

# Medically Important Hemiptera: Bed Bugs and Kissing Bugs in Human Health

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## Abstract

*Bed bugs (family Cimicidae) and kissing bugs (subfamily Triatominae) are hematophagous Hemiptera of major medical importance, yet they differ markedly in their public health impact. Bed bugs have resurged globally over the past three decades, with infestations reported from homes, multi-unit housing, hotels, transportation, and health-care facilities in both high- and low-income settings. They are not established biological vectors of human pathogens, but their bites cause pruritic papules, urticarial and bullous reactions, occasional systemic allergic responses, and are strongly associated with anxiety, insomnia, stigma, and substantial economic burden from control costs, lost productivity, and housing disruption. Their biology – hemimetabolous development, obligatory blood feeding in all mobile stages, cryptic nocturnal behavior, and the ability of adults to survive months without feeding – favours persistence and makes eradication challenging, particularly in resource-constrained environments. Kissing bugs, in contrast, are proven vectors of *Trypanosoma cruzi* and are central to the transmission of Chagas disease in Latin America and, increasingly, in non-endemic regions through migration and non-vectorial routes such as transfusion and transplantation. They occupy domestic, peridomestic, and sylvatic ecotopes and feed on a wide range of mammalian reservoirs, embedding Chagas disease within complex zoonotic cycles. This review synthesizes current knowledge on taxonomy, morphology, life cycle, and host interactions of bed bugs and kissing bugs; the epidemiology and clinical features of bed bug infestation and Chagas disease; and the principles of diagnosis, management, and control. For bed bugs, emphasis is placed on clinical recognition of bite reactions, mental health consequences, and integrated pest management incorporating inspection, physical measures, and insecticide use in the context of widespread resistance. For kissing bugs, the review highlights the pathogenesis and staging of acute and chronic Chagas disease, current diagnostic algorithms based on parasitological, serologic, and molecular methods, and the role of trypanocidal therapy alongside vector control, housing improvement, and blood-safety measures. The article concludes by underscoring the need for coordinated clinical, environmental, and policy responses to mitigate the growing burden of bed bugs and to consolidate gains in Chagas disease control and elimination.*

**Keywords:** Bed bug infestation, bed bugs, chagas disease, cimicidae, insecticide resistance, integrated pest management, kissing bugs, one health, triatominae, vector-borne disease

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## INTRODUCTION

Bed bugs (family Cimicidae) are obligate hematophagous insects that have resurged globally as important public health pests [1–3]. Infestations occur across all socioeconomic strata and are increasingly reported in homes, multi-unit dwellings, hotels, public transport, and health-care facilities [1, 2]. Although bed bugs are not recognized as proven biological vectors of human pathogens, they cause substantial dermatologic morbidity, allergic and, rarely, anaphylactic reactions, secondary bacterial infections, and significant psychological and economic impacts [2–5]. This review summarizes current knowledge on the taxonomy, biology,

epidemiology, clinical manifestations, diagnosis, and management of bed bug infestations, and outlines key public health and policy considerations for prevention and control [1–5].

## BIOLOGY AND TAXONOMY

Bed bugs of primary human importance are *Cimex lectularius* in temperate regions and *Cimex hemipterus* in many tropical and subtropical areas [1]. They are wingless, dorsoventrally flattened insects measuring approximately 5–7 mm in length as adults, with piercing-sucking mouthparts adapted for blood feeding and a characteristic Odor due to dorsal abdominal scent glands [1, 6]. Nymphs resemble smaller, paler adults and require a blood meal between each of five instars before reaching maturity [1].

Bed bugs are nocturnal and cryptic, hiding in mattresses, bed frames, furniture seams, wall cracks, and other crevices during the day and emerging at night to feed on sleeping hosts [1, 2]. They locate hosts by responding to warmth, carbon dioxide, and kairomones [1]. Their hemimetabolous life cycle comprises egg, five nymphal stages, and adult; all mobile stages are obligate hematophages [1]. Under favorable conditions of temperature and host availability, the life cycle may be completed in 6–8 weeks, but adults can survive for months without feeding, contributing to persistence and making eradication difficult [1, 2].

