Hindawi
Canadian Journal of Infectious Diseases and Medical Microbiology
Volume 2023, Article ID 4349078, 15 pages
https://doi.org/10.1155/2023/4349078

Research Article

A Community-Level Knowledge, Attitude, and Practice about Dengue Fever and the Identification of Mosquito Breeding Containers in Dire Dawa City of Ethiopia: A Cross-Sectional Study

Taye Kebede,[1,2] **Bedasa Tesema**,[3] **Akalu Mesfin**,[4] **and Dejene Getachew**[5]

[1]*Department of Biomedical Sciences and Immunology, Natural Sciences College, Madda Walabu University, P.O. Box 247, Bale-Robe, Ethiopia*
[2]*Aklilu Lemma Institute of Pathobiology, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia*
[3]*Epidemiology and Biostatistics Unit, Department of Public Health, College of Medicine and Health Sciences, Ambo University, P.O. Box 19, Ambo, Ethiopia*
[4]*Department of Biology, College of Natural and Computational Sciences, Dire Dawa University, P.O. Box 1362, Dire Dawa, Ethiopia*
[5]*Department of Applied Biology, School of Applied Natural Sciences, Adama Science and Technology University, P.O. Box 1888, Adama, Ethiopia*

Correspondence should be addressed to Taye Kebede; tayekebede2012@gmail.com

Received 18 February 2023; Revised 15 May 2023; Accepted 20 May 2023; Published 25 May 2023

Academic Editor: Bishnu P. Marasini

Background. Lately, dengue fever (DF) is an emerging viral disease, one of the top 10 threats to global health, causing 24 million–130 million symptomatic cases and 10,000–50,000 deaths yearly. DF threat has expanded beyond traditional areas of endemicity, with over 50% of the world population now estimated to live in areas at risk of dengue virus (DV) transmission. Hence, the current study aimed to assess the community's knowledge, attitude, and practice about DF transmission and its prevention and to identify mosquito breeding containers in Dire Dawa City, Ethiopia. *Methods*. A household-based cross-sectional study was conducted from February to September 2022. A semistructured questionnaire was used to collect data. Immature stages of mosquitoes were collected from human habitations to identify their breeding containers. Both descriptive and inferential statistics were used to analyze the data. A p value of <0.05 was used to declare a significant association between variables at a 95% level of confidence. *Results*. About 95.1% of respondents had information about DF, where the majority (58.0%) heard from relatives, friends, and families and 43.3% from health professionals. Only 17.9% knew DF was caused by viruses. Around 83%, 79%, and 50.8% of respondents knew that fever, headache, and back pain are the sign and symptoms of DF, respectively. Sadly, only 4.2% knew that DF vectors bite during day time and 10.5% of respondents did not know DF transmission season. The majority (80.5%) of respondents knew that DF is a preventable disease. Totally, 6,853 water-holding containers were identified, out of this 77% were jerrycans and 14.1% were barreled. Out of the identified water-holding containers, 7.73% were positive for mosquito larvae/pupae. House index (HI), container index (CI), and Breteau index (BI) were 19.5, 8.38, and 45.14, respectively. *Conclusion*. The majority of the community members has no awareness of the DF vectors, time of bites, pick transmission season, and their protection mechanisms. The habit to store water in and around habitation was prevalent. Hence, programmed and institutionalized awareness is mandatory for the control and prevention of DF and its vectors and for breaking the transmission cycle in Dire Dawa communities.

1. Introduction

Currently, tropical and subtropical regions of the world suffer from DF [1], predominantly in urban and semiurban areas [2]. About half of the world's population lives at risk of DF infection [3], among whom 50–100 million people get infections every year [4]. DF is caused by one of the four closely related virus serotypes (DEN-1, DEN-2, DEN-3, and DEN-4), which belongs to the genus *Flavivirus* and family Flaviviridae [5]. The fifth and latest addition to the existing serotypes of dengue viruses (DENV-5) was announced in October 2013 and is genetically similar to the other four serotypes [6]. A person living in DF endemic area can have infections with these different DV serotypes in his lifetime due to lack of cross-immunity against the other serotype [7].

In Africa, DV infected 15.7 million people in 2010 [8]. Though the disease spread dramatically in different parts of the continent [9], many cases of DF are more frequently reported among travellers than the local population because of under-recognized and under-reported as a result of inadequate knowledge even among the health care providers [10], related prevalent febrile illnesses and lack of diagnostics testing kits and systemic surveillance [11]. In 2010, DV infected annually between 500,000 and 1 million people of all age groups in Ethiopia [8]. There were findings reported from Borena [12] and Arba Minch districts [13] in southern Ethiopia. In Dire Dawa city dwellers, death from DF was reported since 2013 from 11,409 suspected cases during that time, out of which 50.2% were males [14]. Also, a published report between October 7, 2017 and November 14, 2017 revealed around 309 DF cases in Dire Dawa city [15]. In recent years, despite a rising number of reported cases due to DF, there is limited information on the knowledge, attitudes, and practices of the Dire Dawa administration city communities towards DF and its preventive measures [16], though instrumental for successful control of the disease.

Human beings are the main host of DV, with *Aedes* mosquitoes being the principal vectors. *Aedes aegypti* and *Aedes albopictus* are the two most important vectors. *Aedes aegypti* is a highly domesticated, strongly anthropophilic, day-biting, nervous feeder, and is a discordant species [17]. It prefers to lay its eggs in artificial containers commonly found in and around homes, such as flower vases, septic tanks, old automobile tires, drums, cement cisterns, buckets that collect rainwater, domestic water containers, and trash [18]. DF symptoms are commonly characterized by acute febrile illness with sometimes biphasic fever (high body temperature) (≥38.5°C), severe headache, vomiting, myalgia, and joint pain and sometimes with a transient macular rash, petechiae, bruising, and palpable liver [19].

Vector control interventions are the most widely used method to reduce or prevent DV transmission in most endemic countries. These vector control interventions include source reduction, cleanup campaigns, regular container emptying and cleaning (targeting households (HHs), cemeteries, green areas, and schools), covering water-holding containers, installation of water supply systems, and solid waste management [20]. The community needs to be educated about the specific behaviour of the vector and the corrective environmental modification (permanent and long-lasting) and environmental manipulation (temporary and short-lived) measures that they need to take to reverse *Aedes* mosquito breeding. Hence, *Aedes aegypti* larval surveillance in water-storage containers in houses or premises is very important [21]. In Dire Dawa city, at the community level, there is a paucity of information on the controlling role of knowledge, attitude, and practice of the community members together with that of vector breeding site explorations. Thus, the current study aimed to assess the knowledge, attitude, and practice of the community about dengue fever transmission and prevention, together with that of mosquito breeding container identification in Dire Dawa City, Ethiopia.

2. Materials and Methods

2.1. Study Area and Period. The study was conducted in Dire Dawa administration city, from February to September 2022. The coordinates of Dire Dawa city are 9°35′35″ N and 41°51′57″ E (Figure 1) and are found at a distance of 515 kilometers from Addis Ababa (Ethiopian capital city) in the east direction. Dire Dawa administration city has 9 urban kebeles (kebele is the smallest demographic administrative unit in Ethiopia) and 38 rural kebeles with a total land coverage of 1213.2 km^2. Dire Dawa is located 1200 meters above the sea level. It experiences an annual minimum temperature of 17.4°C, a maximum temperature of 31.3°C, and an annual mean temperature of 24.3°C. It is hot almost the whole year round, which picks up in June (when it exceeds 35°C). In winter, it is warm during the day, but the nights are quite cool on the opposite. It has 670 mm of rainfall per year, with two relatively rainy periods, from March to May and July to September. Also, the city has two dry periods, from October to February and in June. The current study period covered both rainy seasons in the study area, short and long rainy seasons, which facilitate the breeding of mosquitoes.

