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ORIGINALS

Social determinants, knowledge, attitudes, and practices related to tick exposure in Northwest Mexico

Determinantes sociales, conocimientos, actitudes y prácticas relacionadas con exposición a garrapatas en el Noroeste de México

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ABSTRACT:
Introduction: Ticks are of great medical and veterinary importance. Rocky Mountain spotted fever (RMSF) is a highly lethal disease that can be prevented and treated.
Objective: To analyze determinants of KAP (knowledge, attitudes, practices) regarding tick exposure and their association with household characteristics in a region with high prevalence of rickettsiosis transmitted by the tick *Rhipicephalus sanguineus*.
Methods: A cross-sectional study was conducted in Sonora, Mexico, using stratified random sampling of 228 households in high-incidence areas. A 30-item questionnaire assessed KAP on vector-borne diseases, employing dichotomous, categorical, and Likert scale responses. The chi-square test evaluated associations between variables (p<0.05 significance). Data analysis was performed using IBM® SPSS Statistics software.
Results: The median age of household representatives was 36.9 years; 66.0% were women. Higher levels of knowledge about tick-borne diseases, preventive measures, symptoms, and greater motivation to avoid ticks correlated with educational level (p<0.001), occupation (p=0.001), attitudes and practices like the frequency of dogs entering households (p=0.005), prior tick findings on dogs (p=0.030), fumigation practices (p=0.017), and higher perceived risk of tick bites (p=0.023).
Conclusion: A limited understanding of tick-related risks highlights gaps in KAP, reflecting insufficient individual awareness and systemic public health education failures.

Keywords: Rhipicephalus sanguineus; Vulnerable Population; Social Determinants of Health; Tick-borne Diseases; Rickettsiosis; Knowledge Attitudes Practices.

RESUMEN:
Introducción: Las garrapatas tienen gran importancia médica y veterinaria. La fiebre manchada de las Montañas Rocosas (FMMR) es una enfermedad altamente letal que puede prevenirse y tratarse.
Objetivo: Analizar los determinantes del conocimiento, actitudes y prácticas (CAP) sobre la exposición a garrapatas y su asociación con las características de las viviendas en una región con alta prevalencia de rickettsiosis transmitida por la garrapata *Rhipicephalus sanguineus*.
Métodos: Se realizó un estudio transversal en Sonora, México, mediante muestreo aleatorio estratificado en 228 viviendas ubicadas en áreas de alta incidencia. Se aplicó un cuestionario de 30 ítems para evaluar el CAP sobre enfermedades transmitidas por vectores, utilizando respuestas dicotómicas, categóricas y escalas de Likert. La prueba chi-cuadrada evaluó las asociaciones entre variables (significancia $p<0.05$). Análisis de datos fue realizado utilizando el software estadístico IBM® SPSS.
Resultados: La media de edad de los representantes de las viviendas fue de 36.9 años; el 66.0% eran mujeres. Niveles más altos de conocimiento sobre enfermedades transmitidas por garrapatas, medidas preventivas, síntomas y mayor motivación para evitar las garrapatas se asociaron con el nivel educativo ($p<0.001$), ocupación ($p=0.001$), actitudes y prácticas como la frecuencia de entrada de perros al hogar ($p=0.005$), hallazgos previos de garrapatas en perros ($p=0.030$), prácticas de fumigación ($p=0.017$) y una mayor percepción del riesgo de picaduras de garrapatas ($p=0.023$).
Conclusión: La comprensión limitada de los riesgos relacionados con las garrapatas pone de manifiesto las brechas en los CAP, reflejando insuficiencia tanto en la conciencia individual como en la educación en salud pública.

Palabras clave Rhipicephalus sanguineus; Población Vulnerable; Determinantes Sociales de la Salud; Enfermedades Transmitidas por Garrapatas; Rickettsiosis; Conocimientos Actitudes y Prácticas.

