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Knowledge towards health impacts of climate change among Amhara Sayint community, Northeastern Ethiopia

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Abstract

Purpose – This study aims to assess the knowledge of Amhara Sayint district community in Northeastern Ethiopia towards the health impacts of climate change.

Design/methodology/approach – A community-based cross-sectional study was conducted from 20 July to 5 September 2022, involving 605 randomly selected households in Amhara Sayint district, Northeastern Ethiopia. Data were collected through face-to-face interviews using a pilot-tested and content-validated questionnaire administered via Kobo Collect survey tool. The data were then exported to STATA for management and analysis. A proportional odds approach of ordinal logistic regression model was fitted with a 95% confidence level to identify factors associated with the community's knowledge towards the health impacts of climate change.

Findings – Of the total respondents, 3.47% (95% confidence interval [CI]: 2.1, 5.3) and 42.98% (95% CI: 38.9, 47) had inadequate and medium levels of knowledge towards the health impacts of climate change, respectively. Proportional odds model analysis result indicated that gender (female) (adjusted odds ratio [AOR] = 1.49; 95% CI: 1.053, 2.13), wealth status (poorest) (AOR = 1.97; 95% CI: 1.01, 3.83), educational status (unable to read and write) (AOR = 4.13; 95% CI: 1.25, 13.68) and participation status in environmental protection activities (not) (AOR = 1.78; 95% CI: 1.17, 2.71) were factors that significantly associated with inadequate and medium levels of knowledge towards the health impacts of climate change.

Research limitations/implications – The result of this research is not supported by qualitative methods.

Practical implications – Residents of the study area know the climate is changing; however, they lack adequate knowledge towards the health impacts of climate change.

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Social implications – Significant number of people have inadequate level of knowledge about health impacts of climate change so relevant health education is needed.

Originality/value – This research is original in its focus on assessing public knowledge about the health impacts of climate change in the Amhara Sayint district, northeastern Ethiopia, a perspective often overlooked in existing studies. Its findings are crucial for guiding future research and developing targeted public health strategies and educational initiatives.

Keywords Climate change, Awareness, Proportional odds model, Amhara Sayint, Ethiopia

Paper type Research paper

List of Abbreviations

AOR = Adjusted odds ratio;
SDG = Sustainable Development Goal;
CDC = Centers for Disease Control and Prevention; and
IPCC = Intergovernmental Panel on Climate change.

Introduction

Developing countries are disproportionately affected by climate-induced flood and drought-related mortality and morbidity, impacting 2.2 million people per year (ergovernmental Panel on Climate Change) (IPCC, 2022). Nowadays, such impacts of climate change are worsening, especially in sub-Saharan countries, including Ethiopia (WHO, 2019). The exacerbation of climate variability and extreme weather events, such as high temperatures and intense rainfall, triggered malaria epidemics in the highlands of western Kenya, Uganda and Ethiopia (Rocklöv and Dubrow, 2020). In the Horn of Africa, people migrate due to drought, which increases their health needs and compromises their health status (Lindvall *et al.*, 2020). Other than direct impacts on public health, climate change causes declining groundwater levels, drives up water prices and creates water-related conflict (Somalia Climate portal, 2019). In the Horn of Africa, more than 16.2 million people lack sufficient access to drinking water and sanitation (OCHA, 2022).

Ethiopia has experienced numerous climate change extremes including drought, flood, volcano and earthquake (Ethiopia Climate portal, 2021). In 2015, about 18.2 million Ethiopians were victims of a drought, called *El Niño* (Oxfam El Niño in Ethiopia, 2016). The recent drought event in Wollega in 2016 is also tangible evidence of the impacts of climate change in Ethiopia. Ethiopia is in the grip of its worst drought in recent history (De Waal, 1991). It has been reported that more than ten million Ethiopians need urgent assistance due to the climate-related crisis (WFP, 2016). It is reported that over 3.5 million people in Ethiopia no longer have access to safe drinking water (Caritas Australia, 2022).

There has been an intense effort at the national and international levels to curb the above-mentioned impacts of climate change. These include the Centers for Disease Control and Prevention (CDC) which developed the Building Resilience to help health departments prepare for and respond to climate change against vulnerability (Marinucci *et al.*, 2014). Furthermore, under Sustainable Development Goal (SDG)-13, the United Nations has emphasized the necessity of providing regular health education on impact mitigation and early warning measures (Elder and Bartalini, 2019). Ethiopia's environmental protection authority also points out the need for public knowledge to ensure the sustainability of the environment (FDRE, 1997). Furthermore, to halt the impacts of climate change, Ethiopia set a mitigation policy of the Climate-Resilient Green Economy strategy through planting of a tree each summer season. The strategy aims to reduce greenhouse gas emissions and build climate resilience status (FDRE, 2019).

