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Determination of strategies used for the prevention of mosquito bites

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ABSTRACT

Background: Vector borne diseases are one of the prevailing global healthcare problems caused by mosquito bites. The main objective of this study was to determine the strategies used for the prevention of mosquito bites by general public of Kaski district, a mosquito bite prone area of Western Nepal, as evidenced by rising dengue cases.

Methods: A cross-sectional study with 435 households were surveyed, for the strategies used for mosquito bite prevention, in representative 15 wards of one metropolitan and four rural municipalities of Kaski district, selected by simple random sampling technique. The survey was conducted during a period of November, 2022 – February, 2023. Data was analyzed using Statistical Package for Social Science (SPSS).

Results: Approximately 4% of study participants used traditional methods such as smoke from burnt medicinal plants, burnt clothes and grass, and the application of mustard oil for the prevention of mosquito bites. Majority (92%) of participants used non-traditional methods like mosquito net, mosquito incense, mosquito bat and mosquito repellent for the prevention of mosquito bites. Only 13% of study participants used some kind of personal use mosquito repellent; cream being the most commonly used one. Age, ethnicity, residence, education and income were found to be significantly associated with the use of mosquito bite prevention strategy. Majority of the respondents were unaware of the governmental plans and their implementation for mosquito control and bite prevention strategies.

Conclusion: This study summarises the strategies used for the prevention of mosquito bites by the residents of Kaski district of Nepal. Future interventional studies are warranted to enhance the awareness about the effective strategies for the prevention of mosquito bites.

Keywords: Kaski; mosquito bite; Nepal; prevention strategies; vector borne disease.

INTRODUCTION

Vector borne diseases (e.g., malaria, dengue and yellow fever) are a considerable burden for healthcare sector.[1] Protection from mosquito bites could prevent vector borne diseases[2] via elimination/reduction of mosquitoes.[3] However, it is practically impossible. Therefore, alternative strategies including insecticide-treated nets, indoor spraying, and various commercial mosquito repellents have proven efficacious in the prevention of vector-borne diseases.[4, 5]

Kaski district is prone to vector borne diseases as evidenced by a recent dengue outbreak in 2019 with a total of 17,992 cases.[6] Such outbreaks define a necessity to evaluate the strategies used for the prevention of mosquito bites. Therefore, the aim of this study was to determine different strategies (preventive measures), used by general public of Kaski district, for the prevention of mosquito bites. This study is the first of its kind for Kaski district that provides important information regarding strategies used for the prevention of mosquito bites.

METHODS

A cross-sectional study was done with households from the representative wards of Pokhara Metropolitan and other rural municipalities (Annapurna, Machhapuchhre, Madi, and Rupa) of Kaski district. Sample size for the study was 384 households. Considering a non-response rate of 10%, the sample size was 427 households. There

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are one metropolitan and four rural municipalities in Kaski district. The ward distributions among these administrative units include Pokhara Metropolitan City (33 wards), Annapurna Rural Municipality (11 wards), Machhapuchre Rural Municipality (9 wards), Madi Rural Municipality (12 wards), and Rupa Rural Municipality (7 wards). Therefore, a total of 72 wards are present in Kaski district. A total of 15 wards were included in the study. Three wards (selected by simple random sampling) from each metropolitan and rural municipality of Kaski district were included for the household survey. The study population (435 households) was thus divided equally into 15 wards, giving a survey population of 29 for each ward. Transect sampling was then used to randomly select the households for survey.

A structured questionnaire was prepared and validated for use in the data collection. Inclusion criteria for the study were: a) households within Kaski district, b) willing to give consent, and c) household individuals with good understanding of the interview questions. Exclusion criteria for the study were: a) household individuals with difficulty in understanding the interview questions, and b) household individuals below 18 years of age. An individual from each representative household was interviewed to collect the information, which was then filled in on the questionnaire form. A total of 45 households were included for the pre-testing of the questionnaire. The households were selected from 5 wards (i.e., 9 households from each ward). One ward each from Pokhara Metropolitan City, Annapurna Rural Municipality, Machhapuchhre Rural Municipality, Rupa Rural Municipality, and Madi Rural Municipality was randomly selected. The households from selected wards were interviewed using a questionnaire form. The participants were then asked for feedback regarding comprehension and format using a cognitive debriefing form that included both close- and open-ended questions. A revision of the questionnaire was then carried out based on the feedback. The content validity of the revised questionnaire was conducted using expert opinions. Experts in the field of public health checked the content of the questionnaire and, evaluated if all the aspects of the objectives were fulfilled in the questionnaire and then approved it.

