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Food insecurity of rural households in Boset district of Ethiopia: a suite of indicators analysis

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Abstract

Background: Despite several efforts made so far to improve the overall food insecurity situation, the challenge is still a major problem in Ethiopia since a long time ago. Hence, the purpose of this study is to examine the food insecurity situation and identify the determinants among the rural households of Boset district. To this end, 397 household heads were selected through systematic sampling technique from six sample *kebeles*. In addition, focus group discussions, key informant interviews, and personal observations were also used to supplement the survey data. Then, the food insecurity status of households was measured with a suite of indicators.

Results: The results revealed that 26.5%, 21.7%, and 41.3% of respondents were highly food insecure through Months of Adequate Household Food Provisioning, Household Food Insecurity Access Scale, and Household Dietary Diversity Score, respectively. On top of these, 56.9%, 46.1%, and 64.0% of the respondents did not have access to water supply, not owned latrine, and dispose waste in an unsafe way, respectively. Furthermore, results from the inferential statistics showed that educational status, farmland size, total annual income, distance from health facilities, and the availability of supporting organizations were positively associated with household food security situation, while access to irrigable land, frequent drought, distance to input/output markets, and distance to road transport were negatively associated.

Conclusion: From the study findings it can be observed that all the dimensions of food (*in*)security should be focused for effective intervention. More specifically, those determinants with both positive and negative associations with food security may deserve the attention of the local authorities. Similarly, there is a need for a reorientation of an approach which is beyond a quick and simple fix. Besides, an integration of efforts between different sectors at both local and national levels is sought to bring a lasting solution to food insecurity.

Keywords: Food insecurity, Determinants, Suite of indicators, Boset, Rural Ethiopia

Background

The issue of where our next meal comes from has bedeviled humankind for much of our existence [1]; thus, food insecurity is a daily reality for hundreds of millions of people around the world [2]. In our today's time, one can observe our world's population living in a situation where there are serious strains. To this end, it was illustrated that "a threefold challenge now faces the world: match the rapidly changing demand for food from a larger and more affluent population to its supply; do so in ways that are environmentally and socially sustainable; and ensure that the world's poorest people are no longer hungry" [3]. Furthermore, it was predicted that "it seems incontrovertible that we are facing a global paradox, such that by 2030, we will have to produce more food with less water to feed approximately another billion people" [4].

A closer look at the Ethiopian context depicts that the food insecurity problem is an issue which deserves special attention to be tackled. Different scholars have depicted that food insecurity has been a daunting

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challenge to Ethiopia [5–8]. In recent years, commercial food import and food aid have been accounting for a *significant* proportion of the total food supply in the country [8]. Due to such high dependence on food import, Ethiopia was identified as vulnerable to uncertainties of food import from the international market [9]. Moreover, it was confirmed that, despite the attempts made to improve the food security situation, the *actual* number of people exposed to food shortages in Ethiopia has remained significantly high [10].

Oromia Bureau of Agriculture [11] indicated that the food insecurity situation in Boset district was so precarious. The bureau revealed that due to the fact that Boset district is prone to frequent drought, it was included in the Productive Safety Net Program (PSNP). A district could be included in the PSNP when confirmed by experts that there prevails chronic food insecurity situation. In 2014/2015 there were 58,131 households who were beneficiaries from the PSNP.

Based on the fact that food insecurity is a real challenge for the life and livelihood of Ethiopia, and the study area in particular, it can be justified for a further study so that a solution could be sought. It was mentioned that food security matters immensely, because the consequences of food insecurity can affect almost every facet of society [12]. In addition, a document produced by International Food Policy Research Institute (IFPRI) [13] has stressed that food insecurity situation is a human tragedy on a vast scale, made even more heartbreaking because it is avoidable. Schanbacher [14], on the other hand, mentioned that if food sovereignty's demands are not met, it constitutes a massive violation of human rights. It was also maintained that, in geopolitical terms, deeper food crisis will undoubtedly engender more collective insecurity [15]. Relatedly, taking statements of former US President Obama at the 2012 G8 Summit, it was indicated that food security is "an economic imperative" since a poorly nourished population is a less economically productive one [12].

Given the above-discussed rationale, the concept of food (*in*)security needs to be operationalized so that a common understanding could be reached. This is because food (*in*)security is a dynamic phrase having so many definitions emerging overtime [16–19]. A review of different literature showed that food (*in*)security has evolved from a focus on availability of food, to access and utilization, and to stability in all dimensions [20]. Notwithstanding all the contentions and varying definitions of food (*in*)security over time, now scholars seem to agree on the comprehensive definition given on the World Food Summit of 1996. We have adopted the following definition in this paper:

Food security exists when all people at all times have physical or economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [21].

From this definition one can identify four key dimensions of food security: availability of sufficient food; economic, physical, and social access to the resources needed to acquire food; stability of this availability and access; and utilization that includes nutrition, food safety and quality, clean water, and sanitation [22–25]. Consequently, it can be deducted food insecurity could result if one or more of the key dimensions fail to be fulfilled [12, 26].

So far there have been so many research works conducted in different parts of Ethiopia on food insecurity. However, many of the research works conducted [27–30] used a single indicator (mainly food balance model or calorie availability) to measure the food insecurity situation which could capture only a portion of the whole situation. Such an approach, however, could underestimate the prevalence of food insecurity and its consequences; make the diagnostics difficult; and lead to the design of "one-size-fits-all" interventions [31]. That is why our paper deviates from that traditional way of studying food insecurity by employing multiple indicators so that the situation could be understood comprehensively. In fact, the use of a suite of indicators is a call of the time which is advocated by authoritative organizations such as FAO, IFAD, and WFP and leading scholars such as Carletto et al. [23], Coates [31], to mention few.

Therefore, it is based on the existing high prevalence, recurrence of food insecurity, and the need to study food insecurity in a comprehensive way that this paper was conceived. The paper aims to analyze the food insecurity situation of the rural households in Boset district, which has been a hot spot for food assistance for a long period of time. Besides, identification of determinants of the food insecurity in the study area is the other aim of the study. Thereby, this study could build on similar findings on the topic and would enable to understand food insecurity in its multidimensionality.

