Effect of climate variability, crop production, and household food insecurity on malnutrition among women: A mediation analysis from a drought-prone area in Southern Ethiopia

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Abstract

Malnutrition is viewed as one of climate change's five most considerable adverse health impacts. As many previous studies have shown correlations between climate, food production, and social factors on the nutritional status of women, we hypothesized a causal effect of climate variations on crop production, household food security, and our outcome, the nutritional status of adult women. Using a cohort design, we ensured a temporal relationship between the main exposures preceding the mediator and the outcome. Women living in 904 households from nine randomly selected subsistence farming in rural *Kebeles*, the lowest administrative unit in the Boricha district, were visited quarterly to collect nutritional status (outcome variable), household food security status (HHFS), and sociodemographic information. Climate data was obtained from the Google Earth Engine. Generalized structural equation modeling (GSEM) was used to measure the association between rainfall, the normalized difference vegetation index (NDVI), a proxy measure for crop production, and women's nutritional status (BMI) after adjusting for the mediation effect of HHFS. The analysis adjusted the clustering effect of *Kebele* and household. The study showed that the NDVI and HHFS directly affected women's body mass index. Furthermore, household heads who attended primary education, total energy expenditure of women, and household wealth were positively associated with women's BMI. On the other hand, older women and women who were not members of a community-based health insurance household had a lower BMI. Climate variability, crop production, and household food security could be causally linked to women's nutritional status, suggesting that rural people depending on rain-fed subsidence farming for crop production are vulnerable to the impact of climate variability.

Keywords Normalized difference vegetation index (NDVI), Women, BMI, Climate variability, Mediation analysis, household food security, famine

Introduction

Ethiopia has repeatedly been affected by episodes of drought and famine over the centuries [1, 2]. Even without drought, acute and chronic forms of malnutrition are prevalent. However, in recent decades, the prevalence of stunting has been reduced [3]. Malnutrition among women is also high. As women conduct much of the work in the household, malnutrition among these individuals affects their daily lives as their work capacity is reduced [4].

The causes of malnutrition among children and adults are complex, but the availability of rain is crucial as it is closely associated with food productivity in subsistence farming communities. Hence, some have labeled malnutrition as one of climate change's five most critical adverse impacts [5]. Poverty remains a leading cause of both malnutrition and famine. When severe malnutrition occurs during political and social unrest, it is often called a complex famine [6].

Climate variability "includes all the variations in the climate that last longer than individual weather events." In contrast, climate change refers to variations that persist for a more extended period, typically decades or more [7]. Our relatively short research views climate variability as stress multipliers to factors that indirectly or directly affect nutrition and health. In areas such as southern Ethiopia, the primary strategy of the population to meet the effects of global warming would be enhanced adaptation. The countries' carbon footprint is negligible but slowly increasing [8]. Adaptation refers to "changes in processes, practices, and structures to moderate potential damages or benefits from climate change." Our research aims to enhance our understanding of these processes and thus improve the livelihoods of people living in such areas.

Nonetheless, systematic evidence quantifying these impacts needs to be improved. Most of the earlier research on the relationships between nutrition indicators and food insecurity was correlational and based on cross-sectional studies [5]. Thus, there is limited evidence for a causal link between climate or weather patterns, food production and availability, and malnutrition. What need to be improved are interdisciplinary studies linking the possible chain of events from weather variability to food production and malnutrition, particularly for rural subsistence farmers. Long-term survey data, such as cohort studies and interventional research, can capture the dynamic nature of food poverty and show causal relationships [5]. We hypothesize that causal pathways link climate variability, food production, and malnutrition. Thus, by studying one smaller community over time, our study aimed to investigate associations between climate variability on crop production and malnutrition among women in subsisting farming and drought-prone communities in southern Ethiopia. Furthermore, we aimed to see how community interventions could influence the abovementioned association.

Methods

Climate in Ethiopia

The study area in Boricha in Sidama in Southern Ethiopia receives rain twice yearly, from March to May and June to September. Rain-fed agriculture owned by smallholder farmers dominates the primary land use. Reliance on rain-fed farming for subsistence and rainfall variability exposes people to high risks of harvest loss, quickly resulting in food insecurity.

Precipitation trends in Ethiopia indicate that southern Ethiopia's rainfall has decreased since 1971 [9]. From February to May, the main rain period in Boricha, precipitation declined by

2.6 mm/year in the spring region from 1971–2010. Thus, since 1971, rainfall may have been reduced by as much as 30 % [9]. On resource-poor farms in southern Ethiopia, the spring crop may determine whether the annual productivity reaches the critical margin [10].

Study setting

This study was conducted in a former Boricha *woreda* (recently split into Boricha, Darara, and Bilate woredas), located in the western part of the Sidama Region. The study *Kebeles* were selected from Boricha woreda before it was divided into three, and thus, the study *Kebeles* were categorized under two of the new woredas called Boricha and Bilate Zuria woredas. The area covers about 600 km^2 (Fig 1).

