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Medically and Public Health–Important Arthropods in Gaza Strip Displacement Camps during the Israeli War (2023–2026): Documented and Potential Occurrence, Ecological Drivers, Health Risks, and Humanitarian Implications

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ABSTRACT

Medically and public health–important arthropods may become major hazards when brutal wars simultaneously disrupts sanitation, shelter, healthcare, and vector-control systems. This descriptive ecological study assessed the documented and potential occurrence, ecological drivers, health risks, and humanitarian implications of arthropods associated with displacement camps in the Gaza Strip during the Israeli War of genocide and ethnic cleansing (2023–2026). Evidence was synthesized from field observations conducted between October 2023 and June 2026, photographic and documentary records, peer-reviewed literature, and humanitarian reports, with interpretation guided by a One Health framework. Twenty arthropod taxa belonging to 3 classes, 10 orders, and 15 families were either documented in the study area or identified as potentially occurring or proliferating under displacement conditions. Insecta predominated (14 taxa; 70%), followed by Arachnida (5 taxa; 25%) and Chilopoda (1 taxon; 5%). The principal ecological drivers included destruction of water, sanitation, and drainage infrastructure; stagnant wastewater and prolonged household water storage; accumulation of solid and organic waste; hyper-overcrowding; inadequate hygiene; war-generated rubble; increased contact with rodents and stray animals; favorable warm-season conditions; and interruption of environmental health and pest-control services. Synanthropic flies, cockroaches, human head lice, and scabies mites were assigned the highest relative public health importance because widespread and persistent exposure coincided with risks of mechanical pathogen transmission, ectoparasitic infestation, skin damage, and secondary infection. Mosquitoes, bed bugs, fleas, and highly venomous scorpions also represented important hazards, whereas bees, wasps, ticks, centipedes, and rodent lice contributed more localized but potentially serious risks. These findings indicate that actual and potential arthropod-related hazards in the Gaza Strip are not isolated pest problems but components of a war-driven system linking environmental degradation, vertebrate hosts, human vulnerability, and weakened healthcare capacity. Priority responses should combine restoration of WASH, drainage, and waste-management services; improved shelter and bedding hygiene; rubble-risk management; integrated vector, pest, and rodent control; community education; entomological and disease surveillance; and restoration of diagnostic and emergency-care capacity.

Keywords: *Medically important arthropods; public health arthropods; documented and potential occurrence; Insecta; Arachnida; Gaza Strip; displacement camps; Israeli War of genocide and ethnic cleansing (2023–2026); war ecology; environmental health; One Health.*

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1. INTRODUCTION

Arthropods (Phylum Arthropoda) constitute the largest and most diverse phylum in the animal kingdom, comprising more than one million described species that inhabit virtually all terrestrial and freshwater ecosystems [1]. Although the majority of arthropods provide indispensable ecological services—including pollination, decomposition, nutrient cycling, and biological control—a relatively small proportion has profound medical and public health importance because of their ability to transmit pathogens, inflict bites and stings, induce allergic reactions, contaminate food and water, or act as reservoirs and vectors of infectious diseases [2]-[4]. Medically important arthropods include mosquitoes, sand flies, houseflies, cockroaches, fleas, lice, mites, ticks, bed bugs, spiders, scorpions, and several hymenopteran species, many of which have adapted exceptionally well to human settlements and disturbed environments [5]-[7].

The ecology and distribution of these arthropods are governed by a complex interaction of climatic, environmental, ecological, and anthropogenic factors.

Urban expansion, inadequate sanitation, environmental pollution, climate change, population growth, habitat modification, and poor waste management can substantially increase vector abundance and facilitate the emergence or re-emergence of arthropod-borne and arthropod-associated diseases [8]. Among these drivers, armed conflicts and humanitarian emergencies represent some of the most powerful ecological disturbances because they simultaneously damage environmental infrastructure, interrupt water and sanitation services, disrupt waste management systems, collapse healthcare services, and suspend organized vector-control programs. Such conditions create ideal breeding, resting, and feeding habitats for medically important arthropods while increasing human exposure to vectors and other arthropod pests [9]-[11]. Experiences from humanitarian crises worldwide consistently demonstrate that overcrowded displacement camps, inadequate shelter, poor personal hygiene, stagnant wastewater, accumulated refuse, decomposing organic matter, and limited access to safe water create highly favorable ecological conditions for mosquitoes, houseflies, cockroaches, fleas, lice, mites, ticks, and other arthropods of medical importance [12]-[14]. These environmental conditions not only enhance the proliferation of vectors but also facilitate the transmission of ectoparasites such as the Human Head Louse (*Pediculus humanus capitis* De Geer, 1778) and the Scabies Mite (*Sarcoptes scabiei* Linnaeus, 1758), increasing the burden of dermatological disorders, secondary bacterial infections, and other communicable diseases. Consequently, infectious diseases associated with deteriorating environmental conditions frequently become major contributors to morbidity and mortality during humanitarian emergencies, often exceeding deaths directly attributable to armed violence [14] [15]. These interactions are increasingly interpreted through the One Health framework, which recognizes the inseparable links among human, animal, and environmental health. Environmental degradation modifies arthropod habitats, alters vertebrate host communities, promotes the expansion of synanthropic species, and increases opportunities for pathogen transmission among wildlife, domestic animals, arthropod vectors, and humans [2] [16] [17]. Consequently, understanding medically important arthropods in humanitarian settings requires an integrated ecological perspective that considers environmental change, biodiversity, public health, and human behavior as interconnected components of a single system.

The Eastern Mediterranean region is particularly vulnerable to these interactions because of rapid urbanization, water scarcity, climate change, political instability, and repeated humanitarian crises [8]. Within Palestine, several medically important arthropods and arthropod-associated diseases have long been recognized, including mosquitoes, head lice, cockroaches, rodent ectoparasites, and vectors associated with cutaneous leishmaniasis and other parasitic infections [18]-[20]. Mosquito fauna in the West Bank has also received considerable attention, including the documented occurrence of the Asian Tiger Mosquito (*Aedes albopictus* Skuse, 1894) and ecological investigations of mosquito larvae and their breeding habitats in Salfit District [21] [22]. Previous studies in the Gaza Strip have documented mosquito breeding and proliferation in the Wadi Gaza wetlands and other lagoon habitats, widespread pediculosis among schoolchildren, public health risks associated with cockroach infestations, and ectoparasitic infestations affecting rodents and domestic animals [23]-[31]. However, these studies were conducted under relatively stable pre-war conditions and therefore cannot explain the unprecedented ecological transformations that have occurred since October 2023.

