



Exposure settings, tick removal practices, and underdiagnosis risks of Lyme Borreliosis in student of I. Horbachevsky Ternopil National Medical University: a cross-sectional study

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Abstract. This article presents a comprehensive analysis of epidemiological survey results from 275 higher education students, aimed at studying the frequency of *Ixodidae* tick attacks, exposure settings, level of awareness regarding vector-borne disease transmission risks, and tick removal practices. Despite the predominantly urban sample (69,8 % of respondents residing in urban areas), a high intensity of contact with ticks was established: 54,9 % of all respondents reported exposure to these arthropods, and 46,6 % reported direct tick attachment. An investigation into attack locations revealed that peak tick activity occurs in forest and meadow biocoenoses. However, 3,6 and 1,8 % of respondents reported attacks in parks and gardens, respectively, indicating the potential for arthropod exposure within residential areas. The highest number of tick attacks occurred in the Ternopil region (16,4 % of all respondents), likely related to their place of residence, while 15,3 % could not recall the exact territory. The highest number of attacks was recorded in June and July (14,9 and 12,0 % of all respondents, respectively), whereas in May and August, these rates were 8,7 and 5,1 %. The majority of surveyed students discovered ticks by chance or during self-examination following exposure to high-risk areas. This highlights the crucial role of self-inspection, which enabled most individuals to detect ticks within the first 24 hours of attachment. An analysis of the behaviors of 128 respondents who reported tick attachment revealed that only 28,1 % sought professional medical care. In 53,1 % of cases, ticks were removed by non-medical third parties, while 18,8 % removed them independently, significantly increasing the risk of trauma and infection. Although laboratory-confirmed Lyme borreliosis was documented in only 4 cases, the presence of pathognomonic erythema migrans in 35,2 % of victims, against a background of low diagnostic testing rates (only 21,8 %), suggests substantial

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underdiagnosis of tick-borne diseases. These findings underscore the urgent need to intensify health education efforts among youth, implement effective personal prophylaxis strategies, and improve health literacy regarding post-tick-bite action algorithms.

Keywords: *Ixodidae* ticks; tick bites; vector-borne diseases; Lyme Borreliosis; erythema migrans; epidemiological survey; health literacy; student; Ternopil region.

Introduction

The problem of the spread of *Ixodidae* ticks in western Ukraine remains highly relevant due to extensive forest cover, high-humidity climatic conditions, and the socio-economic situation of a country at war. Abandoned agricultural lands overgrown with shrubs have become ideal breeding grounds for rodents, which serve as hosts for ticks [1]. Migration processes in Ukraine during the full-scale invasion have altered the country's demographic structure. Internally displaced persons, who previously resided in the urbanized regions of southern and eastern Ukraine, now live in different climatic conditions, where warm winters allow ticks to remain active even in December or February. Cold regions and highlands are becoming habitable for ticks during earlier winter periods. This explains the upward movement of ticks into mountainous areas, as well as their colonization of urban landscapes. Tick populations adapt well to urban environments, meaning human-vector contact occurs not only in forests but also during routine city walks [2]. Urban parks, public gardens, and suburban dacha plots have become ideal biotopes for ticks, while high population density increases the frequency of contact between the host and the blood-sucking parasite. This, in turn, facilitates the spread of tick-borne diseases transmitted by the *Ixodidae* family, including tick-borne encephalitis, Lyme borreliosis, and so-called "co-infections" involving simultaneous infection with *Borrelia*, *Anaplasma*, and *Babesia* [3]. The extraordinary plasticity of the *Ixodidae* family makes them exceptionally successful from an epidemiological standpoint, necessitating the continuous updating of data on their distribution to inform the public and improve tick control methods.

Large regional universities accumulate youth from many villages, towns, and regions, which allows for the representation of various territories through the method of so-called active citizen participation, or "citizen science" [4]. Young people lead an active lifestyle and frequently visit natural tick biotopes, such as parks, public gardens, meadows, and forests, not only in their places of residence but also around their places of study; therefore, they have a high probability of coming into contact with blood-sucking parasites.

The aim of the study: to assess the prevalence of *Ixodidae* tick bites, exposure settings, and the level of awareness regarding vector-borne disease risks and removal practices among students at I. Horbachevsky

Ternopil National Medical University (TNMU), through a cross-sectional survey.