Though many national and international interventions have been launched to curb the impacts of climate change, relevant studies indicate insufficient knowledge level of the community about the impacts of climate change (Nigatu *et al.*, 2014; Kabir *et al.*, 2016; Kahsay *et al.*, 2019; Odonkor *et al.*, 2020). This implies that, unless public knowledge regarding the impacts of climate change is thoroughly investigated from all perspectives and appropriate actions are taken, the health impacts of climate change will continue to rise. This will lead to a higher incidence of death and disease, including respiratory and cardiovascular diseases, vector-borne disease, malnutrition and heat-related disasters (Duran-Encalada *et al.*, 2017; WHO, 2018; Dietz, 2020). Therefore, thorough investigation of public understanding about the health impacts of climate change is crucial for effective intervention.

However, there are limited studies on public knowledge towards the impacts of climate change and its associated factors. Moreover, the available studies on climate change impacts are mostly descriptive and have primarily investigated the issue from an agricultural perspective (Suryanto and Rahman, 2019; Abeje *et al.*, 2019). Therefore, farmers were the focus of those studies. Consequently, the knowledge of the general community members, namely, farmers, government employees and merchants, about the impacts of climate change from a public health perspective is largely ignored (Simane *et al.*, 2016). This creates a knowledge gap in the scientific community regarding the level of public awareness about the health impacts of climate change and its associated factors.

Additionally, almost all previous studies conducted on knowledge towards climate change grouped the respondent's knowledge level into two classes. However, this dichotomization might fiercely designate an individual with a medium level of knowledge into either the good or poor knowledge category, which is not ideal for priortization in a resource limited set up. Therefore this study takes those gaps in to acount and aims to assess knowledge towards the health impacts of climate change and its associated factors among the community of Amhara Sayint district in Northeastern Ethiopia. In line with other studies, the findings of the study will contribute its share for planning relevant interventions and addressing SDG Goal 13: climate action (United Nations, 2016).

Materials and methods

Study area and period

The study was conducted in Amhara Sayint district of Northeastern Ethiopia from 20 July to 5 September 2022. Amhara Sayint district is located about 602 km away from Addis Ababa, capital of Ethiopia. The district is situated between 10° 50' 0" N - 11° 10' 0" N latitude and 38° 30' 0" - 39° 0' 0"E longitude (Figure 1). Moreover, as almost the entire district residents are rural dwellers, there is no resilient infrastructure to cope with the unexpected health impacts of climate change. This increases the risks to the health impacts of climate change.

Study design

A community-based cross-sectional study was employed to assess knowledge towards the health impacts of climate change.

Population

The source population of this study was all the population of Amhara Sayint district aged between 18 and 64 years. If appropriate intervention is given to enhance the potential knowledge gap of this group of the community, they can make a significant change in combating the changing climate and its health impact. The study population was all population in the selected *kebeles* (lowest administrative unit in Ethiopia) of the district aged from 18 to 64 years.

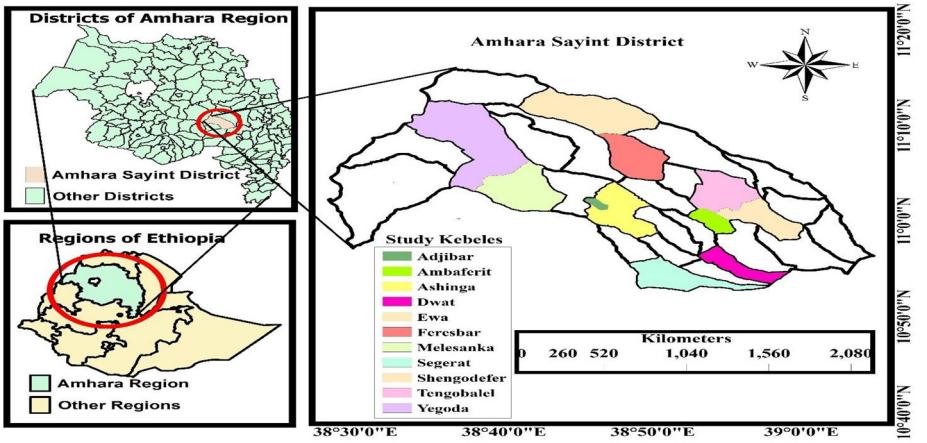

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Figure 1. Map of the study area, Amhara Sayint district, South Wollo, Northeastern Ethiopia, 2022

Sample size determination

The sample size was determined using the single population proportion formula for knowledge [equation (1)] and Epi Info software version 7.2.2 for factors associated with knowledge. The final sample was determined with the consideration of proportion (p = 58.8%) (Adhikari *et al.*, 2022), 95% level of confidence, and 5% margin of error. The result with an adequate (largest) sample was taken as the final sample size. The adequate sample size calculation procedure is conducted as follows:

$$n = \frac{\left(z\alpha/2\right)^2 * (P)(1-P)}{(d)^2} \quad (1)$$

Kelsey *et al.* (1996) where,

n = sample size;

$Z_{\alpha/2}$ = critical value of the normal distribution at $\alpha/2$ (95% confidence level);

α = 0.05 and the critical(Z) value is 1.96;

p = sample proportion, which is 0.58 (58.8%); and

d = margin of error which was taken as 0.05 (5%) (Daniel and Cross, 2018.

$$n = \frac{(1.96)^2 \times (0.588) \times (1-0.588)}{(0.05)^2} \approx 372$$

As multistage sampling (two sampling procedures of kebeles followed by households) was applied in this study (see Figure 2), a design effect of 1.5 was considered to minimize sampling error. Therefore, considering a 1.5 design effect, 10% non-response rate (Kabir *et al.*, 2016; Severin and Jacobs-Small, 2017), and 1% missing/incomplete data, the final sample size for this investigation was 620.