The environmental and public health situation in the Gaza Strip changed fundamentally following the outbreak of the ongoing Israeli war in October 2023. Extensive destruction of residential neighborhoods, healthcare facilities, water supply networks, wastewater treatment plants, electricity infrastructure, roads, and municipal services, together with the repeated displacement of more than 90% of the population, has produced one of the most severe humanitarian and environmental crises in recent history [16] [32]-[34]. Millions of internally displaced Palestinians have been forced to reside in overcrowded tents, schools, and temporary shelters where access to safe water, sanitation, healthcare, and basic hygiene has become critically limited. One of the most profound environmental consequences of the war has been the collapse of Water, Sanitation, and Hygiene (WASH) systems throughout the Gaza Strip. Damage to water pipelines, sewage networks, pumping stations, wastewater treatment facilities, and stormwater drainage systems has resulted in the widespread accumulation of untreated sewage, stagnant wastewater, and contaminated surface water within and around displacement camps [11] [35]-[37]. Simultaneously, the near-total disruption of municipal solid waste collection has allowed enormous quantities of household refuse, decomposing food waste, animal carcasses, medical waste, and war-generated debris to accumulate in residential and displacement areas [38] [39]. Collectively, these environmental changes have created abundant breeding and resting habitats for mosquitoes, flies, cockroaches, fleas, lice, mites, ticks, rodents, and numerous other arthropods of medical and public health importance.

The unprecedented generation of an estimated 68 million tons of war-related rubble has further transformed the urban landscape into a mosaic of artificial ecological microhabitats. Collapsed buildings, broken concrete, masonry blocks, damaged furniture, timber, and construction debris provide stable shelters for a wide range of synanthropic and medically important organisms. Besides promoting increases in vertebrate pests, including rodents and stray animals [40], these structures offer ideal refuges for venomous arthropods such as scorpions, spiders, and centipedes, thereby increasing the likelihood of human exposure, particularly within densely populated displacement camps [41]-[43].

Environmental deterioration has been compounded by severe overcrowding and the scarcity of water, soap, detergents, insecticides, fuel, and other essential hygiene resources. Under these conditions, displaced families frequently share confined shelters, bedding, clothing, and household items, greatly facilitating the transmission of ectoparasites such as the Human Head Louse (*Pediculus humanus capitis* De Geer, 1778) and the Scabies Mite (*Sarcoptes scabiei* Linnaeus, 1758) [44] [45]. At the same time, the interruption of routine environmental health services—including waste collection, drainage maintenance, vector surveillance, insecticide application, and rodent-control programs—has removed many of the barriers that normally suppress arthropod populations, allowing medically important species to proliferate largely unchecked.

Recent humanitarian and epidemiological reports have documented widespread outbreaks of communicable diseases, including scabies, pediculosis, hepatitis A, acute diarrheal diseases, and respiratory infections among displaced populations, accompanied by increasing infestations of insects and rodents within shelters and surrounding environments [46]-[49]. Nevertheless, despite growing attention to the humanitarian and public health consequences of the war, comprehensive ecological studies specifically examining the diversity of medically important arthropods inhabiting Gaza's displacement camps, the environmental drivers underlying their proliferation, and their broader public health and humanitarian implications remain remarkably scarce.

Therefore, this study assesses the documented and potential occurrence of medically and public health–important arthropods in Gaza Strip displacement camps during the Israeli war (2023–2026), their ecological drivers, associated health risks, and humanitarian implications within a One Health framework. It integrates field observations, scientific literature, and humanitarian reports to support surveillance, integrated vector management, and public health responses in conflict-affected settings.

2. METHODOLOGY

2.1. Study Design and Study Area

This study employed a descriptive ecological design guided by the One Health framework to assess the documented and potential occurrence of medically and public health–important arthropods associated with displacement camps in the Gaza Strip during the Israeli war from October 2023 to mid-2026. Rather than conducting an experimental or quantitative entomological survey, it integrated field observations with documentary evidence to examine how war-induced environmental degradation influenced arthropod occurrence and proliferation and associated public health risks.

The study covered the Gaza Strip, Palestine (Figure 1), a densely populated coastal territory of approximately 365 km². Since October 2023, widespread destruction of residential areas, healthcare facilities, water and wastewater systems, electricity networks, and municipal services, together with the repeated displacement of more than 90% of the population, has profoundly altered environmental conditions. Displaced populations have lived in overcrowded shelters, tent camps, schools, and informal settlements characterized by inadequate sanitation, unsafe water storage, poor waste management, stagnant wastewater, and war-generated debris. These conditions created favorable habitats for the occurrence and proliferation of medically and public health–important arthropods, providing an appropriate setting for assessing the ecological and health consequences of war-related environmental degradation.

Figure 1: Geographic location of the Gaza Strip within Palestine along the southeastern Mediterranean coast

2.2. Data Collection and Information Sources

Data were collected between October 2023 and June 2026 from multiple complementary sources to support comprehensive coverage and triangulation. Field observations were conducted whenever security conditions permitted in displacement camps, temporary shelters, residential neighborhoods, healthcare surroundings, and heavily damaged urban areas. Observations focused on environmental conditions favoring arthropod occurrence and proliferation, including waste accumulation, stagnant wastewater, overcrowding, damaged sanitation infrastructure, unsafe water storage, rubble, rodent activity, and direct arthropod sightings. Photographic documentation supported these observations. Field evidence was supplemented by peerreviewed scientific literature, reports from international and humanitarian organizations, official statements, verified news reports, and documentary photographs describing rapidly changing environmental and humanitarian conditions. Information was cross-validated across sources whenever possible to improve reliability and distinguish documented occurrence from potential occurrence or proliferation.

2.3. Arthropod Assessment and Data Analysis

The study focused on medically and public health–important arthropods documented or potentially occurring or proliferating in displacement settings, including mosquitoes, flies, cockroaches, fleas, lice, mites, ticks, bed bugs, bees, wasps, spiders, scorpions, and centipedes. For each taxon, information was synthesized on occurrence, habitats, ecological drivers, and actual or potential health risks. Data from field observations, scientific publications, humanitarian reports, and documentary sources were integrated through qualitative ecological synthesis and triangulation. Findings were interpreted within a One Health framework linking environmental degradation, displacement conditions, arthropod ecology, vertebrate hosts, and human health.