Among the urban challenges of Dire Dawa are periodical floods entering the city, and the majority of the population lives in slums or substandard housing. Again, though well planned, the central part of the city lacks maintenance. In addition, due to excessive informal settlements, it suffers access to clean water and proper sanitation. The sanitation problem is exacerbated due to drainage filling up with mud during flooding and forgotten maintenance. The poor solid waste collection coverage (only 48% of solid waste is collected) and the lack of sewerage and stormwater drainage systems are other contributing factors to the declining better livelihood of the city citizens [22]. The 2017 population estimate indicated that Dire Dawa administration city has a total population of 478,596 and a total household of 106,355. Out of the total population, 316,159 were residents of the urban area. There are 70,257 HHs in the urban area of the city administration [23].

2.2. Study Design. A community-based cross-sectional study was conducted in Dire Dawa administration city.

2.3. Source Population. All registered residents of Dire Dawa administration city who were living for at least 6 months in the city, adults, and eligible to participate in the study.

2.4. Study Population. All sampled adults above 18 years of age, who volunteered to give consent for the interview, were mentally stable, and lived in the study area for at least 6 months were included.

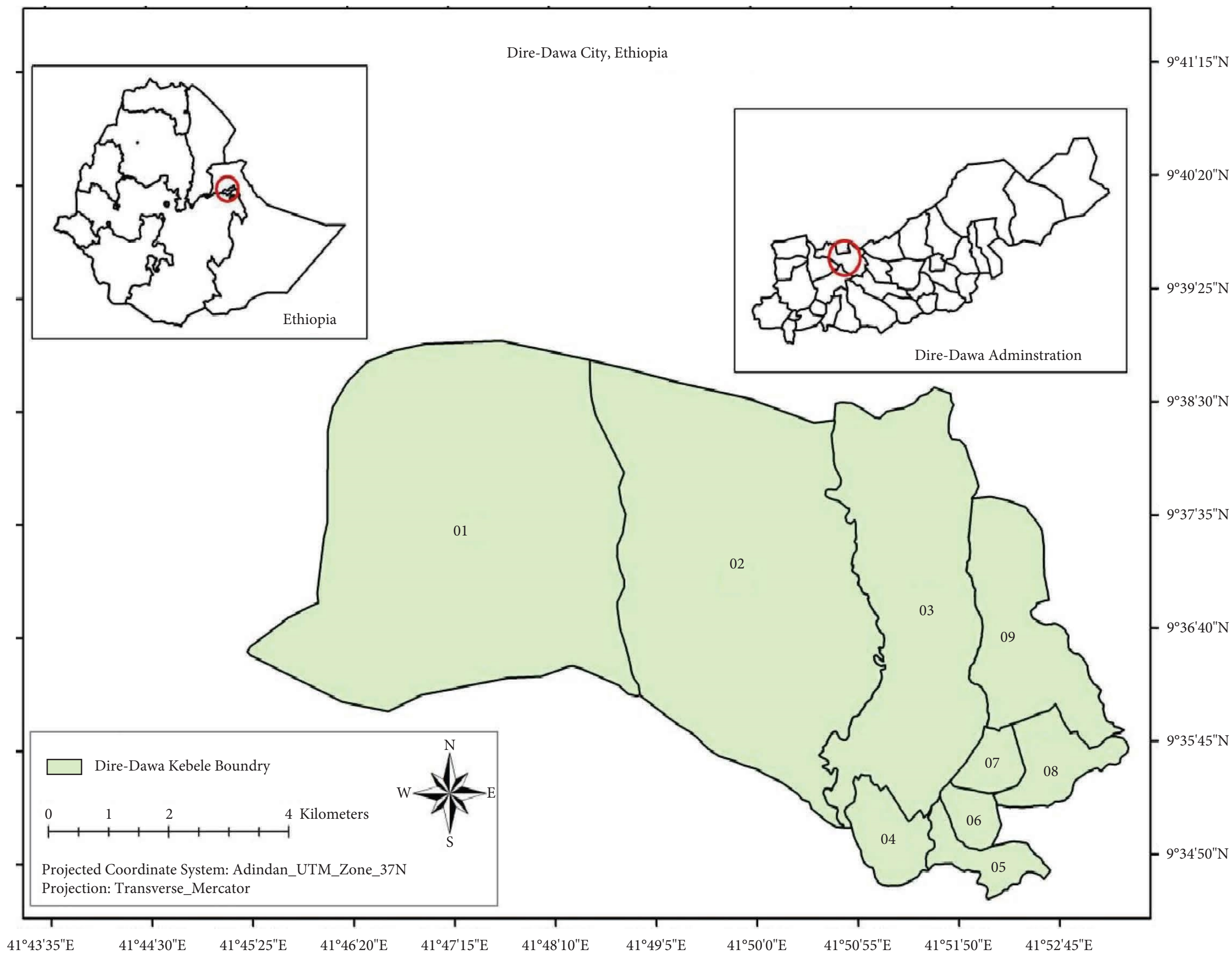

Figure 1: Map of the study area: Dire Dawa city.

2.5. Sample Size Determination and Sampling Technique. The total number of HHs in the Dire Dawa administration city was 106,355, while 70,257 of these HHs were from urban areas (see S1 File). The current study's target population was HHs that were found in the urban area. The sample size was calculated by using a single population proportion formula with a standard variate (Z value) at 95% of confidence interval (CI) of 1.96, by assuming an expected proportion of knowledge, awareness, or practice of the community members about DF of 50% and a marginal error of 3% [24]. Then, the calculated sample size was 1067. To minimize errors for the likelihood of a nonresponse rate, 10% of the total sample size was added. Accordingly, the overall minimum sample size was 1174.

Then after, the total sample size of the participants was proportionally allocated to each kebele as follows:

$$\mathbf{n_h} = \left[\frac{n}{N}\right]\mathbf{N_h}, \tag{1}$$

where $\mathbf{n_h}$ is the sample HHs that were taken from each kebele, $\mathbf{n}$ is the total samples included in the current study, $\mathbf{N}$ is the total household in the study area, and $\mathbf{N_h}$ is the total household in each kebele (the proportion of source population in each kebele) (see S1 File). A systematic random sampling technique was used to select individuals included in the study. Proportionally, 59 or 60 class intervals were used to get the next participant. If both household heads were available, the male parent was sampled. If one of the HH heads was available during the data collection period, either of them was included.

2.6. Data Collection Tools. Face-to-face interviews were administered using semistructured questionnaires consisting of open- and close-ended questions to collect data. The first part of the questionnaire included demographic characteristics, the second part was about knowledge, and the third part was about attitude and practices of DF transmission and its control interventions. The questionnaire was prepared in the English language by the research team. The questionnaire was translated into Afaan Oromoo, Soomaali, and Amharic languages for data collection and then back-translated to the English language during the data entry period by consulting the relevant academicians from Madda Walabu University (MWU) and Jigjiga University (JJU). The questionnaire was pretested.

Knowledge of participants about DF was investigated by asking if participants have heard about the disease, their source of information, causative agents, the incubation period of the disease, signs and symptoms, transmission ways, breeding sites of the vectors, biting time of the vector, and transmission season. Respondent's feeling was asked about the severe levels of DF disease, the transmissibility of DF, and the risk to contract the disease if it can be transmitted by contact and if disease transmission could be preventable and controllable through vector management. Information was gathered about the prevention practice of DF, the practice of storing water in their surroundings, prevention methods they use to protect against mosquito bites, control of mosquitoes, and their advice to infected people for cure [25].

2.7. Inclusion and Exclusion Criteria

2.7.1. Inclusion Criteria. The inclusion criteria were residents in Dire Dawa city who lived for at least 6 months, aged more than 18 years of age, and were willing to participate in the study.

2.7.2. Exclusion Criteria. Persons under the age of 18 years, temporary residents, mentally ill residents who had a communication problem, and people who refused to give their consent were excluded from the study.

