households were food insecure in the wet and dry season, respectively. Food insecurity was positively associated with paternal occupation (being non-farmer) [AOR (95% CI) = 2.9 (1.8, 4.6)]. In contrast, being in the middle [AOR (95% CI) = 0.50 (0.37, 0.68)] and higher [AOR (95% CI) = 0.32 (0.24, 0.44)] household’s socio-economic positions and dry season [AOR (95% CI) = 0.38(0.29, 0.52)] had protective effect against food insecurity.

Conclusions: Food insecurity was more common in wet season and associated with basic household factors. Season-oriented food security interventions should be designed to enable the poor rural households have access to adequate food and achieve desired Millennium Development Goals in low-income countries including Ethiopia.

Keywords: Ethiopia; Household Food Insecurity; Kersa; Longitudinal study

Background

Food and Agriculture Organization (FAO) understood food insecurity as a situation that exists when all people, at all times, lack physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life[1]. It has become a common public health problem in both developed [2] and low-income countries [3–7] that is affecting 5% to 25% of the general population [8]. It also continues to affect Ethiopians despite the continued efforts made in the past decades [9].

An estimated 870 million or one in every eight people is chronically under-nourished worldwide. The majority of these live in low-income countries such as sub-Saharan Africa (SSA) and certain parts of Asian continent, where nearly a quarter of the population was undernourished in 2010–2012 [10]. Food insecurity is believed to be one of the major factors for under-nourishment in Ethiopia [11–12], and is pervasive in sub-Saharan Africa (SSA) [8,13], particularly in Ethiopia where 14 million Ethiopians have been affected by famine [14]. This implies the achievement of Millennium Development Goals (MDGs) particularly MDG 1 which is eradication of extreme poverty and hunger requires sustainable food security interventions among population in these settings since food insecurity and undernutrition erode human capital, reduce resilience to shocks, and reduce productivity due to impaired physical and mental capacity [15].

Evidence from former studies have identified socio-economic factors such as farm size of the households, occupational status, inadequate food production, poverty [3,5,8,16–23], maternal age and smoking status of the head of the household [9,23] as the major risk factors for food insecurity. Other studies from low-income countries have also indicated that households with large families having economically dependent adults and urban residence are predictors of household food insecurity [2,7,24]. In Ethiopia as well many of the risk factors for food insecurity are related to socio-economic factors [1,11,12,25–27].

There is scarcity of information about seasonal variation in the prevalence of household’s food insecurity in low-income countries including Ethiopia making use of an advanced statistical analysis to design nationwide time-oriented food security interventions [24,28]. Therefore, identifying the seasonal variation in the magnitude of household food insecurity and its correlates is important for policy makers and programers to design appropriate food security interventions in low-income countries like Ethiopia.

Methods

Study setting

The study was conducted in Kersa Demographic Surveillance and Health Research Centre (KDS-HRC) of Haramaya University, eastern Harage zone of Oromia national regional state from August, 2011 to February, 2012. Oromia is one of the administrative regions in Ethiopia. KDS-HRC was established in 2007 and is one of the Demographic Surveillance Sites (DSS) in the country comprising 10,256 households with a total adult population of 48,192 and 7,198 children under five, at the time of the study [29].

J. KDS-HRC has three agro-climatic zones: low land, high land, and midland. It is also divided into ten rural kebeles (the smallest administrative units in Ethiopia) and two semi-urban areas.
In all the study sites, there are agricultural developmental agents who provide the rural farmers with basic information on up-to-date agricultural technologies. Agriculture is the main livelihood of the study population according to the report of the District’s Agricultural Office. Crop production is basically on annual basis, except in few locations where it is biannual. Sorghum and maize are the common grains cultivated in the district. Potato and other vegetables are also scarcely produced. Subsistent crops are often planted during the wet season and harvested during the dry season [30]. Khat, a stimulant plant with amphetamine like effects, is predominantly produced as a cash crop [31]. Moreover, there are primary health care institutions within the geographic coverage of the DSS serving the rural communities with primary health care services [32,33].

