Review

An Alarming Public Health Problem: Ticks and Tick-Borne Pathogens in Urban Recreational Parks

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ABSTRACT

Ticks function as critical vectors for a wide range of pathogens that pose significant risks to both human and animal health. In recent years, the number and diversity of tick-borne pathogens have increased at an unprecedented rate, elevating tick-borne diseases (TBDs) to a major public health concern on a global scale. TBDs present a dual challenge, not only affecting human populations but also causing substantial economic losses in livestock industries across the world. The geographic distribution of many TBDs is shifting, with emerging, re-emerging, and resurging cases influenced by environmental factors such as deforestation and climate change. In China, rapid urbanization and concurrent improvements in urban ecological conditions have contributed to the expansion of tick habitats and increased human exposure to tick populations. Recent research warns that ticks and their associated pathogens present significant risks in urban environments, particularly in locations such as parks, playgrounds, and zoos. Despite these threats, public awareness of tick-borne diseases remains critically low. This review consolidates current knowledge on tick species and tick-borne pathogens found in urban parks and proposes strategic control measures to inform effective tick management policies both in China and globally.

Ticks are hematophagous arthropods that parasitize humans and animals (*1*). Second only to mosquitoes in their epidemiological significance, ticks serve as crucial vectors for numerous infectious pathogens (*2*). Currently, China possesses approximately 125 tick species (*3*). The global prevalence of tick-borne pathogens and their associated diseases is continuously rising, posing significant threats to human health, labor productivity, livestock industry profitability, and biodiversity (*3*).

While often found in forested, mountainous, and hilly regions, environmental improvements have expanded the suitable habitat of ticks into urban areas, particularly recreational parks. The growing presence of ticks and tick-borne pathogens in these environments presents an emerging public health concern that demands attention (*4–5*). Multiple studies investigating urban tick populations have demonstrated their widespread presence in urban landscapes (*6–7*). Notably, the diversity and prevalence of tick-borne diseases (TBDs) in urban environments now rival those observed in non-urban settings. Despite increasing reports of tick infestations in urban parks, comprehensive reviews addressing this significant public health concern remain limited. This review first examines the tick species and tick-borne pathogens present in urban recreational parks, followed by an analysis of the potential prevention measures as well as control strategies.

TICK SPECIES AND TICK INFESTATION IN URBAN RECREATIONAL PARKS

Ixodes ricinus L. (Acari: Ixodidae), commonly known as the castor bean tick, is a significant vector of several pathogens of medical and veterinary importance. This species progresses through four main developmental stages: eggs, larvae, nymphs, and adults (male or female) (*8*). It predominantly inhabits deciduous and mixed forests, as well as woodlands, moorlands, and scrublands, where its survival and reproduction depend on suitable microclimatic conditions and host availability. Urban hedgehog populations can effectively maintain stable *I. ricinus* populations in metropolitan areas (*9–10*). Studies in the UK have documented tick presence across various life stages in 7.2% of transects in Bushy Park and 37.6% in Richmond Park. *Ixodes scapularis* Say and *I. pacificus* Cooley & Kohls (Acari: Ixodidae), known respectively as the deer tick and western black-legged tick, are principal vectors of human pathogens in the United

States. Following egg hatching, these species undergo three developmental stages — larva, nymph, and adult — with a typical lifespan of around 2 years (*11*). *I. scapularis* primarily inhabits unmaintained herbaceous vegetation, maintained lawns, and leaf litter in urban parks, with adults showing higher density in edge ecotones and nymphs predominantly occupying the leaf layer (*12*). In contrast, *I. pacificus* primarily associates with grassy areas within urban park environments (*13*).

Ixodes persulcatus Schulze (Acari: Ixodidae), the taiga tick, represents one of the most significant disease vectors affecting humans and animals across the Northern Hemisphere, with a distribution spanning the entirety of the Eurasian continent (*14*). As a characteristic forest tick, *I. persulcatus* dominates coniferous and broadleaf mixed forests. Its breeding habitats in urban recreational parks encompass coniferous forests, broadleaf forests, mixed forests, shrublands, and grasslands (*15*).

Ixodes hexagonus Leach (Acari: Ixodidae), the hedgehog tick, represents one of the most prevalent tick species in Central Europe. While *I. hexagonus* parasitizes various carnivorous mammals in suburban environments, all developmental stages most frequently occur on hedgehogs (*16*). This species-host association remains present in urban recreational parks across Europe, where hedgehogs serve as the primary hosts (*17–19*).