INTRODUCTION

Ticks are blood-feeding arthropods that parasitize dogs, cats, rodents, cattle, and humans. They can transmit various bacterial, viral, and parasitic pathogens and are distributed worldwide. Ticks are of significant medical and veterinary importance [1–3]. Hard ticks feed from humans or any other animal for prolonged periods, and their bites can be initially painless and go unnoticed for hours or even days. Their mouthparts contain vasodilatory enzymes and anti-inflammatory, anti-hemostatic, and immunosuppressive substances. These substances work as anesthetics in the saliva, facilitating successful blood feeding[4,5].

The brown dog tick (*Rhipicephalus sanguineus*) transmits Gram-negative intracellular bacteria of the genus *Rickettsia*. This includes *Rickettsia conorii, R. massiliae,* and *R. rickettsii,* which causes Rocky Mountain Spotted Fever (RMSF), the most severe rickettsiosis in North America[6,7].

RMSF is a highly lethal disease that can be prevented and treated. Infection symptoms include fever, headache, myalgia, and malaise. A rash and eschar formation may also be present but are not always conclusive. Early recognition is crucial for effective antibiotic treatment, mainly with doxycycline, to prevent complications and fatal outcomes[8,9].

Prevention is key in the absence of a vaccine. To avoid ticks, careful attention must be paid to using insect repellent, deworming pets, fumigating, wearing long clothing, and checking for ticks on the body and in pets after any outdoor activity in endemic areas[10–12]. In this context, among the Social Determinants of Health (SDH) defined as the circumstances in which people are born, grow, and live that affect their health outcomes,

this research specifically focuses on those related to housing conditions, as well as people's knowledge, attitudes, and practices (KAP) for preventing tick exposure[13]. This focus allows for a more precise analysis of the factors influencing the risk of disease acquisition in the study population.

Vulnerable populations living in environments without good sanitation and limited access to nursing and medical care are at a greater risk of exposure to RMSF. The tick carries the disease and is most prevalent between April and October. This disease is considered a challenge for public health due to the complexity of associated social conditions and lack of risk perception. Epidemic outbreaks are related to social lag and the perception of vector exposure risk [3,14,15].

The KAP model is a crucial tool in public health research; it provides an organized framework for understanding health behaviors, which enables the development of effective interventions and assessment of future outcomes. In the context of populations vulnerable to tick-borne diseases such as rickettsiosis, KAP surveys are essential, as they help gauge the existing awareness of the population regarding this health issue[16–18].

In Northwest Mexico, Sonora is experiencing the reemergence of disease-causing vectors and the transmission of microorganisms that are not common in the region. RMSF is a significant public health problem in Sonora, with around 100 cases per year and a fatality rate between 20.0% and 40.0%. This is due to climate change, population displacement, disorderly urban growth, and preference for pets such as dogs; while pet ownership is culturally well-accepted, owners often fail to maintain adequate sanitary conditions for their animals. This negligence constitutes a frequent health risk, particularly in areas with a high prevalence of ticks [19,20].

Vector-borne diseases represent more than 17% of infectious diseases and cause over 700,000 deaths annually. These diseases, caused by parasites, bacteria, or viruses, disproportionately affect the poorest populations and are mostly concentrated in tropical and subtropical zones. Climate change has altered transmission patterns by affecting pathogens, vectors, and hosts [21]. While most preventive practices target tropical areas, it is important to highlight that in regions like Sonora, Mexico, which has a dry and arid climate, there are areas with high tick density and endemic rickettsiosis, necessitating focused public health attention and vector control measures.

The objective of this research was to analyze the KAP related to tick exposure and their association with SDH such household characteristics in a region with a high prevalence of tick-borne rickettsiosis. Furthermore, this study holds significant relevance for the nursing field, particularly in public and community health. The findings will directly enhance nursing practice by providing an evidence-based framework for targeted patient education and community outreach programs. Specifically, it will enable nurses to move beyond a reactive approach and develop proactive interventions focused on the identified social and environmental determinants of KAP. This empowers nursing professionals to lead initiatives in risk-factor mitigation, such as guiding families on proper pet care and home sanitation practices. By pinpointing knowledge gaps and high-risk household characteristics, the research provides nurses with the critical data needed to improve early symptom recognition, advocate for prompt medical intervention, and ultimately reduce the morbidity and mortality associated with spotted fever in endemic regions.