Four seasons are commonly known in Ethiopia: spring (September – November), winter (December – February), Autumn (March-May), and Summer (June – August) [34]. However, only winter and summer seasons were considered in this study to compare the status of household food security during harvest and post-harvest times, respectively as they relate to the availability of food in the household.

**Study Design and Participants**

This study was part of a longitudinal household survey that was conducted on rural mothers and their respective children under the age of five years (mother–child pair) in the wet and dry seasons to assess seasonal changes in the prevalence of acute child undernutrition [35]. For this particular study, we were interested in assessing household food security status by interviewing mothers of those children both at the base-line and end-line of the follow-up. The sample size was calculated by using sample size formula for cohort study to achieve adequate power with the following assumptions: two sided alpha = 0.05, β = 0.1, proportion of food insecurity among exposed [uneducated mothers in semi-urban and rural households] to be 0.28 [9], proportion of food insecurity among control group (educated mothers in semi-urban and rural households) to be 0.20, and estimated loss to follow-up to be 20% yielding a total of 1,436 study samples. However, all the mothers (2132) who had completed their follow up were considered for this study to increase the power of the study.

Mothers were recruited from the households of the 12 kebeles under the DSS. Initially, the households in each kebele were selected by using simple random sampling from the sampling frame of the KDS-HRC proportional to the estimated population size of each kebele [29]. Mothers were then drawn from the randomly selected households in each study kebele/village proportional to the maximum sample size allocated for the baseline nutritional survey. In this study, these mothers were interviewed to assess the household’s food security status. If more than one mother–child pair lived in the selected household, one mother was selected by lottery method to participate in the study. The same mother was interviewed twice (at the base-line and end-line of the study) to obtain important information on the household food security status.

**Measurements**

Data were collected at the base-line during the peak level of the wet season in August, 2011 and in February, 2012 in the dry season at the end-line of the study. A structured and pretested questionnaire was used to collect household’s background information from the mothers. In order to assess household’s food security status, the questionnaire was adapted from the Food and Nutrition Technical Assistance Project (FANTA) Household Food Insecurity Access Scale (HFIAS) generic questions standardized for this purpose [36]. The questions were initially prepared in English and translated into local language (“Afaan Oromo”). Data collectors with at least high school level of education were recruited from the nearby community. The data collection process was supervised by diploma nurses and other relevant professionals having equivalent training in the related fields. Both categories received intensive training for one week on the questionnaire and interviewing techniques.

The outcome variable, household food security status was defined as follows. Food security status was determined by using nine standardized Household Food Insecurity Access Scale (HFIAS) occurrence and frequency of occurrence questions that were developed under the guidance of Food and Nutrition Technical Assistance (FANTA) project of USAID in 2007 for this purpose. Accordingly, the respondents were asked about the amount and variety of meal that they have eaten, and the occurrence of food shortage for the household members, in which they did not eat for the whole day or eat only in the night time during the past four weeks preceding the survey [36]. All “Yes” responses for the occurrence questions were coded “1” and “No” responses were coded “0”, and the responses were summed to produce an index of household food insecurity. The index had high internal consistency (Cronbach’s alpha = 0.90) [26]. Later on, households who responded “No” to all nine food security questions were categorized as food secure and coded “1” while households who responded “Yes” to all nine food security questions were categorized as food insecure and coded “0” for further analysis.

The main independent variables of the study were maternal education, paternal education and occupation, household’s socioeconomic position, season of data collection, food source of the household, and frequency of cultivation. The household socioeconomic position (SEP) or wealth index was determined by using 28 household’s related variables such as household’s assets such as presence or absence of television, radio, refrigerator and domestic animal, household’s monthly income, environmental health conditions such as methods of waste disposal, water supply (sources of water for household domestic purposes and methods of water storage), and dwelling related characteristics including the type of floor, roof, and wall of the residential house of the household. Before calculation of the SEP categorical variables were made dummy before initiating the analysis while ordinal ones were ordered from less important to very important one.