2.8. Study Variables

2.8.1. Dependent Variables. The dependent variables were knowledge regarding DF (which consists of the source of information, its causative agents, signs and symptoms, vectors and its breeding habitat, and biting time), attitudes towards DF (which consists of the illness brought about with DF, its transmissibility, risk of contracting it, prevention status, and mosquitoes control mechanisms), and community practices about DF (which consists of water storing behaviour, disease preventive measures, and vector control practice).

2.8.2. Independent Variables. The independent variables were socio-demographic factors.

2.9. Survey of Mosquitoes' Larvae and Pupae. Artificial water-holding containers both inside houses and peridomestic areas were visually inspected thoroughly for the presence of containers which support mosquito larvae and pupae breeding in each of the HHs that were voluntary to participate in the study. Physical characteristics and availability of the immature stage (larvae and/or pupae) of mosquitoes in each water-holding container were recorded. Samples of mosquito larvae and pupae were collected and transported to the Zoological Sciences Laboratory of Dire Dawa University.

2.10. Mosquito Species Identification. Larvae and pupae collected were allowed to emerge into an adult. Adults were killed with chloroform and identified into species under a dissecting microscope using the leading key identification methods developed by the authors of [26, 27].

2.11. Data Quality Assurance. A semistructured questionnaire was used to collect the data. The questionnaire was prepared in English and translated to three different local languages (Afaan Oromoo, Soomaali, and Amharic) and back-translated to English during data entry into software by consulting pertinent language experts from MWU and JJU. The training was given to the data collectors, and close supervision was conducted during the data collection period. A questionnaire was pretested on 5% of the total sample size of the study to assure the consistency and validity of the study instrument. A pilot test analysis was executed and all the necessary modifications were made accordingly to the study tool. The collected data were reviewed, checked for completeness, and properly recorded after the analysis.

2.12. Statistical Analysis. Data analysis was performed by using Statistical Products for Social Sciences (SPSS) software Window version 27. Both descriptive and inferential statistics were used to analyze the overall variables. Categorical variables were interpreted using frequency and percentage, while the continuous variables were interpreted using mean and standard deviation (SD) [24]. The associations between independent and dependent variables were tested using Pearson's chi-square test. Values were considered significantly different if the p value <0.05. For attitudes, the response categories were given the scores of 1, 2, 3, 4, and 5 for "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," in that order. Attitudes were considered negative if the score was lower than or equal to 50% of the total score. Larval indices were determined by HI (the percentage of houses infested with larvae and/or pupae), CI (the percentage of water-holding containers infested with larvae and/or pupae), and BI (the number of positive containers per 100 houses inspected) [28]. According to the World Health Organization (WHO) [2], the indices were calculated to assess the levels of *Ae. aegypti* infestations based on the following formulae:

House index (HI): percentage of houses infested with larvae and/or pupae.

$$\mathrm{HI} = \frac{\text{Number of houses infested}}{\text{Number of houses inspected}} x100. \quad (2)$$

Container index (CI): percentage of water-holding containers infested with larvae or pupae.

$$\mathrm{CI} = \frac{\text{Number of positive containers}}{\text{Number of containers inspected}} x100. \quad (3)$$

Breteau index (BI): number of positive containers per 100 houses inspected.

$$BI = \frac{\text{Number of positive containers}}{\text{Number of houses inspected}} x100. \quad (4)$$

3. Results and Discussion

3.1. Results

3.1.1. Respondents' Socio-Demographic Characteristics. The socio-demographic characteristic of the respondents is depicted in Table 1. Out of all the study participants, 39.5% were male individuals. Most of the respondents fall in the age category of 25–34 years (364, 31.0%), were married (802, 68.3%), and were educated at different levels (915, 77.9%). Out of the total study participants, 741 (63.1%) subjects have an occupation to generate their income.

3.1.2. Respondents' Knowledge about Dengue Fever. Under this section, the participants' prior source of information about DF, knowledge about DF signs and symptoms, the causative agent of DF, and its transmission are summarized. The majority (1117, 95.1%) of the respondents have heard at least once and had prior information about DF. There is no significant difference in having information among different sexes, age categories, and marital status, but there is a significant difference concerning the education level categories ($\chi^2 = 26.156$, $p < 0.001$) and occupation ($\chi^2 = 33.997$, $p < 0.001$). Most of the study participants had heard about DF from relatives, friends, and families (648), followed by health professionals (484) (Figure 2).

Around 572 study participants knew at least three signs and symptoms of dengue fever caused by viruses. There is no statistically significant difference among respondents in terms of sex, and marital status ($p \geq 0.05$). On the other hand, there was a statistically significant difference in age, education level, and occupation of the study participants from Dire Dawa city ($p < 0.05$).

Two hundred ten respondents knew that DF is caused by viruses. The chi-square test shows that there is no statistically significant difference among respondents in terms of sex, age, and marital status ($p > 0.05$). However, there was a statistically significant difference between education level and source of income (occupation). Two thousand seven hundred twenty-seven of the respondents knew that dengue fever is transmitted by mosquito bites. There is no statistically significant difference between sex and age ($p > 0.05$). However, there is a statistically significant difference among marital status, education level, and source of income in knowing that DF is transmitted by mosquito bite ($p < 0.05$) (Table 2).

Four hundred fifteen participants (35.3%) or their family members were previously infected by DF, out of which 298 (71.8%) were in the year 2022. Among the respondents, 773 (65.8%) did not know the causative agents of DF, while 210 (17.9%) of the participants correctly described its cause as viruses. Around 855 (72.8%) did not know the incubation period of the pathogen; while 974 (83.0%), 927 (79.0%), and 596 (50.8%) the respondents stated that fever, headache, and back pain were the sign and symptoms of DF in that order. However, 95 (8.1%) did not know any signs and symptoms of DF (Table 3).

Table 1: Socio-demographic characteristics of the respondents.

Characteristics	Count ($n = 1174$)	Percentage
Sex		
Male	464	39.5
Female	710	60.5
Age (in years)		
18–24	183	15.6
25–34	364	31.0
35–44	331	28.2
45–54	137	11.7
55–64	125	10.6
Marital status		
Single	270	23.0
Married	802	68.3
Divorced	31	2.6
Widowed	71	6.0
Educational level		
No formal education	259	22.1
Primary	340	29.0
Secondary	406	34.6
Graduated	169	14.4
Occupation		
Farmer	32	2.7
Government employee	183	15.6
Merchant	315	26.8
Housewife	274	23.3
Self-employee	155	13.2
Daily labourer	56	4.8
No occupation	159	13.5

3.1.3. Respondents' Knowledge of Dengue Transmission. Around 25.2% of the respondents did not know the transmission ways of DF. The members answered the transmission ways as through contact with tainted people ($n = 62$, 5.3%), eating sullied nourishment ($n = 58$, 4.9%), by house flies ($n = 48$, 4.1%), and drinking sullied water ($n = 115$, 9.8%). However, 727 (61.9%) respondents stated correctly as DF is transmitted by mosquito bites. Out of those who reacted correctly to the transmission ways, 111 (9.5%) thought that all mosquitoes can transmit DF and 38 respondents (3.25%) were able to identify DF-causing mosquitoes. About 68 percent replied that the DF-transmitting vector mosquitoes breed on HHs water-holding containers, but 192 (16.4%) did not know where the dengue vector mosquitoes breed. One hundred sixty-eight (14.3%) did not know the time of such a mosquito bite. Only 49 (4.2%) replied the vectors bite during day time. However, 26.7% and 31.2% of the respondents replied dengue vector mosquitoes bite during the night and early evening, respectively. Regarding the pick dengue transmission season; 408 (34.8%) responded during the rainy season, 399 (34.0%) after the rainy season, and 99 (8.4%) at any time of the year (Table 4).