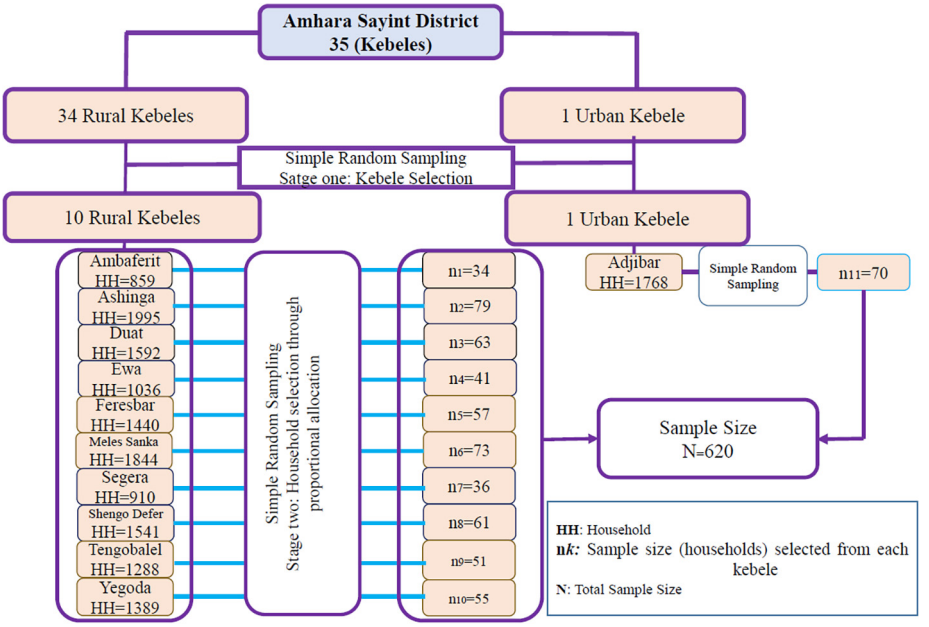

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Figure 2. Sampling procedure for selection of respondents for assessing knowledge towards health impacts of climate change in Amhara Sayint district, Northeastern Ethiopia, 2022

The sample was proportionally allocated to each selected kebeles based on the number of households [equation (2)]. To minimize the introduction of sampling error through stage sampling, respondents of each kebele were selected using simple random sampling techniques from the list of households in that kebele's community-based health information frame. Thus, data on sociodemographic characterstics and knowledge towards the health impacts of climate change were collected from the available household member preferably household head or otherwise spouse. However, in their (head/spouse) absence, data was collected from the available household members (aged 18–64 years) who were selected randomly from other adult members in case more than one member existed at the time of data collection.

$$n_j = \left(\frac{n * Nj}{N}\right) \quad (2)$$

where "n_j" is the sample size allocated for the kebele$_j$, "N_j" is the total households of kebele$_j$, "N" is the total households of the *whole study* kebeles (15664), and "n" is the total sample size for the study.

Inclusion and exclusion criteria

All individuals of the study kebele with the age of 18–64 and 6 or more months of residence in that kebele were included in the study. However, of those included in the study, those who were mentally and critically ill during the data collection were excluded.

Data collection procedures

Data were collected by four data collectors (public health and environmental health professionals). Follow-up was done by two supervisors and the principal investigator. Face-to-face interviews and observation (for wealth status measurement items) were used as data collection techniques. A pilot tested and content validated questionnaire, which can be accessed online (https://ee.kobotoolbox.org/x/PWaSebia), was used as a data collection tool. It was prepared in English, translated into the local language (Amharic), back-translated into English to ensure consistency, and subsequently used in its Amharic version. It contained sociodemographic variables and 16 questions (Section VII) about the health impacts of climate change, which were adapted and/or synthesized from relevant literatures, primarily from sources (Hahn *et al.*, 2009; Clasen, 2015; Suryanto and Rahman, 2019), as well as other studies (Japan-Caribbean Climate Change Project, 2016; Theresa, 2020; Rahman *et al.*, 2021).