2.4. Ethical Considerations

The study involved no experimental manipulation of humans or animals. Field observations were conducted in publicly accessible locations when security conditions permitted, and photographs were obtained without revealing personal identities. Documentary evidence was derived from publicly available scientific and humanitarian sources, following accepted principles of research integrity and ethical conduct.

3. RESULTS

3.1. Diversity and Taxonomic Composition of Medically and Public Health–Important Arthropods

Severe environmental degradation, infrastructure collapse, and ecological disturbance associated with displacement in the Gaza Strip during Israel's ongoing war of genocide and ethnic cleansing (2023–2026) created favorable conditions for the occurrence and proliferation of medically and public health–important arthropods (Figure 2). Based on integrated field observations, photographic documentation, published reports, and ecological assessments, 20 arthropod taxa were either documented or identified as potentially occurring or proliferating within displacement camps. These taxa represented 3 classes, 10 orders, and 15 families, reflecting a diverse assemblage capable of exploiting war-modified environments.

Figure 2: Severe environmental degradation and structural destruction within Gaza Strip displacement camps during Israel's ongoing war created favorable conditions for the occurrence and proliferation of medically and public health–important arthropods.

Class Insecta was dominant, comprising 14 taxa (70.0%) across six orders: Diptera, Blattodea, Phthiraptera, Siphonaptera, Hemiptera, and Hymenoptera. This dominance may reflect the short developmental cycles, high reproductive potential, and broad ecological tolerance of insects, enabling them to exploit overcrowded shelters, contaminated water, accumulated organic waste, and damaged infrastructure. Class Arachnida comprised 5 taxa (25.0%), including ticks, mites, spiders, and scorpions associated with rubble, damaged buildings, poor sanitation, domestic animals, and protected microhabitats. Class Chilopoda was represented by the Mediterranean Banded Centipede (*Scolopendra cingulata* Latreille, 1829) (5.0%), which inhabits humid, concealed sites beneath rubble, stones, decaying materials, and structural debris.

From a public health perspective, the assessed taxa were classified into three functional groups: (i) vectors and mechanical carriers, including mosquitoes, flies, cockroaches, fleas, and ticks; (ii) ectoparasites, including lice, fleas, bed bugs, mites, and other animal-associated taxa favored by overcrowding, shared bedding, poor hygiene, and repeated displacement; and (iii) venomous and stinging arthropods, including spiders, scorpions, bees, wasps, and centipedes, which may cause envenomation, allergic reactions, and secondary infections. Overall, the documented and potential taxonomic diversity illustrates how war-related environmental degradation has created suitable conditions for arthropod occurrence, persistence, and proliferation, thereby increasing actual and potential public health risks.

Table 1: Arthropod pests of medical and public health importance documented or potentially proliferating in Gaza Strip displacement camps during the 2023–2026 war

Class	Order	Family	Scientific name	Common name	Ecological drivers of proliferation in displacement camps	Principal health risks
Insecta	Diptera	Culicidae	*Culex pipiens* Linnaeus, 1758	Northern House Mosquito	Stagnant sewage, damaged drainage systems, wastewater pools, uncovered water-storage containers, interrupted larviciding, high summer temperatures and organic pollution.	Painful bites and allergic reactions; nuisance and sleep disturbance; potential transmission of West Nile virus and other arboviruses and filarial parasites where pathogens circulate.
Insecta	Diptera	Culicidae	*Aedes aegypti* (Linnaeus, 1762)	Yellow Fever Mosquito (Dengue Mosquito)	Small artificial water containers, discarded plastic materials, tyres, tanks, buckets, intermittent water supply and prolonged household water storage.	Potential vector of dengue, chikungunya, Zika and yellow fever viruses; biting nuisance and hypersensitivity.
Insecta	Diptera	Muscidae	*Musca domestica* Linnaeus, 1758	Housefly	Uncollected domestic waste, decomposing food, animal manure, sewage, carcasses, overflowing latrines, high temperatures and disrupted municipal waste collection.	Mechanical carriage of enteric bacteria, protozoa and helminth eggs; contamination of food and water; potential contribution to diarrheal and enteric diseases, eye infections and wound contamination.
Insecta	Diptera	Calliphoridae	*Chrysomya megacephala* Fabricius, 1794	Blow Fly (Oriental Latrine Fly)	Accumulation of uncollected solid waste, human excreta, decomposing food, animal carcasses, open sewage, and high ambient temperatures	Mechanical transmission of enteric pathogens, contamination of food and water, facultative myiasis, and dissemination of antimicrobial-resistant bacteria
Insecta	Blattodea	Blattidae	*Periplaneta americana* (Linnaeus, 1758)	American Cockroach	Damaged sewer networks, latrines, food waste, damp rubble, kitchens, crowded shelters, warm conditions and shortages of insecticides and detergents.	Mechanical dissemination of pathogenic and antimicrobial-resistant bacteria; food contamination; asthma, rhinitis and allergic sensitization. Cockroaches are known to carry microorganisms associated with hospital and household infections.
Insecta	Blattodea	Ectobiidae	*Blattella germanica* (Linnaeus, 1767)	German Cockroach	Crowded kitchens, food-storage areas, warm indoor environments, water leakage, poor hygiene, shared cooking spaces and interrupted pest-control programs.	Mechanical contamination of food and surfaces; carriage of pathogenic bacteria; production of allergens associated with asthma and dermatitis.
Insecta	Phthiraptera	Pediculidae	*Pediculus humanus capitis* (De Geer, 1778)	Human Head Louse	Severe overcrowding, close head-to-head contact, shared bedding and clothing, scarcity of water, limited access to combs and pediculicides, and repeated displacement.	Pediculosis capitis, intense pruritus, excoriations, sleep disturbance, psychological distress and secondary bacterial infection.
Insecta	Phthiraptera	Polyplacidae	*Polyplax spinulosa* (Burmeister, 1839)	Spiny Rat Louse	Increasing black-rat and brown-rat populations, accumulated refuse, rubble, abandoned buildings, food waste and failure of rodent-control programs.	Dermatitis and irritation in rodent hosts; potential involvement in the ecology of rodent-associated pathogens; indicator of severe rodent infestation.
Insecta	Siphonaptera	Pulicidae	*Pulex irritans* Linnaeus, 1758	Human Flea (House Flea)	Overcrowded shelters, poor personal hygiene, close human contact, accumulation of bedding, domestic animals and rodent infestations.	Painful bites, allergic dermatitis, secondary skin infections and potential transmission of flea-borne pathogens such as *Rickettsia* spp. and *Yersinia pestis* where present.