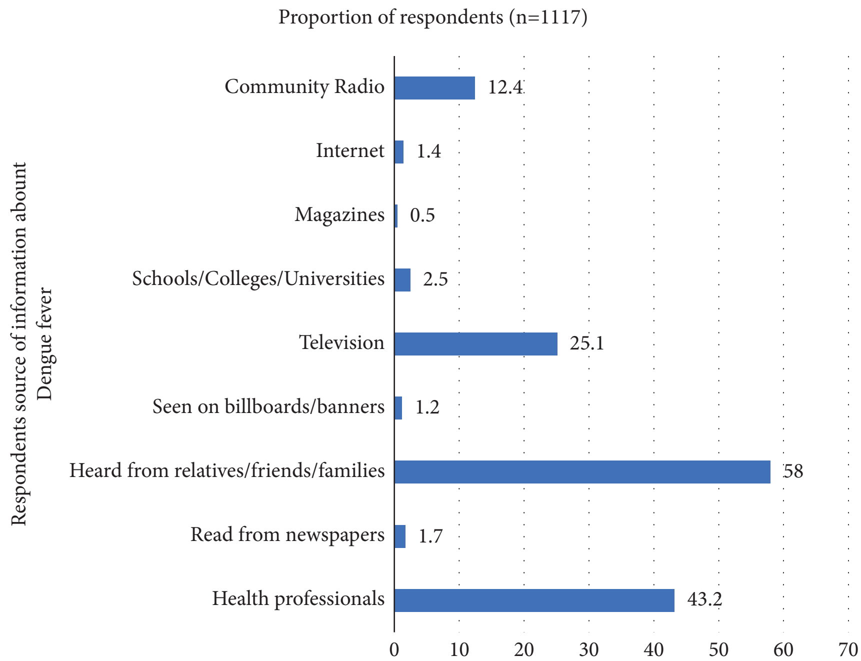

Figure 2: Respondents' prior source of information about DF.

3.1.4. Attitude towards Dengue Fever. Regarding the attitude of the study participants towards DF, 863 (73.5%) strongly agreed and 212 (18.1%) agreed that DF causes a serious illness (Table 5). More than 3/4th of the respondents perceived that DF could not be transmitted by being in contact with infected people. About 80% felt that DF is a preventable disease. Out of those who believed DF is preventable, they believe that DF could be prevented by controlling the breeding places of mosquitoes (85.6%) and community active participation serves as a good strategy to prevent DF (85.5%).

3.1.5. Participants' Practice towards Dengue Prevention. Around 39% of the participating community members had the practice of storing water in and around their houses. Out of those who store water in and around their house, 173 (37.6%) store for 2–7 days, 25 (5.4%) for up to 2 weeks, and 15 (3.3%) for more than two weeks. Among the hones utilized to dodge mosquitoes chomp was utilizing bug spray-treated bed nets (567, 48.3%), smoking houses (526, 44.8%), screening windows (457, 38.9%), and screening entryways (449, 38.2%). However, a low number of respondents uses repellents and protective cloth with long sleeve. Furthermore, 18% did not use any protective measures.

The societal control hones of DF vector mosquitoes were nothing (147, 12.5%), sent cleaning houses (870, 74.1%), disposal of stagnant water (702, 59.8%), and cleaning of garbage/trash (496, 42.2%). However, only 29.2% covered water-holding containers tightly, 14.2% turned upside down water-holding containers, 3.8% applied chemicals on stored water, and 12.5% did not know how to control DV transmitting mosquito vector. Also, 786 (66.7%) of the study participants were in a position to advise infected persons to go to health facilities (Table 6).

3.1.6. Identified Water-Holding Containers. Barrels, jerrycan, plastic drums, tyres, buckets, clay pots, and cisterns were identified as water-holding containers in the study area (Figure 3). 6853 water-holding containers were identified. From the total identified containers, 5277 (77%) were jerrycans followed by the barrel (970, 14.1%). Only one cistern was identified in the compound of the sampled residents (Table 7).

Water-holding containers were identified from the participants' compound from the kebeles of Dire Dawa administration city. From the total containers identified, 3862 (56.3%) were exposed to sunlight, 5522 (80.5%) were closed type, 6110 (89.1%) hold tap water, and 530 (7.7%) of them found with larvae/pupae of mosquitoes (Table 8).

Out of those 530 positive containers for immature stages of mosquitoes, 311 (58.7%) were found under direct exposure to sunlight, 279 (52.6%) were found in closed status, and 331 (62.4%) were containers filled up with rainwater. Thirty-six households were identified with at least two types of water-holding containers being positive for young stages of mosquito breeding (Table 9).

From the total HHs visited during the study, 229 houses were positive for mosquito larvae and/or pupae (Figure 4).

House index (HI): percentage of houses infested with larvae and/or pupae:

$$\text{HI} = \frac{229}{1174} x100 = 19.5. \quad (5)$$

Container index (CI): percentage of water-holding containers infested with larvae or pupae:

Table 2: Participants' response concerning prior information, sign and symptoms, causative agent, and transmission of DF ($n = 1174$).

Variables	Categories	Have prior information about DF				Measure signs and symptoms of DF				Virus as the causative agent of DF				DF is transmitted by mosquito bite			
		No (%)	Yes (%)	χ^2	p value	Knew ≤3(%)	Knew >3(%)	χ^2	p value	No (%)	Yes (%)	χ^2	p value	No (%)	Yes (%)	χ^2	p value
Sex	Male	4.7	95.3	0.022	0.883	48.7	51.3	2.03	0.154	8.2	19.8	1.966	0.161	34.7	65.3	3.71	0.054
	Female	4.9	95.1			53.0	47.0			83.4	16.6			40.3	59.7		
Age	18–24	5.6	94.4	10.54	0.229	61.2	38.8	30.6	0.000	83.7	16.3	10.04	0.262	39.9	60.1	6.75	0.240
	25–34	3.2	96.8			54.4	45.6			82.3	17.7			35.4	64.6		
	35–44	4.4	95.6			43.1	56.9			79.4	20.6			36.6	63.4		
	45–54	8.0	92.0			45.3	54.7			86.9	13.1			41.6	58.4		
	55–64	5.5	94.5			53.5	46.5			80.3	19.7			40.2	59.8		
	≥65	10.0	90.0			70.0	30.0			90.0	10.0			60.0	40.0		
Marital status	Single	3.7	96.3	3.227	0.358	56.3	43.7	4.42	0.220	80.0	20.0	6.467	0.091	43.7	56.3	16.5	0.001
	Married	5.2	94.8			49.5	50.5			82.3	17.7			34.4	65.6		
	Divorced	9.7	90.3			58.1	41.9			74.2	25.8			51.6	48.4		
	Widowed	2.8	97.2			49.3	50.7			91.5	8.5			52.1	47.9		
Education level	No formal educated	10.0	90.0	26.16	0.000	61.4	38.6	28.6	0.000	88.8	11.2	39.14	0.000	53.7	46.3	50.8	0.000
	Primary	5.6	94.4			55.3	44.7			85.3	14.7			37.9	62.1		
	Secondary	2.7	97.3			47.3	52.7			81.8	18.2			35.7	64.3		
	Graduated	0.6	99.4			37.3	62.7			66.3	33.7			20.1	79.9		
Occupation	Farmer	18.8	81.2	34.01	0.000	71.9	28.1	18.1	0.012	84.4	15.6	28.94	0.000	53.1	46.9	23.9	0.001
	Employee	1.1	98.9			47.5	52.5			71.6	28.4			27.9	72.1		
	Merchant	2.2	97.8			46.3	53.7			82.9	17.1			32.1	67.9		
	Housewife	8.0	92.0			48.5	51.5			87.2	12.8			43.4	56.6		
	Self-employee	7.1	92.9			56.1	43.9			76.8	23.2			45.2	54.8		
	Daily laborer	1.8	98.2			51.8	48.2			82.1	17.9			39.3	60.7		
	No occupation	5.0	96.0			61.0	39.0			88.7	11.3			42.1	57.9		

p value <0.05 implicates significant association between the variables, whereas p value ≥0.05 indicates nonsignificant association between variables.

Table 3: Knowledge of dengue virus transmission and its sign and symptoms ($n = 1174$).