Ethical approval was obtained from the Nepal Health Research Council before conducting the study (Protocol Registration Number: 246/2022 P; approved on July 18, 2022). Each participant provided verbal and written informed consent. The questionnaire and informed consent were prepared in English and translated into simple and clear Nepali language before conducting the survey. Date collection was performed during a period of November, 2022 – February, 2023. We followed strict confidentiality guidelines to mitigate safety concerns for our participants.

Raw data was edited manually to check for completeness and accuracy. Data was entered in Epi data and cross-checked to minimize inconsistencies or errors during the data entry. The data was analyzed using Statistical Package for Social Science (SPSS). Univariate, bivariate, and multivariate analyses were performed. $P<0.05$ was considered statistically significant. For multivariate analysis, by applying the enter method in binary logistic regression analysis, all independent variables were entered into various categories that were strongly associated with the chi-square test in order to produce an adjusted odds ratio.

RESULTS

A total of 435 participants were included in the study. **Table 1** shows the socio-demographic and socio-economic characteristics of the study participants. More than half (51.3%) of the respondents were under the age ≤ 46 years (median age = 46 years). Approximately 60% of the respondents were female. Most of the study participants (45.1%) were Brahmin and Chhetri followed by Janajatis. Similarly, more than three-quarters (80.7%) of the respondents followed the Hindu religion, and more than half of the participants (55.6%) had a family size ≤ 4. Nearly half (45.5%) of the participants had a secondary level of education, and around a quarter were illiterate. Occupation wise, nearly half of participants were engaged in agriculture (45.1%), followed by business (23.9%), and service (16.3%). More than half of the study participants had a monthly family income ≤ Rs. 25,000 (median income = Rs. 25000).

Majority of the participants (90.3%) had heard about vector borne diseases. About 4% of the study participants had suffered from such a disease, and all of those cases were of dengue, as confirmed by the reports available from the healthcare provider. Individuals were aware of the methods to minimize mosquito populations, which included keeping the area around the house clean (57%), drainage shelling (20%), and not letting water stagnate (22%). Around 1% of the study participants were unaware of any measures to minimize the mosquito population.

Approximately 4% of the respondents used some kind of traditional method for the prevention of mosquito bites. Among the participants using traditional methods, 45% used smoke from burnt titepaati (*Artemisia sinensis*),

and other methods included the use of smoke from burnt tejpatta (*Cinnamomum tamala*) (15%), burnt clothes (15%), burnt simali (*Vitex negundo*) (15%), burnt green grass (5%), and the application of mustard oil (5%). Furthermore, approximately 92% of the study participants used some kind of non-traditional method for the prevention of mosquito bites. These methods included the use of mosquito net (48.4%), mosquito incense (18.5%), mosquito repellent (31.8%), and a mosquito bat (1.2%).

Approximately one-third of the study participants knew about personal use mosquito repellents for direct application to the body. Around 13% of the study participants had used some kind of mosquito repellent. Results show that the commonly used mosquito repellents for personal use, which included lotion (1.8%), odomos cream (89.1%), oil (1.8%), spray (5.5%), and Dettol (1.8%). Odomos cream was the most commonly used mosquito repellent for personal use. Furthermore, regarding the preference, the study participants preferred mosquito repellents in the form of cream (65.3%), spray (31.2%), lotion (3.2%), and liquid (0.3%).

Majority (88.3%) of the participants mentioned that the strategies they used were sufficient for the prevention of mosquito bites. Interestingly, only 16.3% of the study participants were aware of the governmental plans for controlling the mosquito population or preventing mosquito bites. And only 1% of the study participants reported the implementation of governmental plans for the prevention of mosquito bites.