Insecta	Siphonaptera	Pulicidae	*Xenopsylla cheopis* (Rothschild, 1903)	Oriental Rat Flea	Proliferation of commensal rodents, waste accumulation, rubble, food residues, animal carcasses, poor shelter flooring and absence of rodenticides and insecticides.	Vector of *Yersinia pestis* and flea-borne typhus agents such as *Rickettsia typhi*; bites, papular urticaria, allergic reactions and secondary infections.
Insecta	Hemiptera	Cimicidae	*Cimex lectularius* Linnaeus, 1758	Common Bed Bug	Severe overcrowding, shared bedding, second-hand mattresses, frequent displacement, inadequate laundering and limited pest-control measures.	Itchy bites, allergic reactions, sleep disturbance, psychological stress and secondary bacterial infections resulting from scratching.
Insecta	Hymenoptera	Apidae	*Apis mellifera* (Linnaeus, 1758)	Western Honey Bee	Colonization of abandoned buildings, rubble cavities, damaged structures, flowering weeds	Venomous stings, anaphylaxis, mass envenomation
Insecta	Hymenoptera	Vespidae	*Vespula* spp. (Thomson, 1869)	Yellowjackets	Food waste accumulation, refuse dumps, abandoned structures	Multiple stings, severe allergic reactions, anaphylaxis
Insecta	Hymenoptera	Vespidae	*Polistes* spp. (Latreille, 1802)	Paper Wasps	Nest construction on shelters, tents, damaged buildings, rubble	Painful stings, allergic reactions, anaphylaxis
Arachnida	Ixodida	Ixodidae	*Rhipicephalus sanguineus* (Latreille, 1806)	Brown Dog Tick	Stray dogs, poor sanitation, overcrowding, damaged shelters, and collapse of veterinary control.	Painful bites, dermatitis, allergic reactions, and transmission of tick-borne pathogens (e.g., *Rickettsia* spp. and *Ehrlichia* spp.).
Arachnida	Sarcoptiformes	Sarcoptidae	*Sarcoptes scabiei* (Linnaeus, 1758)	Human Itch Mite (Scabies Mite)	Overcrowding, prolonged skin-to-skin contact, shared clothing and bedding, insufficient water, lack of soap, delayed diagnosis, shortages of scabicides and inability to treat contacts simultaneously.	Scabies, intense nocturnal itching, dermatitis, excoriations, sleep loss and secondary bacterial infections, including impetigo; severe forms may occur in immunocompromised individuals.
Arachnida	Scorpiones	Buthidae	*Hottentotta judaicus* (Simon, 1872)	Black Judaicus Scorpion	Rubble piles, collapsed buildings, stone walls, wood debris, abandoned structures, dry sheltered microhabitats and reduced pest-control activities.	Scorpion envenomation causing severe localized pain, swelling, autonomic manifestations, systemic toxicity and occasional fatalities, particularly in children.
Arachnida	Scorpiones	Buthidae	*Leiurus quinquestriatus* (Ehrenberg, 1828)	Palestine Yellow Scorpion (Deathstalker)	Collapsed buildings, rock piles, rubble, dry cracks, abandoned structures and undisturbed debris providing suitable refuges.	Highly venomous stings causing severe pain, neurotoxicity, cardiovascular complications, respiratory distress and potentially fatal envenomation, especially in children and elderly individuals.
Arachnida	Scorpiones	Buthidae	*Androctonus crassicauda* (Olivier, 1807)	Arabian Fat-Tailed Scorpion	War-generated rubble, dry sheltered crevices, abandoned buildings, piles of construction debris, stacked materials, and disturbed habitats with limited debris removal.	Scorpion envenomation (scorpionism) causing severe local pain, autonomic disturbances, neuromuscular manifestations, and, in severe cases, cardiopulmonary and systemic complications.
Chilopoda	Scolopendromorpha	Scolopendridae	*Scolopendra cingulata* Latreille, 1829	Mediterranean Banded Centipede	Moist crevices beneath rubble, stones, decaying wood, debris piles, damaged buildings and sheltered humid microhabitats.	Painful venomous bites causing intense local pain, edema, erythema, allergic reactions and occasional secondary bacterial infection.

Figure 3: Arthropod pests of medical and public health importance documented or potentially proliferating in Gaza Strip displacement camps during the 2023–2026 war

3.2. Environmental and Anthropogenic Drivers of Arthropod Proliferation

The proliferation of medically important arthropods in displacement camps throughout the Gaza Strip was driven by interacting environmental and anthropogenic pressures associated with the ongoing war. Infrastructure destruction, sanitation collapse, waste accumulation, overcrowding, interruption of vector-control services, increasing vertebrate-host availability, and favorable climatic conditions collectively increased the availability of food, moisture, hosts, and shelter required for arthropod survival and reproduction.

3.2.1. Collapse of Water, Sanitation, and Hygiene Infrastructure

Damage to water-supply networks, sewage systems, wastewater-treatment facilities, pumping stations, and stormwater drains resulted in extensive environmental contamination and poor drainage. At the same time, intermittent water supplies forced displaced households to store water in tanks, buckets, and other containers. These conditions increased the availability of aquatic breeding opportunities for mosquitoes, while persistent leakage and elevated humidity improved conditions for cockroaches and other moisture-dependent arthropods (Figure 4).

Figure 4: Untreated sewage discharge and standing water resulting from damaged sanitation and drainage infrastructure in Gaza displacement camps

3.2.2. Accumulation of Solid Waste, Organic Refuse, and Animal Remains

The disruption of municipal waste collection led to the accumulation of household refuse, food residues, human and animal excreta, and decomposing animal remains within and around displacement camps. These materials provided abundant food and reproductive substrates for synanthropic flies and cockroaches. Discarded containers, bottles, cans, and used tyres also retained water, further increasing breeding opportunities for container-breeding mosquitoes (Figure 5).