Dengue virus transmission and sign and symptom-related questions	n (%)
Had you/your family member contracted dengue fever?	
Yes	415 (35.3)
No	759 (64.7)
If yes to the above question, in which year?	
2022	298 (71.8)
2021	87 (21.0)
2019/20	30 (7.2)
What is the causative agent of dengue fever infection?	
I do not know	773 (65.8)
Virus	210 (17.9)
Bacteria	156 (13.3)
Protozoa	29 (2.5)
Fungus	6 (0.5)
What is the incubation period of dengue fever infections?	
I do not know	855 (72.8)
Within 3 days	157 (13.4)
3–7 days	88 (7.5)
7–15 days	65 (5.5)
More than 2 weeks	9 (0.8)
What do you think are the sign and symptoms of dengue fever?	
I do not know	95 (8.1)
Vomiting	453 (38.6)
Skin rash	76 (6.5)
Fever	974 (83.0)
Muscle pain	324 (27.6)
Back pain	596 (50.8)
Bleeding	174 (14.8)
Joint pain	477 (40.6)
Stomach pain	147 (12.5)
Headache	927 (79.0)
Eye pain	149 (12.7)

$$\text{CI} = \frac{530}{6323} x100 = 8.38. \tag{6}$$

Breteau index (BI): number of positive containers per 100 houses inspected:

$$\text{BI} = \frac{530}{1174} x100 = 45.14. \tag{7}$$

From 530 larvae- and pupae-positive containers, 2760 larvae and 139 pupae were collected from their breeding habitats and transported to the laboratory and reared to the adult stage. From these, 1761 adults emerged, from where 1157 were identified as *Ae. aegypti* while the rest 604 were *Culex* mosquitoes.

3.2. Discussion. This study was conducted to understand the knowledge, attitude, and practice of the Dire Dawa city community on dengue fever. In addition to this, artificial containers that use as breeding places for mosquitoes in and around human habitation of the study participants were identified. The result indicated that most of the study

Table 4: Participant's knowledge of DF transmission and vectors ($n = 1174$).

Dengue transmission-related questions	n	%
How DF is transmitted?		
Do not know	296	25.2
Contact with infected patients	62	5.3
Eating contaminated food	58	4.9
House flies	48	4.1
Drinking contaminated water	115	9.8
Blood transfusion	12	1.0
Mosquito bite	727	61.9
Can all mosquitoes transmit dengue fever?		
Yes	111	9.5
No	730	62.2
Do not know	333	28.3
Can you easily differentiate dengue vector mosquitoes from others?		
Yes	38	3.24
No	1136	96.76
Where do you think dengue vector mosquitoes breed?		
Do not know	192	16.4
In tree hole	206	17.5
In household water-holding containers	800	68.1
On plant axil	91	7.8
On roof gutter	273	23.3
On ditches	338	28.8
In discarded tires	431	36.7
On plant pot	302	25.7
At what time of the day that DF vectors bite?		
Do not know	168	14.3
Day time	49	4.2
Early in the evening	366	31.2
Night time	313	26.7
Morning	18	1.5
Both day and night	260	22.1
When do you think dengue fever transmission is high?		
Do not know	123	10.47
During the rainy season	408	34.75
After rainy season	399	33.98
Dry season	145	12.4
Any time	99	8.4

participants were female; this was because most of the time females were available at home to be involved in the study. The majority of respondents (95.1%) have heard about dengue fever. There was no significant difference in hearing about dengue on sex, age, and marital status. However, this study revealed that the level of education and source of income were significantly different among respondents in having information about dengue fever. This could be because working adults are more likely to be involved in health campaigns and education in their workplace and have more information on dengue fever compared to the unemployed. People with better economic status may have better access to and appreciation for reliable information [29].

Most of the respondents (58.0%) heard about dengue fever from their relatives, friends, and families as well as from health professionals (43.3%). A study conducted in an urban slum of south India showed that 47% of the respondents knew about dengue fever through television and

Table 5: Respondent's attitude towards dengue fever ($n = 1174$).

Items	Scales	n (%)	Mean score	Std. deviation
Dengue fever causes a serious illness	Strongly disagree	46 (3.9)	4.57	0.913
	Disagree	32 (2.7)		
	Neutral	21 (1.8)		
	Agree	212 (18.1)		
	Strongly agree	863 (73.5)		
Dengue fever is a transmissible disease	Strongly disagree	125 (10.6)	3.62	1.91
	Disagree	218 (18.6)		
	Neutral	39 (3.3)		
	Agree	390 (33.2)		
	Strongly agree	402 (34.2)		
You are at risk of contracting dengue fever	Strongly disagree	199 (17.0)	2.74	1.319
	Disagree	488 (41.6)		
	Neutral	28 (2.4)		
	Agree	333 (28.4)		
	Strongly agree	126 (10.7)		
Dengue fever can be transmitted when there is contact with infected people	Strongly disagree	339 (28.9)	2.23	1.204
	Disagree	563 (48.0)		
	Neutral	34 (2.9)		
	Agree	158 (13.5)		
	Strongly agree	80 (6.8)		
Dengue fever is a preventable disease	Strongly disagree	75 (6.4)	4.00	1.219
	Disagree	136 (11.6)		
	Neutral	19 (1.6)		
	Agree	435 (37.1)		
	Strongly agree	509 (43.4)		
Controlling the breeding places of mosquitoes is a good strategy to prevent dengue fever	Strongly disagree	60 (5.1)	4.3	1.124
	Disagree	75 (6.4)		
	Neutral	19 (1.6)		
	Agree	279 (23.8)		
	Strongly agree	725 (61.8)		
Communities should actively participate in controlling the vectors of dengue fever	Strongly disagree	61 (5.2)	4.31	1.125
	Disagree	79 (6.7)		
	Neutral	19 (1.6)		
	Agree	278 (23.7)		
	Strongly agree	725 (61.8)		
Total mean score			3.68	

Table 6: Practices towards dengue fever prevention ($n = 1174$).

Dengue prevention practice related questions	n (%)	Mean score	Standard deviation
Do you have the practice of storing water in and around your house?			
Yes	460 (39.2)	0.39	0.488
No	714 (60.8)		
For how long do mostly you store water?			
Two days	247 (53.7)	0.58	0.741
2–7 days	173 (37.6)		
7–15 days	25 (5.4)		
>15 days	15 (3.3)		
What preventive measures are you taking to avoid contact with mosquitoes?			
No measure taken	211 (18.0)	0.18	0.382
Smoking houses	526 (44.8)	0.45	0.498
Mosquito repellent	87 (7.4)	0.07	0.262
ITNs	567 (48.3)	0.48	0.5
Screening doors	449 (38.2)	0.38	0.486
Protective cloth with long sleeve	102 (8.7)	0.09	0.282
Spraying houses with insecticides	372 (31.7)	0.32	0.465
Screening windows	457 (38.9)	0.39	0.488
What methods are you using to control DF vector mosquitoes?			
Do not know	147 (12.5)	0.13	0.331
Cleaning of garbage/trash	496 (42.2)	0.42	0.492
Cover water container tightly	343 (29.2)	0.29	0.455
Spraying houses with insecticides	230 (19.6)	0.20	0.397
Turn water containers upside down	167 (14.2)	0.14	0.349
Cleaning house	870 (74.1)	0.74	0.438
Elimination of stagnant water	702 (59.8)	0.6	0.491
Application of chemicals on stored water	45 (3.8)	0.04	0.192
Other	2 (0.2)	0.0	0.041
What do your advice people infected with DF to be cured of infection?			
Did not give any advice	253 (21.5)	0.22	0.411
To go to health facilities	786 (66.7)	0.67	0.471
Shitini	326 (27.7)	0.28	0.448

Shitini = perceived traditional healing practice with local spicy food with a significant burning sensation.

radio and 35% of them were from newspapers and banners [30]. In a study conducted in Malaysia, television was used as the main source of information followed by printed media and radio to hear about DF [31]. Communities of Vientiane, the Lao PDR [32], central Nepal [33], Southeast Brazil [34], and Jhansi City [35] showed TV and/or radio are the main source of information about DF.

