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ABSTRACT

BACKGROUND: Human illnesses caused by parasites, viruses, and bacteria that are transmitted by vectors are called vector-borne diseases. Vector-borne diseases usually affect the poorest populations, particularly where there is a lack of access to adequate housing, safe drinking water, and sanitation. This community-based cross-sectional study was, conducted to assess the prevalence of self-reported vector-borne diseases and associated factors in the rural communities of northwest Ethiopia.

METHODS: A community-based cross-sectional study design with structured observation was conducted among 1191 randomly selected rural households in northwest Ethiopia from April to June 2017. Data were collected by using a structured questionnaire; and observation checklist. Multivariable binary logistic regression analysis was used to identify variables associated with the prevalence of self-reported vector-borne diseases on the basis of adjusted odds ratio (AOR) with 95% confidence interval (CI) and *P*-values <.05.

RESULTS: In the current study, 216 (18.1%) of the rural households reported one or more vector-borne diseases. Scabies (9.5%) were the most reported vector-borne disease followed by Malaria (6.9%). The prevalence of self-reported vector-borne diseases was statistically associated with the head of the family (mother) (AOR = 0.13, 95% CI = 0.02-0.72), regular cleaning of the living environment (AOR = 0.51, 95% CI = 0.36-0.74), poor cleanness of the living rooms (AOR = 1.77, 95% CI = 1.03-3.03), and moderate cleanness of the floor (AOR = 1.64, 95% CI = 1.06-2.52).

CONCLUSION: The prevalence of self-reported vector-borne diseases was high in the rural communities of northwest Ethiopia. The low prevalence was associated with family head; regular cleaning of living environment and cleanness of the floor. Designing and strengthening an intervention strategy for environmental sanitation, regular cleaning of living house, and keeping personal hygiene shall be considered.

KEYWORDS: Self-reported, vector-borne diseases, adjusted odds ratio, malaria, scabies, tungapenetrans, northwest Ethiopia

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Background

Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans. Many of these vectors are blood-sucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host after the pathogen has replicated. Often, once a vector becomes infectious, they are capable of transmitting the pathogen for the rest of their life during each subsequent bite/blood meal.[1]

Globally, vector-borne diseases are a major cause of death and illness; every year there are more than 700 000 deaths from diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis, and onchocerciasis.[2-4]

The vector-borne disease is highest in tropical and subtropical areas, and they disproportionately affect the poorest populations. Since 2014, major outbreaks of dengue, malaria, chikungunya, yellow fever, and Zika have afflicted populations, claimed lives, and overwhelmed health systems in many countries.[5] Other diseases such as Chikungunya, leishmaniasis, and lymphatic filariasis cause chronic suffering, life-long morbidity, disability, and occasional stigmatization.[5-7]

The distribution of vector-borne diseases is determined by a complex set of demographic, environmental, and social factors.[8] Many vector-borne diseases are preventable, through protective measures, and community mobilization.[9,10]

Vector-borne diseases affect the poorest populations, particularly where there is a lack of access to adequate housing, safe drinking water, and sanitation. These conditions are very