Variable measurements and description

In this study, the outcome of interest was knowledge about the health impacts of climate change. It was determined by 16 climate change and health-focused questions (Section VII), which were designed to assess participants' knowledge towards the health impacts of climate change. Each question, given equal weight to maintain consistency with established benchmarks, had "Yes", "No" and "Not sure" options and was evaluated quantitatively based on correctness. A correct response was scored as "1", while an incorrect or unsure response, which was chosen for descriptive purposes, was scored as "0". For a negative question, options were reverse-coded before analysis. Then, each response of the respondents was summed up. After all, respondents were classified as having adequate (11–16 points), medium (6–10 points) or inadequate (0–5 points) levels of knowledge according to previous study (Theresa, 2020).

Latent explanatory variables, such as the wealth index, were determined based on the nationally harmonized parameters of wealth indicators. After determining the principal components of wealth by Eigenvalue of 1, their standardized value was categorized into 5 groups, and labeled as poorest, poorer, middle, richer or richest (EDHS, 2016). Crowdedness was also determined by indicators dividing the number of dwellers per room, provided that a room with greater than 1.5 persons is an indicator of crowded housing (EPA, 2010).

Data quality assurance and analysis

Data quality assurance issues were considered before, during and after data collection. Before data collection, the questionnaire was prepared in English then translated to Amharic, and back-translated to English for ensuring consistency. The questionnaire was content and/or face-validated. In addition, it was first pilot tested on 50 samples in a neighboring area called *Abuara* kebele of Borena District. The pilot study aimed to ensure that the respondents understood the questions clearly and to check the reliability of the tool before the actual data collection. From the results of the pilot analysis, certain measures were taken to ensure the reliability/consistency (reproducibility) of items. Based on the indication of reliability analysis, some items were removed and the final tool prepared for the principal study had a Cronbach's alpha constant of 0.72.

The data analysis was based on individual community members as unit of analysis. This approach allowed for a detailed examination of factors influencing knowledge towards the health impacts of climate change among community members. The collected data was exported from the Kobo server to STATA version 15.0 through an STATA command called *kobo2stata*, for management, cleaning and further analysis. Re-categorization of categorical

data and categorization of continuous data has been made for a proper analysis. Incomplete data was cleared and only completed data/cases were analysed.

After managing the data, the knowledge of the respondents about the health impacts of climate change was described through text, charts and figures. Continuous data was also described as, median and/or mean ± SD (standard deviations) based on the normality of the data. The frequency and cross-tabulation of explanatory variables against knowledge towards the health impacts of climate change were displayed in the table (Table 1). The proportional odds assumption was checked through the parallel line test method and it was non-significant notifying that the proportional odds model (other than the partial proportional odds model) was good to run. Thus, the proportional odds model was fitted to identify factors associated with knowledge towards the health impacts of climate change at a 95% confidence level. A *p*-value of ≤ 0.05 was considered as a cut-off point for statistical significance. After running a proportional odds model and determining the predicted probability of knowledge level, the marginal (additional) percentage point of the knowledge level as a result of the change in predictor from the reference category to the current category was determined through average marginal effect while keeping the other predictors at their means (Table 3).

Note that: In the proportional odds model, the contrasting panels are a category or lower vs all the higher categories of the ordered response variables. All the lower categories were coded as "0" and all the higher categories were coded as "1". However, the regression coefficient is interpreted as the ordered log odd of being in the higher category. Thus, the first category is the reference category (Williams, 2016). The finding from the proportional odds model result of this finding was thus interpreted as the ordered log odds of having inadequate and medium levels of knowledge towards the health impacts of climate change versus having adequate knowledge among a certain category of respondents relative to their reference category is certain times higher or lower.

Results

Socio demographics and behavioral characteristics of the respondents

In this study, a total of 605 respondents completed the questionnaire, giving a response rate of 97.6%. The majority of interviewees were male (393, 65%). Participants were between the ages of 20 and 64 years and had a median age of 40 years. Nearly all of the participants were non-government employees (557, 92.07%). About 208 (34.38%) of the respondents had no formal education. The great majority of the respondents (574, 95%) were married. Furthermore, about 215 (35.54%) and 220 (36.36%) of the respondents were under the poor and middle wealth category, respectively (Table 1).

Knowledge towards health impacts of climate change

The knowledge of the respondents was determined based on 16 knowledge-based items/questions. It has been found that 123 (20.33%; 95% CI: 17– 24) respondents did not think of climate change as a global problem. It was also evident that about 57 (9.42%; 95% CI: 7–12.4) respondents did not hear of climate change. The result of this investigation showed that 21 (3.47%, 95% CI: 2.1, 5.2) and 260 (42.98%; 95% CI: 38.99, 47.02) respondents had inadequate and medium levels of knowledge, respectively, towards health impacts of climate change (see Figure 3). Furthermore, about 324 (53.55%, 95% CI: 49.4, 57.5) respondents were found to have adequate knowledge. Among respondents with a medium and inadequate level of knowledge, males take the higher percentage (Table 1).