MATERIAL AND METHODS

A cross-sectional study was conducted using stratified random sampling, where data were collected from households in a region with a high incidence of tick-borne rickettsiosis. Twenty-eight households from the state of Sonora participated in this study, providing information on knowledge, risk perception, housing conditions, and other variables related to exposure to *R. sanguineus* ticks. The Research Ethics Committee approved the macro project from which the results presented are derived (CONBIOÉTICA-26-CEI-001-20200122).For the sample calculation, the formula n = N*X / (X + N - 1) was used where $X = Z_{\alpha/2}^2 * p * (1-p)/E^2$; where $Z_{\alpha/2}$ is the critical value of the normal distribution (for 95% confidence level the critical value is 1.96), E is the margin of error (5%), p is the proportion of the sample and N the size of the finite population [22], the final result for the calculation of the sample was n=179 households. However, the final sample for our study consisted of n=228 households, which was stratified in 4 main regions of Sonora (Hermosillo, Caborca, Cd. Obregón, Banamichi and Guaymas) of at least 30 households per stratum. An adult representative was identified in each household to answer our data collection tool, who voluntarily participated and provided written informed consent.

A structured questionnaire was used to collect data on KAP about contact with ticks and prevention measures for 30 items. This questionnaire was developed from the Manual of Standardized Procedures for the Epidemiological Surveillance of Vector-Borne Diseases and the Official Mexican Standard NOM-032-SSA2-2014, For Epidemiological Surveillance, Promotion, Prevention and Control of Vector-borne Diseases [23]. The instrument consisted of three principal sections: 8 questions on sociodemographic data, 12 on attitudes and prevention practices, and 8 on knowledge.

The 30-question questionnaire was developed to identify KAP of vector-borne diseases using standardized procedures. It was validated by the judgement of experts, who participated in three health professionals with experience in public health, who rated the instrument on average as satisfactory. In addition, a pilot test for external validity was carried out with a small stratum of the population of 18 households, where the necessary adjustments were made for the final application of the instrument [24]. The questionnaire evaluates variables using dichotomous and categorical responses and a Likert scale of 1 to 5.

The IBM SPSS 23 software statistical package was used to analyze data on the population, score, and knowledge level about exposure to *R. sanguineus*. The chi-square test assessed the independence or relationship between two or more categorical variables. Where the variables to be analyzed were selected, and the frequencies between their levels in a sample size of n=228 were calculated. The results were presented in contingency tables, and a significance level of *p*-value <0.05 was established for the following hypotheses: H_0: Variables are independent, and H_1: Variables have a significant relationship.

The present study follows the guidelines established in the Regulations of the General Health Law on Health Research. All participants provided informed consent, and the Research Ethics Committee reviewed the protocol (CONBIOÉTICA-26-CEI-001-20200122). Participation in the study was voluntary, and personal data were protected under the General Law on Protection of Personal Data in Possession of Individuals.

RESULTS

The questionnaire was implemented in 228 homes in different municipalities of Sonora. The median age of representatives per household was 36.9 years, and 66.0% (n=150) were women. Of the total population surveyed, 37.3% had professional education, 36.9% had a high school, and 18.9% had a middle school education. The occupations of family representatives were varied and are shown in Table 1.

Table 1: Sociodemographic characteristics of the population. Sonora, Mexico 2023-2024.