Materials and Methods

To achieve this goal, an online survey consisting of 30 questions was created using the Google Forms service. Convenience sampling strategy was applied; the link to the online form was distributed via corporate email to first- to third-year students from TNMU. Students on these courses, aged between 17 and 21, took part in an anonymous the survey, following the analysis of the responses, only the fully completed questionnaires were selected, numbering 275. Incomplete responses were excluded from the sample.

Results

The first section of the questionnaire included questions about the student's course of study, gender and place of residence. The vast majority of our respondents, accounting for 69,9 % (192 out of 275), were urban residents, 19,6 % (54 out of 275) permanently resided in rural areas, and only 10,5 % (29 out of 275) of the students lived in urban-type settlements. More than half (62,5 % – 172 out of 275) of the higher education students, denied visiting locations with a high probability of encountering *Ixodidae* ticks, such as forests, forest-park zones, public gardens, and meadows. Frequently, 23,7 % (65 out of 275) of individuals visited areas with an increased risk of tick contact, while 13,8 % (38 out of 275) of the students did so quite rarely. However, 46,5 % (128 out of 275) reported being bitten by ticks, with the majority of them consisting of individuals who had been bitten twice 16,7 % (46 out of 275), or more within a single spring-summer season (8,4 % 23 out of 275). Nevertheless, the number of respondents who detected a tick on their clothing or body was slightly higher 54,9 % (151 out of 275), which underscores the importance of self-examination after spending time in high-risk areas. Nearly a third of the respondents, totaling 38,9 % (107 out of 275), detected a tick on themselves after being in a forest, 3,6 % (10 out of 275) in a park zone, 2,9 % (8 out of 275) in a meadow, and 1,8 % (5 out of 275) of the students in a garden, while 7,6 % (21 out of 275) of the respondents could not associate the tick attack with staying in any of the aforementioned locations.

When asked about the locality where the attachment of the parasite occurred 16,4 % (45 out of 275) respondents reported tick bite in Ternopil Region (Fig.1).

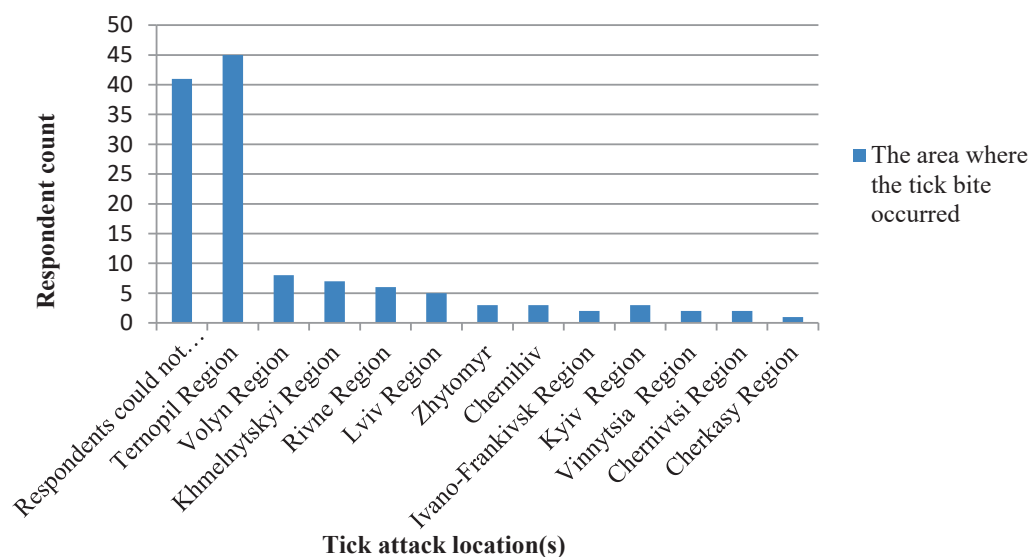


Fig. 1. Area(s) with reported tick attacks / bites.

Meanwhile, 15,3 % (42 out of 275) of the respondents reported attacks by the arthropod parasite in their places of permanent residence. Most frequently, bites were reported by residents of Volyn Region (8 individuals), Khmelnytskyi Region (7), Rivne Region (6), and Lviv Region (5). These results are evidently related to the geography of applicants entering TNMU and are consistent with the data from [5, 6]. However, many (14,9 % – 41 out of 275) respondents could not recall the locality of the parasite attack.