Figure 1: Map of the study area in the Sidama Region and Ethiopia

Boricha is a relatively flat area, with a decline in altitude from east to west. The altitude varies from 1320 m in the west to 2080 m in the east. In between, there are some scattered mountain ridges. As recently as a few generations ago, the acacia forest covered the area, but it has become increasingly bare. Very few rivers cross this area. The areas to the lower altitude are severely degraded. Another dominant land use land cover is the scattered trees. They are found to be mixed with farmland and those planted by the dwellers.

Generally, Boricha can be regarded as a water-starved area. Because of this, people in most *Kebeles* (the lowest administrative unit in Ethiopia and contains a health post staffed by two health extension workers) largely depend on artificial ponds that usually dry after the rains. Livestock are essential, and cattle, goats, and donkeys are the primary livestock. The principal crops are maize, haricot bean, coffee, and horticultural crops. The higher altitude areas are green, with eucalyptus, fruit, coffee trees, and an ensete *(Ensete ventricosum)* growing around every house. However, no natural forest exists, and communal grazing land is limited [11].

Study population

The details of the study population were presented elsewhere [12]. In 2021, the districts of Boricha and Bilate Zuria *Woredas* (the third level of the administrative divisions of Ethiopia – after zones and the regional states) were chosen as the study areas. The *woreda* is further subdivided into *Kebeles* (the lowest administrative unit. With a population estimated at 130,000, Boricha had one district hospital, three health facilities, and thirteen health posts. On the other hand, Bilate Zuria served an estimated 147,000 people with five health centers and 17 health posts [13].

Study design

This study is an open and dynamic cohort conducted from June 2021 to June 2022. We selected the same homes as in a previous cohort study [11] to ensure we acquired comprehensive nutrition and food intake data over more extended periods. We focused on women in rural communities because the households are both farmers and dependent on weather changes for their livelihoods.

Sampling and sample size

A multiphase sampling method was employed in the selection of research subjects. Nine of the 30 rural *Kebeles* in the districts were chosen randomly. The cluster sampling method was then used to select households. The study included all eligible females aged 15 to 49 who lived in the chosen households.

OpenEpi 3.03 (Open-Source Epidemiologic Statistics for Public Health; www.OpenEpi.com) was used to calculate the sample size. The sample size chosen for the study was based on the outcome of maternal body mass index (BMI). A sample size of 904 women was determined using assumptions from a previous cohort study: the percentage of mothers with a BMI less than 18.5 kg/m^2 during the pre-harvest season was 54.7%, and the rate during the post-harvest period was 41.7% [14]. A confidence level of 95% and a power of 80% were considered, with a ratio of unexposed to exposed individuals set at 1:1. Considering a design effect of 1.5 and assuming a 20% non-response rate, the final sample size was estimated to be 904 women.

Measurements

Quarterly visits were made to each household. Enumerators gathered information on all births, deaths, and migrations at each house they visited. We conducted a baseline census in June 2021 and then gathered quarterly data on household food insecurity, nutrition status, and sociodemographic characteristics. Weight in kilograms divided by height in square meters was used to create the outcome variable, body mass index (BMI). This study used data collected between June 2021 and June 2022.

Climate Data

There is only one meteorology station per district, but there is no station at the K*ebele* level. Moreover, the data collection at these weather stations was not regular; thus, the data needed to be completed for several months. Weather data for the *Kebeles* was not available. Therefore, the precipitation, temperature, and Normalized Difference Vegetation Index (NDVI) data were downloaded from Google Earth Engine (accessed via https://earthengine.google.com/signup after signing up). The temperature data was downloaded from ERA5-Land monthly averaged data using GRIB format via the following link: https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land-monthly-means?tab=form. The monthly rainfall was obtained using the Climate Hazards Group InfraRed Precipitation (CHIRPS) [15] with a spatial resolution of 0.05 degrees. This study uses each *Kebele's* average precipitation, temperature, and NDVI.

The remote sensing method, NDVI, tracks vegetation dynamics. It may be computed using canopy reflectance in the near-infrared and infrared bands and is less reliant on soil characteristics [16]. The NDVI measures how green and dense the vegetation is captured in a satellite image and is widely employed in crop health and production monitoring. It also serves as a surrogate for measuring the impact of rainfall variability on vegetation conditions. The NDVI has been used as a stand-in measure for crops in Ethiopia [17].

We used the United States Geological Survey (USGS) [18] data server to obtain a retrospective time series of the NDVI, utilizing three distinct datasets with a monthly temporal resolution. Calculated from satellite imagery, it captures visible and near-infrared light wavelengths reflected by vegetation; NDVI measures the difference between these wavelengths. Where: NIR represents the reflectance values of the near-infrared wavelengths, and RED represents the reflectance values of the red wavelengths. This computation generates a value ranging from -1 to +1, with higher values indicating denser, healthier vegetation (closer to +1) and lower values signifying less vegetation or areas with non-vegetative cover (approaching -1) [19]. The average NDVI was obtained from the satellite using Sentinel-2 MSI (Multispectral Instrument, Level-2A), sensor: SENTINEL-2, and with a spatial resolution of 10 meters [15]**.** JavaScript code calculated the monthly average NDVI for the nine study *Kebeles*.