The SEP or wealth index was then grouped as “poor”, “medium”, and “rich” and coded as “1”, “2”, and “3” respectively and used in the further analysis [37,38]. Paternal occupational status was grouped as farmers and others and coded as “0” for farmers and as “1” otherwise. Other categories included civil servants, employees in private business, students and daily laborers. Parental educational background was classified as literate and coded “0” and illiterate which was coded “1”. The literacy status was confirmed by giving them to read materials written in local language. Season of data collection was grouped into the wet season and coded “1” and into the dry season and coded “0”. Mothers were also asked about source of food for the household’s members. Household’s food source was categorized as own production and coded “1” and “others” including market, food aid, etc and coded “0”. The household’s frequency of cultivation for those who had own production was categorized as “less than two time per year” and “two or more times per year” and coded “1” and “0”, respectively.

**Statistical Analysis**

Data were double entered onto EPI-Data Version 3.1 and were exported to STATA version 11 for further analysis. The proportion of the dependent variable was calculated against the season of data collection to check whether there was a seasonal variation in food security within study participants. The explanatory variables were
were tested for multicollinearity by using Variance Inflation Factor (VIF) and tolerance test. The VIF result ranged between 1.00 – 2.98 while the tolerance test result was less than 1. This finding was consistent with prior knowledge of the normal limits of values for multicollinearity test [39].

Haussmann’s test was used to choose between conditional fixed-effects and random-effects logistic regression model for panel data analysis. Accordingly, the test was found statistically significant, p value ≤ 0.05, supporting the use of conditional fixed-effects logistic regression model instead of random-effects logistic regression model [40]. Variability within individual study participant with respect to time variant explanatory variables was compared using conditional fixed-effects logistic regression model. Bivariate analyses were conducted to check the association between dependent variable and explanatory variables.

Hence, all variables with p value of ≤ 0.2 were considered in the multivariate conditional fixed-effects logistic regression analysis to control for all possible confounders and to identify the predictors of household food insecurity. Odds ratio along with 95% confidence intervals was estimated and p values were determined. It has to be noted that conditional fixed-effects logistic regression models are mainly suitable to measure time variant variables while focusing on the determination of variations within individual study participants over different waves of measurements. They aren’t much good for looking at the effects of variables that don’t change across time, like race and sex. With panel data we can control for stable characteristics (i.e. characteristics that do not change across time) whether they are measured or not [40].

Ethical Considerations

The ethical clearance was secured from the Ethical Review Committee of Haramaya University, College of Health and Medical Sciences, Ethiopia, before initiating the study. Informed verbal and written consent was obtained from each respondent before the interview. Illiterate mothers consented by their thumb print after verbal consent. All the study participants have been informed about the purpose of the study and their right either to take part in the study or not. The participants were told that there will not be any form incentives regarding food security interventions at individual base except for the overall use of the study’s results for policy making and programming at the national and local levels to design appropriate food security interventions.

Results

Out of the initial 2,352 mothers that were recruited, only 2,234 fully participated in the surveys. One hundred and two mothers were excluded from the analysis due to incomplete data. Thus, further analysis was conducted on 2,132 mothers, making a response rate of 95.4%. The mean (± SD) age of the mothers was 29.46 (± 0.084) years, while the mean (± SD) weight of the mothers was 29.46 (± 5.48) years. Among the time variant variables included in this study, about 950 households or nearly forty five percent [44.6%, 95% CI: (42.5%, 46.7%)] and about 452 households or 21.2% [95% CI: (19.5%, 22.9%)] of the households were food insecure during the wet and dry seasons, respectively. The average HFIAS was 18.16 (± 0.91) in wet season and 15.70 (± 3.98) in dry season (Table 1).

In the multivariable conditional fixed-effects logistic regression, household food insecurity was positively associated with paternal occupation (being non-farmer) [AOR (95% CI) = 2.9 (1.8, 4.6)] while middle [AOR (95% CI) = 0.50 (0.37, 0.68)] and higher [AOR (95% CI) = 0.32 (0.24, 0.44)] household’s socio-economic position and dry season [AOR (95% CI) = 0.38 (0.29, 0.52)] were found to be protective against food insecurity. The odds of food insecurity were nearly three times higher among households whose husbands were non-farmers by occupation compared with their counterparts. On the other hand, the odds of food insecurity were reduced by half among households in the middle socio-economic position while it was reduced by 68% among those in their high socio-economic position. Moreover, the odds of household food insecurity were reduced by 62% during the dry season compared with the wet season (Table 2).