Theoretical framework

There have been so many theories proposed to explain about food insecurity. In fact, the explanatory powers of those theories depend on the time and existing situation of a particular place. Moreover, having recognized the existence of multiple theories of food insecurity, it was contended that among the different theories of famine (*food insecurity in this case*) no single theory is dominant or capable of excluding the others [32]. Cognizant of this

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fact, we used three of the existing theories to explain the food insecurity situation of the study area.

The first theory considered is the political economy explanation which describes that "the lack of political conditions for an anti-famine contract revolve around anti-democratic tendencies that abrogate any existing democratic rights, thereby hindering timely and effective action to prevent famine, and can therefore be said to involve a famine crime" [32]. This approach attributes famine (*food insecurity*) occurrence, whatever the economic or natural shocks, to governments' incompetence and lack of commitment at best, or to a deliberate action or inaction at worst [33]. Similarly, Devereux [34] argues that "all famines are explained by a combination of 'technical' and 'political' factors, where political factors include bad government policies, failure of the international community to provide relief, and war." Thus, the political economy explanation suggests that whenever incumbent government authorities and even donors are not delivering what they ought to, food insecurity or famine (in the extreme case) could happen.

Second, the climatic and environmental theory deals with the fact that food insecurity happened with the possible increase of extreme events, in which natural hazards are magnified in intensity and frequency [32]. It was also illustrated that "a combination of arable land lost to population pressure, deforestation and overgrazing, together with the possibility of a long-term decline in rain-fall in dryland farming areas in Africa and Asia, will cause declines in crop production and exacerbate food insecurity" [34]. In a similar vein, it was stated that this approach considers drought (sometimes floods) and recently climate change factors in the explanation of disruption or reduction of food output, which may at the end result in food insecurity [33].

The third theory is concerned with food insecurity as an outcome of vulnerable livelihood. Accordingly, this theory gives explanation in the sense that food insecurity could result when households fail to secure access to the various forms of assets, or when the mediating processes (i.e., institutions, organizations, and social relations at work) are not serving what is expected and/or a combination of these factors when interacting with the existing context (history, trends, and vulnerability/shock) [5].

Methods

Description of the study area

Boset district extends between 8°24′–8°51′ north latitude and 39°16′–39°50′ east longitude. It is located in the northeast part of East Shewa Zone, Oromia National Regional State. It is bordered with Adama district in the west; by Amhara National Regional State in the north; by Fantale district in northeast; and by Arsi Zone in

southeast. Data obtained from the population projection by Central Statistical Agency (CSA) [35] indicated that the total population of Boset district for the year 2017 was projected to be 189,795 out of which 42,793 (22.5%) are urban population and 147,002 (77.5%) are rural population.

Based on a report obtained from the district's Finance and Economic Development Office [36], Boset district is located in the midst of the Rift Valley, which extends from the north to south. The same document revealed that climatically most parts of the district (about 89%) belong to tropical (*kolla*) agro-climatic zone and the remaining small section (about 11%) is subtropical (*woina dega*) [36]. Similarly, the document [36] showed that the district is characterized by hot and dry weather with an average annual temperature which varies between 25–30 °C for the tropical (*kolla*) and 15–20 °C for the subtropical (*woina dega*). The rainfall is weakly bimodal with spring (a small rainy season) during the months of April and May, while summer (a long rainy season) during the months of July–September. The average annual rainfall ranges between 700 and 800 mm with the intensity and variability being high in the district. In terms of drainage system the district falls in the Awash River Basin, with no other major streams and lakes.

Research design and data collection

This study was conducted in Boset district, East Shewa Zone of Oromia National Regional State. It was undertaken as a cross-sectional survey using mixed methods research approach. The choice of mixed methods was dictated by the research problem under investigation and to benefit from the merits of using this research approach [37–40].

In terms of sources of data, both primary and secondary sources were utilized. The primary data were generated by employing household survey which was administered by 12 Development Agents (DAs[1]) who are familiar to the study area and conversant with the local language (Afan Oromo). After pretesting and fully developing the structured questionnaire, it was administered face-to-face. Key informant interviews (KIIs) were also held with heads of offices and focal persons from health, women's and children's affairs, water resources, irrigation, crop production, livestock production, natural resources management, disaster preparedness and prevention, World Vision Ethiopia (Boset Area Development Program), and community elders living in the sample *kebeles*.[2]

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[1] Development Agents (DAs) are individuals trained in agriculture colleges for 2 years in areas of crop production, animal health, and natural resources management to promote the agricultural extension program.

[2] A *kebele* is the lowest community-level administrative organ consisting of a number of villages.

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Similarly, focus group discussions (FGDs) with selected 6 men's and 4 women's groups were conducted separately with members comprising 6–10 individuals. The groups were formed on volunteer basis with the help of the DAs working in the respective sample *kebeles.* The criteria for inclusion in the group discussion were household heads lived in the *kebele* for more than 5 years and some knowledge on food insecurity issues. Lastly, personal observations coupled with informal discussions were also employed to generate primary qualitative data. In addition, we have utilized current and relevant journal articles which were mainly published within the last 10 years as sources of secondary information.

To have a full picture of the district, a total of 6 *kebeles* located at different places were selected purposely by the district-level experts after thorough discussion on the topic of the research. Besides, food insecurity status, access to irrigation facilities, and participation in the Productive Safety Net Program (PSNP) were also used as criteria for selecting the *kebeles.*

List of households living in each of the selected *kebeles* was taken as a sampling frame, and then respondents selected using systematic random sampling technique proportionate to the size of households living in each *kebele.* The systematic random sampling technique was employed because it is one of the probability sampling methods and is easy to manipulate during selection of the sample households [41, 42]. Using the formula illustrated by Israel [43], the sample size was calculated, which resulted in a total of 397 participants (48 female- and 349 male-headed households). In the determination of the sample size, a 95% confidence level and a *p* value of 0.05 for maximum variability were assumed.

Mathematically, the formula is presented as:

$$n = \frac{N}{1 + N(e)^2},$$

where *n* stands for the sample size, *N* signifies the total number of households in all the *kebeles*, *e* designates maximum variability which is 5% (0.05), and 1 stands for the probability of the event occurring.