Statistical methods

The data were collected using a cohort design to ensure that the main exposures preceded the mediator and the mediator preceded the outcome. Thus, the mediation enabled us to assess causality and reduce confounding [20]. The socio-demographic data were collected at the start of the study, and we assume that it remained constant over the study period. A Structural Equation Model (SEM) is a multivariate statistical method considered a causal model that includes the linear regression model and Path Analysis [21]. The Path Analysis model includes observed variables and allows a variable to be dependent and independent simultaneously. In addition, several dependent variables can be included, and the indirect and direct effects can be measured.

Data were entered and cleaned using SPSS Version 26 (IBM Corp, Armonk, NY), and STATA Version 17 (Stata Corp, Texas, USA) software was used to analyze the data. Descriptive statistics, such as numerical summary measures and diagrams, were used to summarize the data. The wealth index was constructed using principal component analysis using household assets such as possession of farmland, animals, a mobile phone, an animal cart, a motorcycle, etc., and housing, such as the type of roof, wall, and floor. Household food security level was measured using questionnaires validated in different populations in Southern Ethiopia [22, 23].

BMI, the outcome variable, was a continuous variable with a normal distribution, and therefore, a linear regression model was used to measure the predictors of BMI. The data were collected from three levels: *Kebele,* households, and individuals. Thus, BMI value could be dependent among women in the same *Kebele*. Still, differences between houses and *Kebeles* would invalidate the assumption of standard regression models. In addition, there could be a dependency among the repeated measurements made on the same women over the study period. Thus, we employed a multilevel multiple linear regression model to account for the dependency for mediation analysis. The ICC was computed to check for clustering and dependency, and we observed that the ICC was 0.08 for *Kebele* and 0.12 for households. Therefore, the effect of *Kebele* and household levels was accounted for in the final model. The model's goodness-of-fit was checked using Akaike's information criteria (AIC) and standardized root mean squared residual (SRMR) [24]. The AIC was small, 64328, in the final or complete model compared to a model without government intervention variables such as safety net and Community-Based Health Insurance (CBHI) (AIC = 84816). The standardized root mean squared residual (SRMR) was also in an acceptable range (0.034). A P-value <0.05 was considered statistically significant.

The path diagram was developed using the average change in women's BMI as the outcome variable, measured four times over one year, and exposure variables such as one month lag in NDVI from the measured household food insecurity (HHFI) and two months lag in total rainfall from NDVI. This allowed us to measure the natural sequence of events and correspond to the conceptual framework.

Mediation analysis is a statistical technique used to examine how one variable (the predictor variables) affects another (the outcome variable) through one or more intervening factors [25]. A mediation or path analysis was done to measure the relationship between rainfall, crop production using NDVI as a proxy crop measure, and women's nutritional status (BMI) after adjusting for the mediation effect of household food security. This study considered the HHFS a mediator variable in measuring the relationship between NDVI and BMI. This was checked, and the observed regression coefficient of the exposure variable (NDVI) in the first model (without a mediator) increased from 0.42 to 0.66 in the second model (with a mediator variable). The generalized structural equation modeling (GSEM) was used to measure the sequential mediation effect of household food security status on women's BMI after accounting for clustering at *kebele* (level 3) and household (level 2). The final model was selected using the following steps: first, the unadjusted path model was fitted with NDVI (exposure), household food security score (mediator), and BMI (outcome) variable. Then, the entire mediation analysis model was fitted after adjusting for potential confounding variables. We measured the effects of sociodemographic variables to assess the potential impact of factors that indirectly or directly affect the pathway from precipitation/rainfall to nutritional status/BMI. These include household use of the government's safety net program, use of health insurance, and wealth status, measured in June 2021, and we assumed it to be constant throughout the study period. A theoretical conceptual framework developed by Phalkey et al. (2015) was used in the path analysis (Fig 2) [5].

Figure 2 Conceptual framework adapted from the initially developed by Phalkey et al. [5]

Ethical consideration

The research was approved by the Institutional Review Board at Hawassa University College of Medicine and Health Sciences (Ref.No. IRB/181/13 and dated 20/05/2021) and revised in IRB/275/13. Permission to undertake our study was also obtained from the Sidama Region and relevant local authorities. Local leaders in the *Kebele*, village leaders, and community elders were informed about the study objectives, procedures, and benefits. Informed written consent was obtained from each participant. Participation by household members was voluntary, and measures were taken to ensure their respect, dignity, and freedom.

Results

Sociodemographic Characteristics

Overall, all women (1057) from 904 households living in nine *Kebeles* were followed and evaluated quarterly. The number of women assessed was 910 in September 2021, 903 in December 2021, 866 in March 2022, and 803 in June 2022. The number of women per *Kebeles* ranged from 99 women in Gonowa Bulano *Kebele* to 136 women in Sadamo Dikicha *Kebele.* About two-thirds (61.3 %) of the women were living in households whose heads had attended formal education; 15.8 % of the heads of the households were employed or traders; only 10.9% of households were members of community-based health insurance; 23.1 % of households were beneficiaries of the safety net program; and 33.7 % of the households were poor (Table 1).