Variables	Mean	Standard Deviation
Age (years)	36.9	± 12.7
	f	**%**
Sex		
Man	78	34.0
Woman	150	66.0
Municipality		
Hermosillo	48	21.1
Caborca	34	14.9
Banamichi	46	20.2
Obregon	39	17.1
Guaymas	37	16.2
Other	24	10.5
Schooling		
None	8	3.6
Elementary	8	3.6
Middle school	43	18.9
High school	84	36.9
Professional	85	37.3
Occupation		
House keeping	38	16.7
Student	40	17.5
Merchant	20	8.8
Agricultural	12	5.3
Cattle rancher	15	6.6
Beekeeper	11	4.8
Miner	45	19.7
Administrative	39	17.1
Unemployed	8	3.5

f= frequency, %= percentage, n=228
Source: Authors' elaboration based on the KAP questionnaire applied in northwest Mexico.

The participating households were from different municipalities of Sonora, as shown in Figure 1.

Figure 1. Municipalities in the state of Sonora, Mexico, where households were sampled. 2023-2024. Source: Figure developed by the authors using Microsoft PowerPoint.

Table 2 presents characteristics of the household and KAP of coexistence with dogs in the population. Risk factors include lack of pavement 24.6%, adjacent to vacant land 37.3%, porous wall materials such as wood, bricks and concrete blocks (0.9%, 33.8% and 58.6% respectively), dirt floor 1.8% or cement 37.7% and practices like not fumigating the house in the 45.6% of the households. Only 7.0% of people reported having been previously bitten by ticks.

The questionnaire inquired about presence of stray dogs in the household participants' environment (Table 2) most respondents 69.7% confirmed their presence. Additionally, the attitudes and practices about owning a pet dog in 80.7% of households, with 40.2% having only one dog, 44.6% having two or three dogs and 15.2% owning four or more dogs. Among dog owners (n=184), 38.6% reported practices like deworming their pets every six months, 20.7% dewormed them rarely, 19.6% did so annually, and 12.5% had never dewormed their pets. Participants were also asked about the practices of examining their pets for ticks; 16.9% reported conducting examinations every two months or more, while 10.9% indicated they had never examined their pets for ticks or other parasites. Furthermore, 57.1% of dog owners stated they rarely found ticks on their pets, whereas 16.8% reported always or almost always finding ticks on their dogs. A relevant fact was the frequency with which dogs enter the household where 32.6% said that they are always or almost always inside, 40.8% mentioned that they are occasionally.

Table 2: Households' characteristics and knowledge, attitudes, and practices concerning coexistence with dogs among the population. Sonora, Mexico 2023-2024.

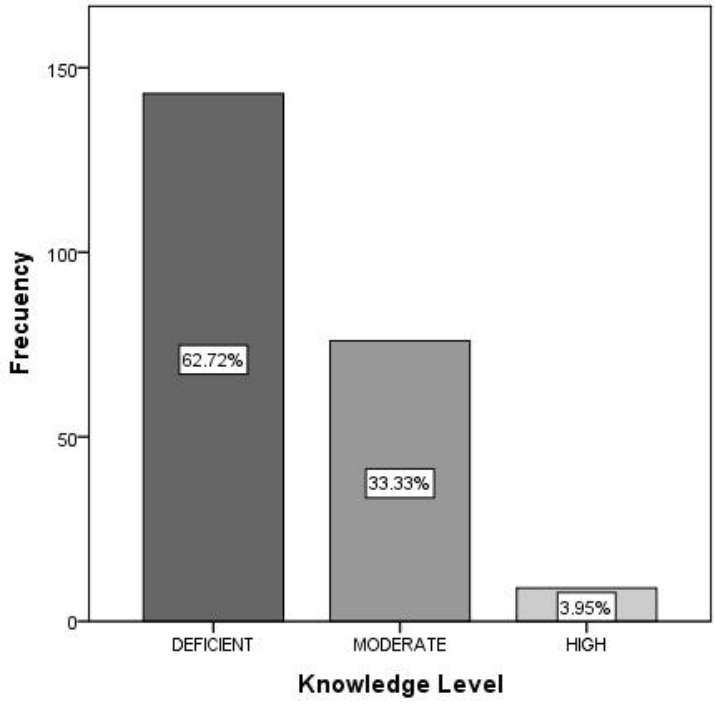
Variables	*f*	%
Persons living in the household		
1 person	4	1.8
2 persons	36	15.8
3-5 persons	141	61.8
6-8 persons	37	16.2
9 or more	10	4.4
Paved street		
Yes	172	75.4
No	56	24.6
Adjacent to vacant land		
Yes	85	37.3
No	143	62.7
Material walls house		
Wood	2	0.9
Brick	77	33.8
Concrete block	133	58.3
Metal sheet	4	1.8
Adobe	2	5.3
Floor material house		
Ceramic	138	60.5
Soil	4	1.8
Cement	86	37.7
Fumigated last year		
Yes	124	54.4
No	104	45.6
Have been bitten by ticks		
Yes	16	7.0
No	212	93.0
Stray dogs in the neighborhood		
Yes	159	69.7
No	69	30.3
Owner of pet dogs		
Yes	184	80.7
No	44	19.3
Number of dogs*		
1	74	40.2
2	56	30.4
3	26	14.1
4 or more	28	15.2
Deworming dogs*		
Every 3 months	16	8.7
Every 6 months	71	38.6
Every year	36	19.6
Rarely	38	20.7
Never	23	12.5