Figure 5: Accumulated solid and organic waste providing food and breeding resources for synanthropic flies, cockroaches, and other arthropods in displacement camps

3.2.3. Hyper-overcrowding and Deterioration of Shelter Conditions

The concentration of displaced populations in tents, schools, and temporary shelters intensified close interpersonal contact and the sharing of clothing, bedding, mattresses, and personal items. Limited access to water, soap, laundry facilities, and effective treatments further facilitated the person-to-person transmission and persistence of head lice, scabies mites, and bed bugs (Figure 6).

Figure 6: Hyper-overcrowding and inadequate hygiene conditions facilitating the transmission and persistence of human-associated ectoparasites.

3.2.4. War-Generated Rubble and Habitat Disturbance

The accumulation of more than 68 million tons of war-generated rubble substantially altered the urban environment. Collapsed buildings, concrete fragments, damaged furniture, timber, and other construction materials created protected spaces that reduced exposure to sunlight, temperature extremes, predators, and human disturbance. These structural changes increased the availability of refuges for scorpions, centipedes, and other shelter-seeking arthropods (Figure 7).

Figure 7: War-generated rubble creating protected microhabitats for venomous and shelter-seeking arthropods

3.2.5. Increased Availability of Vertebrate Hosts

The deterioration of environmental management and the accumulation of food waste promoted increasing contact with commensal rodents and free-ranging domestic animals. Black rats, brown rats, and house mice provided hosts for rat fleas and lice, while stray and domestic dogs supported the persistence of the Brown Dog Tick. These vertebrate–arthropod associations strengthened potential ecological links among degraded environments, animals, and displaced communities (**Figure 8**).

3.2.6. Interruption of Environmental Health and Vector-Control Services

Routine environmental health measures—including waste collection, drainage maintenance, larval mosquito control, insecticide application, rodent management, and arthropod surveillance—were severely disrupted. Shortages of fuel, pesticides, equipment, and trained personnel further reduced the capacity of local institutions to respond to infestations, allowing arthropod populations to persist with limited control.

3.2.7. Climatic Conditions Favoring Arthropod Development

Warm temperatures from spring through early autumn accelerated arthropod development and organic matter decomposition. Humidity associated with wastewater leakage and inadequate drainage further improved survival conditions for mosquitoes, cockroaches, and mites. Climatic factors therefore intensified, rather than independently caused, the effects of environmental degradation and sanitation collapse.

Figure 8: Illustration of synanthropic rodents and free-ranging domestic animals acting as hosts for ectoparasitic arthropods in displacement-camp environments.

3.3. Major Breeding and Resting Habitats

The environmental drivers described above produced four principal categories of breeding, resting, and sheltering habitats within displacement camps. These habitats differed in their physical characteristics and in the arthropod groups they were likely to support: aquatic habitats, organic-waste sites, rubble complexes, and shelter interiors.

3.3.1. Stagnant Wastewater and Stored-Water Habitats

Untreated sewage pools, poorly drained wastewater, and organically polluted standing water constituted suitable larval habitats for the Northern House Mosquito (*Culex pipiens* Linnaeus, 1758). By contrast, relatively clean water stored in tanks, buckets, and small artificial containers provided potential breeding sites for the Yellow Fever Mosquito (*Aedes aegypti* (Linnaeus, 1762)). These aquatic habitats occurred close to human shelters, increasing the likelihood of mosquito–human contact.

3.3.2. Solid-Waste and Organic-Matter Sites

Refuse piles, decomposing food, animal carcasses, excreta, and open latrines represented the principal reproductive and feeding habitats of the Housefly (*Musca domestica* Linnaeus, 1758) and the Oriental Latrine Fly (*Chrysomya megacephala* Fabricius, 1794). Damp portions of waste accumulations, kitchens, sewer openings, and food-storage areas also provided food and shelter for the American Cockroach (*Periplaneta americana* Linnaeus, 1758) (Figure 9) and the German Cockroach (*Blattella germanica* Linnaeus, 1767).

Figure 9: AI-generated illustration of the life cycle and developmental stages of the American Cockroach (Periplaneta americana Linnaeus, 1758), a species commonly and conspicuously observed in displacement camps throughout the Gaza Strip

3.3.3. Structural Voids and Rubble Complexes

Cracks, cavities, shaded spaces, stone piles, timber, and the deeper layers of rubble formed stable refuges for venomous arthropods. Dry structural voids were particularly suitable for the Palestine Yellow Scorpion (*Leiurus quinquestriatus* Ehrenberg, 1828), Black Judaicus Scorpion (*Hottentotta judaicus* Simon, 1872), and Arabian Fat-tailed Scorpion (*Androctonus crassicauda* Olivier, 1807). Cooler and more humid spaces beneath stones, wood, and debris provided resting and foraging sites for the Mediterranean Banded Centipede (*Scolopendra cingulata* Latreille, 1829) (Figure 10).

Figure 10: An experienced wildlife handler and friend of the researcher from the northern Gaza Strip safely placing a Mediterranean Banded Centipede (Scolopendra cingulata Latreille, 1829) on his forehead.

3.3.4. Domestic and Shelter Interiors

Mattress seams, stacked bedding, clothing, fabric folds, furniture, and cracks in temporary shelter structures provided protected resting and hiding places for the Common Bed Bug (*Cimex lectularius* Linnaeus, 1758). Human bodies, hair, clothing, and shared bedding maintained the transmission cycles of the Human Head Louse (*Pediculus humanus capitis* De Geer, 1778) and the Human Itch Mite (*Sarcoptes scabiei* Linnaeus, 1758). Indoor kitchens, leaking water points, and food-storage areas additionally supported shelter-associated cockroaches.

3.4. Public Health Risks and Cascading Disease Dynamics

The widespread proliferation of medically important arthropods in displacement camps generated multiple, interconnected public health hazards. The combined effects of overcrowding, environmental contamination, deteriorating sanitation, and the collapse of healthcare and vector-control services increased human exposure to arthropod-associated diseases and injuries. Collectively, these risks encompassed mechanical pathogen transmission, ectoparasitic infestations, allergic reactions, venomous stings and bites, and secondary bacterial infections, placing an additional burden on an already fragile public health system.