Table 1: Sociodemographic and other characteristics of the study participants

Description	Frequency	Percent
Name of *Kebele*		
Sadamo Dikicha	136	12.9
Alawo Siiso	107	10.1
Furara Aldaada	128	12.1
Aldaada Deele	104	9.8
Kitawo Dambie	113	10.7
Gonowa Bulano	99	9.4
Sadamo cala	120	11.4
Qonsore Haranja	131	12.4
Hanja Goro	119	11.2
Household head education		
No formal education	648	61.3
Grade 1-6	184	17.4
Grade 7-9	130	12.3
Grade >=10	95	9
Occupation of HH head		
Employed and trader	167	15.8
Others	890	84.2
Community Based Health Insurance		
Yes	115	10.9
No	942	89.1
Safety-Net Beneficiary		
Yes	244	23.1
No	813	76.9
Wealth Status		
Poor	356	33.7
Middle	392	37.1
Rich	309	29.2

Household food insecurity and women's nutritional status

The lowest household food insecurity score (4.0) in December coincides with the highest women's mean BMI (20.6) for the same month. The mean (standard deviation, SD) BMI of the women was 20.2 (2.2) kg/m^2 in September 2021, 20.6 (2.2) kg/m^2 in December 2021, 20.57 (2.3) kg/m^2 in March 2022, and 20.3 (2.3) kg/m^2 in June 2022. A statistically significant difference in BMI was observed between September and December 2021 (t-test -4.4; P <0.001). On the other hand, the median (interquartile range) of household food insecurity was 10.0 (6.0-16.0) in September 2021, 4.0 (0.0-9.0) in December 2021, 8.0 (4.0-13.0) in March 2022, and 11.0 (7.0-16.0) in June 2022.

Monthly Rainfall, Temperature, and NDVI

As shown in Fig 3, the total monthly rainfall varied over the months. The monthly total rainfall peaked biannually between July and October 2021 and between mid-February and April 2022. Similarly, the average monthly NDVI was high between August and November 2021. There was a positive correlation between NDVI and one-month lag rainfall, with a correlation coefficient of 0.53 (P <0.001). The average monthly temperature was between 16 and 22 degrees Celsius (Fig 3).

Figure 3 Monthly NDVI, rainfall and temperature in the study area

Predictors of body mass index in multilevel multivariable model

In the multilevel multiple regression analysis, after controlling for potential confounders, the NDVI and household wealth index were positively associated with women's BMI. An increase in the household food security score (HHFS) score was positively associated with

BMI, but the age of the women was negatively associated with BMI. The change in BMI was higher among household heads who attended primary education compared. Moreover, a higher body mass index was observed among those not members of CBHI and non-beneficiaries of the safety net program (Table 2).

Table 2 Multilevel regression model to measure association between BMI, outcome variable, and different covariates

Variables	**β coefficient (95% CI)**	**P-value**
Age in years	-0.01 (-0.02 - -0.005)	0.008
NDVI[$]	0.72 (0.27 - 1.17)	<0.001
HHFS[#]	0.52 (0.37 – 0.68)	<0.001
Household safety net beneficiary		
Yes	1:00	
No	0.18 (0.01 - 0.36)	0.043
Total energy expenditure in a day	0.17 (0.06 – 0.27)	0.002
Community based health insurance member		
Yes	1:00	
No	0.43 (0.19 - 0.67)	<0.001
Household wealth status	0.18 (0.10 - 0.26)	<0.001
Household head education attended 1-6 grade		
No	1:00	
Yes	0.48 (0.27 - 0.68)	<0.001
Household head occupation		
Employed/trader	0.22 (0.01 - 0.44)	0.041
Others	1:00	-

$: Average Normalized Difference Vegetation Index (lag two months); #: Average household Food security score

Mediation analysis

We continued with the mediation analysis using the multilevel linear regression model results. As shown in Table 3 and Fig 4, on average, a unit increase in NDVI was associated with a direct effect of an increase in women's body mass index by about a coefficient of 0.67, 95% CI (0.23 to 1.11). The indirect impact of NDVI on BMI via household food insecurity was -0.21, 95% CI (-0.28 to -0.13). The proportion of total effect medicated was 43%. Similarly, an increase in household food security score (0.06 m/kg^2 (95% CI 0.04 to 0.07)), total energy expenditure (0.17, 95% CI (0.06 to 0.27)), and household wealth index (Coefficient 0.18, 95% CI 0.11 to 0.26) were positively associated with women's BMI. The BMI of the women was higher among household heads who had attended primary education. Furthermore, women's BMI was lower among CBHI. An increase in women's age was negatively associated with their BMI. No significant association was observed between the safety net beneficiary and the household head's occupation.

NB: Categorical variables coded as CBHI (0=no, 1=yes), Safety net (0=no, 1=yes) TEE: Total energy expenditure in kilo calories a day.

Figure 4: Path diagram showing the relationship between changes in women's BMI measured quarterly between June 2021 and June 2022) and lag in rainfall, NDVI, and HHFS.