Discussion

In this study, the prevalence of household food insecurity was [44.6%, 95% CI: (42.5%, 46.7%)] in the wet season and [21.2%, 95% CI: (19.5%, 22.9%)] in the dry season, respectively. Paternal occupation (not being a farmer), household’s middle and higher socio-economic position, and the wet season were also identified as the strong predictors of seasonal variation in the prevalence of household food insecurity.

The prevalence of food insecurity observed during the two waves of the study was not further segregated beyond the point estimate to characterize the severity of the problem since the study participants were believed to be homogenous in most of their characteristics. However, the magnitude of household food insecurity that was observed during wet and dry seasons, in this study, was in accordance with what has been observed in other non-longitudinal studies conducted in various regions of the world including Ethiopia[23,5,7,9], while it was less than some other surveys which employed similar designs [4,6,8]. Such a discrepancy could be attributed to sampling variation in these studies. On the other hand, the result of this study is also comparable with other few longitudinal studies that were conducted in the resource poor countries [24,28] and this might indicate that food insecurity continues to be one of the major public health problems in such low-income countries and that it requires seasonal consideration in order to attain health related MDGs.

The risk of food insecurity was reduced by 62% in the dry season compared with the wet season. This finding was comparable with the results of few longitudinal studies that were conducted in low-income countries including Ethiopia [24,28]. The higher magnitude of food insecurity that was observed in the wet season could be attributed to low availability of food in the market since the wet season considered to be pre-harvest season which may in turn impact the distribution of foods to the needy households by local food aid organization together with lack of good road infrastructure which is suitable for the wet season.

The odds of food insecurity were higher among households whose household heads were non-farmers by their occupation compared with farmers. This finding was similar to other survey conducted in other developing countries [5,9,18]. This could be due to the fact that non-farmers who do not have their own food production, earn low income, and entirely rely on market might have less opportunity to access adequate food compared with their counterparts. The rural households who belonged to the middle and higher socio-economic positions were less likely to be affected by food insecurity. The odds of food insecurity were reduced by half among households in the middle socio-economic position while it was reduced by 70% among rich households compared with poor households. This finding is in accordance with other studies conducted in different parts of the world including Ethiopia [5,8,9,11,12,22,23,25-27] whereby poverty was identified as a major cause of household food insecurity. This could be explained by the fact that better off households are more capable of overcoming food insecurity compared with their counterparts.
<table>
<thead>
<tr>
<th>Characteristics of Study</th>
<th>Subjects</th>
<th>Wet Season Number</th>
<th>%</th>
<th>Dry Season Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food security status</td>
<td>Food secure</td>
<td>1182</td>
<td>55.4</td>
<td>1680</td>
<td>78.8</td>
</tr>
<tr>
<td></td>
<td>Food insecure</td>
<td>950</td>
<td>44.6</td>
<td>452</td>
<td>21.2</td>
</tr>
<tr>
<td>Household assets</td>
<td>Yes</td>
<td>1145</td>
<td>53.71</td>
<td>1225</td>
<td>57.46</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>987</td>
<td>46.29</td>
<td>907</td>
<td>42.54</td>
</tr>
<tr>
<td>Owns oxen</td>
<td>Yes</td>
<td>124</td>
<td>5.82</td>
<td>159</td>
<td>7.46</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2008</td>
<td>94.18</td>
<td>1973</td>
<td>92.54</td>
</tr>
<tr>
<td>Average HFIAS</td>
<td>Mean (± SD)</td>
<td>18.16(0.91)</td>
<td>15.70 (3.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s weight (Kg)</td>
<td>Mean (± SD)</td>
<td>50.1(6.35)</td>
<td>50.8 (5.98)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Time variant characteristics of study participants by season of data collection Kersa district, east rural Ethiopia, 2012. HFIAS = Household Food Insecurity Access Scale.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>COR (95% CI)</th>
<th>AOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s education</td>
<td>Literate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>illiterate</td>
<td>2.8 (2.4, 3.2)**</td>
<td>1.1 (0.8, 1.5)</td>
</tr>
<tr>
<td>Paternal education</td>
<td>Literate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>illiterate</td>
<td>1.9 (1.6 , 2.3)*</td>
<td>1.2 (0.9, 1.5)</td>
</tr>
<tr>
<td>Paternal occupation</td>
<td>Farmers</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Others £</td>
<td>1.7 (1.2 , 2.3)**</td>
<td>2.9 (1.8, 4.6) **</td>
</tr>
<tr>
<td>Socio-economic position</td>
<td>Poor</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0.5 (0.4, 0.7)*</td>
<td>0.5 (0.4, 0.7)*</td>
</tr>
<tr>
<td></td>
<td>Rich</td>
<td>0.4 (0.3, 0.5)*</td>
<td>0.5 (0.4, 0.7)*</td>
</tr>
<tr>
<td>Season</td>
<td>Wet</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>0.37 (0.32 , 0.42) **</td>
<td>0.38 (0.29 , 0.52) **</td>
</tr>
<tr>
<td>Food source of household</td>
<td>Others 2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Own production</td>
<td>0.44 (0.37 , 0.52 )**</td>
<td>0.89 (0.70, 1.1)</td>
</tr>
<tr>
<td>Frequency of cultivation</td>
<td>≥ 2 times</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&lt; 2 times</td>
<td>1.2 (0.9 , 1.4)</td>
<td>1.2(0.9 , 1.5)</td>
</tr>
</tbody>
</table>