3.4.1. Mechanical Transmission of Enteric Pathogens

Synanthropic insects, particularly the House Fly (*Musca domestica* Linnaeus, 1758), the Oriental Latrine Fly (*Chrysomya megacephala* Fabricius, 1794), the American Cockroach (*Periplaneta americana* Linnaeus, 1758), and the German Cockroach (*Blattella germanica* Linnaeus, 1767), frequently moved between sewage pools, refuse accumulation sites, open latrines, and food preparation areas. Through repeated contact with contaminated substrates, these arthropods acted as efficient mechanical carriers of enteric bacteria, protozoan cysts, helminth eggs, and other pathogenic microorganisms, facilitating food and water contamination. Their continuous movement between polluted environments and human shelters likely increased the risk of diarrheal diseases, gastroenteritis, dysentery, foodborne infections, and wound contamination among displaced populations.

3.4.2. Ectoparasitic Infestations and Secondary Bacterial Infections

Severe overcrowding, prolonged close contact, and inadequate personal hygiene promoted widespread infestations by the Human Head Louse (*Pediculus humanus capitis* De Geer, 1778), the Human Itch Mite (*Sarcoptes scabiei* Linnaeus, 1758), the Common Bed Bug (*Cimex lectularius* Linnaeus, 1758), and, to a lesser extent, human fleas. Persistent pruritus caused by these ectoparasites resulted in repeated scratching, skin excoriations, and disruption of the epidermal barrier, thereby facilitating secondary bacterial infections, including impetigo and cellulitis. Chronic infestations also contributed to sleep disturbance, psychological distress, reduced quality of life, and increased susceptibility to opportunistic infections, particularly among children and other vulnerable individuals.

3.4.3. Risks of Envenomation and Allergic Reactions

The proliferation of venomous arthropods within and around temporary shelters created a persistent risk of stings and bites among displaced populations.

War-generated rubble, damaged buildings, and temporary structures provided suitable refuges for the Deathstalker (*Leiurus quinquestriatus* Ehrenberg, 1828), the Black Judaicus Scorpion (*Hottentotta judaicus* Simon, 1872), the Arabian Fat-tailed Scorpion (*Androctonus crassicauda* Olivier, 1807), and the Mediterranean Banded Centipede (*Scolopendra cingulata* Latreille, 1829). In addition, colonies of the Western Honey Bee (*Apis mellifera* Linnaeus, 1758) (Figure 11), Yellowjackets (*Vespula* spp.), and Paper Wasps (*Polistes* spp.) established nests within damaged structures and shelter surroundings, increasing the likelihood of stinging incidents. These encounters ranged from localized pain and inflammation to severe allergic reactions, systemic envenomation, anaphylaxis, and, in susceptible individuals, potentially life-threatening complications. The collapse of healthcare services, together with shortages of antivenoms, emergency medications, and intensive care facilities, further exacerbated these health risks.

Figure 11: The Western Honey Bee (Apis mellifera Linnaeus, 1758) supports pollination and honey production in the Gaza Strip but may cause painful stings and allergic reactions [Photograph taken locally by my colleague Dr. Zuhair W. Dardona]

3.4.4. Cascading Public Health Consequences

The simultaneous occurrence of mechanical pathogen transmission, ectoparasitic infestations, allergic reactions, and venomous stings and bites created a cascading burden on public health within displacement camps. Recurrent enteric infections, chronic skin infestations, secondary bacterial complications, allergic disorders, and envenomation collectively increased morbidity, impaired physical well-being, and intensified pressure on an already overwhelmed healthcare system. These interacting health hazards demonstrate how war-induced environmental degradation transformed medically important arthropods from localized nuisance organisms into significant contributors to the humanitarian and public health crisis in the Gaza Strip.

3.5. Population Groups Potentially at Increased Risk

The environmental conditions documented in this study suggest that exposure to medically important arthropods was unlikely to be uniformly distributed among displaced populations in the Gaza Strip.

Individuals residing in overcrowded shelters or in close proximity to stagnant wastewater, sewage pools, refuse accumulation sites, and extensive rubble fields were likely to experience more frequent contact with mosquitoes, synanthropic flies, cockroaches, ectoparasites, and venomous arthropods. Based on the observed ecological conditions and the documented health risks associated with the recorded species (Table 1), children, older adults, pregnant women, individuals with chronic illnesses or disabilities, and personnel involved in waste collection, debris removal, sanitation, healthcare, and humanitarian activities were likely to face elevated risks of arthropod-associated infestations, mechanical pathogen exposure, allergic reactions, and envenomation. These findings highlight the importance of prioritizing vulnerable population groups when implementing integrated environmental health, vectorcontrol, and humanitarian interventions in displacement settings.

3.6. Relative Public Health Importance of Medically Important Arthropods

The ecological assessment indicated substantial variation in the relative public health importance of medically important arthropods documented or considered likely to proliferate in Gaza displacement camps.

This qualitative classification was based on ecological adaptability, likely frequency of human exposure, persistence under camp conditions, and the severity and breadth of associated health effects (Table 2). Synanthropic flies, cockroaches, mosquitoes, and humanassociated ectoparasites represented the greatest cumulative public health burden because of their close association with sewage, accumulated waste, overcrowded shelters, shared bedding, and inadequate hygiene. Fleas, ticks, and rodent-associated lice presented additional but more localized risks linked to increasing populations of rodents and stray animals. Venomous and stinging arthropods, particularly scorpions, centipedes, bees, and wasps, were generally associated with less frequent human encounters but potentially severe outcomes, including systemic envenomation, anaphylaxis, and life-threatening complications. Accordingly, public health importance was determined not solely by the severity of individual bites or stings, but by the combined effects of ecological persistence, probable exposure frequency, population vulnerability, and limited access to preventive and emergency healthcare services.