Table 1. Sociodemographic and behavioral characteristics of the respondents against knowledge towards health impacts of climate change, Amhara Sayint district, northeastern Ethiopia, 20 July to 5 September 2022

Factors	Adequate knowledge *N* (%)	Medium knowledge *N* (%)	Inadequate knowledge *N* (%)	Total *n* (%)
Gender				
Male	229 (37.9)	153(25.3)	11(1.7)	393
Female	95 (15.7)	107 (17.7)	10 (4.8)	212
Religion				
Christian	258 (42.6)	228 (37.7)	19 (3.1)	505
Muslim	66 (10.9)	32 (5.3)	2 (0.3)	100
Educational status				
Can't read and write	6 (1)	14 (2.3)	7 (1.2)	27
Read and write	83 (13.7)	79 (13.1)	4 (0.7)	166
Elementary	202 (33.4	139 (23.0)	5 (0.8)	346
High school	6 (1)	5 (0.8)	3 (0.5)	14
College and above	27 (4.5)	23 (3.8)	2 (0.3)	52
Age				
<25	76 (12.5)	74 (12.2)	3(0.5)	153
25–34	232 (38.3	167(27.6)	15(2.5)	414
35–44	16 (2.6)	19 (3.1)	3 (0.5)	38
Occupation				
Government officials	26 (4.3)	20 (3.3)	2 (0.3)	48
Farmers	287 (47.4)	219 (36.2)	17 (2.8)	523
Merchant	11(1.8)	21 (3.5)	2 (0.3)	34
Marital status				
Married	308 (50.9)	247 (40.8)	19 (3.1)	574
Divorced	16 (2.6)	13 (2.1)	2 (0.3)	31
Residence				
Urban	25 (4.1)	34 (5.6)	9 (1.5)	68
Rural	299(49.4)	226(37.4)	1292.0)	537
Media utilization frequency				
I don’t use any	286 (47.3)	212 (35.0)	9 (1.5)	507
1–4 days a week	21 (3.5)	34 (5.6)	11 (1.8)	66
Over 4 days a week	17 (2.8)	4 (0.7)	11 (1.8)	32
Media type				
I don't use any	288 (47.6)	213 (35.2)	12 (2)	513
Radio	35 (5.8)	39 (6.4)	6 (1.0)	80
Television	1 (0.2)	8 (1.3)	3 (0.5)	12
Wealth index				
Poorest	78 (12.9)	71 (11.7)	6 (1)	155
Poor	82 (13.6)	61 (10.1)	4 (0.7)	147
Medium	48 (7.9)	45 (7.4)	5 (0.5)	98
Rich	72 (11.9)	70 (11.6)	5 (0.7)	147
Richest	44 (7.3)	13 (2.1)	1 (0.7)	58

(*continued*)

Table 1. Continued

Factors	Adequate knowledge *N* (%)	Medium knowledge *N* (%)	Inadequate knowledge *N* (%)	Total *n* (%)
Beneficiary from organization working on environmental protection				
No	79 (13.1)	72 (11.9)	5 (0.8)	156
Yes	245 (40.5)	188 (31.1)	16 (2.6)	449
Relevant training				
No	285 (47.1)	213 (35.2)	9 (1.5)	507
Yes	39 (6.4)	47 (7.7)	12 (2.0)	98
Community-based health insurance membership				
No	24 (4.0)	29 (4.8)	4 (0.7)	548
Yes	300 (49.6)	231 (38.2)	17 (2.8)	57

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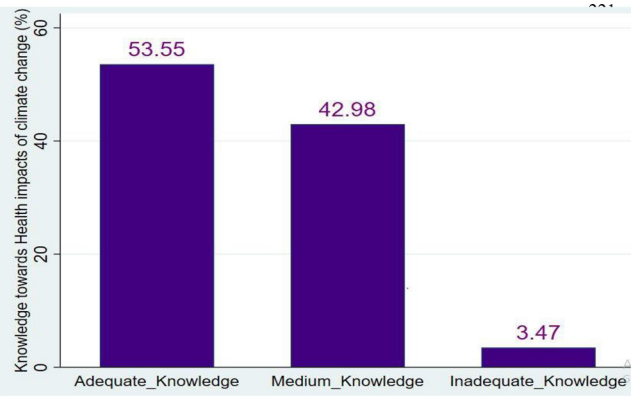

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Figure 3. Knowledge level of respondents towards health impacts of climate change, Amhara Sayint district, Northeastern Ethiopia, 20 July to 5 September 2022

Factors associated with knowledge towards health impacts of climate change

As indicated in the methods section, the proportional odds model was fitted with explanatory variables against knowledge towards the health impacts of climate change (Table 2). The results showed that being female (adjusted odds ratio [AOR] = 1.49; 95% CI: 1.05, 2.13), poorest wealth status (AOR = 1.97, 95% CI: 1.01, 3.83), unable to read and write (AOR = 4.13, 95% CI: 1.25, 13.68), and did not participate in environmental protection activities (AOR = 1.78, 95% CI: 1.17, 2.71) were found to be significantly associated with inadequate and medium level of knowledge towards health impacts of climate change. Based on the first panel (having adequate knowledge versus inadequate and medium knowledge), for female respondents, the odds of having either inadequate or medium level of knowledge is 1.49