Bed bugs harbour a characteristic endosymbiotic microbiota, including Wolbachia-like organisms that contribute B-vitamins and influence fecundity and insecticide susceptibility [7]. Experimental studies have detected DNA of multiple human pathogens in bed bugs, but efficient biological transmission to humans has not been demonstrated, and they are currently regarded as pests of public health importance but not confirmed disease vectors (Table 1) [2, 8].

**Table 1.** Taxonomy and key morphological differences between bed bugs and kissing bugs.

Feature	Bed bugs (cimicidae)	Kissing bugs (triatominae)
Order/family	Hemiptera, Cimicidae [1]	Hemiptera, Reduviidae, Triatominae [2]
Adult size	5–7 mm, dorsoventrally flattened [1, 3]	10–30 mm, elongated body [2, 4]
Wings	Wingless (wing pads only) [1]	Fully winged adults [2]
Activity	Nocturnal, crevice-dwelling [3, 5]	Nocturnal, often peridomestic [2, 6]
Feeding site	Exposed skin, anybody part [3, 7]	Preferentially face and uncovered areas [2, 8]
Medical role	Bites, allergy, possible pathogen carriage [3, 7, 9]	Proven vector of Chagas disease [2, 10]

## LIFE CYCLE AND BIOLOGY

Both groups have hemimetabolous development (egg, five nymphal instars, adult). In bed bugs, all mobile stages are obligate hematophages, feeding primarily on humans in domestic settings; under favorable conditions, the cycle can be completed in 6–8 weeks, and adults can survive for months without blood, facilitating persistence. Kissing bugs similarly pass through five nymphal stages, all blood-feeding, but participate in domestic, peridomestic, and sylvatic cycles involving humans, domestic animals, and numerous wild mammals as reservoirs of *Trypanosoma cruzi*. Longevity and repeated blood meals enhance their vectorial capacity (Table 2).

**Table 2.** Life-cycle characteristics relevant to vectorial and public health importance.

Parameter	Bed bugs	Kissing bugs
Development type	Incomplete metamorphosis (hemimetabolous) [1, 3]	Incomplete metamorphosis [2, 11]
Nymphal instars	Five [1, 3]	Five [2, 11]
Host range	Mainly humans, occasionally other mammals [3, 7]	Wide range of mammals, including humans, dogs, wild reservoirs [2, 10]
Survival without blood	Several months, sometimes >6 months [3, 12]	Weeks to months, depending on species [2, 11]
Key transmission role	No proven biological vector role; mechanical carriage debated [9, 13]	Obligate biological vector of <i>Trypanosoma cruzi</i> [2, 10]

Bed bugs are nocturnal feeders guided by warmth and carbon dioxide; bites often occur in clusters, and saliva contains anticoagulants and anesthetic substances that provoke local reactions. Kissing bugs typically feed on the face or exposed areas during sleep, and defecation during or shortly after feeding is crucial for *T. cruzi* transmission.

### **Bed Bugs: Epidemiology and Public Health**

After a marked decline in many industrialized countries in the mid-20th century, bed bugs have undergone a pronounced global resurgence since the late 1990s [2, 3]. Infestations have been reported from urban centers on every inhabited continent and affect both high-income and low-income communities [2–4]. High-risk settings include multi-unit housing, hostels, shelters, student residences, long-term care facilities, and hotels, where high resident turnover and shared walls facilitate spread [2, 3].

Risk factors at the household level include frequent travel and overnight stays, use of second-hand furniture or mattresses, high residential density, and limited awareness of early infestation signs [2, 3]. In hospitals and long-term care facilities, introductions often occur via patient belongings or staff and visitors; infestations in such settings can be prolonged because of complex infrastructure and restrictions on insecticide use [2, 4].