Table 3: Mediation analysis of the direct, indirect, total, and proportion of total effect mediated on women's BMI (outcome variable)

Effect of	Outcome	Direct effect (95% CI)	Indirect effect (95% CI)	Total effect (95% CI)	Proportion of total effect mediated
NDVI[$]	BMI via HHFS	0.66 (0.22 to 1.10)**	-0.20 (-0.28 to -0.13)***	0.46 (0.01 to 0.90)*	0.43
HHFS[#]	BMI	0.06 (0.04 to 0.07)***		0.06 (0.02 to 0.09)***	
CBHI[&]	BMI via HHFS	-0.50 (-0.74 to -0.27)***	-0.99 (-1.54 to -0.44)***	-0.36 (-0.60 to -0.13)**	2.75
HH[@] head education 1 to 6	BMI via HHFS	0.67 (0.47 to 0.87)***	1.10 (0.66 to 1.55)***	0.76 (0.56 to 0.96)***	1.45
Safety net	BMI	-0.15 (-0.33 to 0.02)		-0.15 (-0.33 to 0.02)	
Wealth status	BMI via HHFS	0.18 (0.10 to 0.26)***	0.02 (-0.01 to 0.06)	0.18 (0.11 to 0.27)***	0.11
Occupation	BMI via HHFS	-0.19 (-0,41 to 0.01)	0.15 (-0.04 to 0.34)	-0.24 (-0,46 to -0.03)*	0.63
Age	BMI	-0.01 (-0.02 to 0.003)*		-0.01 (-0.02 to 0.003)*	
RF[##]	NDVI	0.0036(0.0034 to 0.0038)***			
TEE	BMI	0.17 (0.06 – 0.27)		0.17 (0.06 – 0.27)	

$:Normalized Difference Vegetation Index; #: Household food security score; &: Community Based Health Insurance; @: Household; ##: Rainfall. The final model was selected using AIC

Discussion

As we hypothesized, our study shows a direct effect of rainfall on the NDVI and an indirect effect of the NDVI via HHFS on women's BMI. Using a cohort design, we ensured a temporal relationship between the main exposures preceding the mediator and the outcome. Thus, the mediation analysis enabled us to assess causality and reduce confounding. Furthermore, our relatively short research shows that climate variability is a stress multiplier to factors that indirectly or directly affect nutrition and health, such as wealth, health insurance, education, and workload.

Our analytical model accounted for data clustering at the *Kebele* and household levels to obtain a precise measure of the coefficients' standard error. We adjusted for potential confounding effects of important sociodemographic variables. The time sequence of the occurrence of exposure, mediator, and outcome variables was used to build a mediation analysis model, adding evidence to claim for cause links between climate variability and crop production, household food security, and malnutrition.

The advantage of studying in smaller areas is that it enables us to address details obtained through household studies. Even if this may limit the generalization of the findings, the study area is representative of drought-prone and subsistence farming rural communities in Ethiopia, a country with repeated episodes of climate variability and change, crop failures, and famines.

A limitation of our study is that we didn't directly measure the food production in the affected household but used remote sensing information. Although NDVI data correlates well with food production, future studies should evaluate the use of remote sensing with the variety of foods produced on local farm plots. Furthermore, our study used self-reports while measuring HHFS, which might introduce measurement bias. This might be because participants might have reported a household's food insecurity with the expectation of getting food aid. However, earlier and repeated validation studies from similar areas in Ethiopia assessed the food insecurity measuring tool as reliable [22, 23].

Our study confirms earlier results from Ethiopia and Africa that rainfall was associated with NDVI, a proxy for crop production, and that crop production, household food security, and wealth were correlated to an increase in women's BMI [26-30]. Unlike previous studies in southern Ethiopia, we did not find an association between using the safety net program (SNP) and women's BMI [31]. Similarly, we did not demonstrate any effect of the Safety Net program. However, the number of persons using health insurance and the safety net program was small, and an inadequate sample size could explain the lack of associations in our study. On the other hand, our mediation model improved when including these variables.

The lack of longitudinal data is a serious constraint for researchers in countries such as Ethiopia. Our study demonstrates that it is possible to retrospectively access valid climate data from publicly available sources and combine them with relatively short-duration studies.

Climate variability, crop production, and household food security could be causally linked to women's nutritional status, suggesting that rural people depending on rain-fed subsidence farming for crop production are vulnerable to the impact of climate variability. Government interventions such as education, CBHI, and SNP could help mitigate the effect of climate variability. In the current study area, mitigating climate variability through improving household food security, wealth status, and educational status could reduce the climate variability stress in the affected populations.

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Household locations within nine rural Kebeles in the western Sidama, Ethiopia