Table 2 shows the association between socio-demographic and socio-economic variables and mosquito bite prevention strategy. The result depicts that age, ethnicity, and residence were found to be significantly associated with the mosquito bite prevention strategy. Variables such as sex, marital status, and religion were not found to be significantly associated with the mosquito bite prevention strategy. Age ≤ 46 years (younger age group) had a two times higher probability of using the effective strategy than age > 46 years (older age group) (OR 2.449 CI 1.641-3.655). Participants residing in urban area had a two times higher probability of using the effective strategy than those residing in rural area (OR 3.494 CI 2.144-5.693). Educational status and income were found to be significantly associated with mosquito bite prevention strategies whereas occupation was not. Participants who were illiterate were around 0.3 times less likely to use effective strategy than the participants who were literate (OR 0.254, CI 0.145-0.447). Participants with household income less than or equal to 25000 were 0.4 times less likely to use the effective strategy than participants whose household income was greater than 25000 (OR 0.410, CI 0.276-0.610).

Table 3 illustrates that people residing in urban area were found to be significantly associated with the use of traditional methods whereas, other variables like: age, sex, religions, ethnicity and marital status were not found to be significantly associated with the use of traditional methods. People residing in urban area were around 4 times more likely to use the traditional method than the people residing in rural area (OR 3.814, CI 1.427-10.197). Furthermore, the table shows that educational status, occupation, and income were not significantly associated with use of traditional methods.

Table 4 illustrates that age, religion, ethnicity, and residence were significantly associated with awareness of the governmental plan implemented for the prevention of mosquito bites. Participants who followed Hindu religion were 12 times more likely to be aware of the governmental plan than individuals who followed other religions (OR 12.832, CI 1.744-95.395). Brahmin/Chhetri were 0.5 times less likely to be aware of the governmental plan than Janajatis, and other ethnic groups (OR 0.517, CI 0.272-0.983). Participants who reside in urban area were 0.2 times less likely to be aware of the governmental plan that those who reside in rural area (OR 0.240, CI 0.073-0.793). Furthermore, the table shows that there is an association between educational status and awareness of the governmental plan whereas there is no association between the occupation and awareness about the governmental plan. Illiterate people were 0.1 times less likely to be aware about the governmental plan than literate people (OR 0.126, CI 0.030-0.531).

Table 5 shows the predictors of strategy used for mosquito control and awareness about governmental plans for mosquito control. Compared to illiterate individuals, persons who are literate have a higher odd (AOR=2.84, 95% CI: 1.536-5.251) of using an efficient strategy for mosquito control. Similarly, participants residing in rural areas were more likely (AOR=3.719, 95% CI: 1.075-12.860) to be aware as compared to those who were from rural areas. Furthermore, the table shows literate participants were more likely (AOR=6.758, 95% CI: 1.533-29.797) to be aware of Government plans for mosquito control compared to illiterate participants.

Table 1. Socio-demographic and socio-economic characteristics of study participants.

	Characteristics	Frequency (n=435)	Percent (%)		Characteristics	Frequency (n=435)	Percent (%)
Socio-demographic	**Age (years)** (Median = 46 years, IQR=27)			Socio-economic	**Educational status**		
	≤ 46	223	51.3		Illiterate	101	23.2
	> 46	212	48.7		Literate	41	9.4
	Sex				Basic	50	11.5
	Female	256	58.9		Secondary level	198	45.5
	Male	179	41.1		Bachelor and above	45	10.3
	Residence				**Occupation**		
	Urban	87	20.0		Service	71	16.3
	Rural	348	80.0		Business	104	23.9
	Ethnicity				Unemployed	21	4.8
	Brahmin/Chhetri	196	45.1		Agriculture	196	45.1
	Janajati	175	40.2		Foreign employment	6	1.4
	Dalit	62	14.3		Housewife	37	8.5
	Madhesi/Tharu	2	0.5		**Income (Rs.)**		
	Religion				≤ 25,000	251	57.7
	Buddhist	75	17.2		> 25,000	184	42.3
	Christian	5	1.1				
	Hindu	351	80.7				
	Muslim	4	0.9				
	Marital status						
	Married	396	91.0				
	Unmarried	37	8.5				
	Widow	2	0.5				
	No. of family members (Median= 4, IQR= 2)						
	≤ 4	242	55.6				
	> 4	193	44.4				

Table 2. Association between socio-demographic variables and mosquito bite prevention strategy.