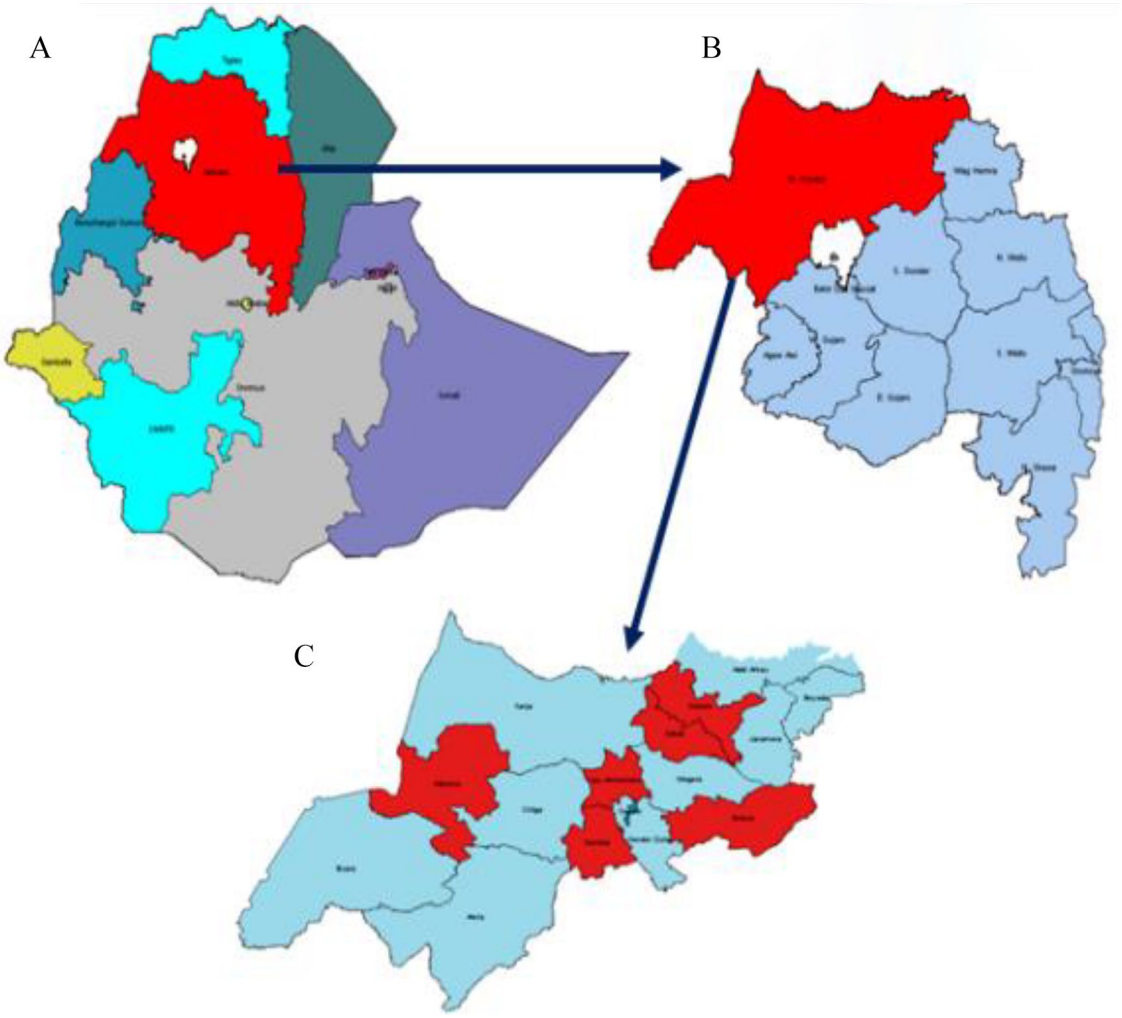

Figure 1. (A) Map of Ethiopia showing regional states and city administrations, (B) map of Amhara region showing zones, and (C) map of North Gondar zone showing districts. The red colored maps indicate the study areas.

common in Ethiopia, especially in rural settings. However, there are no studies on the prevalence of self-reported vector-borne diseases and associated factors in the study area. This community-based cross-sectional study was, conducted to assess the prevalence of vector-borne diseases and associated factors in the rural communities of northwest Ethiopia.

Method

Study design and setting

A community-based cross-sectional study design with structured observation was conducted from April to June 2017 in the former north Gondar administrative zone (Figure 1). At present, the administrative zone is subdivided into 3 zones: namely central Gondar, north Gondar, and west Gondar. The former north Gondar Administrative zone was bordered on the south by Lake Tana, west Gojam, Agew Awi, and the Benishangul-Gumuz region, on the west by Sudan, on the north by the Tigray region, on the east by Wag Hemra, and on the southeast by south Gondar. Based on the 2007 Census conducted by the central statistical agency of Ethiopia (CSA), the Zone has a total population of 2 929 628, an increase of 40.26% over the 1994 census, of whom 1 486 040 are men and 1 443 588 women; with an area of 45 944.63 km^2, North Gondar has a population density of 63.76. While 462 700 or 15.79% are urban inhabitants, a further 2148 or 0.07% are pastoralists. A total of 654 803 households were counted in this Zone, which results in an average of 4.47 persons to a household, and 631 509 housing units.[11]