LR chi² = 333.17, Prob > chi² = 0.00001, Log likelihood = -543.89331

Table 2: Predictors of household food insecurity among rural residents, Kersa district, east rural. Ethiopia, 2012. [* = p < 0.05, ** = p < 0.001, COR = Crude Odds Ratio, £ = daily labourer, , students, etc. 2 = market, food aid, etc.
This study has the following strengths: One is that the application of conditional fixed-effects logistic regression model for panel data analysis has helped in controlling for both time variant and time invariant variables of the study. In this case, the study participants often serve as their own controls. The effects of time invariant variables are controlled for whether they are measured or not. Fixed-effects models are thus less vulnerable to omitted variable bias even when we fail to measure certain variables because they estimate only within-individual variations while discarding any information about differences between individuals unlike random - effects models [40]. The other is that the study was conducted in one of the Demographic Surveillance Site (DSS) in the country where random selection of study participants into the study was possible due to the existing sampling frame of the DSS. This could reduce the effect of selection bias and control for environmental factors such as climatic variation which might have a direct and indirect relationship with household’s food insecurity. Moreover, standardized household food insecurity access scale questions which have been developed by Food and Nutrition Technical Assistance Project (FANTA) were used to measure food security status [36].

Finally, this study could have the following limitations: Firstly, retrospective collection of the information on food security status might have resulted in recall bias. Secondly, it is likely to introduce an interviewer bias while administering HFIAS questions if the questions are managed as leading questions for the respondents which could end up in misclassification of household food security status. Thirdly, the social desirability bias might be the case as the concerns of being food insecure could have some societal implications in the population. Some respondents might deny the presence of food insecurity while responding to the study tools which could have led to under reporting of food insecurity. However, due attention was given to the training of data collectors, data collection procedures, and field work supervision which could minimize any biases of interest.

Conclusion

In this study, household food insecurity was more common in the wet season. Basic household factors such as paternal occupation and household’s socio-economic positions were identified as important predictors of seasonal variation in the prevalence of household food insecurity in this study area. Season - oriented food security interventions such as food subsidy and transfer system, income generating schemes like micro –credit and food for work programs should be designed to enable poor rural households to have access to adequate food and achieve desired. Millennium Development Goals in low – income countries including Ethiopia.

Competing Interests

The authors declare that they have no competing interests.

Authors’ Contributions

GE participated in the design of the study, performed the data collection, performed the statistical analysis and served as the lead author of the manuscript. YB participated in the design of the study and contributed to finalization of the manuscript. AW participated in the design of the study, statistical analysis and in finalizing the manuscript. All authors read and approved the final manuscript.

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