When asked about the specific location of the tick bite, respondents primarily referred to the area around Ternopil. Specifically, 12 % of the students (33 out of 275) reported being bitten on the outskirts of Ternopil, in a meadow, or in a forest, while 4,4 % (12

out of 275) experienced a tick bite during a walk in green areas, such as urban parks or public gardens. Residents of other regions were unable to specify the precise location, likely because the bites had occurred in the distant past.

Considering that the activity of *Ixodidae* ticks depends on the interaction of key climatic factors and has a seasonal nature [7], it was expedient to analyze the responses of the students regarding the time of year when they detected a tick bite.

The respondents answers indicate that the highest number of tick attacks occurred in June and July, accounting for 14,9 % (41 out of 275) and 12 % (33 out of 275) of the respondents, respectively, while attacks in April and May were reported by 1,9 % (5 out of 275)

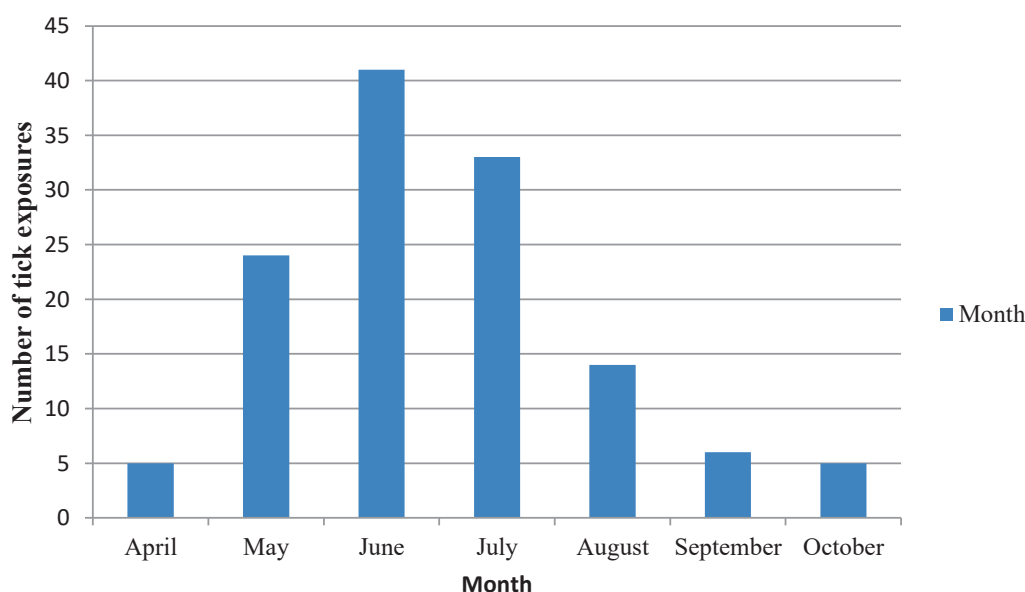


Fig. 2. The month in which the tick bite occurred.

and 8,7 % (24 out of 275) of those surveyed, respectively (Fig. 2). Tick attachment in August was reported by 5,1 % (14 out of 275) of the higher education students, whereas in September and October, it was noted by only 2 % (6 out of 275) and 1,8 % (5 out of 275) of the respondents, respectively. Recent studies demonstrate a similar trend toward a summer peak in ixodid tick activity across European countries, and these data may be linked to the activity patterns of different tick developmental stages [8, 9].

Many warm-blooded vertebrates, ranging from mice and rats to ungulates, can serve as hosts for various developmental stages of *Ixodidae* ticks. Among domestic animals, cats and dogs are of significant epidemiological importance, as they primarily inhabit or visit the same locations as humans. Indeed, 25 higher education students, representing 9 % of all respondents, indicated that the tick bite was associated with walking domestic pets (dogs, cats). Furthermore, 121 respondents (44 % of all surveyed) reported detecting a tick on a dog, 73 individuals (26,5 % of those surveyed) on a cat, and only 7 individuals (2,5 %) detected a tick on domestic ungulates.

As mentioned above, the proportion of students who found ticks on their clothing or body was quite high 54,9 % (151/275). The vast majority of the that respondents, accounting for 51,6 % (78/151) detected a tick on their clothing or body by chance; 44,4 % (67/151) of the higher education students noticed the parasite during self-examination after staying in a green area, and only 4 % (6/151) of the respondents found the parasite when they felt pain at the site of tick attachment.