Data analysis
Food insecurity analysis
Based on the nature of the variables measured, to analyze the data collected both descriptive and inferential statistics were employed. Accordingly, to measure the food insecurity status through different indicators, sources of food for households, and mechanisms of filling food gaps we have mainly used percentages, mean, and standard deviation. The final analysis of the quantitative data was performed using STATA, version 12, data management

software after the coded responses to the questionnaires were entered into computer. In addition, results of the FGDs, KIIs, and the field observations were transcribed and analyzed according to themes emerged.

Different authors and organizations have suggested the necessity to comprehensively analyze the four dimensions of food (*in*)security [23, 44] and to use a suite of indicators to capture the complex realities of food insecurity [e.g., 23, 31, 45]. This is because each measure captures and neglects different phenomena intrinsic to the concept of food security, thereby subtly influencing prioritization among food security interventions [46].

Following those suggestions, the indicators we employed include: the identification of Months of Adequate Household Food Provisioning (MAHFP); Household Food Insecurity Access Scale (HFIAS); Household Dietary Diversity Score (HDDS); and assessing the access and use of water supply, sanitation, and hygiene (WASH) facilities.

According to Bilinsky and Swindale [47], when using the MAHFP, although the response options start with the month of January, the respondent is asked to think back over the previous 12 months, starting with the current month. This is done by adjusting the months according to when one conducts the survey so that the current month appears first. Hence, respondents could be asked to identify in which months (during the past 12 months) they did not have access to sufficient food to meet their household needs. The purpose of these questions is to identify the months in which there is limited access to food regardless of the source of the food (i.e., production, purchase, barter or food aid) [47].

Based on information obtained from Namana and Souli [48] and making some modifications households were classified into three categories of food insecurity: least food insecure which includes households that reported being able to satisfy their food requirement for 10–12 months; moderately food insecure which includes households that were able to satisfy their food needs for 7–9 months of the year; and most food insecure which includes households that cannot feed their household members for 6 and more months during the previous year.

The other indicator to food insecurity measurements based on subjective responses is HFIAS [23]. The HFIAS is based on the idea that there is a set of predictable reactions to the experience of food insecurity that can be summarized and quantified, allowing for measurement through household surveys [23, 49].

It was indicted that the HFIAS has a set of nine questions which represent universal aspects of the experience of food insecurity, capturing information on food shortage, food quantity and quality of diet to determine the

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status of a given household's access to food [23]. In addition, households and populations can be classified according to the severity of their food security status along a spectrum, by using data on the severity and frequency of their experiences over the previous 30 days [23].

Based on the description given by Coates et al. [49], the maximum score for a household is 27 (the household response to all nine frequency-of-occurrence questions was "often," coded with response code of 3) and the minimum score is 0. (The household responded "no" to all occurrence questions, frequency-of-occurrence questions were skipped by the interviewer and subsequently coded as 0 by the data analyst.) The higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experienced.

The HDDS, on the other hand, is calculated by summing the number of unique food groups consumed during the last 24 h [23]. The value of this variable will range from 0 to 12, in which lowest HDDS value signifies higher food insecurity status and vice versa. Even though there is no international consensus on which food groups to include in the scores [50], the HDDS denotes 12 food groups in which the following are considered in this study: cereals; root and tubers; vegetables with tubers; vegetables which are leafy; fruits; meat, poultry, offal; eggs; fish; pulses/legumes/nuts; milk and milk products; oil/fats; and sugar/honey.

Based on the findings from a review of different empirical studies made by Ruel [51] and Faber et al. [52] the cutoff point for the HDDS in this study is made that $HDDS \leq 5$ represents low dietary diversity, HDDS 6–7 medium dietary diversity, and $HDDS \geq 8$ high dietary diversity. This categorization could signify most food insecure, medium food insecure, and food secure, respectively.

To obtain a complete picture of the factors that ultimately determine the food insecurity status of a given household, non-food factors were also considered. This is because the various non-food factors contribute to determining the level of the food insecurity outcomes [23]. Accordingly, access to basic services such as clean water and sanitation together with their use was considered in this study.

Hence, based on review of the empirical studies, the MAHFP is used to assess the availability dimension, HFIAS to examine the access dimension, HDDS to measure the quality [23, 51], and WASH to assess the utilization dimension. The stability dimension, on the other hand, could be captured by looking into the results of the other three components, as it cuts across all these dimensions [23, 45].

Specification of the logit model

To identify the determinants of household food (*in*) security a binary logistic regression model was used.

Following the work of Tewodros and Fikadu [29] the functional form of the logistic model is presented as follows:

$$P_i = E\left(Y = {1}/{X_i}\right) = \frac{1}{1 + e^{-(\beta_o + \beta_j X_i)}}. \tag{1}$$

Substituting $(\beta_o + \beta_j X_i)$ by Z_i, the equation would become:

$$P_i = \frac{1}{1 + e^{-Z_i}} = \frac{e^{Z_i}}{1 + e^{Z_i}}, \tag{2}$$

where $P_i = E(Y = 1)$ is the probability that a household is food secure. z_i is a set of explanatory variables of the ith household. β_o and β_j are the parameters to be estimated.

If P_i is the probability that a household is food secure, as is given in Eq. 2, the probability of food insecurity is then expressed as:

$$1 - P_i = \frac{1}{1 + e^{z_i}}. \tag{3}$$

From this, the odds ratio in favor of food security thus could be:

$$\text{The Odds ratio } = \frac{P_i}{1 - P_i} = \frac{e^{Z_i}/1 + e^{Z_i}}{1/1 + e^{Z_i}} = e^{Z_i}. \tag{4}$$

Since logit model uses logarithmic transformation to assume linearity of the outcome variables on the explanatory variables, the specific logit model to predict the odds of household food security is given in Eq. 5.

$$\ln\left[\frac{P_i}{1 - P_i}\right] = Z_i = \beta_0 + \beta_j X_i, \tag{5}$$

where β_0 is the constant and β_i, where $i = 1, 2, \ldots j$, are the coefficients of the exogenous variables to be estimated. X_i is a vector of explanatory variables.