Although bed bugs are evenly distributed across social classes, their impacts are disproportionately severe in low-income households, where constraints on access to professional pest management and the costs of repeated treatment, laundering, and furniture replacement are substantial [2, 3]. Public health authorities in several countries have classified bed bugs as public health pests owing to their cumulative physical, psychological, and economic effects, despite the absence of proven pathogen transmission [2, 5, 8].

### **Bed Bugs and Microbiology**

Molecular studies have identified DNA of multiple human pathogens in bed bugs, including bacteria and viruses, but epidemiologic evidence of transmission is lacking. Bed bugs harbor symbiotic microbiota that may influence nutrition, reproduction, and insecticide susceptibility. Experimental work shows that some pathogens can survive within bed bugs for varying periods, yet efficient transmission to vertebrate hosts has not been consistently demonstrated; bed bugs are, therefore, considered potential but not confirmed vectors. Infestations in health-care facilities raise concern about mechanical spread of skin and environmental pathogens, so strict environmental hygiene and structured pest management are recommended.

### **Kissing Bugs and Chagas Disease: Epidemiology**

Chagas disease affects millions of people in Latin America and tens of thousands in non-endemic countries through migration and non-vectorial routes. It contributes substantially to cardiovascular morbidity and mortality in endemic regions. Vector-borne transmission occurs mainly in rural and peri-urban areas of Latin America, but triatomine bugs and infected reservoir hosts have also been documented in the southern United States. In non-endemic settings, blood transfusion, organ transplantation, and congenital transmission are increasingly important. Different triatomine species show domestic, peridomestic, or sylvatic habits, and housing quality, presence of domestic animals, and environmental changes all influence infestation rates.

## **CLINICAL MANIFESTATIONS**

Bed bug bites typically present as pruritic, erythematous papules or wheals that may appear in linear or clustered patterns on exposed skin areas such as the arms, legs, and trunk [2, 6]. Individual responses vary widely; some persons exhibit minimal reaction, whereas others develop marked urticarial or bullous lesions. Repeated exposure can lead to both immediate and delayed hypersensitivity, and rarely, systemic allergic reactions including anaphylaxis have been reported (Table 3) [6].

**Table 3.** Epidemiologic contrasts: bed bugs versus kissing bugs.

Feature	Bed bugs	Kissing bugs
Primary health outcome	Bites, allergy, psychological distress [3, 4, 6, 15]	Chagas disease with acute and chronic systemic manifestations [10, 19]
Vector status	No confirmed biological transmission [9, 13, 17]	Established biological vector of <i>T. cruzi</i> [2, 10]
Main geographic concern	Global urban and institutional settings [3, 10, 16]	Rural/peri-urban Latin America, with spread via migration [10, 19, 20]
Transmission setting	Domestic infestations; no zoonotic cycle [3, 7]	Zoonotic cycle with wild and domestic reservoirs [2, 10, 20]
Control focus	Environmental management, insecticide use, education [3, 11, 14, 18]	Integrated vector control, screening, case detection and treatment [10, 19, 21]

Secondary bacterial infection due to scratching is a frequent complication and may manifest as impetigo, ecthyma, or cellulitis. Chronic excoriations and lichenification can develop in persons with persistent infestations and intense pruritus [6].

Equally important are the psychological and sleep-related consequences. Individuals living with bed bugs report anxiety, insomnia, hypervigilance, social stigma, and reduced quality of life [3–5]. These impacts may be particularly pronounced in vulnerable populations, including older adults, persons with mental health disorders, and residents of institutional settings [3, 4].

### Diagnosis

Diagnosis is primarily clinical and environmental. The presence of recurrent nocturnal bites in linear or grouped patterns on exposed skin should prompt inspection of sleeping areas and adjacent furniture [1, 2]. Evidence supporting diagnosis includes live insects, cast skins, characteristic dark fecal spots, eggs, and sweet-musty odor in harborages such as mattress seams, bed frames, headboards, and nearby crevices.