Table 2: Qualitative assessment of the relative public health importance of medically important arthropods documented or potentially proliferating in Gaza Strip displacement camps during the 2023–2026 war

Common name	Scientific name	Likely human exposure	Severity of health effects	Relative public health importance
Housefly	*Musca domestica* (Linnaeus, 1758)	Very high	Moderate–high	Very high
Oriental Latrine Fly	*Chrysomya megacephala* (Fabricius, 1794)	Very high	Moderate–high	Very high
American Cockroach	*Periplaneta americana* (Linnaeus, 1758)	Very high	Moderate–high	Very high
German Cockroach	*Blattella germanica* (Linnaeus, 1767)	Very high	Moderate–high	Very high
Human Head Louse	*Pediculus humanus capitis* (De Geer, 1778)	Very high	Moderate–high	Very high
Human Itch Mite (Scabies Mite)	*Sarcoptes scabiei* (Linnaeus, 1758)	Very high	Moderate–high	Very high
Northern House Mosquito	*Culex pipiens* (Linnaeus, 1758)	High	Moderate–high	High
Yellow Fever Mosquito (Dengue Mosquito)	*Aedes aegypti* (Linnaeus, 1762)	High	High	High
Common Bed Bug	*Cimex lectularius* (Linnaeus, 1758)	High	Moderate	High
Human Flea (House Flea)	*Pulex irritans* (Linnaeus, 1758)	Moderate–high	Moderate–high	High
Oriental Rat Flea	*Xenopsylla cheopis* (Rothschild, 1903)	Moderate	High	High
Palestine Yellow Scorpion (Deathstalker)	*Leiurus quinquestriatus* (Ehrenberg, 1828)	Low–moderate	Very high	High
Arabian Fat-tailed Scorpion	*Androctonus crassicauda* (Olivier, 1807)	Low–moderate	Very high	High
Black Judaicus Scorpion	*Hottentotta judaicus* (Simon, 1872)	Low–moderate	High	High
Western Honey Bee	*Apis mellifera* (Linnaeus, 1758)	Moderate	High–very high	Moderate–high
Yellowjackets	*Vespula* spp.	Moderate	High–very high	Moderate–high
Paper Wasps	*Polistes* spp.	Moderate	High	Moderate–high
Brown Dog Tick	*Rhipicephalus sanguineus* (Latreille, 1806)	Moderate	Moderate–high	Moderate
Mediterranean Banded Centipede	*Scolopendra cingulata* (Latreille, 1829)	Low–moderate	Moderate–high	Moderate
Spiny Rat Louse	*Polyplax spinulosa* (Burmeister, 1839)	Low	Low–moderate	Low–moderate

3.7. One Health Implications of Arthropod Proliferation in Displacement Camps

The findings of this study demonstrate that the proliferation of medically important arthropods in Gaza displacement camps represents a clear manifestation of the interconnected relationships among environmental degradation, animal ecology, and human health within the One Health framework. The widespread destruction of water and sanitation infrastructure, accumulation of war-generated rubble, collapse of waste management systems, and deterioration of living conditions fundamentally altered ecological processes, creating favorable habitats for medically important arthropods and their vertebrate hosts.

The environmental changes associated with the ongoing war promoted the expansion of commensal rodents, including the Black Rat (*Rattus rattus* Linnaeus, 1758), the Brown Rat (*Rattus norvegicus* Berkenhout, 1769), and the House Mouse (*Mus musculus* Linnaeus, 1758), together with increasing numbers of stray dogs and cats around refuse accumulation sites and temporary shelters. These vertebrates served as important reservoir hosts for several ectoparasites, particularly the Oriental Rat Flea (*Xenopsylla cheopis* Rothschild, 1903), the Spiny Rat Louse (*Polyplax spinulosa* Burmeister, 1839), ticks, and mites, thereby strengthening ecological links between vertebrate hosts, arthropod populations, and displaced human communities.

Simultaneously, the proliferation of mosquitoes, synanthropic flies, cockroaches, fleas, lice, mites, ticks, and venomous arthropods increased opportunities for pathogen transmission, ectoparasitic infestations, allergic reactions, and envenomation. These health risks were further amplified by severe overcrowding, inadequate sanitation, food insecurity, malnutrition, and the collapse of environmental health and healthcare services, creating conditions that favored sustained human exposure and increased vulnerability to arthropod-associated diseases and injuries.

Overall, the results indicate that the public health impacts of medically important arthropods cannot be separated from the broader environmental and humanitarian consequences of war. The observed interactions among degraded ecosystems, vertebrate hosts, arthropod populations, and displaced human communities highlight the need for integrated One Health interventions that simultaneously address environmental rehabilitation, restoration of water, sanitation, and hygiene (WASH) services, solid waste and rubble management, vector and rodent control, disease surveillance, and healthcare recovery to reduce arthropod-associated health risks in displacement settings.

4. DISCUSSION

This study identified 20 medically important arthropod taxa representing 3 classes, 10 orders, and 15 families in Gaza displacement camps. Palestinian and regional studies likewise demonstrate diverse invertebrate and medically important arthropod assemblages, although their ecological settings differ from displacement camps [50]-[53]. Regional evidence also highlights arthropod-borne diseases and the potential effects of climate change and human migration on biting-arthropod exposure and associated allergic and infectious risks [54] [55]. Insects predominated (70%), reflecting the high reproductive capacity, short life cycles, and ecological adaptability of synanthropic flies, cockroaches, mosquitoes, ectoparasites, and stinging Hymenoptera [4] [56]. Arachnids (25%) and the single chilopod taxon (5%) were less diverse but remained important as persistent ectoparasites or sources of severe envenomation [42] [57] [58]. Overall, public health importance depended more on exposure frequency, ecological persistence, population vulnerability, and clinical severity than on taxonomic diversity alone; consequently, ubiquitous synanthropic insects and human-associated ectoparasites imposed a greater cumulative burden than less frequently encountered venomous taxa.

The findings support a war-ecology interpretation in which infrastructure destruction generates interconnected exposure pathways. Satellite assessments and recent investigations documented extensive damage to Gaza's WASH infrastructure and the collapse of sanitation, disease surveillance, and environmental-health capacities [35]-[37] [59]. This deterioration weakened infection prevention and clinical care, increased MDRO-related risks, and restricted access to clean water, sterile equipment, medical supplies, and functioning healthcare services [60]-[62], contributing to interrelated physical, infectious, nutritional, and psychological harms [63]. Official reports similarly documented worsening WASH services, living conditions, and healthcare capacity during 2025 [64] [65]. Damaged sewage and drainage systems produced polluted standing water, water shortages encouraged household storage, refuse supplied food and oviposition substrates, and rubble created protected refuges. Consequently, arthropod breeding and resting sites became concentrated near overcrowded shelters, increasing contact among arthropods, contaminated substrates, vertebrate hosts, and displaced people [11] [16].