Variables	*f*	%
Check for ticks on pets*		
2-3 per week	58	31.5
2-3 per month	40	21.7
Once a month	35	19.0
> 2 months	31	16.9
Never	20	10.9
Find ticks*		
Always	1	0.5
Almost always	30	16.3
Rarely	105	57.1
Never	42	22.8
I don't know	6	3.3
Frequency of dogs enters the household*		
Never	49	26.6
Occasionally	75	40.8
Almost always	30	16.3
Always	30	16.3

f= frequency, %= percentage, n=228
*Housing with dog(s) (n=184)
Source: Authors' elaboration based on the KAP questionnaire applied in northwest Mexico.

The knowledge level of a surveyed community in Sonora, Mexico, was categorized based on their score on the epidemiological questionnaire. The categories were high (75-100 points), moderate (50-74 points), and deficient (<50 points). Figure 2 showed that only 4.0% had a high level of knowledge, 33.3% had a moderate level, and 62.7% had a deficient level.

Figure 2. Knowledge levels about tick exposure among households from northwest Mexico. Source: Figure developed by the authors using IBM® SPSS Statistics software.



Associations between the main variable, knowledge level, and the SDH for each household were analyzed using the chi-square test and are presented in contingency tables, as shown in Table 3. P-values < 0.05 were considered significant. Among the factors with significant associations were occupation ($p = 0.001$), educational attainment ($p < 0.001$) where higher knowledge levels were associated with higher education levels, attitudes and practices like the frequency of dogs entering the household ($p = 0.005$), owners having previously found ticks on their dogs ($p = 0.030$), households practicing fumigation ($p = 0.017$), and an attitude of higher perceived risk of tick bites on the Likert scale ($p = 0.023$). The remaining variables did not show statistically significant associations.

Table 3: Factors associated with the level of knowledge by chi-square test <0.05. Sonora, Mexico. 2023-2024.

Variables	**Categories**	**Category levels of knowledge**			***P* value***
		Deficient	**Moderate**	**High**	
Sex	Woman	94	53	3	0.094
	Man	49	23	6	
Municipality	Hermosillo	28	17	3	0.092
	Caborca	21	11	2	
	Banamichi	39	7	0	
	Cd. Obregón	21	16	2	
	Guaymas	22	13	2	
	Other	12	12	0	
Occupation	Home	30	8	0	0.001†
	Student	14	21	5	
	Merchant	16	4	0	
	Agricultural	8	3	1	
	Cattleman	11	3	1	
	Beekeeper	3	8	0	
	Miner	33	12	0	
	Administrative	22	15	2	
	Unemployed	6	2	0	
Schooling	None	8	0	0	<0.001†
	Elementary	6	2	0	
	Middle school	37	6	0	
	High school	56	24	4	
	Professional	36	44	5	
Number of persons living in the household	1 person	3	1	0	0.949
	2 persons	23	12	1	
	3-5 persons	88	48	5	
	6-8 persons	22	12	3	
	9 or more	7	3	0	
Presence of stray dogs	No	47	22	0	0.109
	Yes	96	54	9	
Pet dogs	No	28	16	0	0.315
	Yes	115	60	9	