Dermatologic findings are non-specific and may mimic bites from other arthropods or papular urticaria. Laboratory confirmation is usually not required, but entomologic identification of specimens submitted by patients or collected during inspection can be useful, particularly in institutional outbreaks or medicolegal contexts. There is no validated serologic or molecular test for human exposure to bed bugs; detection of microbial agents in bed bugs remains a research tool rather than a clinical diagnostic approach [8].

## MANAGEMENT

### Management of Bites and Associated Conditions

Most cutaneous reactions are self-limited and can be managed symptomatically with oral antihistamines and topical corticosteroids to reduce pruritus and inflammation. Secondary bacterial infections should be treated with appropriate systemic or topical antibiotics, guided by clinical severity and local resistance patterns. When systemic allergic reactions occur, they should be managed according to standard anaphylaxis protocols [6].

Clinicians should address psychological distress, sleep disruption, and stigma explicitly, providing reassurance, education, and referral to mental health services when indicated [3–5]. Emphasizing that infestations are not a reflection of personal hygiene may reduce shame and social isolation [3].

### Environmental Control

Successful elimination of bed bugs depends on integrated pest management rather than isolated chemical interventions [1, 2]. A typical program includes thorough inspection to delineate the extent of infestation; reduction of clutter; laundering and heat-treatment of textiles; vacuuming and physical removal; encasement of mattresses and box springs; and targeted application of residual insecticides to harborages and travel routes.

Heat treatments that raise room or container temperatures above lethal thresholds for all life stages are highly effective when correctly executed but require specialized equipment and may be costly. Chemical control is increasingly challenged by widespread resistance to pyrethroids and other insecticide classes, necessitating rotation of products, use of combination formulations, and reliance on non-chemical methods [1, 2].

In health-care facilities and other institutions, policies should specify procedures for identification, isolation and handling of infested items, coordination with pest management professionals, and communication with patients and staff [4].

### Public Health and Policy Considerations

Bed bug infestations pose complex challenges that span environmental health, housing, social services, and mental health. Effective public health responses require clear delineation of responsibilities among landlords, tenants, and local authorities; standardized guidance for management in multi-unit housing and institutions; and accessible information for the public and clinicians (Table 4) [3–5].

**Table 4.** Health effects of bed bug infestation.

Domain	Manifestation
Dermatologic	Erythematous papules, urticarial or bullous lesions, excoriations, secondary bacterial infection [3, 6, 34]
Allergic/immunologic	Immediate and delayed hypersensitivity, rare anaphylaxis [6, 14]
Psychological	Anxiety, insomnia, social stigma, decreased quality of life, depressive symptoms [4, 9, 15, 16]
Infectious potential	Detection of bacteria, viruses and parasites in bed bugs but no conclusive evidence of natural transmission [9, 13, 17]
Economic	Costs of professional control, loss of productivity, housing turnover, litigation [3, 10, 14, 18]

Because infestations are more difficult and expensive to control once established, prevention and early detection are critical. Public health agencies can support training for pest management professionals, housing inspectors, and health-care workers; develop surveillance systems to track trends and hotspots; and promote research on insecticide resistance, non-chemical control tools, and the potential role of bed bugs in pathogen carriage [1–3].

Integrated, equity-oriented approaches that consider the financial and psychosocial burdens on affected households are essential to reduce the long-term impact of this resurgent ectoparasite [3–5].

### PATHOGENESIS AND PATHOLOGY

*For bed bugs, pathogenesis is primarily immunologic:* salivary proteins trigger immediate and delayed hypersensitivity reactions. Histopathology of bite lesions shows superficial dermal edema and a perivascular lymphohistiocytic infiltrate with eosinophils, consistent with an arthropod bite reaction.