	Variables	Strategy for prevention of mosquito bite		P-value	Odds ratio (OR) (Unadjusted)	95% Confidence Interval (CI)
		Effective Strategy	Ineffective strategy			
Socio-demographic	**Age (years)**					
	≤ 46	107(48%)	116 (52%)	*0.000	2.449	1.641-3.655
	> 46	58(27.4%)	154 (72.6%)			
	Sex					
	Male	64(35.8%)	115 (64.2%)	0.434		
	Female	101(39.5%)	155 (60.5%)			
	Marital status					
	Married	153(38.6%)	243 (61.4%)	0.410		
	Unmarried	12 (32.4%)	23 (67.4%)			
	Widow	0 (0%)	2 (100%)			
	Ethnicity					
	Brahmin/ Chhetri	87 (44.4%)	109 (55.6%)	*0.036		
	Janajati	59 (33.7%)	116 (66.3%)			
	Dalit and Others	19(29.7%)	45 (70.3%)			
	Religion					
	Hindu	141 (40.2%)	210 (59.8%)	0.137		
	Buddhist	21 (28.0%)	54 (72.0%)			
	Christain and others	3 (33.3%)	6 (66.7%)			
	Residence					
	Urban	54 (62.1%)	33 (37.9%)	*0.000	3.494	2.144-5.693
	Rural	111 (31.9%)	237 (68.1%)			

	Variables	Strategy for prevention of mosquito bite		P-value	Odds ratio (OR) (Unadjusted)	95% Confidence Interval (CI)
		Effective Strategy	Ineffective strategy			
Socio-economic	**Occupation**					
	Service	34 (47.9%)	37(52.1%)	0.336		
	Business	42 (40.4%)	62 (59.6%)			
	Unemployed	7 (33.3%)	14 (66.7%)			
	Agriculture	65 (33.2%)	131 (66.8%)			
	Foreign employment	3 (50.0%)	3 (50.0%)			
	Housewife	14 (37.8%)	23 (62.2%)			
	Educational status					
	Illiterate	17 (16.8%)	84 (83.2%)	*0.000	0.254	0.145-0.447
	Literate	148 (44.3%)	186 (55.7%)			
	Income (Rs.)					
	≤ 25000	73 (29.1%)	178 (70.9%)	*0.000	0.410	0.276-0.610
	> 25000	92 (50%)	92 (50%)			

Effective strategy: Atleast two strategies followed as per the Centers for Disease Control and Prevention (CDC) recommendations for the prevention of mosquito bite

Ineffective strategy: Less than two strategies followed as per the CDC recommendations for the prevention of mosquito bite

**Statistically significant at p<0.05*

Table 3. Association between socio-demographic/socio-economic variables and traditional method used.

	Variable	Use of traditional method		P-value	Odds ratio (OR) (Unadjusted)	95% Confidence Interval (CI)
		Yes	No			
Socio-demographic	**Age (years)**					
	≤ 46	6 (2.7%)	217 (97.3%)	0.179		
	> 46	11 (5.2%)	201 (94.8%)			
	Sex					
	Female	9 (3.5%)	247 (96.5%)	0.613		
	Male	8(4.5%)	171 (95.5%)			
	Religion					
	Buddhist and others	2 (2.4%)	82 (97.6%)	0.545		
	Hindu	15 (4.3%)	336 (95.7%)			
	Ethnicity					
	Brahmin/chhetri	10 (5.1%)	186 (94.9%)	0.187		
	Janajati	7 (4%)	168 (96%)			
	Dalit and other	0 (0%)	64 (100%)			
	Marital status					
	Married	15 (3.8%)	382 (96.2%)	0.652		
	Unmarried	2 (5.3%)	36 (94.7%)			
	Residence					
	Urban	8 (9.2%)	79 (90.8%)	*0.010	3.814	1.427-10.197
	Rural	9 (2.6%)	339 (97.4%)			
Socio-economic	**Educational status**					
	Illiterate	3 (3%)	98 (97%)	0.773		
	Literate	14 (4.2%)	320 (95.8%)			
	Occupation					
	Service	9 (5%)	172 (95%)	0.232		
	Unemployed	0 (0%)	58 (100%)			
	Agriculture	8 (4.1%)	188 (95.9%)			
	Income (Rs.)					
	≤ 25000	8 (3.2%)	243 (96.8%)	0.454		
	> 25000	9 (4.9%)	175 (95.1%)			

**Statistically significant at p<0.05*

Table 4. Association between socio-demographic/socio-economic variables and awareness about governmental plan implemented for the prevention of mosquito bite.