Description of the variables employed The dependent variable in this model is the result obtained from the HDDS value as measured by counting the food groups that households have consumed during the last 24 h of the study period. Households with $HDDS \geq 8$ are food secure and represented by 1, and those with $HDDS < 8$ are food insecure and represented by 0. The independent variables constitute gender, age, educational status, household size, participation in non-farm activities, farmland size, access to irrigable land, total annual income, noticed frequent drought and flood occurrence, access to weather forecast,

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Table 1 Variables hypothesized to affect food security in the study area

Explanatory variables	Description	Expected sign
Gender	Dummy takes the value of 1 if male and zero otherwise	+
Age	Continuous	+/−
Educational status	Dummy takes the value of 1 if formal education and zero otherwise	+
Household size	Continuous	+/−
Participation in non-farm activities	Dummy takes the value 1 if there is access and zero otherwise	+
Farmland size	Continuous	+
Access to irrigable land	Dummy takes the value 1 if there is access and zero otherwise	+
Total annual income	Continuous	+
Noticed frequent drought	Dummy takes the value 1 if they have noticed and zero otherwise	−
Noticed frequent flood occurrence	Dummy takes the value 1 if they have noticed and zero otherwise	−
Access to weather forecast	Dummy takes the value 1 if there is access and zero otherwise	+
Availability of *kebele* assistance	Dummy takes the value 1 if there is access and zero otherwise	+
Access to DA services	Dummy takes the value 1 if there is access and zero otherwise	+
Access to health extension services	Dummy takes the value 1 if there is access and zero otherwise	+
Access to credit services	Dummy takes the value 1 if there is access and zero otherwise	+
Distance from input/output markets	Continuous	−
Distance to road transport	Continuous	−
Distance to health services	Continuous	−
Availability of other (NGO) support organizations	Dummy takes the value 1 if there is access and zero otherwise	+

Table 2 Number of months respondents consume their own produce by *kebele*

Name of *kebele*	Number of months						Total	
	3–6 months		7–9 months		10–12 months			
	n	%	*n*	%	*n*	%	*n*	%
Buta Wagare	3	14.3	11	52.4	7	33.3	21	100.0
D/Wanga	9	30.0	13	43.3	8	26.7	30	100.0
Q/H/Mirqasa	50	31.3	100	62.5	10	6.2	160	100.0
Sara Areda	5	9.6	47	90.4	0	0.0	52	100.0
Sifa Batte	30	27.8	75	69.4	3	2.8	108	100.0
Tiri Birreti	8	30.8	13	50.0	5	19.2	26	100.0
Total	105	26.5	259	65.2	33	8.3	397	100.0

Pearson χ^2 (10) = 58.5444, Pr = 0.000

availability of *kebele* assistance, access to DA services, access to health extension services, access to credit services, distance from input/output markets, distance to road transport, distance to health services, and availability of other (NGO) support organizations. The variables hypothesized to affect the food security are presented in Table 1 together with their expected sign.

Results and discussion

Food insecurity as measured by MAHFP

The availability dimension of the food insecurity of the respondents as measured by the MAHFP indicates that only 8.3% of them were least food insecure, 65.2% moderately food insecure, and 26.5% most food insecure (see Table 2).

Results from Table 2 show across all the *kebeles* majority of respondents fall in the category of 7–9 months (moderately food insecure). The statistical test conducted also shows there is statistically significant difference ($p < 0.001$) in terms of the number of months respondents encounter food insecurity across the sample *kebeles*. For example, there was no respondent from Sara Areda *kebele* who fall in the least food insecure category as compared to 33.3% of the respondents in Buta Wagare *kebele*. Here it can be learned that interventions aimed to

tackle food insecurity in the study area should consider the severity level of the problem.

In line with what was obtained in the survey, key informants and focus group discussants all indicated that food insecurity occurs on seasonal basis. In the words of the focus group discussants "always after Ethiopian Easter is celebrated" food insecurity occurs in most of the *kebeles* in the study area, which shows a cyclical pattern of inadequate availability and access to food. Focus group discussants in four of the sample *kebeles* (except Sifa Batte and Q/H/Mirqasa) expressed the months of June to September are those in which households experience the worst food shortage compared to other months. Related to the cyclical pattern of food insecurity, the finding may signify a need for mechanisms to be designed accordingly to avoid the depletion of resources while trying to compensate for the diminishing access to food.

As far as the consequences of the months of inadequate food provisioning is concerned, it was highlighted that seasonality and being food deficit from own production even in normal years can be implicated in making people less food secure [53]. It can also be deducted that the stability component of the respondents' food security could be highly compromised; this is because "stability in the availability of and access to food should be ensured regardless of sudden shocks like climatic crisis or cyclical events which involve seasonal food scarcity" [25].

To fill the gap that is created from consuming own production, opportunities of earning income from non-farm activities are so important. However, it is only 15.1% ($n=60$) of the respondents who reported to engage in different non-farm income-generating activities. Given such limited opportunity for generating income outside their farming, one can imagine what the food insecurity situation could look like, especially for those who are consuming their own produce for only 3–6 months.

Generally, households could have different sources of food for their consumption. And understanding the basic patterns of the sources and how they vary across locations, population groups, and over time will provide a particularly important starting point for understanding the general nature of the food security problem [54]. Accordingly, respondents have identified different sources of food as indicated in Table 3.

Results from Table 3 show all of the respondents obtained food from their own production. This is just because they were engaged in farming activities. Next is obtaining food by purchase (63.2%), through aid (40.3%), and through borrowing (21.9%). It can be learned that one source of getting food was not adequate to feed the whole family members throughout the year. Again, it can be seen that more than half of the respondents replied to have obtained food from

Table 3 Sources of food for the households (multiple responses)

Sources of getting food	Responses		Percent of cases
	n	Percent	
Get from their own production	397	44.4	100.0
Get from purchase	251	28.0	63.2
Get their food by borrowing	87	9.7	21.9
Get their food through aid	160	17.9	40.3
Total	895	100.0	225.4

purchase, and that issue of price fluctuation and market in general are important factors that merit special attention when dealing with food insecurity in the study area. This is because "given the heavy dependence of both the rural and urban poor on markets, inflation has potentially devastating effects on the food security of poor households" [55].

Furthermore, it was demonstrated that particularly for the poor, who spend more than 50% of their income on food consumption, changes in the prices of major staple crops can have a dramatic impact [56, 57]. Likewise, scholars have again explained that an increase in food prices could have both direct impacts and reductions in real incomes for poor consumers who spend a large share of their income on food that will inhibit their access to available food [12, 58].