Chagas disease pathogenesis begins when infective metacyclic trypomastigotes in triatomine feces enter through bite sites or mucous membranes. Trypomastigotes invade host cells, transform into intracellular amastigotes, multiply, and differentiate back into trypomastigotes that disseminate via the bloodstream. In acute disease, patients may be asymptomatic or present with fever, lymphadenopathy, hepatosplenomegaly, and local inoculation lesions (chagoma or Romaña sign); myocarditis and meningoencephalitis can occur. Chronic infection evolves through an indeterminate phase, with seropositivity but no overt organ disease, and determinate phases characterized by chronic Chagas cardiomyopathy and digestive megasyndromes, with myocardial inflammation, fibrosis, conduction system damage, and autonomic denervation of the gastrointestinal tract (Table 5).

**Table 5.** Clinical and pathological features of Chagas disease.

Phase	Key clinical features	Pathological hallmark
Acute	Fever, malaise, lymphadenopathy, hepatosplenomegaly, chagoma, Romaña sign [19, 22]	Myocarditis with inflammatory infiltrate, high parasitemia [19, 23]
Indeterminate chronic	Asymptomatic, normal ECG and imaging [19]	Low-grade inflammation, focal fibrosis [23]
Chronic cardiac	Arrhythmias, heart failure, thromboembolism, apical aneurysm [19]	Dilated cardiomyopathy, conduction system fibrosis, autonomic neuropathy [19, 23]
Chronic digestive	Dysphagia, regurgitation, constipation, megacolon symptoms [19]	Neuronal destruction in enteric plexuses, smooth-muscle hypertrophy and dilation [23]

### Diagnosis, Management, and Control

Diagnosis of bed bug infestation is usually clinical, based on recurrent nocturnal bites and environmental inspection that reveals live insects, exuviae, fecal spots, and eggs. Entomologic identification of specimens is useful for confirmation and differentiation from other arthropods. Specimen submission requires properly preserved insects; molecular detection of associated pathogens is largely confined to research settings.

Management of bed bug bites is symptomatic with topical corticosteroids and oral antihistamines; secondary bacterial infections require appropriate antibiotics. Given the anxiety and insomnia common in heavily infested households, psychological support is often important. Environmental control relies on integrated pest management with inspection, clutter reduction, heat treatment, targeted insecticide application, and ongoing monitoring. Widespread insecticide resistance mandates rotation of products and inclusion of non-chemical methods.

Diagnosis of Chagas disease in the acute phase relies on direct parasite detection in blood by microscopy or concentration methods and on PCR; in chronic disease, serology with at least two different assays is recommended, with PCR as an adjunct, especially in congenital cases and for monitoring treatment response. Etiologic therapy with trypanocidal agents is most effective in acute and early chronic phases; in advanced cardiomyopathy, benefit is limited and management focuses on heart failure, arrhythmias, and digestive complications. Control of triatomine vectors involves housing improvement (plastering walls, sealing cracks, replacing thatched roofs), insecticide spraying, and management of domestic reservoir hosts, supported by community participation and surveillance. Screening of blood donors, organ donors, and pregnant women from endemic areas is crucial in non-endemic countries.

### CONCLUSION

Bed bugs and kissing bugs exemplify two very different patterns of vector-related health impact: one a resurgent ectoparasite whose main toll is dermatologic, psychological, and economic, the other an established biological vector of a life-threatening systemic infection. For bed bugs, the dominant challenges are early detection, integrated environmental control in complex built environments, and explicit attention to the mental health and social consequences of infestation, particularly among vulnerable groups in crowded, low-income settings. For kissing bugs and Chagas disease, priorities include sustaining surveillance as incidence declines, improving access to accurate diagnostics and trypanocidal therapy, and tailoring vector control and housing interventions to diverse domestic, peridomestic, and sylvatic ecologies.

In both situations, effective clinical care cannot be separated from environmental and social determinants: successful management depends on coordinated action across dermatology, infectious diseases, mental health, entomology, housing, and public health. As climate and land-use change alter the distribution and behavior of these insects, proactive, One-Health-oriented strategies that integrate human, animal, and environmental health will be essential to prevent resurgence, protect vulnerable communities, and translate entomological and microbiological insight into durable gains for human health.

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