Haemaphysalis longicornis Neumann (Acari: Ixodidae) commonly known as the long-horned tick, is native to East Asia. Its life cycle comprises four developmental stages: egg, larva, nymph, and adult (*20*). This species inhabits diverse ecological niches within parks, including shrubland, grassland, deciduous forests, mixed forests, and coniferous forests. Among these habitats, these four major biomes support significantly higher tick populations compared to other environments: broadleaf forests, coniferous forests, shrublands, and grasslands (*21–22*).

Hemaphysalis flava Neumann (Acari: Ixodidae) is widely distributed throughout East Asia and progresses through four developmental stages: egg, larva, nymph, and adult (*23–26*). Studies have demonstrated that *H. flava* exhibits a strong association with woodland habitats in urban parks, with peak collection rates from domestic dogs and cats occurring in October and notably minor prevalence during the summer months of July and August (*24*,*27*).

Amblyomma americanum (Acari: Ixodidae), the lone star tick, is an aggressive three-host tick predominantly found in eastern North America, with particular prevalence in the south of the United States. This species maintains its population through feeding on white-tailed deer, ground-nesting birds, and various other wildlife hosts (*28*). Surveillance studies have documented substantial *Am. americanus* populations in residential parks featuring paved walking trails, golf putting greens, and recreational playgrounds in the state of Oklahoma, USA (*29*).

Dermacentor reticulatus Fabricius (Acari: Ixodidae), the ornate cow tick, belongs to the Metastriata group of ixodid ticks (*30*). The highest density of *D. reticulata* was recorded in a suburban park in northern Italy. Mixed forest areas dominated by oak trees and characterized by the presence of ponded waters are the main habitats of this tick species (*31–32*).

Dermacentor occidentalis Marx (Acari: Ixodidae) is distributed throughout California, except for the arid regions of the Central Valley and southeastern desert (*33*). The species has also been documented in neighboring US states such as Oregon and Baja California in Mexico (*34*). Its life cycle exhibits stage-specific host preferences: immature stages primarily parasitize rodents, particularly squirrels, while adults preferentially feed on larger mammals including cattle, horses, deer, and humans. Adult ticks remain active year-round, with peak activity observed during the months of April and May, while nymphal stages predominate during spring and summer months. While adults commonly parasitize cattle, horses, deer, and humans, they are rarely found on dogs and bears. The species is frequently encountered in urban parks throughout southern California, USA (*13*).

Dermacentor variabilis Say (Acari: Ixodidae), commonly known as the American dog tick or wood tick, is a widespread three-host tick species in North America that parasitizes a diverse array of hosts, including humans (*35*). Studies have demonstrated that this species predominantly inhabits grasslands, shrublands, savannahs, and woodlands in urban areas, with native encroaching tree species potentially contributing to increased tick populations (*36*). The species is frequently encountered in urban parks throughout the United States (*37–38*).

Rhipicephalus sanguineus Latreille (Acari: Ixodidae), the brown dog tick, exhibits a strong host preference for dogs but occasionally parasitizes other hosts, including humans (*39*). This species is commonly associated with stray dogs in urban parks. Host infestation can result in severe clinical manifestations, including anemia, weight loss, developmental stunting, and in extreme cases, can induce mortality (*40–42*).

Ornithodoros spheniscus (Acari: Argasidae), a human-aggressive tick species, primarily parasitizes seabirds in Chile (*43*). The saliva of ticks within the genus *Ornithodoros* contains multiple toxic compounds (*44*). *O. spheniscus* has been documented parasitizing seabirds and causing toxicosis in humans who were bitten in a Chilean national park (*45*).

Ornithodoros turicata (Acari: Argasidae) is distributed throughout several regions of North America (*46*). This species demonstrates promiscuous feeding behavior, parasitizing hosts such as ground pigs, squirrels, prairie dogs, snakes, and gopher tortoises (*47*). *O. turicata* ticks have been collected in public parks containing rodent waste (*48*).

PATHOGENS CARRIED BY TICKS IN URBAN RECREATIONAL PARKS

Tick-borne encephalitis, a significant public health concern, is caused by tick-borne encephalitis virus (TBEV). The virus comprises 5 distinct genotypes, with the European, Siberian, and Far Eastern variants being predominant, each characterized by unique epidemiological patterns and clinical manifestations (*49*). In urban parks across Europe, TBEV transmission primarily occurs through bites from *Ixodes* ticks, particularly *I. ricinus* (*50*).