Furthermore, an analysis of the questionnaires revealed that 46,5 % of respondents (128/275) had been bitten by ticks. Among those who experienced tick attachment, three-quarters (75,0 % – 96/128) detected the tick within 24 hours (Table 1). Additionally, 14,8 % (19/128) did so the following day, while only 3,9 % (5/128) found it after several days. Finally, 6,3 % (8/128) of respondents could not recall when the tick was removed.

More than half of the bitten respondents 53,1 % (68/128) had the tick removed with the help of non-medical third parties; 18,8 % (24/128) extracted the ectoparasite independently, and 28,1 % (36/128) sought assistance from healthcare professionals.

These facts are quite alarming, since incorrect removal of the ectoparasite may cause its contents to enter the wound, or part of it may remain in the skin. This increases the risk of contracting tick-borne infections, including Lyme disease, and can also lead to potential wound suppuration and prolonged healing. The use of dangerous "folk methods," such as applying oil, alcohol, creams, or cauterization, can stimulate the secretion of a larger volume of saliva containing potential infectious pathogens into the wound.

Overall, 45 out of 128 students (35,2 % of those who reported tick attachment) noted the appearance of erythema. Among these respondents, 35,6 % (16/45) reported erythema at the bite site, 8,9 % (4/45) observed it in areas distant from the bite site, and 55,6 % (25/45) could not recall its exact localization. Regarding the onset of erythema, 31 of these respondents (68,9 %) did not remember when it appeared. Meanwhile, 8 individuals (17,8 %) noted its onset within 24 hours, 1 student reported redness within 24–48 hours after tick detection, 3 respondents stated that erythema appeared after 3 days, and 1 respondent each detected erythema 7 and 14 days post bite, respectively.

Laboratory testing for *Borrelia* was conducted by only 28/128 respondents, representing 21,8 % of the students who reported tick attachment. Among them, 85,7 % respondents (24/28) tested negative, while only 14,3 % (4/28) received a positive result. Rather than indicating low infection rates, this suggests an insufficient level of screening, which in turn increases the risks of untimely diagnosed cases, potentially significantly complicating treatment and contributing to the development of complications [10].

Discussion

The higher education students indicated the emergence of unusual symptoms after detecting a tick on themselves. In particular, 2 individuals each noted the development of fever and headache. A decrease in concentration during classes was reported by 1 individual. Enlargement of lymph nodes near the bite site or itching at the bite site was noted by 1 individual each. One student reported facial nerve palsy, and 2 students noted the development of joint inflammation. Evidently, the appearance of symptoms prompted 46 individuals representing 35,9 % of the 128 students who reported tick attachment, to

Table 1. Distribution of respondents by tick bite status and detection timing

Time to tick detection following attachment	Respondent count	Method of tick removing	Respondent count
24 hours	96	with assistance from others	68
48 hours	19	independently	24
more than 48 hours	5	with medical assistance	36
could not recall	8		
	Total 128		Total 128

consult a physician, of whom 15 students received treatment. Following the tick bite, 22 individuals were under dispensarization (follow-up monitoring) by a dermatologist, 10 individuals by a cardiologist, and 3 individuals by a neurologist. Diagnoses that could be associated with a tick bite were established in 7 respondents. Treatment for chronic tick-borne diseases was received by 15 individuals, accounting for 11,7 % of the students who reported tick attachment.

There is a high probability that the friends and relatives of individuals who have suffered a tick bite may also be at risk. This is explained by the fact that they often share the same environmental conditions, visiting the same natural areas (forests, parks, suburban dacha plots), and engaging in shared recreational activities or outdoor pursuits. Ticks are not transmitted directly from person to person; however, their prevalence in a particular locality poses an equal threat to everyone present in that environment. Therefore, if a bite is detected in one individual, it is expedient to consider their close social circle as also belonging to a high-risk group. Indeed, according to our survey results, 127 higher education students, representing 46,2% of the surveyed respondents, answered affirmatively regarding tick attacks on their relatives or acquaintances. Moreover, 72 individuals noted that their close ones had been bitten twice, 4 individuals developed complications following a bite, and 2 individuals were diagnosed with borreliosis.

Conclusions

1. A high prevalence rate of tick bites was established among student youth (46,5 % of all respondents), with 9 % of respondents linking them to walking pets. Tick attacks occurred most frequently in natural biotopes. Respondents listed natural biotopes – forests and meadows at 38,9 and 2,9 %, respectively – as the most common locations where tick attacks took place; tick attacks in parks and gardens were reported by 3,6 and 1,8 %, respectively, although 7,6 % of students could not specify the exact location of the tick attack.