Sample size determination and sampling procedures

The sample size was calculated using simple population proportion formula with the following assumptions: prevalence of self-reported vector-borne disease in rural communities = 50% hence there was no similar study, level of significance (α) = 5%, 95% confidence interval (standard normal probability), z: The standard normal tabulated value, and margin of error (d) = 5%.

$$n = \frac{(Z_{\alpha/2})^2 P(1-P)}{d^2} = \frac{(1.96)^2\, 0.5(1-0.5)}{0.05^2} = 384$$

Since we have passed 3 stages to reach out to the study subjects a design effect of 3 was considered; and a non-response rate of 5%, the final sample size was 1210. A multistage

random sampling technique was used to recruit study subjects. First, 4 districts were randomly selected from the former north Gondar Administrative zone. Then, 7 kebeles (the lowest administrative unit in Ethiopia) were selected, we used the lottery method for both selection procedures.[12] Finally, households in each selected kebele were selected using a systematic random sampling technique.[13]

Measurement of outcome variable

Prevalence of self-reported vector-borne diseases in the rural communities of northwest Ethiopia, the primary outcome variable of the study was defined as the presence of at least 1 vector-borne disease among the 7 common diseases: scabies, relapsing fever, malaria, yellow fever, filariasis, Leishmaniasis, and tungapenetrans.

Data collection tools and procedures

Data were collected using a structured questionnaire and observation checklist. The questionnaire was used to access self-reported vector-borne diseases and other related information such as socio-demographic characteristics, health information delivery system, supportive supervision system, personal hygiene practices, environmental hygiene practices, liquid and solid waste management, water quality and safety, food hygiene, and safety, housing sanitation, control of insects, rodents, and other biting species; and disease morbidity/mortality and management. We recorded and check the living environment, housing conditions, and personal hygiene practices of each family member in the selected household using the checklist. We interviewed the female head for the household level information. Both the questionnaire and observation checklist was developed from similar published studies with some modifications to address area-specific characteristics.[14-19] The tools were first prepared in the English language and translated to Amharic language and back-translated to English to check the consistency of translation. The translation was done by the team members and experts out of the team from our institution. The tools were piloted among 121 households (10% of the sample) outside the study area before the actual data collection. Data were collected by trained environmental health experts. Field supervisors checked the data collection process and confirmed the completeness of data on a daily basis. Every challenge faced by the data collectors each day was discussed with the principal investigator and field supervisors to take the necessary action.

Data processing and analysis

Data were entered using EPI-INFO version 3.5.3 statistical package[20] and exported into Statistical Package for Social Sciences (SPSS)[21] for further analysis. For most variables, data were analyzed by frequencies and percentages. The model fitness was checked by Hosmer and Lemeshow test ($P = .384$). After checking the correlation of independent variables, significance was determined using crude and adjusted odds ratios with 95% confidence intervals. To determine the association between the different predictor variables with the dependent variable, first bi-variable analysis between each independent variable and outcome variable was investigated using a binary logistic regression model and then all variables having P-value $<.25$ in the bi-variable analysis were suggested as a criterion for variable selection for inclusion into a multivariable model. So that all variables with a P-value of $<.25$ in the bi-variable were analyzed for multi-variable logistic regression.[22-24]

P-value $<.05$ with a 95% confidence interval were regarded as significant determinant factors and the strength of the association between the variables were classified based on their value of odds ratio (OR).

Results

Socio-demographic characteristics

In this study, a total of 1191 rural households were included with a response rate of 98.4%. The majority, 1060 (89%) of the head of the household was fathers. Six hundred eighty-nine (57.9%) and 878 (73.7%) of the fathers and mothers couldn't read and write respectively. Five hundred fourteen (43.2%) of the households had a family size of greater than 5 (Table 1).