Severe fever with thrombocytopenia syndrome (SFTS), an emerging infectious disease, is caused by the SFTS virus (SFTSV), a novel member of the order Bunyavirals in the family Phenuiviridae (*51–52*). This syndrome has been documented throughout East Asian countries, including the Republic of Korea (ROK) (*53–54*). SFTSV maintains its circulation through an enzootic cycle involving ticks and vertebrate hosts. *Haemaphysalis longicornis* ticks, which serve as vectors for SFTSV, are widely distributed throughout China (*55*).

Rickettsiae are obligate intracellular Gram-negative bacteria belonging to the genus Rickettsia within the Rickettsiaceae family, order Rickettsiales. These pathogens cause human diseases primarily through vector-borne transmission (via ticks, lice, mites, and fleas) and occasionally through airborne routes (*56*). *Rickettsiae* are classified into two main groups: the typhus group and the spotted fever group (SFG). SFG rickettsiae are predominantly associated with hard ticks (Ixodidae), with exceptions being *R. akari* (mite-borne) and *R. felis* (flea-borne). *Ixodes* ticks can maintain and propagate SFG *Rickettsia* (SFGR) through both transovarian and transovarial transmission (*57–58*). Recent studies have identified *R. sanguineus* as a crucial vector for SFGR transmission between domestic dogs and humans (*59*). SFGR exhibits a global distribution pattern with potential for further geographic expansion through vector ticks. Research has confirmed SFGR presence in urban forest park tick populations (*35*,*60*). Notable examples include the detection of two SFG rickettsiae — *R. rhipicephali* and *Rickettsia* sp. 364D (now *R. philipii*) (*61*) — in *D. occidentalis* in southern California, United States. In Ukraine, researchers documented *Rickettsia raoultii* presence in ticks across three different parks, with infection rates varying from 5% to 68%.

Anaplasma phagocytophilum is an obligate intracellular bacterium that causes human granulocytic anaplasmosis (HGA), an acute febrile illness prevalent throughout the Northern Hemisphere (*62*). The clinical manifestations of HGA range from mild to severe, with subclinical symptoms including fever, cough, headache, diarrhea, and vomiting, while critical cases may progress to sepsis, multiple organ failure syndrome, and acute nephritis (*63*). Studies have demonstrated significantly higher prevalence of *A. phagocytophilum* in ticks collected from urban parks (*64–65*). For instance, an ecoepidemiologic investigation conducted during 2009-2011 revealed that *A. phagocytophilum* was detected in 67 (76.1%) of 88 urban hedgehogs sampled from Margaret Island in Budapest, Hungary (*66*).

The causative agent of Lyme disease, *Borrelia burgdorferi* sensu lato (BBSL), relies on *Ixodes* ticks for transmission to vertebrate hosts. These spirochetes have evolved complex interactions with their tick vectors to maintain basic metabolic functions and optimize their colonization, persistence, and transmission cycles (*67*). BBSL infections are particularly prevalent in *I. ricinus* populations across European urban parks, though infection rates show considerable spatial variation (*10*,*12*,*68*). In the United States, studies from New York have documented high BBSL infection rates in *I. scapularis* collected from urban parks (*69*). Similarly in China, research by Cao et al. revealed a 13.1% positivity rate for *B. burgdorferi* in ticks sampled from urban parks in Quzhou, Zhejiang province.

Piroplasmas (class: Aconoidasida, order: Piroplasmida), comprising parasites in the families Babesiidae and Theileriidae, are the etiological agents of piroplasmosis (*70*). These parasites can be transmitted to mammals, including humans, during blood feeding by all tick life stages through transovarian transmission (*71*). *Babesia* species are intraerythrocytic protozoan parasites with complex life cycles involving multiple developmental stages and morphological forms, maintained in nature through transmission between *Ixodes* ticks and various mammalian hosts. While over 100 *Babesia* species have been documented, only a select few - notably *B. microti*, *B. divergens*, and *B. duncani* - are confirmed human pathogens (*70*,*72*). *I. ricinus* serves as the primary vector for piroplasma transmission across Europe, while this role is predominantly fulfilled by *I. persulcatus* in China (*8*,*73*).

TECHNIQUE AND STRATEGIES FOR TICK CONTROLS

From a macro perspective, the One Health concept provides a comprehensive framework for managing health crises by integrating human, animal, and ecosystem health, with TBD management as its integral component (*74*).