Table 2. Proportional odds model analysis of factors associated with public knowledge towards health impacts of climate change, Amhara Sayint district, Northeastern Ethiopia, 20 July to 5 September 2022

Factors	Std. error	AOR (95%CI)	*p*-value
Inadequate or medium level of knowledge vs adequate knowledge			
Gender (ref-male)			
Female	*0.269*	*1.49 (1.05–2.127)*	*0.026 **
Age	0.171	1.08 (0.791–1.475)	0.624
Educational status (ref-College and above)			
Can't read and write	*2.524*	*4.13 (1.247–13.685)*	*0.02**
Read and write	0.366	1.1 (0.572–2.11)	0.773
Primary education	0.267	0.84 (0.457–1.573)	0.603
High school	1.441	2.21 (0.615–7.937)	0.22
Wealth index (ref-richest)			
Poorest	*0.668*	*1.97 (1.01–3.831)*	*0.046**
Poor	0.542	1.58 (0.811–3.101)	0.178
Middle	0.746	2.05 (1.01–4.189)	0.047
Rich	0.720	2.11 (1.08–4.121)	0.029
Media utilization frequency (ref-everyday)			
I don't use any	0.38	0.78 (0.302–2.06)	<0. 629
1–4 days a week	0.92	1.84 (0.696–4.906)	0.217
Participation in environmental protection activities (ref-yes)			
No	*0.381*	*1.78 (1.169–2.707)*	*0.007**
Beneficiary from organization working in environmental protection (ref-yes)			
No	0.182	0.92 (0.763–1.654)	0.699
Relevant training (ref-yes)			
No	0.586	1.27 (0.514–3.141)	0.602

Source: Created by authors

times higher compared to the same odds of male respondents while adjusting other variables constant.

Average marginal effects

From the average marginal effect analysis as depicted below (Table 3), it has been found that keeping the other predictors at their mean value, all other variables (educational status, gender, wealth status and participation in environmental protection activities) significantly affected the predicted margins of knowledge towards health impacts of climate change.

For instance, for respondents who were unable to read and write, the odds of having adequate knowledge reduced by 31.7 percentage points (AME, 95% CI: −54.34, −9.04) (Table 3 and Figure 4) relative to the person attending college and above.

Furthermore, relative to male respondents, the margins (extra percentage) of having adequate knowledge towards the health impacts of climate change for female respondents were decreased by 9.3% (see Figure 5) percentage points (AME, 95% CI: −17.4, −1.1).

Table 3. Average marginal effects of predictors on knowledge towards the health impacts of climate change, among respondents, Amhara Sayint district, Northeastern Ethiopia, 20 July to 5 September 2022

Predictors	Average marginal effects (%) on knowledge level					
	Adequate	*p*-value	Medium	*p*-value	Inadequate	*p*-value
Educational status (ref-college and above)						
Can't read and write	−0.31694	*0.006**	0.240	*0.002**	0.076915	0.132
Read and write	−0.023	0.773	0.021	0.774	0.002	0.768
Primary education	0.040	0.605	−0.0364	0.603	−0.0040	0.625
Secondary education	−0.192	0.198	0.161	0.173	0.031	0.354
Gender (ref-male)						
Female	−0.1000	*0.025**	0.0884	*0.024**	0.011	0.053
Wealth (ref-richest)						
Poorest	−0.162	*0.037**	0.147	*0.039**	0.014	*0.044**
Poor	−0.108	0.164	0.099	0.166	0.008	0.163
Medium	−0.173	0.039*	0.157	0.04*	0.016	0.059
Rich	−0.179	*0.021**	0.162	*0.023**	0.016	*0.03**
Participation in environmental protection activities (ref-yes)						
No	−0.143	*0.006**	0.124	*0.005**	0.018	*0.035**

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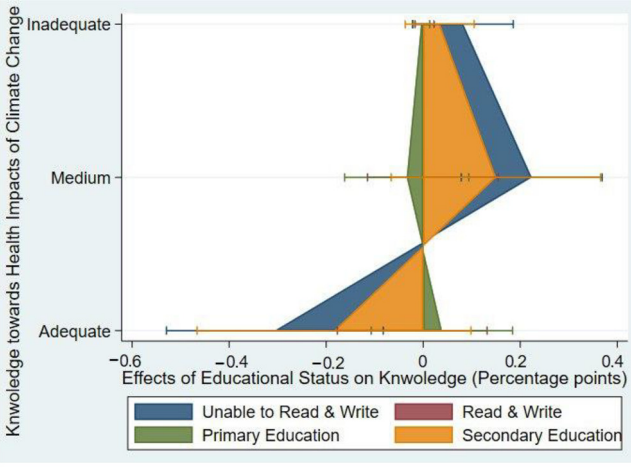

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Figure 4. Average marginal effect of educational status on knowledge of participants towards health impacts of climate change, Amhara Sayint, Northeastern, Ethiopia, 2022