	Variables	Aware about governmental plan		P-value	Odds ratio (OR) (Unadjusted)	95% Confidence Interval (CI)
		Yes	No			
Socio-demographic	**Age (years)**					
	≤ 46	34(15.2%)	189 (84.8%)	*0.004	2.544	1.324-4.891
	> 46	14 (6.6%)	198 (93.4%)			
	Sex					
	Female	32 (12.5%)	224 (87.5%)	0.243		
	Male	16 (8.9%)	163 (91.1%)			
	Religion					
	Hindu	47 (13.4%)	304 (86.6%)	#0.001	12.832	1.744-95.395
	Buddhist, Christian and others	1 (1.2%)	83 (98.8%)			
	Ethnicity					
	Brahmin/Chhetri	15 (7.7%)	181 (92.3%)	*0.042	0.517	0.272-0.983
	Janajati, Dalit and others	33 (13.8%)	206 (86.2%)			
	Marital status					
	Married	42 (10.6%)	355 (89.4%)	0.289		
	Unmarried	6 (15.8%)	32 (84.2%)			
	Widow					
	Residence					
	Urban	3 (3.4%)	84 (96.6%)	*0.012	0.240	0.073-0.793
	Rural	45(12.9%)	303(87.1%)			
Socio-economic	**Educational status**					
	Illiterate	2 (2%)	99 (98%)	*0.001	0.126	0.030-0.531
	Literate	46 (13.8%)	288 (86.2%)			
	Occupation					
	Service	13 (18.3%)	58 (81.7%)	0.146		
	Business	10 (9.6%)	94 (90.4%)			
	Unemployed	3 (5.2%)	55 (94.8%)			
	Agriculture	22 (11.2%)	174 (88.8%)			
	Foreign employment	0 (0%)	6 (100%)			

**Statistically significant at p<0.05, # fisher exact value*

Table 5: Multivariate analysis of predictors of strategy used for mosquito control and awareness about government plans for mosquito control.

	Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	P-value
	Socio-demographic factors			
Predictors of strategy used for mosquito control	**Age (years)**			
	≤ 46	0.57	0.347-0.0949	*0.030
	> 46	1		
	Ethnicity			
	Brahmin/Chhetri	0.92	0.475-1.791	0.810
	Janajati	0.95	0.496-1.831	0.886
	Dalit and others	1		
	Educational attainment			
	Illiterate	1	1.536-5.251	*0.001
	Literate	2.84		
	Place of residence			
	Urban	0.291	0.168-0.502	*0.00
	Rural	1		
Predictors of awareness about government plans for mosquito control	**Age (yrs)**			
	≤ 46	0.577	0.289-1.151	0.119
	> 46	1		
	Ethnicity			
	Brahmin/Chhetri	0.759	0.234-2.461	0.645
	Janajati	0.369	0.122-1.116	0.077
	Dalit and others	1		
	Educational attainment			
	Illiterate	1		
	Literate	6.758	1.533-29.797	*0.012
	Place of residence			
	Urban	3.719	1.075-12.860	0.119
	Rural	1		

**Statistically significant at p<0.05*

DISCUSSION

The present study aimed to determine strategies used by people, residing in Kaski district for the prevention of mosquito bites. The findings of this study provide valuable insights into the use of traditional and non-traditional methods for the prevention of mosquito bites. A total of 435 participants were included in the study, and more than half of the participants had an age ≤ 46 years with approximately 60% of them being female. In Nepal, males are mostly responsible for the household earnings, and hence majority of the male population either works at a different place or has foreign employment, leading to majority of the female household population.[7] Ethnicity wise, Brahmins and Chhetris were the most common participants, followed by Janajatis and majority of the participants followed Hindu religion. This population distribution was similar to that presented by Paudel et al. in a recent study.[8] Nearly half of the study participants had a secondary

level education, and around a quarter were illiterate. The literacy rate of Gandaki Province is about 71%, and the observed results correlate with this information.[9]

Nearly half of the study participants were engaged in agriculture and had a family income of ≤ Rs. 25,000 followed by business and service. Nepal is an agriculture-based country, and hence a large number of populations still relies on agriculture as a major occupation. A recent study from 2018 showed the monthly household income of Rs. 13,224.[10] Increased household income in our study could be a result of increased wages and increased inflation rates.