The cornerstone of TBD management lies in effective tick control. While chemical control remains a common approach for tick mitigation, there are currently no registered insecticides specifically approved for environmental tick control. For parasitic ticks, acaricide application involves direct treatment of tick-prone hosts through spraying, water-based acaricide baths, or topical "pour-on" preparations (*75*). However, prolonged acaricide use presents two significant challenges: the development of tick resistance and adverse environmental impacts on non-target organisms, particularly birds and beneficial insects. For free-ranging ticks, recent advances in pheromone-aided management techniques have shown considerable promise, as highlighted by Sonenshine (*76*). These innovative approaches include: 1) pheromone-enhanced matrices for vegetation application, 2) tick decoys, 3) bont tick (*Am. hebraeum*) decoys, and 4) pheromone confusants. The pheromone-enhanced matrix system targets nymphal and adult deer ticks by incorporating specific attractant components such as guanine, xanthine, and hematin. These components can be combined with acaricides such as permethrin in oily droplets or microfibers for field application (*77*–*78*). Additionally, silver nanoparticles (Ag NPs) have emerged as a promising avenue for biomedical applications, particularly in managing free-ranging tick populations (*79*). However, the implementation of chemical control methods for free-ranging ticks remains an incremental process, with limited registered pesticides available for environmental application (*80*). Research in this area has been relatively sparse, with only a few studies exploring alternatives such as plant-derived extracts for free-ranging tick control (*81*–*83*).

Two key interventions have been identified for effective tick control in urban parks. First, reducing potential tick host populations is essential. For example, in Basel, Switzerland, pigeon populations were halved as a result of implementing feeding bans (*84*). Additionally, implementing systematic management strategies for urban rodents and stray dogs and cats has proven effective for tick control (*85*–*86*). Second, maintaining park infrastructure through regular garbage collection and vegetation management, particularly along human pathways and trails, is essential (*87*). Beyond these population control measures, raising public awareness about tick bite risks, potential tick habitats, and fundamental personal protection practices is paramount (*88*–*89*). While regional variations exist in tick-borne disease management strategies — including environmental control, chemical interventions, personal protection measures, and health education — any adopted strategy must adhere to scientific principles and demonstrate both reasonability and feasibility to ensure effective control of tick-borne diseases.

Regular evaluation of control measures and strengthened tick surveillance are essential for assessing intervention effectiveness. China has established comprehensive monitoring networks for both parasitic and free-living ticks. In the United States, the CDC provides guidance and financial support to states for implementing tick surveillance initiatives, incorporating tick data collection within ArboNET, their existing arthropod-borne disease surveillance framework (*90*). In Europe, Italy maintains tick-borne disease surveillance as a crucial component of their human health program, emphasizing human data and expertise (*91*). These diverse national approaches to tick and tick-borne disease surveillance and control demonstrate global commitment to addressing this public health challenge. The effectiveness of control measures can be evaluated through monitoring changes in tick density and tick-borne disease infection rates.

CONCLUSION

Tick infestation in urban parks represents a significant and escalating public health concern. The documented tick species belong to two families - Ixodidae and Argasidae — with hard ticks (Ixodidae) comprising the majority of species and showing particularly high prevalence rates.

The detection of diverse pathogens in urban park ticks, including tick-borne encephalitis virus, Bunyavirus, *Rickettsia*, *Anaplasma phagocytophilum*, *Borrelia burgdorferi*, and Piroplasmas, appears increasingly common. Over recent decades, both the geographic distribution of tick populations in urban recreational parks and the prevalence of tick-borne diseases have demonstrated a marked expansion. To mitigate disease transmission risk, there is an urgent need to enhance public awareness and education regarding personal protection measures among urban residents.

Several critical knowledge gaps currently limit our ability to conduct precise risk assessments, particularly the lack of quantitative ecological, epidemiological, and socioecological data. There is a pressing need for comprehensive eco-epidemiological research and surveillance addressing key factors such as tick occurrence patterns, pathogen prevalence rates, vertebrate host dynamics, and human exposure patterns within urban recreational environments. From a broader perspective, understanding the complex factors influencing urban park tick distribution - including vegetation composition, climatic parameters (temperature and humidity), and host animal populations — is crucial. Additionally, further research is needed to elucidate the intricate relationships between tick microbiomes and their effects on tick development, pathogen transmission dynamics, and environmental pesticide efficacy. These challenges require interdisciplinary collaboration among medical practitioners, public health scientists, geographers, meteorologists, and urban park management stakeholders to effectively assess and reduce tick infestation risks and associated disease burden.

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