In our study, most respondents identified fever, headache, and back pain were signs and symptoms of dengue fever but 8.1% did not know any of the signs and symptoms. Other studies also showed that the majority of participants identified general symptoms of dengue fever as fever and headache as reported by [33, 34]. Age, education level, and source of income were variables that indicated variation in the knowledge of signs and symptoms. People become more knowledgeable about the signs and symptoms of the disease when they live in communities with a high prevalence [36], due to their close observation of dengue infection contracted by their family members and/or neighbours [37].

The present study revealed that about 61.9% of respondents knew that dengue fever is transmitted by mosquito bites. Some participants incorrectly responded as it is transmitted by contacting infected persons (5.3%), eating contaminated food (4.9%), by house flies (4.1%), and drinking contaminated water (9.8%). Studies conducted in the Philippines showed that the vast majority of the respondents knew that dengue is caused by a mosquito bite [31, 38]. However, in other studies, only about half of the respondents knew that dengue is transmitted by a mosquito [35, 39]. The majority of respondents (68.1%) knew that dengue vectors breed in household water-holding containers but less than half of the respondents replied that the vector breeds in a tree hole, plant axil, roof gutter, ditch, discarded tire, and plant pot. Like our study, studies conducted in other countries showed most respondents indicated the prominent breeding site for the vector as standing clean water [30, 35]. Only 22.1% responded as dengue vector mosquito bites during the day and at night. In other study areas, it was considered as these mosquitoes mostly bite at night [30, 36, 39] or early in the morning [31]. This might be because the study area is endemic to malaria and thus residents are more familiar with the malaria vectors that are generally active during the night [36]. In our study, 34.0% knew transmission of dengue fever is high after the rainy season. A study in Malaysia showed that respondents incorrectly replied that dengue epidemics start during hot weather [31].

FIGURE 3: Identified *Aedes* mosquito breeding habitats: (a) barrel, (b) mud pots, (c) torn jerrican, (d) open plastic drum, (e) torn barrel, (f) plastic bowl, (g) plastic drums and jerrycans, and (h) tyre.

Our study revealed that most respondents agreed that dengue fever causes a serious illness which is a transmissible and preventable disease. This is in line with other studies [33, 39] but contrasted with another study [31] which reported only 4.0% of all the respondents were afraid of DF and its complications. Such misconceptions may lead to the assumption that dengue fever is an unavoidable disease for local people because, from the local perspective, avoidance of mosquitoes alone is not sufficient to prevent the disease [36].

Our ponder uncovered that 39.2% of investigate members had the hone of putting away water in and around their houses with a moo number of respondents utilizing larval source administration strategies. Even though most members detailed covering their water tanks after utilize, this circumstance makes community engagement in the disposal of mosquito breeding destinations in water holders exceedingly vital [36].

Less than 50% of the respondents use ITNs, smoking houses, screening windows, and screening doors, and 18% did not use any protective measures. In other studies, the respondents use different control methods with different proportions [31, 38, 39]. In another study, the community mostly depends on managing the mosquitoes' breeding habitats [32]. To curb dengue, reducing the vector

Table 7: Types of water-holding containers identified in each kebele.

Kebeles	Container types: Barrel		Jerrycan		Plastic drum		Tyre		Bucket		Cistern		Clay pot	
	HH	*n*	HH	*n*	HH	*n*	HH	*n*	HH	*n*	HH	*n*	HH	*n*
01	—	—	53	251	30	40	—	—	—	—	—	—	—	—
02	95	192	198	994	51	76	7	14	30	58	1	1	2	2
03	50	89	89	463	2	2	—	—	7	10	—	—	—	—
04	37	71	77	408	9	15	4	8	18	29	—	—	1	1
05	48	99	63	331	20	58	2	2	6	7	—	—	1	1
06	30	52	78	467	15	18	—	—	7	7	—	—	3	4
07	78	147	99	543	16	26	—	—	16	33	—	—	5	7
08	78	148	88	431	22	52	2	5	6	10	—	—	5	6
09	107	172	201	1389	43	78	3	4	18	26	—	—	3	6
Total		970		5277		365		33		180		1		27

HH = household; *n* = number of containers identified.

Table 8: Containers type and its associated characteristics in suiting mosquitoes' young stages breeding site.

Types of container	Sun exposure			Lid status		Water type				Larvae/pupae	
	Lit	Partial	Shade	Open	Closed	Tape	Rain	Mixed	Ground	Negative	Positive
Barrel	611	—	359	227	743	695	275	—	—	767	203
Jerrycan	3005	13	2259	860	4417	4984	290	3	—	5076	201
Roto	117	1	247	112	253	290	71	3	1	311	54
Tyre	32	—	1	32	1	9	24	—	—	11	22
Bucket	83	—	97	94	86	114	65	1	—	142	38
Cistern	1	—	—	1	—	1	—	—	—	1	—
Clay pot	13	—	14	5	22	17	10	—	—	15	12
Total	3862	14	2977	1331	5522	6110	735	7	1	6323	530

Table 9: Containers types and their characteristics in suiting larvae and pupae breeding among the positive HHs for young stages of mosquitoes.

Types of container	HH number	Number of positive containers	Sun exposure		Lid status		Water type			
			Lit	Shade	Open	Closed	Tap	Rain	Mixed	Ground
Barrel	129	203	137	66	86	117	60	143	—	—
Jerrycan	55	201	102	99	79	122	115	86	—	—
Roto	35	54	23	31	38	16	10	40	3	1
Tyre	12	22	22	—	22	—	—	22	—	—
Bucket	25	38	19	19	21	17	8	30	—	—
Clay pot	9	12	8	4	5	7	2	10	—	—
Total		530	311	219	251	279	195	331	3	1

HH = household.

population and preventing virus transmission are equally important. Without community participation, it is impossible to reduce dengue prevalence [29, 33]. Among respondents, 66.7% advised people infected with dengue fever to go to health facilities to get cured of the infection while 27.7% advised DF-infected patients to take shitni (local spice with high burning sensation, while eaten made of green pepper, ginger, tomato, and salad as main ingredients).

To combat dengue fever by breaking the chain of disease transmission, it is important to know the breeding places that lead to mosquito eradication, including the types and locations of breeding sites [40]. Entomologic indices, BI in particular, allow the identification of geographic units at high risk for dengue transmission [41–43]. In a study conducted in the Kandy district of Sri Lanka, three different risks of HI, HI >6.75% were defined as low risk, while HI >9.43 and HI >12.82 were defined as moderate and high risk, respectively [44]. A study conducted in China showed as for BI and CI, BI = 8.1, and CI = 11.7 were used as the optimal cut-off value for discriminating outbreaks of DF [45]. Our study revealed that, HI, CI, and BI of 19.5, 8.38, and 45.14, respectively. Based on the results used as cut-points indicated above, the community of Dire Dawa city are at high risk of dengue fever outbreaks. Larval indices (HI, CI, and BI) for *Aedes* larvae in both high and low-incidence districts were 35, 13, and 43 and 22, 8, and 34, respectively. The housing index was found to be an indicator of DHF transmission in North Sumatera province. Based on the WHO standard for high-risk DHF areas (HI 10), it was found that both high and low DHF incidence districts had

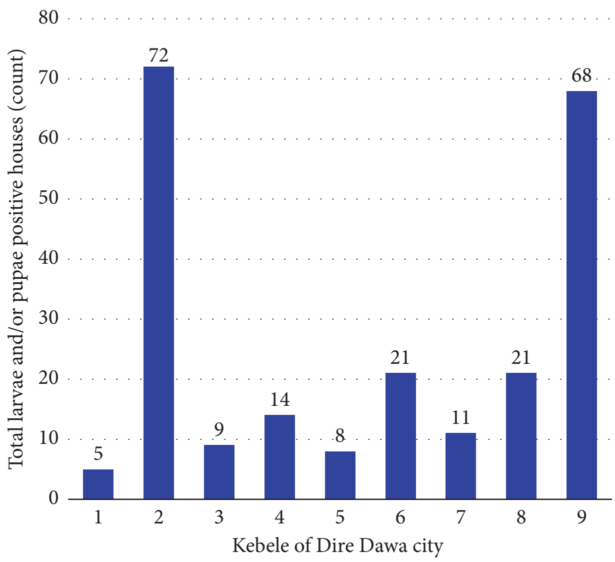

Figure 4: Number of houses with larvae and/or pupae positive in each kebele.

an HI higher than 10, which indicated a high risk for DHF transmission [40]. In another study, the average BI value was extremely high (86.25) in two villages, and similar values were also seen in HI (42.79%) and CI (30.46%). This was considerable idle containers and water cisterns with clean water were put in or around the yard (accounting for 95.4% of the total number of water containers), which would provide a perfect breeding place for *Ae. albopictus* [43].