Similarly, relative to a person participating in environmental protection activities, the margins of having adequate knowledge for a person who did not participate in environmental protection activities decreased by 13.4 percentage points (AME= 13.4%, 95% CI = −23.23, −3.60) (see Figure 6). Furthermore, relative to a person participating in

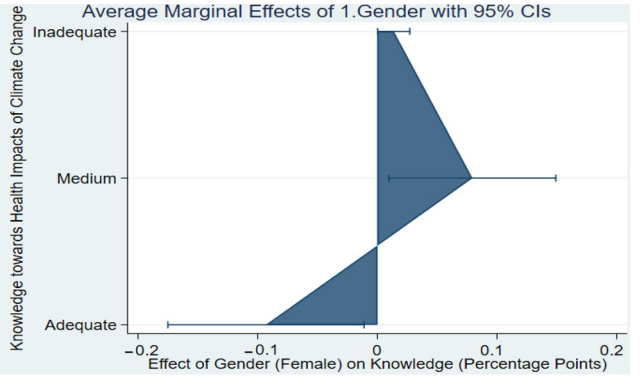

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Figure 5. Average marginal effects of Gender on the predicted probability of knowledge towards the health impacts of climate change among respondents in Amhara Sayint district, Northeastern Ethiopia, 2022

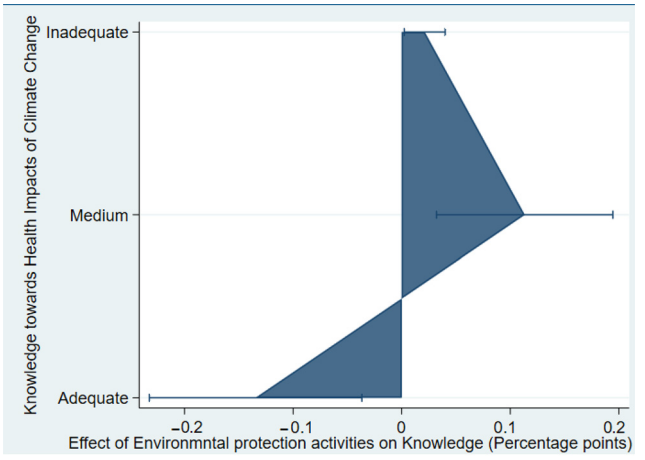

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Figure 6. Average marginal effects of participation in environmental protection activities on the predicted probability of knowledge towards the health impacts of climate change among respondents in Amhara Sayint district, Northeastern Ethiopia, 2022

environmental protection activities, the probability of having inadequate knowledge towards the health impacts of climate change for a person who couldn't participate in environmental protection activities increased by 2.12 percentage points (AME = 2.12%, 95% CI = 0.23,4).

The finding also indicated that keeping other variables at their means, the predicted probability of having adequate knowledge towards the health impacts of climate change decreased by 16.2 percentage points (AME = −16.2%, 95% CI = −31.46, −1) for the poorest

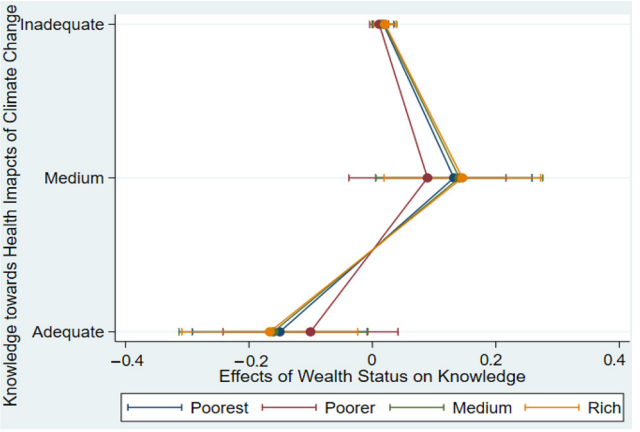
respondent relative to richest. Furthermore, the predicted probability of having inadequate knowledge increased by 1.8 percentage points (AME = 1.8%, 95% CI = 0.13, 35) for rich respondents relative to the poorest (see Figure 7).

Discussion

The investigation on knowledge towards the health impacts of climate change revealed that about 9% of respondents reported that they had not heard about the health impacts of climate change. This is in line with a relevant study in Thailand, which reported 8% (Rahman *et al.*, 2021). However, this finding is much lower than a similar study in Bangladesh where 45.8% had no information about climate change (Kabir *et al.*, 2016). The possible reason for this might be that the majority of residents in our study area participate in environmental protection activities where they might get climate-related health education. Similarly, this figure is lower than that reported in Ghana where 29.6% of respondents did not hear of climate change (Odonkor *et al.*, 2020). This might be associated with the campaign on awareness to the general public in our study area as opposed to the less public awareness in the counter study area, Ghana, as indicated by the authors (Akrofi *et al.*, 2019).