Variables	Categories	Category levels of knowledge			*P* value*
		Deficient	Moderate	High	
Number of dogs	None	28	16	0	0.231
	1	43	26	5	
	2	40	14	2	
	3	12	12	2	
	4 or more	20	8	0	
Frequency of dogs enters the household	Never	63	30	0	0.005†
	Occasionally	44	24	7	
	Almost always	22	6	2	
	They're always inside	14	16	0	
Finding ticks on the dog(s)	Always	1	0	0	0.030†
	Almost always	26	4	0	
	Seldom	56	40	9	
	Never	28	14	0	
	I don't know	4	2	0	
	I don't have dogs	28	16	0	
Fumigated in the last year					
	No	66	38	0	0.017†
	Yes	77	38	9	
Risk perception Likert scale	1	38	17	0	0.023†
	2	36	12	0	
	3	23	19	2	
	4	26	14	2	
	5	20	12	5	

*Chi-square test, †Significance <0.05, n=228
Source: Authors' elaboration based on the KAP questionnaire applied in northwest Mexico.

DISCUSSION

This study looked at the determinants of KAP on exposure to ticks, as the association between knowledge levels and household characteristics or related factors in a region with high prevalence of Rickettsia transmitted by ticks, such as Sonora, northwest of Mexico. Statistical analysis using the chi-square test was carried out, which revealed that factors such as education level, occupation, close cohabitation with pet animals, vector prevention practices in the home and perceived increased risk were linked to higher levels of knowledge about transmitted diseases, preventive measures, symptoms and greater motivation to avoid ticks.

RMSF poses significant diagnostic challenges as its early symptoms are nonspecific and can easily be mistaken for other febrile illnesses. Therefore, timely and adequate treatment is critical to avoiding potentially fatal outcomes [(11)]. In this study, 80.7% of households had dogs as ideal hosts for the tick *Rhipicephalus sanguineus*. However, risk practices and attitudes related to pet care prevailed. For example, infrequent deworming was common, increasing the risk of parasitic infections and transmission of zoonotic diseases. Ticks, known vectors of RMSF, were frequently found in 16.8% of

domestic dogs as reported by their owners, highlighting the increased risk of exposure to pathogens. In addition, 45.6 per cent of households reported practices such as no-fumigation in the past year. This lack of preventive measures creates a favorable environment for the proliferation of ticks and other vectors, which implies a carefree attitude towards zoonotic diseases, ultimately increasing the potential for disease transmission such as RMSF [20].

These findings underscore the need for improved public health education on the importance of regular pet care, environmental management, and vector control to mitigate risks associated with RMSF and other tick-borne diseases. This aligns with the results observed in the systematic review and meta-analysis by Fischhoff et al. [25], supports the use of passive surveillance of tick bites as a predictor of disease risk.

It was observed that most household representatives had a knowledge level about vector-borne diseases, and their prevention was classified as deficient (62.7%), while only 4.0% achieved a high knowledge level. This aligns with findings from Castañeda-Porras [26], which revealed low awareness of vector-borne diseases, their signs and symptoms, control measures, and appropriate use among the Colombian population with similar characteristics.

A study conducted in the city of Hermosillo Sonora, northwest of Mexico by Reyes-Castro, et al [17], found that 26.0% were not aware or were unsure about prevention strategies for RMSF, as well as low socioeconomic status were less likely to have heard of RMSF (OR: 0.39;95%CI: 0.25-0.59), used tick-avoidance products on their pets (OR: 0.40; 95% CI: 0.17-0.99) or checked if their dogs had ticks (OR: 0.25; 95% CI: 0.09-0.74). Data that coincides with the data found in the different municipalities (including Hermosillo) of our study. Emphasizing the main problems regarding practices adopted by the Sonoran population despite community efforts.