Regarding knowledge about preventive measures for vector-borne diseases, the majority (90.3%) of the participants had heard about the diseases. General public awareness and governmental policies regarding public announcements for vector borne diseases might have led to increased awareness about the disease.[11] In contrast, poor knowledge of vector-borne diseases, and poor prevention practices were observed in a study performed in Western Jamaica.[12] Approximately 4% of the participants suffered from vector borne diseases and all the cases were of dengue. Kaski district is prone to dengue as suggested by a recent dengue outbreak that might have led to all the cases of dengue among the suffering participants.[6]

Different measures used by the study participants to minimize mosquito populations around the residence included: keeping the area clean, drainage shelling, and not letting water stagnate. Around 1% of the participants were unaware of any measures useful in minimizing the mosquito population around the residence. The governmental policy of making public announcements regarding the different mosquito control measures led to awareness among the study population[11] and subsequent utilization of these measures around the residence.

The prevention of mosquito bites is the most effective method to prevent vector borne diseases. The study participants used traditional and non-traditional methods for the prevention of mosquito bites indoors and outdoors. Approximately 4% of the respondents used traditional methods, and the most common method used was smoke from burnt titepaati (*Artemisia sinensis*) followed by smoke from burnt tejpatta (*Cinnamomum tamala*), burnt simali (*Vitex negundo*), burnt green grass, burnt clothes, and the application of mustard oil. In a similar study conducted in 5 African communities, the results showed extensive use of traditional herbal remedies for the prevention of mosquito bites.[13] Smoke is one of the traditional methods used for repelling mosquitos.[14] Medicinal plants like titepaati[15], tejpatta[16], and simali[17] have several medicinal values, and their aromatic oils in vaporized forms can prevent mosquito bites by a potential mechanism of inhibiting olfactory senses of mosquitos thus leading to mosquito repellence. In a study from Ethiopia, the smoke of plant leaves from *Corymbia citriodora*, *Ocimum suave*, *Ocimum integrifolia*, *Olea europaea,* and *Ostostegia integrifolia* was used as effective mosquito repellent.[18] Smoke of burnt clothes, burnt green grass and the application of mustard oil can function as a repellent in a similar manner by inhibiting the olfactory senses.

Approximately 92% of the study participants used some kind of a non-traditional methods for the prevention of mosquito bites including the use of mosquito net, mosquito incense, mosquito repellant, and mosquito bat. Similar findings were observed in studies conducted in India[19], and Bolivia[20] which demonstrated the use of mosquito repellant, indoor residual spray and mosquito net as the most commonly used methods for the prevention of mosquito bite.

Approximately, one-third of the study participants had knowledge about personal use mosquito repellents for direct application to the body. This can be attributed to lack of publicity regarding the personal use mosquito repellents as compared to the public announcements that encourage cleanliness and promote the use of mosquito nets and incense. Also, the patterns of the use of personal use mosquito repellents is dependent on the person's behavior that is deeply embedded in social circumstances.[21] Only 13% of the study participants had used personal use mosquito repellents with major utilization of Odomos cream containing N, N-diethyl benzamide.[22] Odomos cream is commonly used in neighboring country, India and hence was commonly used by people who lived there for work or education previously or their family members.[22] Survey on preference among participants regarding the personal use mosquito repellents demonstrated creams and sprays as preferred ones. This might be attributed to easy and convenient application of such formulations and experience of the prior use of such formulations.[23]

A vast majority of the study participants mentioned the sufficiency of their strategies for the prevention of mosquito bites. This can be attributed to limited knowledge and a lack of availability of different effective strategies.[24] Only 16.3% of the study participants were aware of the governmental plans for controlling the mosquito population or preventing mosquito bites.