On the other hand, it can also be seen that getting food through borrowing has the least contribution (Table 3). This is because, according to focus group discussants, the ever increasing poverty of the rural residents and the monetization of everything have eroded the value of supporting each other among the community members.

Since majority of respondents were not found to have consumed only from their own produce throughout the year, and the unavailability of income diversification opportunities could indicate the existence of food gaps. Hence, findings about the mechanisms of filling food gaps from Table 4 show the rural households used different mechanisms of filling food gaps.

The finding shows multiple mechanisms that households used to fill the food gaps they are confronted with. However, non-farm activities, remittance, and borrowing contribute relatively minimum. Besides, most of the mechanisms used by respondents appear to be unreliable.

Looking closely at the mechanisms of filling food gaps some of them need to be treated with special precautions as their end result may not be the one which was intended. For instance, during the study period, it was observed that so many households including those

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Table 4 Mechanisms of filling food gaps (multiple responses)

Food gap filling	Responses		Percent of cases
	n	**Percent**	
Fill food gap through aid	128	19.8	33.5
Fill food gap through borrowing	90	14.0	23.6
Engage in food-for-work	158	24.5	41.4
Engage in non-farm activities	60	9.3	15.7
Engage in casual labor	142	22.0	37.2
Fill food gap through remittance	67	10.4	17.5
Total	645	100.0	168.9

considered to be better came to the district agriculture office to complain about their exclusion from benefitting out of the PSNP. Even at times of informal discussions with residents in the district, people told that overcoming the food insecurity problem without the PSNP is unthinkable. Besides, staff members of the food security team in the district mentioned the difficulty in discriminating households who are going to graduate from the program, as there is no one who wants to graduate.

Related to what is physically observed and highlighted by the district staff members, one of the mechanisms that deserve careful handling is food aid. On this issue different scholars advised to handle food aid with caution. For example, it was reported food aid as one of the oldest forms of foreign aid and one of the most controversial [59]. Similarly, Barrett [60] mentioned "while there is effectively universal agreement as to the desirability of the goal of reducing acute and chronic food insecurity, there remains considerable dispute as to how effective food aid is in achieving the goal." It was emphasized the undesirable aspect, "negative dependency," which arises when meeting current needs comes at the cost of reducing recipients' capacity to meet their own basic needs in the future without external assistance [60]. Furthermore, the negative dependency typically arises when individuals, households, or communities alter their behavior in response to the provision of assistance that unwittingly creates disincentives to undertake desirable behavior (e.g., to grow a crop, or to allocate time to work) [60].

In line with the argument made in the preceding paragraph, it was explained that "food aid dependency undermines food security in Ethiopia at every level, from the household to the national government" [61]. This is because the government has little incentive to expend its scarce resources on food security programs as long as the international community remains willing to sink its food surpluses into Ethiopia [61]. Similarly, even very recently it was depicted that "despite the existence of the PSNP, there has not been a reduction in food aid to Ethiopia. In fact, the 2015 appeal issued by the Government of Ethiopia and humanitarian partners is one of the biggest ever at 1.4 bn USD" [62].

> Box 1. Reflection of a key informant from World Vision Ethiopia of Boset district. The key informant stated that engaging in daily labor (Merti and Africa Juice companies), charcoal making and firewood selling, petty trading, renting out land with cheap price, diversifying income sources through irrigation, and taking credit from private money lenders are the mechanisms through which the local people fill the food gap created.

As far as food gap filling mechanisms are concerned, it can be deducted that some of the mechanisms, such as food aid, charcoal and firewood selling, and renting out land could result in undesirable results that call for a critical review of the country's strategy. This is because community members (in the case of the study area) and even nations could fall addicted to such quick fixing but downgrading way of solving a problem.

Food insecurity as measured by HFIAS

Based on the nine generic questions (see Table 5) of the access-related conditions, the finding shows it is only 26.2% ($n = 104$) who never worried having not enough food, whereas the remaining 73.8% ($n = 293$) of surveyed households have experienced problems of both economic and physical access to food at varying levels of food insecurity.

Looking at the finding on the basis of the severity level, out of the total score of 2607, it can be observed that 30.8% of households encountered access problems "rarely," 41.9% "sometimes," and 27.3% "often" during the last 1 month of the study period.

Furthermore, the finding shows the mean score of HFIAS for the respondents is 12.9 with a standard deviation of 4.3, while the minimum and the maximum were 1 and 22, respectively. Based on the categorization made by FAO [63] on a study conducted in Mozambique to determine the cutoff point, a score of 0–11 was taken as "most food secure"; 12–16 medium food insecure; and a score above 17 most food insecure. Accordingly, it was found in the study that 39.8% ($n = 158$) were most food secure; 38.5% ($n = 153$) were medium food insecure; and 21.7% ($n = 86$) were most food insecure.

Of course, the HFIAS is better interpreted when used to assess Household Food Insecurity Access Prevalence (HFIAP) [10]. Accordingly, the HFIAP indicator categorizes households into four levels of household

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Table 5 Distribution of households by HFIAS condition

S/no.	HFIAS conditions	Severity status and number of households					
		Rarely		Sometimes		Often	
		n	%	n	%	n	%
1	Worried having not enough food	152	51.88	129	44.03	12	4.10
2	Not able to eat the food kinds he/she preferred	55	13.90	212	53.81	127	32.23
3	Able to eat only a limited variety of foods	6	1.52	167	42.39	221	56.09
4	Able to eat some foods that he/she did not want to eat	195	68.18	89	31.12	2	0.70
5	Able to eat a smaller meal than he/she felt needed	47	11.93	208	52.79	139	35.28
6	Able to eat fewer meals/day because there was not enough food	17	4.33	165	41.98	211	53.69
7	Absolutely no food to eat in the household	178	69.80	77	30.20	0	0.00
8	Slept at night hungry because there was not enough food	95	73.08	35	26.92	0	0.00
9	Went a whole day and night hungry b/c there was not enough food	58	85.29	10	14.79	0	0.00
	Total score	803	30.8	1092	41.9	712	27.3

Clues to the severity status

(1) Rarely (once or twice in the past 4 weeks)