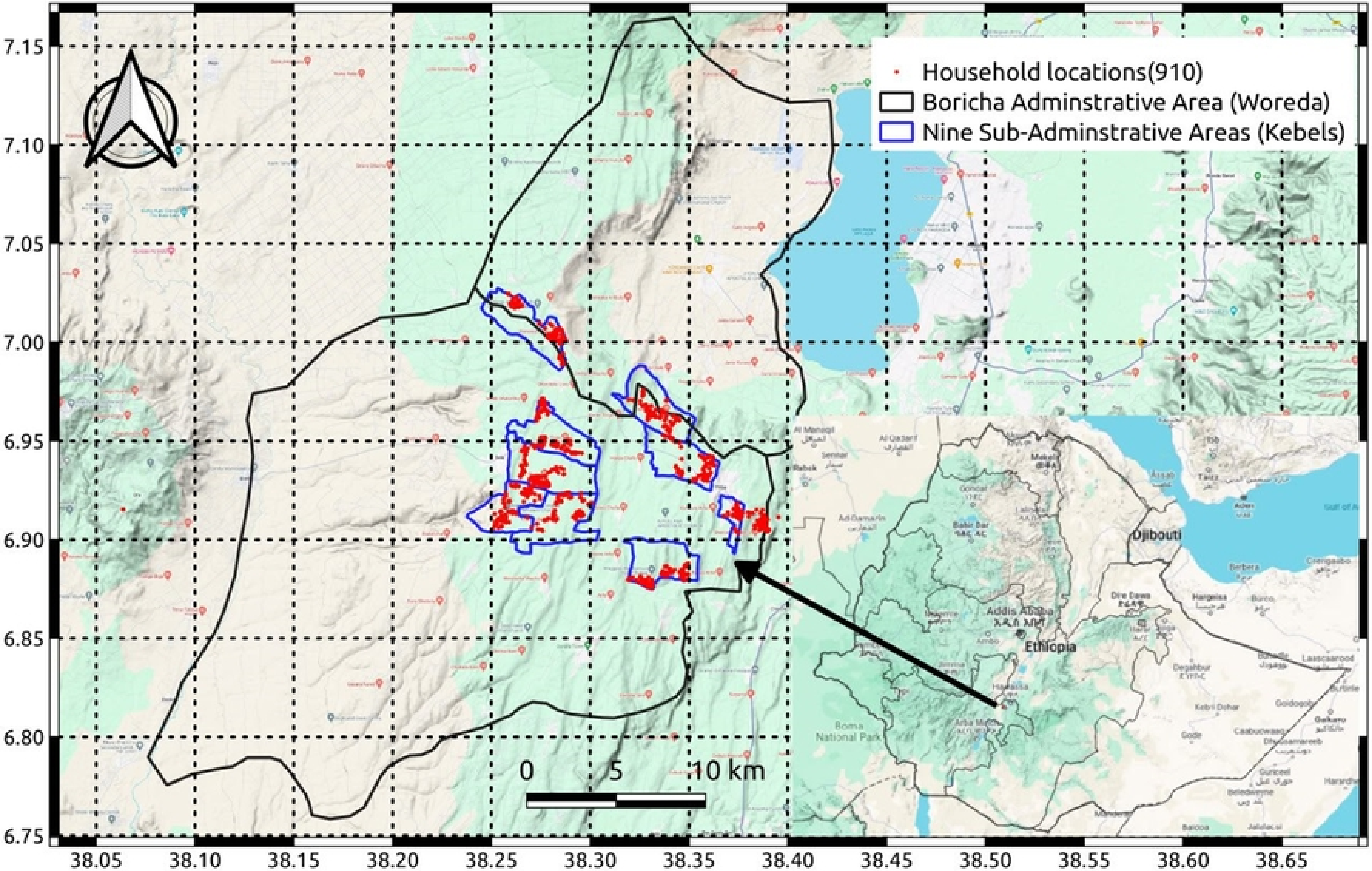


Figure 1

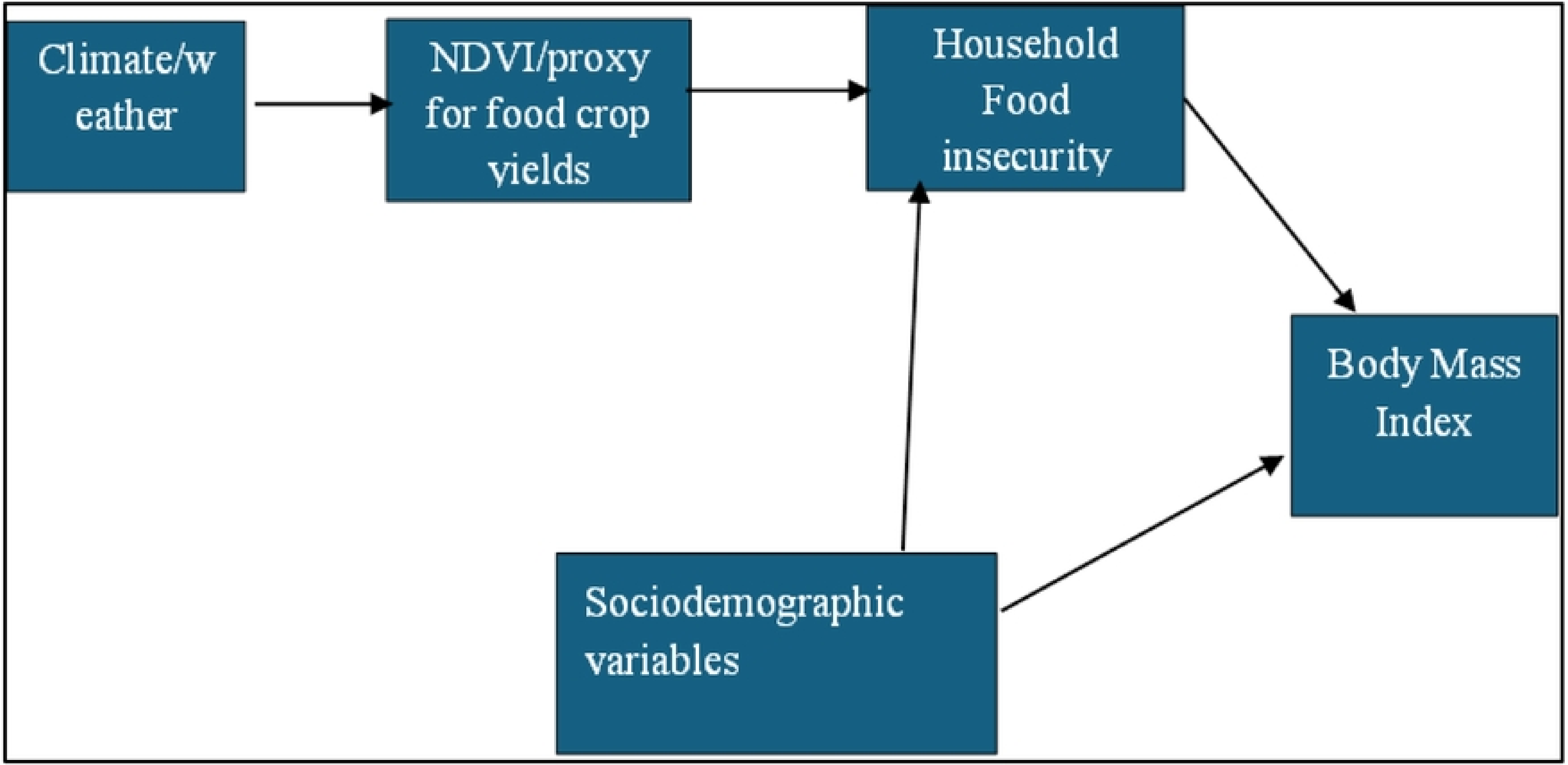

Climate/w
eather
NDVI/proxy
for food crop
yields
Household
Food
insecurity
Body Mass
Index
Sociodemographic
variables