Findings indicate that pet owners who have previously found ticks in their dogs allow them to enter the home frequently and exhibit a perceived increased risk of ticks being associated with higher levels of disease awareness transmitted by ticks. This association may be explained by increased exposure and understanding of the risks posed by ticks, which may lead to greater interest in seeking information and taking preventive action. Frequent contact with pet animals that host ticks could act as a direct motivator for owners to learn about the health implications for both their own and their pets. In addition, experiencing the presence of ticks in first person may increase your perception of vulnerability, reinforcing the need to understand preventive practices and recognize signs and symptoms of tick-borne diseases as referenced in the literature [27].

Additionally, cultural attitudes and practices may influence how individuals perceive the threat of vector-borne diseases and their commitment to implementing preventive strategies. As various authors have noted, even when control measures are known, there can be a gap in their application due to misconceptions or a lack of risk perception. Therefore, public health campaigns must be designed to address these cultural factors and improve risk perception, ensuring individuals understand the personal and community consequences of vector-borne diseases [26,28].

Ultimately, while knowledge is essential, it may not be enough to inspire behavioral changes. Closing the knowledge gap must go hand in hand with empowering communities to act. This includes supplying the resources, tools, and support systems

necessary for individuals to implement preventive measures effectively. For example, governments and health organizations should ensure that vulnerable populations can access affordable vector control solutions, such as insecticides, acaricides, tick repellents, and regular pet veterinary care.

Overall, the results provide a snapshot of the current situation in various communities where vector prevalence and the incidence of diseases such as RMSF are growing problems. This highlights the need for a multifaceted approach that enhances knowledge about vector-borne diseases and addresses structural, social, and economic barriers to effective prevention and control. Collaboration with public health authorities, community leaders, and educational institutions is essential to creating a more informed and proactive public and ultimately reducing the burden of vector-borne diseases in at-risk populations.

Among the main limitations, the use of self-administered questionnaires may have introduced response bias. In addition, although stratified random sampling was applied in high-incidence areas, the results cannot be generalized to the entire northwest region of Mexico. Future studies should include environmental and healthcare access variables, and the KAP questionnaire should be validated in different sociocultural contexts to strengthen comparisons and guide more targeted interventions.

CONCLUSIONS

This lack of knowledge about vector-borne diseases poses a significant public health concern, as it is closely linked to SDH such as education, socioeconomic status, and access to health information. The limited or non-existent understanding of the risks associated with vectors, such as ticks, highlights significant gaps in the population's KAP related to health. These deficiencies not only reflect a lack of individual awareness but also systemic shortcomings in public health education and outreach. As a result, risky behaviors and inadequate environmental practices persist, creating conditions that favor the proliferation of disease vectors and ultimately increase the risk of zoonotic disease transmission.

To address this issue, targeted interventions promoting health and preventing vector-borne diseases, such as those transmitted by ticks, are strongly recommended. These interventions should focus on improving public awareness, encouraging regular veterinary care for pets, and implementing effective environmental management practices, such as fumigation and proper waste disposal. Moreover, community-based education programs that provide clear, accessible information about the risks posed by vectors, the importance of early detection, and preventive measures are essential to fostering a better understanding of the problem.

Furthermore, adopting multidisciplinary interventions is essential for understanding the intricate interactions among biological, environmental, psychosocial factors, and the perceived behavioral control elements that contribute to the spread of zoonotic diseases. These strategies should involve collaboration among public health authorities, veterinarians, environmental experts, and community organizations. Such approaches will tackle the immediate risks posed by vectors and encourage a long-term shift in risk perception and behavior within the population. How individuals and communities perceive the threats of vector-borne diseases is crucial for achieving sustainable

improvements in public health outcomes. A comprehensive and integrated effort is necessary to reduce conditions that enable zoonotic diseases to thrive and safeguard the population from future outbreaks.

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CONFLICTS OF INTEREST

In compliance with the ICMJE uniform disclosure form, all authors declare the following: They declare that they have no conflict of interest.

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