2. Ticks attached most frequently in 16,4 % of respondents while they were in the Ternopil region

and neighboring regions; however, 15,3 % of higher education students could not recall the territory where the attack occurred.

3. The highest number of tick contacts occurred in June – July, reported by 14,9 and 12 % of respondents, respectively. Significantly fewer attacks took place in May, August, and September – October, reported by 8,7, 5,1, and 2 % of respondents, respectively. These results may be related to the activity of different life cycle stages of ticks in the corresponding months.

4. More than half of those surveyed (54,9 %, 151/275) discovered a tick on their clothing or body by chance. The vast majority of these respondents indicate finding the tick by chance or after performing a self-examination, which highlights its importance following exposure to high-risk areas.

5. Among the respondents who reported a tick bite (46,5 %, 128/275), three-fourths (75 individuals) discovered the tick within 24 hours of attachment. However, more than half of these respondents (53,1 %, 68/128) had the tick removed by non-medical third parties, or removed it themselves (18,8 %, 24/128), which could have increased the risk of injury and infection due to unprofessional actions. A low level of seeking professional medical care was recorded at 28,1 % of those surveyed (36/128).

6. Despite the low percentage of laboratory-confirmed cases of Lyme borreliosis (4 individuals), the presence of erythema migrans in 35,2 % (45/128) of respondents who reported a tick bite, against the backdrop of a low testing rate (21,8 %, 28/128), suggests potential underdiagnosis of the disease. The risk of infection extends to the students immediate circle due to shared exposure in endemic areas.

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Conflict of interest.

The authors declare no conflict of interest.

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Умови інфікування, способи видалення кліщів та діагностика хвороби Лайма серед студентів Тернопільського національного медичного університету імені І. Я. Горбачевського: перехресне дослідження

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Анотація. У статті представлено комплексний аналіз результатів епідеміологічного опитування 275 студентів із Тернопільського національного медичного університету імені І. Я. Горбачевського, спрямованого на вивчення частоти нападів іксодових кліщів, умов контакту з ними, рівня обізнаності щодо ризиків передачі трансмісивних захворювань та практики видалення кліщів. Попри те, що більшість опитаних (69,8 %) проживали в міській місцевості, було встановлено високу інтенсивність контактів із кліщами: 54,9 % респондентів повідомили про

контакт із цими членистоногими, а 46,6 % – про випадки їх безпосереднього присмоктування. Аналіз місць нападу показав, що пік активності кліщів припадає на лісові біоценози. Водночас 3,6 і 1,8 % респондентів зазнали нападу кліщів у парках і садах відповідно, що вказує на ймовірність контакту з ними у межах населених пунктів. Найбільшу кількість випадків нападу кліщів зафіксовано в Тернопільській області (16,4 % серед усіх опитаних), що, ймовірно, пов'язано з місцем їхнього проживання, тоді як 15,3 % не змогли точно вказати територію, де стався напад кліща. Найвищі показники нападів припали на червень і липень (14,9 та 12,0 % відповідно), тоді як у травні та серпні вони становили 8,7 і 5,1 % відповідно. Більшість опитаних здобувачів виявляли кліщів випадково або під час самоогляду після перебування в зонах підвищеного ризику. Це підкреслює важливість самоогляду, завдяки якому більшість осіб змогли виявити кліщів протягом першої доби після присмоктування. Аналіз дій 128 респондентів, у яких було зафіксовано присмоктування кліща, показав, що лише 28,1 % звернулися за професійною медичною допомогою. В 53,1 % випадків кліщів видаляли сторонні особи без медичної освіти, а у 18,8 % – їх самостійно, що значно підвищувало ризик травмування та інфікування. Хоча лабораторно підтверджений Лайм-бореліоз було задокументовано лише у 4 випадках, наявність патогномонічної мігруючої еритеми у 35,2 % постраждалих на тлі низького рівня діагностичного тестування (лише 21,8 %) свідчить про значну недодіагностику захворювання. Отримані результати підкреслюють нагальну потребу в посиленні санітарно-просвітницької роботи серед молоді, впровадженні ефективних стратегій індивідуальної профілактики та підвищенні рівня обізнаності щодо алгоритмів дій після укусу кліща.

Ключові слова: іксодові кліщі; укуси кліщів; трансмісивні хвороби; хвороба Лайма (бореліоз); мігруюча еритема; епідеміологічне дослідження; рівень обізнаності; здобувачі; Тернопільська область.