(2) Sometimes (three to ten times in the past 4 weeks)

(3) Often (more than ten times in the past 4 weeks)

Table 6 Distribution of households by Household Food Insecurity Access Prevalence (HFIAP)

Question	Frequency		
	Rarely	Sometimes	Often
1a	152	129	12
2a	55	212	127
3a	6	167	221
4a	195	89	2
5a	47	208	139
6a	17	165	211
7a	178	77	0
8a	95	35	0
9a	58	10	0
Clue to the severity conditions:			
	Food secure /access/ = 9.4%		
	Mildly food insecure /access/ = 27.2%		
	Moderately food insecure /access/ = 33.8%		
	Severely food insecure /access/ = 29.6%		

food insecurity (access): food secure, and mild, moderately, and severely food insecure [49]. Thus, households are categorized as increasingly food insecure as they respond affirmatively to more severe conditions and/or experience those conditions more frequently. Results on the HFIAP are presented in Table 6.

Results from Table 6 show there were only few (9.4%) of the respondents who are food secure; i.e., such households experience none of the food insecure conditions, or just worry, but rarely. To the contrary, the result shows there are 3 times more respondents who were severely food insecure; i.e., households already cut back on meal size or the number of meals often, and/or experience some of the three most severe conditions.

Food insecurity as measured by HDDS

The results of the finding on the HDDS show respondents were found to have consumed an average of 6 food groups with a standard deviation of 1.53. Besides, the minimum HDDS value is 3 and the maximum HDDS value is 11. The detail of the HDDS value across the sample *kebeles* is presented in Table 7.

The statistical test made on the results of the overall HDDS shows there is a statistical significant difference across the sample *kebeles* about the HDDS at $p < 0.001$ with a degree of freedom which equals 40. Hence, based

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Table 7 HDDS for respondents across *kebeles*

HDDS	Names of *kebeles*													Total	
	Buta Wagare		D/Wanga		Q/H/Mirqasa		Sara Areda		Sifa Batte		Tiri Birreti				
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
3	0	0.0	1	3.3	15	9.4	0	0.0	3	2.8	0	0.0	19	4.8
4	0	0.0	3	10.0	33	20.6	2	3.8	11	10.2	7	27.0	56	14.1
5	5	23.8	6	20.0	55	34.4	8	15.4	10	9.3	5	19.2	89	22.4
6	6	28.6	5	16.7	41	25.6	11	21.2	26	24.1	7	27.0	96	24.2
7	6	28.6	5	16.7	14	8.8	14	26.9	37	34.2	4	15.4	80	20.1
8	2	9.5	3	10.0	1	0.6	12	23.1	17	15.7	1	3.8	36	9.1
9	2	9.5	6	20.0	0	0.0	5	9.6	4	3.7	1	3.8	18	4.5
10	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	1	3.8	2	0.5
11	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0	0	0.0	1	0.3
Total	21	100.0	30	100.0	160	100.0	52	100.0	108	100.0	26	100.0	397	100.0

Pearson χ^2 (40) = 150.0694, Pr = 0.000

Table 8 Whether respondents have access to safe drinking water by *kebele*

Name of *kebele*	Access to safe water				Total	
	No	%	Yes	%	n	%
Buta Wagare	18	85.7	3	14.3	21	100.0
D/Wanga	0	0.0	30	100.0	30	100.0
Q/H/Mirqasa	121	75.6	39	24.4	160	100.0
Sara Areda	42	80.8	10	19.2	52	100.0
Sifa Batte	43	39.8	65	60.2	108	100.0
Tiri Birreti	2	7.7	24	92.3	26	100.0
Total	226	56.9	171	43.1	397	100.0

Pearson χ^2 (5) = 120.2161, Pr = 0.000

on the categorization discussed earlier about 41.3% of the respondents were found to consume less dietary diversity, implying they are more food insecure due to lack of the means to acquire and consume a variety of foods. Those who have medium level of food insecurity account for 44.3%, and only 14.4% of the respondents have HDDS ≥ 8 that they were food secure and were able to acquire and consume a variety of foods. In fact, it should be noted that the HDDS value could be reduced if sugars and beverages are to be taken out, because they do not add to the nutritional quality of the diet [52].

The nexus between WASH and food insecurity

When explaining how much water supply and sanitation practices are crucial, it was stated that populations suffering from hunger are often the same as those that lack adequate water and sanitation [64]. On the other hand, it was argued that ensuring poor people's access to safe drinking water and adequate sanitation and encouraging personal, domestic, and community hygiene will improve

the quality of life of millions of individuals [65]. Moreover, safe drinking water, sanitation, and hygiene (WASH) contribute significantly to the increased capacity of individuals to absorb and use the nutrients in their food [66].

Access to clean water

Access to safe drinking water has a direct contribution to the improvement of the food insecurity problem in different ways. Water is a key driver of agricultural production [67], and accessing safe drinking water has the benefits to reduce exposure to a variety of diseases that obstruct the intake and utilization of food and minimizing expenses related to health [68]. In light of these facts respondents were asked about their access to safe drinking water, and the responses are presented in Table 8.

Results from Table 8 show among the sample *kebeles* respondents of *D/Wanga* (100.0%), *Tiri Birreti* (92.3%), and *Sifa Batte* (60.2%) claimed to have better access to safe drinking water. Their access can be justified (for the first two *kebeles)* due to their proximity to Wolanchity

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Table 9 Respondents' ownership of latrine by *kebele*

Name of *kebele*	Ownership of latrine				Total	
	No	%	Yes	%	*n*	%
Buta Wagare	4	19.1	17	80.9	21	100.0
D/Wanga	2	6.7	28	93.3	30	100.0
Q/H/Mirqasa	139	86.9	21	13.1	160	100.0
Sara Areda	11	21.2	41	78.8	52	100.0
Sifa Batte	23	21.3	85	78.7	108	100.0
Tiri Birreti	4	15.4	22	84.6	26	100.0
Total	183	46.1	214	53.9	397	100.0

Pearson χ^2 (5) = 181.6547, Pr = 0.000

town, and for the third *kebele* its proximity to Bofa (Gode Dhera) town. In the remaining sample *kebeles,* a significant number of the respondents were not lucky to have access to safe drinking water, thereby forcing to resort to other sources for drinking and other domestic purposes.