Figure 2

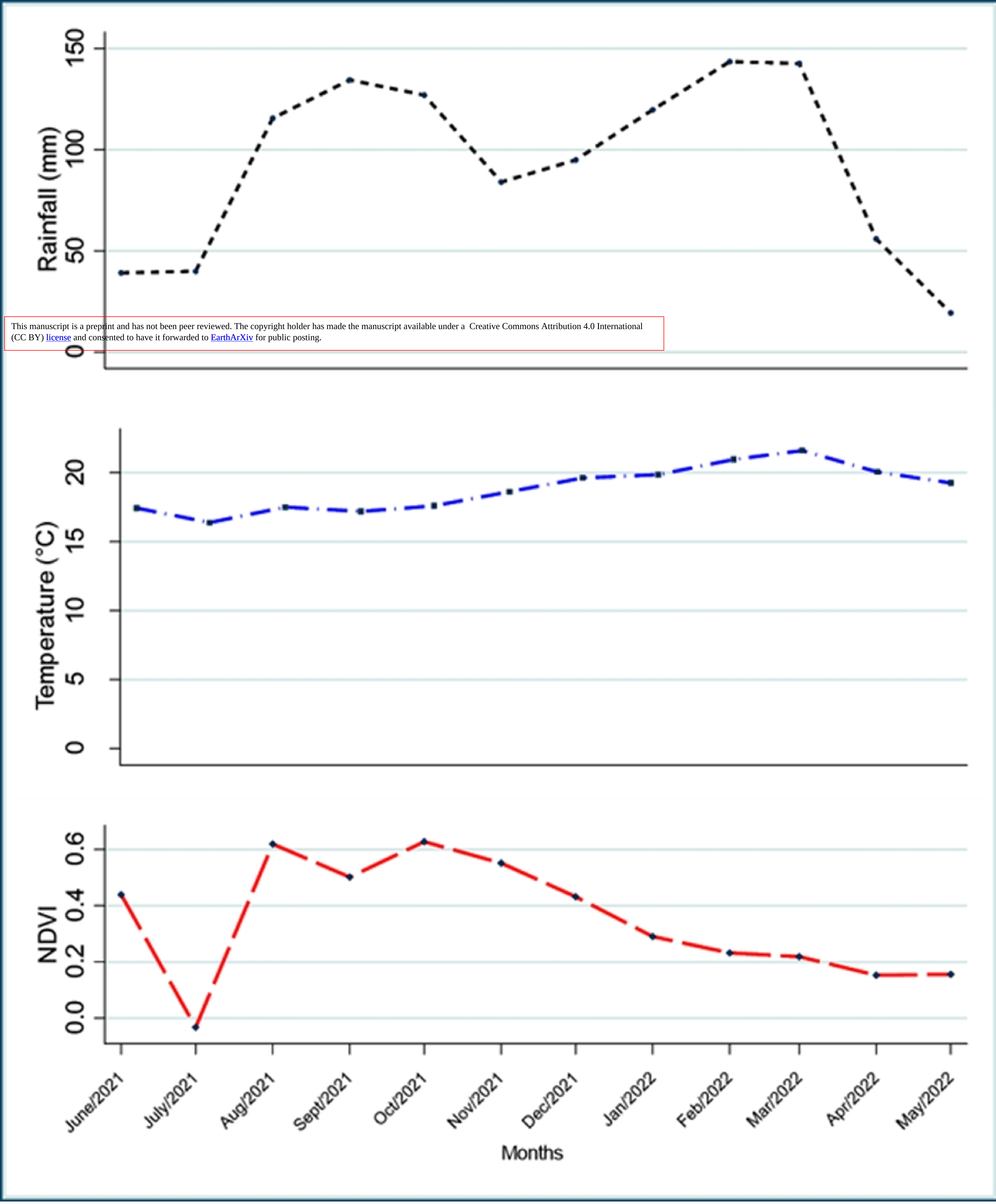
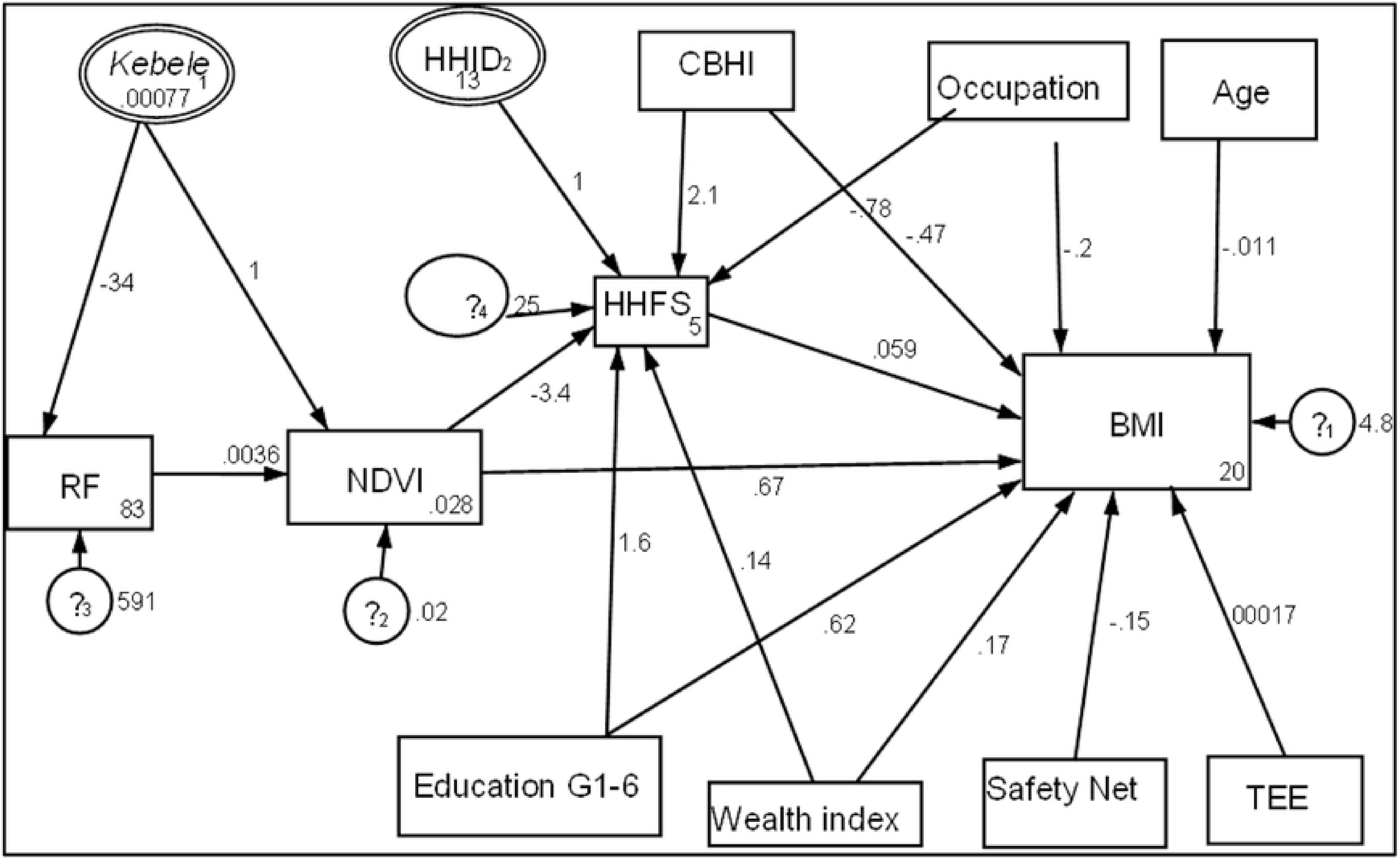

Rainfall (mm)
0
50
100
150
Temperature (°C)
0
5
10
15
20
NDVI
0.0
0.2
0.4
0.6
June/2021
July/2021
Aug/2021
Sept/2021
Oct/2021
Nov/2021
Dec/2021
Jan/2022
Feb/2022
Mar/2022
Apr/2022
May/2022
Months

Figure 3



Kebele
1
.00077
HHID2
13
CBHI
Occupation
Age
1
2.1
-.78
-.47
-.2
-.011
-34
1
?4
25
HHFS
5
.059
-3.4
BMI
?1
4.8
20
RF
83
.0036
NDVI
.028
.67
1.6
.14
?3
591
?2
.02
.62
.17
-.15
00017
Education G1-6
Wealth index
Safety Net
TEE

Figure 4