Health information delivery and supportive supervision systems in the last 3 month

Five hundred twenty-four (44.0%) households reported as they discussed hygiene and sanitation for the last 3 months in the 1 to 5 community health teams. Similarly, 812 (68.2%) of the households reported as they discussed hygiene and sanitation at the family level. Six hundred twenty-six (52.6%) households reported they did not hear of any hygiene and sanitation-related information in the last 3 months (Supplemental Material 1). One to five is a structure in Ethiopia's health care system at the local level; this is a community-based health team structured by the local government to make health information accessible easily. Which mean that 6 peoples would be organized in 1 group and among the group 1 could be the leader of the group based on few criteria. So that the name called 1 to 5 communities team responsible to have a discussion on different health agenda given by the health extension workers.

Environmental and personal hygiene practices

Seven hundred fifty-one (63.1%) households reported that they regularly cleaned the living environment. Similarly, 794 (66%) of households that lived in kebeles declared open defecation free. Seven hundred seventy-eight (65.3%) of households

Table 1. Socio-demographic characteristics of households included in this study, 2017.

SOCIO-DEMOGRAPHIC CHARACTERISTICS	FREQUENCY	PERCENT
Head of the house hold		
Father	1060	89.0
Mother	131	11.0
Maternal educational status		
Can't read and write	878	73.7
Can read and write	196	16.5
Primary and above	117	9.8
Parental education		
Can't read and write	689	57.9
Can read and write	380	31.9
Primary and above	122	10.2
Maternal occupation		
Farmer	1046	87.8
Other	145	12.2
Parental occupation		
Farmer	1046	87.8
Other	145	12.2
Family size		
1-5	677	56.8
>5	514	43.2

washed hands only by water (Table 2). The defecation practice of 584 (49%) households was an open field. One thousand fourteen (85.1%) of the households reported that there were favorable conditions for the breeding of insects (Supplemental Material-2).

Prevalence of self-reported vector-borne diseases

Among the total of 1191 rural households, 216 (18.1%) 95% CI 16%-20%) rural households reported at least 1 vector-borne disease. Scabies (9.5%) was the most reported vector-borne disease followed by malaria (6.9%) (Figure 2).

Factor associated with prevalence of self-reported vector-borne diseases

Using bivariate analysis factors associated with self-report vector-borne diseases were first assessed. All the variables with a *P*-value of <.25 in the bivariate analysis were included for the multivariable analysis. Which includes; Kebele sanitation status, family discussion on hygiene and sanitation practice, 1 to 5 community teams discussion on hygiene and sanitation practice, supervised by kebele leaders, closely follow-up by health workers, heard health information for the last 3 month, waste disposal system, wild animal able to access water source, water source, cleaning of the internal and external environment, cleanness of the floor, ventilation of the house, favorable conditions for the breeding of insects, maternal education, head of the family, parental education, parental occupation, maternal occupation, wash hand only by water, wash hand with soap, wash hand with sand leaves, wash hands with ash, regularly change child cloth, an infestation of body lice, and defecation practice.

After controlling the confounding using the multi-variable logistic regression analysis regular cleaning of the living environment, cleanness of the floor, and head of the family were statistically associated with self-reported vector-borne diseases ($P < .05$).

The prevalence of self-reported vector-borne diseases was 1.77 times more likely to be higher in households with poor cleanness of the floor as compared to good cleanness of the floor (AOR = 1.77, 95% CI = 1.03-3.03). Similarly, the prevalence of self-reported vector-borne diseases was 1.64 times more likely to be higher in those households with medium cleanness of the floor (AOR = 1.64, 95% CI = 1.06-2.52). On the other hand, the

Table 2. Environmental and personal hygiene practices of the rural communities in northwest Ethiopia, 2017.