Lack of awareness may be attributed to inadequate government campaigns or communication strategies. This finding is consistent with studies conducted in other low-income countries, such as Bangladesh, where a lack of awareness about governmental plans was reported.[25] Furthermore, only 1% of the participants reported the implementation of governmental plans for the prevention of mosquito bites, suggesting a lack of effective implementation of the governmental plans and policies.

Age, ethnicity, and residence were significantly associated with the mosquito bite prevention strategy. Effective strategies are defined as those strategies that are followed as per the Centers for Disease Control and Prevention (CDC) recommendations; at least two strategies are followed for the prevention of mosquito bites.[26] Otherwise, the used strategies are defined as ineffective strategies. Younger age groups (≤ 46 years) had a two times higher probability of using the effective strategy as compared to the older age groups (> 46 years), which was attributed to the accessibility of modern technologies (smart phones, websites, visual aids) that could encourage the younger participants to use the effective strategies.[27] Furthermore, Brahmins and Chhetris used more effective strategies as compared to Janajatis and Dalits, resulting from differences in the educational and economic status of different ethnic groups.[28] Participants residing in urban areas had a two times higher probability of using the effective strategy as compared to those residing in rural areas due to the easy access to the prevention strategies and enhanced awareness regarding mosquito bite prevention.[29]

Our study found that educational status and income were significantly associated with mosquito bite prevention strategies, and this finding is consistent with previous studies conducted in Nepal.[21] Household with low income may not be able to afford or access necessary resources for mosquito bite prevention. Age, religion, ethnicity, and residence of the study participants were significantly associated with their awareness of the governmental plan implemented for the prevention of mosquito bites. An association between educational status and awareness about the plan showed that illiterate people were seven times less likely to be aware of the governmental plan for the prevention of mosquito bite. Educational status is important for awareness about different plans, and a similar trend of awareness was observed in a recent study.[30] Furthermore, literate individuals had a higher likelihood of using an efficient strategy and were aware of governmental plans for mosquito control as compared to illiterate individuals. Literacy is linked to awareness, which was observed in a previous study.[27]

Based on these findings, it can be concluded that the residents of Kaski district of Western Nepal use traditional and non-traditional methods for the prevention of mosquito bites. Awareness among the study participants regarding the methods for controlling mosquito population was high. Similarly, use of different methods for mosquito bite prevention, by the study participants, was perceived good enough to prevent mosquito bites. However, few participants were aware of the personal use mosquito repellents which is one of the very effective methods in the prevention of mosquito bites and the subsequent vector borne diseases. The study participants were also unaware of the governmental plans for the mosquito population control and bite prevention. Therefore, household interventional programs regarding mosquito control and bite prevention must be conducted by the government to effectively control mosquito population and prevent the prevalence of the vector borne diseases. Local government should effectively work on this regard to prevent future outbreaks of the vector borne diseases.

There are some limitations of this study. This study covered household survey only of Kaski district of Western Nepal and the results cannot be generalized to the whole population of Nepal. Furthermore, the data collection was performed in selected wards based on simple random sampling technique. Future studies with cluster sampling based on the prevalence of vector borne diseases and the economic levels of the households are warranted. Additionally, future studies covering larger areas such as the coverage of a whole province would provide more concrete results that would be useful in the development and implementation of successful governmental plans for mosquito control and bite preventions.

CONCLUSIONS

Residents of Kaski district, Nepal, used different traditional and non-traditional methods for the prevention of mosquito bites. Traditional methods such as smoke from burnt medicinal plants, burnt clothes, and burnt grass, and the application of a mustard oil were used for the prevention of mosquito bites. Non-traditional methods included the use of mosquito net, mosquito incense, mosquito bat, and mosquito repellent for the prevention of mosquito bites. Only about one-tenth of the study participants used some kind of personal mosquito repellent; cream being the most

commonly used one. Majority of the study participants were unaware of the governmental plan for mosquito control and bite prevention. Future detailed studies are warranted, along with suitable household interventions based on the governmental plans, to enhance awareness about mosquito control and bite prevention strategies.

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COMPETING INTEREST

The authors declare no competing interest.

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