Findings of the six sample *kebeles* show that about 56.9% of the respondents did not have access to safe drinking water. During the FGDs participants informed that even those who have access did not feel the supply is reliable because the facilities were broken down frequently which forced them either to return back to the unsafe sources, or to spend lots of money to buy water for domestic purposes. When discussing how difficult it was getting safe drinking water, the discussants at *B/ Wagare kebele* pointed out that one jerry can that holds 20 L will cost them 10 birr after travelling 2 h on foot. Coupled with the high price, the queue might be so long that sometimes it was in the second day that they could collect the water. A key informant interview made with head of the district's water resources office also showed water shortage was really a serious problem due to deepening of the water table and frequent breakdown of the existing facilities.

As to the implication, it can be said that apart from the direct burden on households' health due to lack of safe drinking water, it has got so many negative implications. For instance, it was mentioned that water availability will be one of the limiting constraints for crop production and food security [69]. In a similar vein, scholars have indicated that farmers' inability to access or control water has an obvious direct impact on potential yields and income, and an indirect impact by reducing potential payoffs from investments in fertilizers, improved seed varieties, and learning technical skills [70].

In a more broader way, it was illustrated that "the lack of adequate water is linked to poverty—households facing water shortages are more likely to be poor or fall into poverty than households not facing such shortages" [71].

Thus, this could imply that households who lack access to water and those who are poor will be more vulnerable to food insecurity. And what is more frustrating is that "… water scarcity will become, more or less, a major threat to food security due to increasing food demand and competition for water resources among sectors" [4].

Among those households who did not get access to safe drinking water an attempt was made to distinguish their sources of drinking water. Accordingly, it was obtained that river/stream (95.6%) is their chief source of water. In fact, these unsafe sources could have detrimental consequences particularly on the health of individuals and on their food security situation in general. Among the negative effects, it was said lack of access to safe water could result in poor health and affect the physical well-being [68].

As far as the burden of collecting water for different purposes is concerned, FGDs held with both women's and men's groups admitted that collecting water was primarily the responsibility of women, followed by grown-up children. This could imply that whenever women are forced to spend more time to haul water, it will reduce their productivity [68] that could end in keeping women in a poverty trap.

Ownership and use of latrines

Among the WASH components one of them that were treated in this study is ownership and use of latrines. The findings from Table 9 show an interesting result that, except in Q/H/Mirqasa *kebele*, in all the remaining *kebeles* latrine was owned by the large majority of the respective households.

Despite the ownership of latrines by majority of respondents, however, there was a problem when it comes to the use. FGDs in all the sample *kebeles* revealed that shortage of water to clean the latrine was bringing bad smell and, as a result, compelled members of households to defecate in unsafe places. A key informant

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Table 10 Respondents' mechanisms of waste disposal

Name of *kebele*	Areas of waste disposal						Total	
	Open field		In the garden		In a waste disposal pit			
	n	%	*n*	%	*n*	%	*n*	%
B/Wagare	5	23.8	3	14.3	13	61.9	21	100.0
D/Wanga	5	16.7	6	20.0	19	63.3	30	100.0
Q/H/Mirqasa	54	33.7	79	49.4	27	16.9	160	100.0
Sara Areda	13	25.0	23	44.2	16	30.8	52	100.0
Sifa Batte	38	35.2	19	17.6	51	47.2	108	100.0
Tiri Birreti	4	15.4	5	19.2	17	65.4	26	100.0
Total	119	30.0	135	34.0	143	36.0	397	100.0

Pearson χ^2 (10) = 69.9092, Pr = 0.000

interview held with the head of the district's health office also confirmed the weak usage of latrines due to shortage of water that could be used for cleaning. So the above percentage shows mainly the physical presence of latrines not necessarily their use.

On the other hand, respondents who did not own latrine were inquired to identify the area of defecation they use. Accordingly, about 70.0% ($n = 128$) expressed to have used bushes and/or forest areas, whereas the remaining 30.0% ($n = 55$) used open field for defecation. Because of such unsafe practice, the rural households could be denied of the benefits that one can obtain by having sanitation and hygiene facilities and good practices. Sanitation reduces or prevents human fecal pollution of the environment, thereby reducing or eliminating transmission of diseases from that source [65]. It was argued that high-tech solutions are not necessarily the best and some simple latrines can be very effective, while untreated sewage distributes pathogens in the environment and can be the source of disease [65].

Mechanisms of waste disposal

With recognition of the fact that proper waste disposal could help to avoid disease creating pathogens, respondents were asked to identify the mechanisms they use.

Findings from Table 10 show only 36.0% of the respondents dispose waste in a waste disposal pit. The remaining 64.0% of the respondents dispose waste in an unsafe way, either in an open field or in the garden. Such act of unsafe disposal of waste could play a role in transmission of diseases, which signifies the need to be cautious about the surrounding environment where people are residing. This is because "it is insufficient for an individual to receive an adequate quantity of food, if he or she is unable to make use of the food due to illnesses resulting from inadequate sanitation or poor sanitary practices" [23].

Determinants of food (*in*)security

As can be observed from Table 11, out of the 19 variables fitted in the binary logistic regression model, 9 significantly affected food insecurity status of the rural households in the study area (Table 11). The discussions made below are based on the findings from Table 11.

Educational status The educational status of the household heads was found to be important in determining their food security situation. With a significance level of less than 5% household heads with better educational status were more likely to be food secure with a 9.6% probability. In fact, the inverse relationship of educational status with food insecurity was also found in other empirical studies [27, 29].

Farmland size Having more cultivable land was strongly associated with 11.4% of being food secure at less than 1% significance level. This could mean that households with more cultivable land could produce more food, may purchase food for consumption from the income they get from their land, or even may diversify their crop to insure for crop failure. Hence, ways should be sought to lift off the pressure on farmland size.

Access to irrigable land A unit increase in access to irrigable land was associated with 9.3% probability of being food insecure with a 10% significance level. This could be due to the meddling of brokers who compel rural households to sell their products with lower prices to those who also cheat them on the scale when measuring the products. Besides, the products which were produced by the farmers require the use of modern inputs which were expensive and not easily available. Thus, the manipulation of the brokers and the cost of modern inputs keep them into a debt spiral that results in food insecurity and even poverty.