ENVIRONMENTAL AND PERSONAL HYGIENE PRACTICES	FREQUENCY	PERCENT
Kebele sanitation status		
Open defecation free	397	33.3
No open defecation free	794	66.7
Regularly cleaning of external area of house		
Yes	751	63.1
No	440	36.9
Cleanness of the floor		
Poor	317	26.6
Moderate	624	52.4
Good	250	21.0
Ventilation of the house		
Poor	324	27.2
Moderate	667	56.0
Good	200	16.8
Regularly wash and change child cloth (n = 824)		
Yes	622	75.5
No	202	24.5
Wash hand only by water		
Yes	778	65.3
No	413	34.7
Wash hand with soap		
Yes	588	49.4
No	603	50.6
Wash hands with sand leaves		
Yes	24	2.0
No	1167	98.0
Wash hands with ash		
Yes	100	8.4
No	1091	91.6
Regularly wash heavy cloths		
Yes	994	83.5
No	197	16.5

prevalence of self-reported vector-borne diseases was lower by 49% in those households who had regularly cleaned the living environment compared to their counterparts (AOR = 0.51, 95% CI = 0.36-0.74). In households where females are heads, the prevalence of vector-borne diseases was minimal (AOR = 0.13, 95% CI = 0.02-0.72) (Table 3).

Discussion

The prevalence of self-reported vector-borne diseases in the rural communities of northwest Ethiopia was found to be 18.1%; 95% CI 16%-20%. Specifically, scabies accounts for 9.5% followed by malaria 6.9%. The prevalence of scabies reported by this study is higher than studies in Tanzania (6%),[25]

Table 3. Factors associated with prevalence of one or more self-reported vector-borne diseases in the rural communities of Ethiopia, 2017.

VARIABLE	VECTOR BORNE DISEASE		COR (95%CI)	AOR (95%CI)	*P*-VALUE
	YES	NO			
Discussion about hygiene and sanitation at family level					
Yes	157	60	0.79 (0.57-1.10)	1.01 (0.68-1.49)	.96
No	656	318	1.00	1.00	
Discussion about hygiene and sanitation at community level team of 1 to 5					
No team	52	236	1.00	1.00	
Yes	111	413	1.24 (0.86-1.79)	1.40 (0.95-2.08)	.25
No	54	325	0.77 (0.51-1.17)	1.07 (0.69-1.65)	.77
Frequently supervised by the community leaders					
Yes	152	65	0.825 (0.59-1.14)	1.05 (0.72-1.51)	.81
No	64	329	1.00	1.00	
Regularly cleaning of external area of house					
Yes	117	634	0.64 (0.47-0.86)	0.51 (0.36-0.74)	.000**
No	99	341	1.00	1.00	
Cleanness of the floor					
Poor	53	264	1.04 (0.66-1.63)	1.77 (1.03-3.03)	.03*
Moderate	123	501	1.27 (0.86-1.88)	1.64 (1.06-2.52)	.02*
Good	43	207	1.00	1.00	
Wash hand only by water					
Yes	151	627	1.29 (0.94-1.78)	1.36 (0.97-1.91)	.07
No	65	348	1.00	1.00	
Head of the family					
Father	204	856	0.32 (0.07-1.43)	0.33 (0.07-1.57)	.16
Mother	9	115	0.10 (0.02-0.54)	0.13 (0.02-0.72)	.02*
Other	3	4	1.00	1.00	
Defecation practice					
Open Field	89	495	0.68 (0.50-0.92)	0.73 (0.53-1.01)	.05
Sanitary latrine	127	480	1.00	1.00	
Parental education					
Can't read and write	117	572	1.00	1.00	
Can read and write	69	311	0.63 (0.39-0.99)	1.13 (0.80-1.59)	.48
Primary school and above	30	92	0.68 (0.42-1.10)	1.48 (0.92-2.38)	.12
Maternal occupation					
Farmer	200	846	1.91 (1.11-3.28)	1.13 (0.55-2.32)	.73
Other	16	129	1.00	1.00	

AOR, adjusted odd ratio; COR, crude odd ratio.
*P = .05. **P = .01, Hosmer and Lemeshow test = 0.384, and VIF = between 1.029 and 1.197.