As many previous study findings report, this study has also limitations. This study was conducted only in the urban setting of the Dire Dawa administration city. Besides, larvae were collected from inside houses and peridomestic areas without taking into consideration the number of people living in the compound of the householders.

4. Conclusions

There is a lack of solid preventive policy and strategy implementations of emerging viral diseases in general and dengue fever (DF) in particular in Dire Dawa administration city of Ethiopia, as the majority of the study participants affirm that they heard of DF from relatives, friends, and families suffering from the disease and did not know the causative agents and incubation period of the DF. Above all, most of the study units do not have the basic knowledge in terms of DF transmission natural history linked to some specific species of mosquitoes. The best indicator of this is that people store water inside and outside houses for domestic use without proper care. Those who have basic knowledge have a positive attitude in averting the risks of DF, but still, the overall community practice is problematic, as a significant proportion of the study participants believe that taking "shitni" (locally prepared spicy food) cures DF. Besides, the current study revealed that the calculated house index, container index, and Breteau index were 19.5, 8.38, and 45.14, respectively, implicating a possibility of high risk of dengue fever outbreaks in the Dire Dawa administration city communities. Hence, designing and implementing protective public policy and strategy for DF is mandatory at the community level in Dire Dawa administration city, as all evaluated indices implicate the inevitable outbreak of DF in the current study area.

Abbreviations

BI: Breteau index
CI: Container index
DF: Dengue fever
DV: Dengue virus
DHF: Dengue hemorrhagic fever
HI: House index
SPSS: Statistical products for social sciences
WHO: World Health Organization.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon request.

Ethical Approval

Ethical approval was obtained from the Dire Dawa University Research and Technology Interchange Directorate Office (reference number: DDU/RTIDO/IRB/0152/22). Again, official permission was obtained from Dire Dawa Administration City Health Bureau. In addition, permission was obtained from each of the nine local kebele administrators.

Consent

As per the Helsinki Declaration, after the purpose of the study was explained, written informed consent was obtained from all participants of the study before enrollment. All study participants fulfilled the minimum legal consenting age (at least 18 years old) for this study. By virtue, confidentiality was applied from the beginning to the end of the study.

Disclosure

All the funding Universities; including Madda Walabu University, Ambo University, Adama Science and Technology University, and the Research Affairs Directorate of Dire Dawa University have no role in the design of the study and collection, analysis, and interpretation of data, and in writing the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All the authors conceptualized, investigated, visualized, and supervised the study, developed methodology, identified the mosquito, administered the project, performed data curation and formal analysis, acquired fund, validated the resources, and provided software. TK drafted the manuscript. All the authors read and approved the final manuscript.

Acknowledgments

The authors would like to thank Dire Dawa University for funding this research project and Dire Dawa Administration City Health Bureau for granting the letter of permission to conduct the research and offering the pertinent data. Also, the authors are grateful to the community of Dire Dawa Administration City, kebele administrators, data collectors, and study participants for their immense support. Finally, the authors appreciate the professional assistance of Mr Nigus Gebremedhin (from Dire Dawa University) in delineating the map of the study area. This research was funded by Madda Walabu University, Ambo University, the Research Affairs Directorate of Dire Dawa University, and Adama Science and Technology University.

Supplementary Materials

Supplementary material 1 (S1 File): Population of Dire Dawa city and number sampled. (*Supplementary Materials*)

References

[1] O. Horstick, Y. Tozan, and A. Wilder Smith, “Reviewing dengue: still a neglected tropical disease?” *PLoS Neglected Tropical Diseases*, vol. 9, no. 4, pp. 1–18, 2015.

[2] (Who) World Health Organization, *Comprehensive Guidelines For Prevention And Control of Dengue and Dengue Haemorrhagic Fever*, vol. 528, World Health Organization Regional Office for South-East Asia, New Delhi, India, 2011.

[3] M. U. G. Kraemer, “The global distribution of the arbovirus vectors *Aedes aegypti* and Ae. Albopictus,” *Elife*, vol. 4, pp. 1–18, 2015.

[4] (Who) World Health Organization, *Global Strategy For Dengue Prevention and Control 2012-2020*, vol. 528, NLM classification: WCR, Geneva, Switzerland, 2012.

[5] A. Murugesan and M. Manoharan, “Dengue virus,” in *Emerging and Reemerging Viral Pathogens: Fundamental and Basic Virology Aspects of Human, Animal and Plant Pathogens*, M. M. Ennaji, Ed., vol. 1, pp. 296–374, Academic Press, Oxford, UK, 2019.

[6] M. S. Mustafa, V. Rasotgi, S. Jain, and V. Gupta, “Discovery of the fifth serotype of dengue virus (dev-5): a new public health dilemma in dengue control,” *Medical Journal Armed Forces India*, vol. 71, no. 1, pp. 67–70, 2015.

[7] J. L. Deen, “The WHO dengue classification and case definitions: time for a reassessment,” *Lancet*, vol. 368, pp. 170–173, 2006.

[8] S. I. Bhatt, Samir, W. Gething et al., “The global distribution and burden of dengue,” *HHS Public Access*, vol. 496, no. 7446, pp. 504–507, 2013.

[9] J. J. Waggoner, “Viremia and clinical presentation in Nicaraguan patients infected with zika virus, chikungunya virus, and dengue virus,” *Clinical Infectious Diseases*, vol. 63, no. 12, pp. 1584–1590, 2016.

[10] A. M. Yusuf and N. A. Ibrahim, “Knowledge, attitude and practice towards dengue fever prevention and associated factors among public health sector health-care professionals: in Dire Dawa, eastern Ethiopia,” *Risk Management and Healthcare Policy*, vol. 12, pp. 91–104, 2019.

[11] A. Amarasinghe, J. N. Kuritsky, G. William Letson, and H. S. Margolis, “Dengue virus infection in Africa,” *Emerging Infectious Diseases*, vol. 17, no. 8, pp. 1349–1354, 2011.

[12] E. G. Geleta, “Serological evidence of dengue fever and associated factors in health facilities in Borena Zone, Southern Ethiopia,” *bioRxiv*, pp. 129–136, 2018.

[13] D. Eshetu, “Seropositivity to dengue and associated risk factors among non-malaria acute febrile patients in Arba Minch districts, southern Ethiopia,” *BMC Infectious Diseases*, vol. 20, no. 1, pp. 1–6, 2020.

[14] A. B. Woyessa, “The first acute febrile illness investigation associated with dengue fever in Ethiopia, 2013: a descriptive analysis,” *The Ethiopian Journal of Health Development*, vol. 28, no. 3, pp. 155–161, 2014.

[15] C. Administration and M. Biru, “Dengue fever outbreak investigation and response in Dire Dawa city administration, Ethiopia,” *Journal of Medicine, Physiology and Biophysics*, vol. 63, pp. 23–27, 2020.