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Table 11 Parameter estimates of the binary logit model with their marginal effects

Explanatory variables	Coefficients	*p* value	Marginal effects
Gender	1.146024	0.119	0.074412
Age	− 0.0012422	0.955	− 0.0014243
Educational status	0.931175	0.032**	0.0962907
Household size	− 0.0142931	0.883	0.0016966
Participation in non-farm activities	0.005792	0.990	− 0.001335
Farmland size	0.9697931	0.000***	0.1142719
Access to irrigable land	− 0.7562149	0.099*	− 0.0926803
Total annual income	0.0000991	0.000***	0.0000112
Noticed frequent drought	− 0.9546311	0.057*	− 0.1109556
Noticed flood occurrence	− 0.2651678	0.535	− 0.0221719
Access to weather forecast	0.8280069	0.413	0.0247848
Availability of *kebele* assistance	0.0351892	0.942	− 0.0084927
Access to DA services	0.7159894	0.185	0.0503655
Access to health extension services	0.2784892	0.556	0.035605
Access to credit services	− 0.6171401	0.145	− 0.0778475
Distance from input/output markets	− 1.676472	0.006***	− 0.1401994
Distance to road transport	− 0.842344	0.066*	− 0.1036628
Distance from health services	1.812996	0.003***	0.1759557
Availability of other support organizations	0.9402377	0.048**	0.0597707
LR χ^2 (19)	103.46		
Prob $> \chi^2$	0.0000		
Pseudo-R^2	0.3167		

***,**,*Significant at 1%, 5%, and 10% probability levels, respectively

Total annual income   The finding on the total annual income shows the existence of statistically strong evidence ($p < 1\%$) that an increase in annual income will increase the probability of being food secure, but the corresponding percentage of increment is much lower than 1%. It could be learned that creating more income-generating opportunities could be helpful by improving their purchasing power, let farmers use modern inputs that improve their production and productivity, and even make them rent in more farmland that could help them diversify their production activities.

Noticed frequent drought   It was obtained from the finding that the more frequent the drought occurs, there is an 11.1% probability for households to become food insecure at 10% significance level. This is due to the fact that frequent drought could result in crop failure that impedes the availability of food and reduce income that households could have earned from their production.

Distance to input and output markets   Distance to input and outputs markets was found to have a strong negative influence on the food security situation of the households; i.e., a unit increase in distance from input and output markets increases the probability of being food

insecure with 14%. This finding is statistically significant at 1% level. It implies that market centers should be expanded so that distance could be shortened and people will easily get inputs which help them improve their production and productivity and also enable them sell their products to generate more income that will be used for consumption smoothing and diversify their income sources.

Distance to road transport   The finding again shows that for a unit increase in the distance from road transport, there is a 10.4% probability for the households to be less food secure with a statistical significance level of less than 10%. This could be because when distance to road transport increases people may not be encouraged to diversify and produce marketable products.

Distance to health facilities   The finding shows an unexpected result that an increase in distance from health facilities is associated with 17.6% probability of increase in being food security at p value of less than 1%.

Availability of other supporting organizations   It was found that the availability of supporting organizations could improve the food security status of households

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with a probability of 6%. This finding is statistically significant at less than 5% level. With a great care not to create dependence syndrome, introducing support by partner organizations could assist in smoothing consumption and even may enable households support themselves.

Conclusion

Food insecurity is more worrisome now than ever before due to the unprecedented variability of the climate and the poverty trap that rural people are in. This paper aimed to examine the food insecurity status and identify their determinants for the rural households in Boset district, East Shewa Zone. The results revealed that households which account 26.5%, 21.7%, and 41.3% are *highly* food insecure through MAHFP, HFIAS, and HDDS, respectively. In addition, the WASH results show 56.9%, 46.1%, and 64% of the households did not have access to safe drinking water, did not own latrine, and dispose waste in an unsafe way, respectively. As far as determinants of food security are concerned, it was found that educational status, farmland size, total annual income, distance to health services, and the availability of supporting organizations were positively associated with being food secure. To the contrary, access to irrigable land, occurrence of frequent drought, distance to input and output markets, and distance from road transport were negatively associated with being food secure.

It can be observed that frequent occurrence of drought is found to have statistical significance in making households food insecure. This finding is in line with what the climatic and environmental theories propose in explaining food insecurity. On the other hand, distance from inputs and outputs markets, and from road transport could show the governments' incompetence and lack of commitment in curbing food insecurity as was argued in the political economy explanation. Lastly, the inability to diversify households' income and the frequent drought occurrence could imply the applicability of the theory that contends food insecurity as an outcome of vulnerable livelihood. Our study suggests that due to the seasonal nature of food insecurity, future research may need to be conducted based on longitudinal data so that consistency of findings could be confirmed and interventions could be made efficient. Besides, decision makers in the area should insist in the future about the use of multiple indicators to clearly understand the nature of the prevailing food insecurity and respond accordingly.

Abbreviations
CSA: Central Statistical Agency; DAs: Development Agents; FAO: Food and Agriculture Organization of the United Nations; FGDs: focus group discussions; HDDS: Household Dietary Diversity Score; HFIAS: Household Food Insecurity Access Scale; HFIAP: Household Food Insecurity Access Prevalence; IFPRI: International Food Policy Research Institute; KIIs: key informant interviews; MAHFP: Months of Adequate Household Food Provisioning; MoARD: Ministry of Agriculture and Rural Development; NGOs: non-governmental organizations; PSNP: Productive Safety Net Program; WASH: water supply, sanitation, and hygiene.

Authors' contributions
GTM designed the study, collected the data, performed the analysis, and developed the manuscript. DT and NS contributed to the research design and analysis, reviewed and made editorial comments on the draft manuscript. All authors read and approved the final manuscript.

Competing interests
The authors declare they have no competing interests.

Availability of data and materials
The authors want to declare that they can submit the data at whatever time based on your request. The datasets used and/or analyzed during the current study will be available from the corresponding author on reasonable request.

Consent for publication
Not applicable.

Ethical approval and consent to participate
Ethical approval was not applicable, but consent to participate was granted by each respondent before engaging in the research.

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