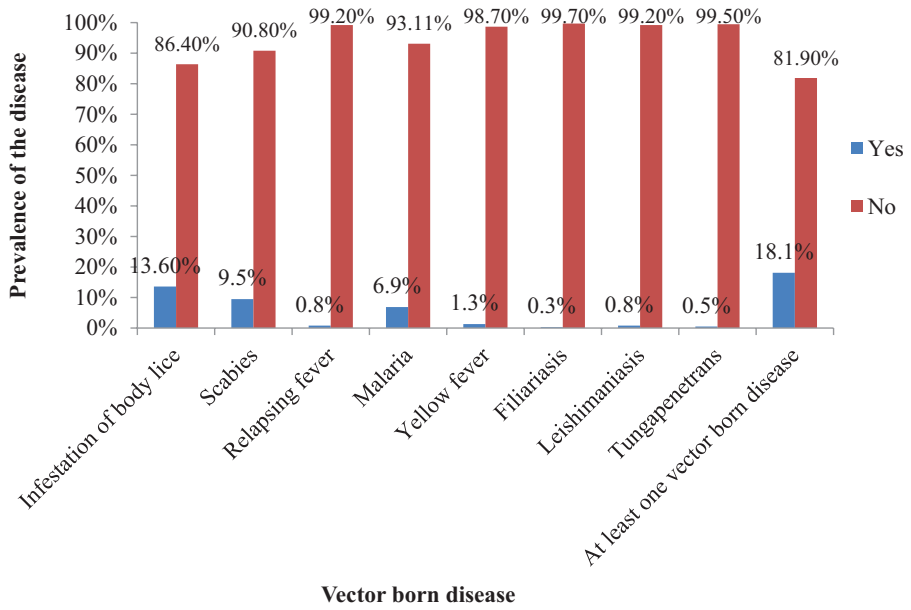

Figure 2. Self-reported vector-borne diseases in the rural settings of northwest Ethiopia, 2017.

similar with the studies in Liberia (9.3%)[26] and lower than Cameron (17.8%).[27] The higher prevalence is might be due to poor waste disposal systems, poor personal and environmental hygiene practices of rural communities.[28] As the current study showed, the defecation practice of 584 (49%) households was an open field and 1048 (88%) of the participant reported that as there was no waste disposal site around a 15 km radius of the water source. The lower prevalence is might be due to the study participant difference, the study participant in the current study is not a high-risk group only.

In the current study, regularly cleaning the living environment was significantly associated with vector-borne diseases. This finding was supported by different studies conducted in developing countries.[26,29,30] This might be due to a clean living environment is not suitable for most of the causative agents of vector-borne diseases.[31-33] This implies that everyone shall keep the personal and environmental hygiene and sanitation regularly and there should be a rule and regulation for those who might dispose of man-made wastes openly.

Cleanness of the floor is also another factor associated with vector-borne diseases. This is because when there is an unclean floor the causative agents of most of the vector-borne diseases could easily be occurring and causes the disease and a clean floor is not favorable for vector breading.[34,35] This implies everyone should clean their floor on a regular basis.

The current study revealed that the low prevalence of vector-borne diseases was significantly associated with the head of the household. This fact can be justified that in a household where the female was head, they can easily decide for every home-based sanitation management including waste disposal, personal, and environmental hygiene practices. In areas where the rural communities have no female head of the household, close and regular supervision and enforcement of rural households by health extension workers or other local health professionals are necessary to have a habit of personal and environmental hygiene and sanitation practices. The health care system shall to strengthening and empowering female leadership and home-based sanitation program in a regular manner by incorporating supportive supervision systems in rural areas.[36-39]

Conclusion

The self-reported vector-borne diseases in the current study were high. Scabies and malaria were the leading vector-borne diseases in the study area. Family head, regular cleaning of living environment, and cleanliness of floors were significantly associated with vector-borne diseases. The health care system shall to fight against those vector-borne diseases by designing appropriate intervention strategies in line with the community living conditions.