[16] T. A. A. Alyousefi, “A household-based survey of knowledge, attitudes and practices towards dengue fever among local urban communities in Taiz Governorate, Yemen,” *BMC Infectious Diseases*, vol. 16, no. 1, pp. 1–9, 2016.

[17] R. Dalpadado, D. Amarasinghe, N. Gunathilaka, and N. Ariyarathna, “Bionomic aspects of dengue vectors *Aedes aegypti* and *Aedes albopictus* at domestic settings in urban, suburban and rural areas in Gampaha District, Western Province of Sri Lanka,” *Parasites and Vectors*, vol. 15, no. 1, pp. 1–14, 2022.

[18] M. Scott, “Halstead, dengue and dengue hemorrhagic fever,” in *Handbook of Zoonoses*, G. W. Beran, Ed., p. 601, Second edition, CRC Press; Taylor and Francis Group, Florida, USA, 1994.

[19] C. Guo, “Global epidemiology of dengue outbreaks in 1990–2015: a systematic review and meta-analysis,” *Frontiers in Cellular and Infection Microbiology*, vol. 7, no. JUL, pp. 1–11, 2017.

[20] C. Buhler, V. Winkler, S. Runge-Ranzinger, R. Boyce, and O. Horstick, “Environmental methods for dengue vector control – a systematic review and meta-analysis,” *PLoS Neglected Tropical Diseases*, vol. 13, no. 7, pp. 1–15, 2019.

[21] S. Sulistyawati, “Dengue vector control through community empowerment: lessons learned from a community-based study in Yogyakarta, Indonesia,” *International Journal of Environmental Research and Public Health*, vol. 16, no. 6, 2019.

[22] UNHSP(Unhsp), *Ethiopia: Dire Dawa Urban Profile*, United Nations Human Settlements Programme, Nairobi, Kenya, 2008.

[23] Central Statistical Agency (Csa), *Population Projections For Ethiopia from 2007-2037*, Central Statistical Agency, Addis Ababa, Ethiopia, 2013.

[24] W. W. Daniel and C. L. Cross, *Biostatistics: A Foundation For Analysis In the Health Sciences, Tenth Edit*, John Wiley & Sons, Las Vegas, VA, USA, 2013.

[25] H. Van Nguyen, “Knowledge, attitude and practice about dengue fever among patients experiencing the 2017 outbreak in Vietnam,” *International Journal of Environmental Research and Public Health*, vol. 16, no. 6, 2019.

[26] Y. M. Huang and R. A. Ward, “A pictorial key for the identification of the mosquitoes associated with yellow fever in Africa,” *Mosquito Systematics*, vol. 13, no. 2, pp. 1–13, 1981.

[27] L. M. Rueda, *Pictorial Keys for the Identification of Mosquitoes (Diptera: Culicidae) Associated with Dengue Virus Transmission*, Magnolia Press, Auckland, New Zealand, 2004.

[28] C. Suwanbamrung, N. Nukan, S. Sripon, R. Somrongthong, and P. Singchagchai, "Community capacity for sustainable community-based dengue prevention and control: study of a sub-district in Southern Thailand," *Asian Pacific Journal of Tropical Medicine*, vol. 3, no. 3, pp. 215–219, 2010.

[29] S. Selvarajoo, "Knowledge, attitude and practice on dengue prevention and dengue seroprevalence in a dengue hotspot in Malaysia: a cross-sectional study," *Scientific Reports*, vol. 10, no. 1, pp. 1–13, 2020.

[30] K. Nagoor, B. Reddy, S. Kahn, R. J. Kalluri, and K. R. John, "Knowledge, attitude and practice on dengue fever and its prevention and control measures in urban slums of South India," *International Journal of Community Medicine and Public Health*, vol. 4, no. 8, p. 3013, 2017.

[31] S. A. R. Al-Dubai, K. Ganasegeran, M. R. Alwan, M. A. Alshagga, and R. Saif-Ali, "Factors affecting dengue fever knowledge, attitudes and practices among selected urban, semi-urban and rural communities in Malaysia," *Southeast Asian Journal of Tropical Medicine and Public Health*, vol. 44, no. 1, pp. 37–49, 2013.

[32] C. Sayavong, J. Chompikul, S. Wongsawass, and C. Rattanapan, "Knowledge, attitudes and preventive behaviours related to dengue vector breeding control measures among adults in communities of Vientiane, capital of the Lao PDR," *Journal of Infection and Public Health*, vol. 8, no. 5, pp. 466–473, 2015.

[33] M. Dhimal, "Knowledge, attitude and practice regarding dengue fever among the healthy population of highland and lowland communities in Central Nepal," *PLoS One*, vol. 9, no. 7, 2014.

[34] A. C. Alves, A. L. dal Fabbro, A. D. C. Passos, A. F. T. M. Carneiro, T. M. Jorge, and E. Z. Martinez, "Knowledge and practices related to dengue and its vector: a community-based study from Southeast Brazil," *Revista da Sociedade Brasileira de Medicina Tropical*, vol. 49, no. 2, pp. 222–226, 2016.

[35] S. Gupta, "A study on knowledge, attitude and practices regarding dengue fever among people living in urban area of Jhansi city (up)," *Journal of Evolution of Medical and Dental Sciences*, vol. 3, no. 73, pp. 15388–15398, 2014.

[36] K. G. Saied, A. Al-Taiar, A. Altaire, A. Alqadsi, E. F. Alariqi, and M. Hassaan, "Knowledge, attitude and preventive practices regarding dengue fever in rural areas of Yemen," *International Health*, vol. 7, no. 6, pp. 420–425, 2015.

[37] N. Gyawali, R. S. Bradbury, and A. W. Taylor-Robinson, "Knowledge, attitude and recommendations for practice regarding dengue among the resident population of Queensland, Australia," *Asian Pacific Journal of Tropical Biomedicine*, vol. 6, no. 4, pp. 360–366, 2016.

[38] B. C. Yboa and L. J. Labrague, "Dengue knowledge and preventive practices among rural residents in samar province, Philippines," *American Journal of Public Health Research*, vol. 1, no. 2, pp. 47–52, 2013.

[39] W. H. Elson, "Cross-sectional study of dengue-related knowledge, attitudes and practices in Villa El Salvador, Lima, Peru," *BMJ Open*, vol. 10, no. 10, pp. 1–9, 2020.

[40] F. A. Siregar, T. Makmur, and N. Huda, "Key breeding place for dengue vectors and the impact of larvae density on dengue transmission in North Sumatera province, Indonesia," *Asian Journal of Epidemiology*, vol. 10, no. 1, pp. 1–9, 2017.

[41] L. Sanchez, "*Aedes aegypti* larval indices and risk for dengue epidemics," *Emerging Infectious Diseases*, vol. 12, no. 5, pp. 800–806, 2006.

[42] V. S. Aryaprema and R. De Xue, "Breteau index as a promising early warning signal for dengue fever outbreaks in the Colombo District, Sri Lanka," *Acta Tropica*, vol. 199, Article ID 105155, 2019.

[43] J. N. Wang, "Relationships between traditional larval indices and meteorological factors with the adult density of *Aedes albopictus* captured by BG-mosquito trap," *PLoS One*, vol. 15, no. 6, pp. 1–16, 2020.

[44] L. Udayanga, N. Gunathilaka, M. C. M. Iqbal, M. M. M. Najim, K. Pahalagedara, and W. Abeyewickreme, "Empirical optimization of risk thresholds for dengue: an approach towards entomological management of Aedes mosquitoes based on larval indices in the Kandy District of Sri Lanka," *Parasites and Vectors*, vol. 11, no. 1, pp. 1–12, 2018.

[45] L. Luo, X. Li, X. Xiao, Y. Xu, M. Huang, and Z. Yang, "Identification of *Aedes albopictus* larval index thresholds in the transmission of dengue in Guangzhou, China," *Journal of Vector Ecology*, vol. 40, no. 2, pp. 240–246, 2015.