Even though the great majority of the respondents in this study heard about climate change, about 19% of them did not think that the climate is changing. This finding is in agreement with a similar study in Leos, which reported 17.2%. This is alarming as it contradicts the statement by the IPCC that climate change is getting worse (Wilson, 2020). Our findings are way below compared with the report in Laguna, Philippines conducted on nutrition workers where 98.7% of respondents thought climate change was a global problem (Theresa, 2020).

The findings of this investigation show that more than half (53.55%) of the respondents had adequate knowledge towards the health impacts of climate change, which is incongruent with other relevant studies performed in northern Ethiopia, Bangladesh and Nepal (Kahsay *et al.*, 2019; Adhikari *et al.*, 2022). However, 95% of nutrition workers in Laguna were found



Source: Created by authors

Figure 7. Average marginal effects of participation in environmental protection activities on the predicted probability of knowledge towards the health impacts of climate change among respondents in Amhara Sayint district, Northeastern Ethiopia, 2022

to be highly knowledgeable (Theresa, 2020). This high figure might be because nutrition workers are more likely to work on climate-related events where they might get climate-related Information.

The result of this investigation showed that poor wealth status, identified as female, lower educational status and not participating in environmental protection activities were positively associated with a medium and inadequate level of knowledge towards the health impacts of climate change. This result is in line with the finding of a similar study in Taiwan where low socioeconomic status was found to be a significant factor for having poor knowledge towards climate change (Rahman *et al.*, 2020). People with high wealth status might have better access to health-related information through different channels, such as radio and/or television (Castro *et al.*, 2013). Similarly, our study revealed that lower educational status had a significant positive association with inadequate and medium levels of knowledge. Similar findings were also reported in Thailand and Leos (Rahman *et al.*, 2021). It makes sense as educated people are expected to have detailed information about climate change-related information during their education career.

This study also revealed gender was significantly associated with knowledge towards the health impacts of climate change; provided that identifying as female was associated with inadequate and medium levels of knowledge. This finding is in line with a relevant investigation in Kenya (Ajuang *et al.*, 2016). In the study area, women have less frequent contact with other people which potentially decrease their access to relevant information.

Furthermore, participation in environmental protection activities was found to be significantly associated with climate change knowledge. Likewise, a study in Nepal on the assessment of the status of climate change and determinants of people's awareness of climate-smart agriculture revealed that participation in environmental protection activities enhances public knowledge towards the health impacts of climate change (Adhikari *et al.*, 2022).

Limitations of the study

This study has certain limitations. Firstly, it only showed a snapshot of the community's knowledge. It would have been great if a follow-up investigation had been conducted to confirm the cause-and-effect relationships among relevant knowledge-based variables. Furthermore, for a better view of the knowledge level of the study communities, spatial analysis on a larger scale would be great. Moreover, most of the items used in these investigations were close-ended, which might have compromised respondents' decisions during the study.

Conclusions and recommendations

Prior investigations of public understanding towards climate change, especially the impacts on public health are highly important for informing respective stakeholders to take timely action. This study assessed the level of public knowledge towards the health impacts of climate change using a quantitative approach. Nearly 3.5% and 42.9% of the district's residents had inadequate and medium levels of knowledge, respectively. Identified as female, unable to read and write, having the poorest wealth status and not participating in environmental protection activities were significant factors for having inadequate and medium levels of knowledge. Therefore, the knowledge level of the community was influenced by sociodemographic and behavioral factors. The implication from this finding was that, although slightly more than half of the district residents had relatively appreciable knowledge towards the health impacts of climate change, a significant proportion of them had inadequate and medium level of knowledge. Therefore, strengthening participation in

environmental protection activities, where people can access climate and health-related information and reaching them with different information channels like, community health workers, radio and television is strongly advisable.

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Declarations:

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Ethics approval and consent to participate: The study was conducted based on the Helsinki Declaration of Ethical Principles for Medical Research Involving Human Subjects. Ethical clearance was obtained from the Ethical Review Committee (ERC) of Wollo University, College of Medicine and Health Sciences (Ref no: CMHS_1536/2014) (Supporting document 1). A supportive letter was also taken from South Wollo Zonal Health Department (Ref no: □□ጤ/165/14) (Supporting document 2) and Amhara Sayint district health office (Ref no: ኩማ□□ጤ/112/14) (Supporting document 3). During the data collection, participants were informed that there was no harm related to their participation in this research (Supporting document 4). They also have been informed that they are selected randomly and their reply is so valuable to solve climate change-related problems of their communities in particular and the global society. Verbal consent was obtained from the study participants. The respondents were informed that they have the full right to withdraw or refuse at any time from the process. Confidentiality of information given by each respondent was properly maintained by avoiding possible identifiers such as names of the study participants. Rather, the identification number was used as a reference, and anonymity was explained clearly to the participant.

Consent for publication: Not applicable.

Availability of data and materials: The data sets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential competing of interests.

Data availability Statement: Inquiries regarding the data supporting this research work can be directed to the corresponding author.

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