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Authors' Contribution

ZG conceived and designed the study. All the authors participated during data collection, data processing and coding, and analysis and interpretation of findings. AN prepared the manuscript. All the authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

Ethical clearance was obtained from the Institutional Review Board of the University of Gondar, and an official letter was submitted to the district administrators. There were no risks due to participation in this research project, and the collected

data were used only for this research purpose. Verbal informed consent was obtained from the household heads. The information collected from each household kept with complete confidentiality.

Consent Publication

This manuscript does not contain any individual person's data.

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Availability of Data and Material

The datasets generated and/or analyzed during the current study are uploaded as a supplementary material (Supplemental Material-3).

Supplemental Material

Supplemental material for this article is available online.

REFERENCES

1. Stoddard ST, Morrison AC, Vazquez-Prokopec GM, et al. The role of human movement in the transmission of vector-borne pathogens. *PLoS Negl Trop Dis*. 2009;3:e481.
2. Nelson KE. *Epidemiology of Infectious Disease: General Principles. Infectious Disease Epidemiology Theory and Practice*. Aspen Publishers; 2007:17-48.
3. Marselle MR, Stadler J, Korn H, Irvine KN, Bonn A. *Biodiversity and health in the face of climate change*. Springer Nature; 2019:1-13.
4. World Health Organazation. *A Global Brief on Vector-Borne Diseases*. World Health Organization; 2014.
5. Beard CB, Visser SN, Petersen LR. The need for a national strategy to address vector-borne disease threats in the United States. *J Med Entomol*. 2019;56:1199-1203.
6. Tabachnick WJ. Challenges in predicting climate and environmental effects on vector-borne disease episystems in a changing world. *J Exp Biol*. 2010;213:946-954.
7. Tilak R, Ray S, Tilak VW, Mukherji S. Dengue, chikungunya . . . and the missing entity – Zika fever: a new emerging threat. *Med J Armed Forces India*. 2016;72:157-163.
8. Parham PE, Waldock J, Christophides GK, et al. Climate, environmental and socio-economic change: weighing up the balance in vector-borne disease transmission. *Philos Trans R Soc B Biol Sci*. 2015;370:20130551.
9. Alonso Aguirre A, Basu N, Kahn LH, et al. Transdisciplinary and social-ecological health frameworks-novel approaches to emerging parasitic and vector-borne diseases. *Parasite Epidemiol Control*. 2019;4:e00084.
10. Dhiman RC, Pahwa S, Dhillon GP, Dash AP. Climate change and threat of vector-borne diseases in India: are we prepared? *Parasitol Res*. 2010;106:763-773.
11. CSA (Central Statistical Agency), "Agricultural Sample Survey," Vol 1. Report on Area and Production of Crops (Private Peasant holdings Meher Season). Statistical Bulletin 578. CSA, Addis Ababa, Ethiopia, 2015.
12. Watson JM, Moritz JB. Developing concepts of sampling. *J Res Math Educ*. 2000;31:44-70.
13. Yates F. Systematic sampling. *Philos Trans R Soc Lond A Math Phys Sci*. 1948;241:345-377.
14. Fewtrell L, Kaufmann RB, Kay D, Enanoria W, Haller L, Colford JM Jr. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect Dis*. 2005;5:42-52.
15. Supply WUJW, Programme SM. *Progress on Drinking Water and Sanitation: 2014 Update*. World Health Organization; 2014.
16. Malone K. Children's rights and the crisis of rapid urbanisation. *Int J Child Rights*. 2015;23:405-424.
17. Braubach M, Jacobs DE, Ormandy D. *Environmental Burden of Disease Associated With Inadequate Housing: A Method Guide to the Quantification of Health Effects of Selected Housing Risks in the WHO European Region*. World Health Organization; 2011.
18. Ababa A. *Federal Democratic Republic of Ethiopia Ministry of Health*. Postnatal Care; 2003.
19. Waddington H, Snilstveit B. Effectiveness and sustainability of water, sanitation, and hygiene interventions in combating diarrhoea. *J Dev Effect*. 2009;1:295-335.
20. Anaemia with Association of Body Mass Index among Karachi University students, Pakistan. *J Pak Med Assoc*. 2021;71:55-58.
21. Brownlow C. *SPSS Explained*. Routledge; 2014.
22. Heinze G, Wallisch C, Dunkler D. Variable selection – a review and recommendations for the practicing statistician. *Biom J*. 2018;60:431-449.
23. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. *Source Code Biol Med*. 2008;3:17.
24. Stoltzfus JC. Logistic regression: a brief primer. *Acad Emerg Med*. 2011;18:1099-1104.
25. Henderson CA. Skin disease in rural Tanzania. *Int J Dermatol*. 1996;35:640-642.
26. Collinson S, Timothy J, Zayzay SK, et al. The prevalence of scabies in Monrovia, Liberia: a population-based survey. *PLoS Negl Trop Dis*. 2020;14:e0008943.
27. Kouotou EA, Nansseu JR, Kouawa MK, Bissek AC. Prevalence and drivers of human scabies among children and adolescents living and studying in Cameroonian boarding schools. *Parasites & vectors*. 2016;9:1-6.
28. Yudhana A, Setyamulyasari R, Pontjowijono D, Rusmawati A, Priyanto KE, Wardani LK. Analysis Of Personal Hygiene And Sanitation Facilities For The Incidence Of Skin Disease In Scavengers At Tpa Klotok, Kediri City. *Eur J Mol Clin Med*. 2020;7:922-934.
29. Abossie A, Yohanes T, Nedu A, Tafesse W, Damitie M. Prevalence of malaria and associated risk factors among febrile children under five years: a cross-sectional study in Arba Minch Zuria district, South Ethiopia. *Infect Drug Resist*. 2020;13:363-372.
30. Haile T, Sisay T, Jemere T. Scabies and its associated factors among under 15 years children in Wadila district, Northern Ethiopia, 2019. *Pan Afr Med J*. 2020;37:224.
31. World Health Organization. *Keeping the Vector Out: Housing Improvements for Vector Control and Sustainable Development*. World Health Organization; 2017.
32. Gubler DJ. The global threat of emergent/re-emergent vector-borne diseases. In Atkinson PW, ed. *Vector biology, ecology and control*. Dordrecht: Springer; 2010: 39-62.
33. Sendari S, Ratnaningrum R, Ningrum M, et al. Developing e-module of environmental health for gaining environmental hygiene awareness. *IOP Conf Ser Earth Environ Sci* 2019;245:012023.
34. Bloomfield SF, Exner M, Signorelli C, Nath K, Scott E. The chain of infection transmission in the home and everyday life settings, and the role of hygiene in reducing the risk of infection. Paper presented at: International Scientific Forum on Home Hygiene London school of Hygiene and Tropical Medicine; 3 September 2012.
35. Peltz JS, Rogge RD. The indirect effects of sleep hygiene and environmental factors on depressive symptoms in college students. *Sleep Health*. 2016;2:159-166.
36. Bilal NK, Herbst CH, Zhao F, Soucat A, Lemiere C. Health extension workers in Ethiopia: improved access and coverage for the rural poor. In: Chuhan-Pole P, Angwafo M, eds. *Yes Africa Can: Success Stiroes From a Dynamic Continent*. World Bank; 2011.
37. World Health Organization. *Increasing Access to Health Workers in Remote and Rural Areas Through Improved Retention: Global Policy Recommendations*. World Health Organization; 2010.
38. Choi SL, Goh CF, Adam MB, Tan OK. Transformational leadership, empowerment, and job satisfaction: the mediating role of employee empowerment. *Hum Resour Health*. 2016;14:73-14.
39. Caselli E, Brusaferro S, Coccagna M, et al. Reducing healthcare-associated infections incidence by a probiotic-based sanitation system: a multicentre, prospective, intervention study. *PLoS One*. 2018;13:e0199616.