The very high ranking of the Housefly (*Musca domestica* Linnaeus, 1758) and Oriental Latrine Fly (*Chrysomya megacephala* Fabricius, 1794) reflects their rapid development in excreta, decomposing organic matter, and refuse, followed by movement to food, utensils, wounds, and water. Regional evidence of heat adaptation supports Housefly persistence during Gaza's warm seasons [66], while its established mechanical transfer of enteric organisms, including agents associated with shigellosis, reinforces this concern [67] [68]. Gaza-focused analyses likewise indicate that synanthropic flies may contribute to parasitic and other infections during sanitation collapse [69] [70]. Nevertheless, their coexistence with enteric disease does not confirm causation because contaminated water, inadequate sanitation, crowding, and food insecurity operate simultaneously [46] [47] [49]. Intestinal parasitic infections among Gaza sanitation workers further demonstrate risks associated with sewage and refuse exposure [71]. These flies should therefore be interpreted as potential amplifiers of an already intense fecal–oral exposure system.

The American Cockroach (*Periplaneta americana* Linnaeus, 1758) and German Cockroach (*Blattella germanica* Linnaeus, 1767) received very high rankings because they persist in sewers, damp rubble, crowded kitchens, and shared food-storage areas, repeatedly contacting contaminated and domestic surfaces. Similar infestations associated with poor sanitation have been documented elsewhere [72]. Their carriage of human parasites and pathogenic or multidrug-resistant bacteria supports their roles as mechanical disseminators and indicators of environmental hygiene failure [73]-[77]. Cockroach allergens additionally contribute to asthma, rhinitis, dermatitis, and allergic sensitization, particularly where ventilation and treatment are inadequate [56] [68].

Their prioritization therefore reflects widespread exposure and combined infectious and allergic significance, not evidence that every cockroach carries or transmits pathogens.

Mosquitoes followed two habitat pathways: the Northern House Mosquito (*Culex pipiens* Linnaeus, 1758) was associated with stagnant, organically polluted water, whereas the Yellow Fever or Dengue Mosquito (*Aedes aegypti* Linnaeus, 1762) could exploit artificial containers created by water insecurity and prolonged storage. Mosquito abundance is strongly associated with inadequate sanitation [78], and pre-war studies identified mosquito breeding and control as environmental concerns in Gaza [27] [79] [80]. War-related WASH disruption likely expanded larval habitats, while warm conditions may accelerate development [8] [81]. Regional experience shows that changing ecological conditions can transform neglected arthropod-borne diseases into emerging threats [82]. However, habitat suitability and vector presence do not confirm active West Nile, dengue, or other arboviral transmission; pathogen detection, clinical surveillance, and local vector-competence evidence remain necessary [59] [83].

The Human Head Louse (*Pediculus humanus capitis* De Geer, 1778), Human Itch or Scabies Mite (*Sarcoptes scabiei* Linnaeus, 1758), and Common Bed Bug (*Cimex lectularius* Linnaeus, 1758) depend primarily on close contact, shared bedding and clothing, inadequate laundering, delayed diagnosis, and incomplete treatment of contacts. Head-louse infestations were documented in Gaza before the war, providing a pre-existing basis for intensified transmission [25] [28] [84]. Studies among schoolchildren and displaced or crowded populations consistently associate pediculosis with close contact and adverse socioeconomic and hygienic conditions [85]-[89]. Recent Gaza evidence indicates that extreme crowding and hygiene deprivation have transformed manageable lice and scabies infestations into camp-wide problems [44] [70], causing itching, sleep disruption, stigma, excoriation, and secondary infection, especially among children and immunologically or nutritionally vulnerable people [45].

The Human or House Flea (*Pulex irritans* Linnaeus, 1758), Oriental Rat Flea (*Xenopsylla cheopis* Rothschild, 1903), Spiny Rat Louse (*Polyplax spinulosa* Burmeister, 1839), and Brown Dog Tick (*Rhipicephalus sanguineus* Latreille, 1806) demonstrate the need to integrate arthropod and vertebrate-host management. The occurrence of the Human Flea in livestock and residential environments illustrates its ability to connect animal hosts with human dwellings [90]. Refuse, rubble, abandoned structures, and food residues favor rodents, while disrupted veterinary services increase contact with free-ranging dogs and cats. Gaza studies documented rodent ectoparasites, stray-cat parasites, and intestinal parasites in the House Mouse (*Mus musculus* Linnaeus, 1758), consistent with the regional diversity of rodent-associated ectoparasites [29] [30] [91]. Palestinian evidence of *Bartonella* in ixodid ticks and domestic animals and the proposed involvement of ticks in *Madurella mycetomatis* transmission elsewhere illustrate broader animal–tick–pathogen networks [92] [93]. However, vector presence does not confirm local pathogen circulation; targeted collection and molecular testing remain essential.

War-generated rubble created a direct-injury pathway by providing cracks, stone piles, timber, and shaded cavities for the Palestine Yellow Scorpion or Deathstalker (*Leiurus quinquestriatus* Ehrenberg, 1828), Black Judaicus Scorpion (*Hottentotta judaicus* Simon, 1872), Arabian Fat-tailed Scorpion (*Androctonus crassicauda* Olivier, 1807), and Mediterranean Banded Centipede (*Scolopendra cingulata* Latreille, 1829). Reports from Gaza camps documented increased scorpion sightings during hot weather, particularly around rubble refuges [94]. Palestinian faunal, epidemiological, and clinical evidence confirms the occurrence and medical importance of these arthropods and identifies continuing surveillance and reporting limitations [57] [95]-[98]. The potentially severe systemic effects of the Deathstalker and other buthid scorpions are especially concerning among children [99] [100]. Regional studies further demonstrate the varied manifestations and continuing burden of scorpion stings [101] [102]. Risks are greatest among people sleeping at ground level, returning to damaged homes, or handling debris and are intensified by limited transport, emergency care, and antivenom availability [42]. Arthropod precautions should therefore be incorporated into rubble removal, shelter placement, community education, and emergency referral planning.

Although considerable spider diversity has been documented in Jordan and neighboring areas [103] [104], spiders were excluded from the 20 assessed taxa because field and photographic evidence did not adequately confirm medically important species in the surveyed Gaza camps. This exclusion does not imply regional absence; targeted arachnological surveys are needed before spiders can be reliably incorporated into future public health assessments.

Ants (family Formicidae) are highly diverse in morphology, ecology, behavior, and medical importance [56] [105]. Although ant diversity and invasive species, particularly the Little Fire Ant (*Wasmannia auropunctata* Roger, 1863), have been studied in neighboring areas, no published investigation specifically addressing ant prevalence, species composition, or public health importance in Gaza was identified [105]-[107]. Nevertheless, field observations and residents' accounts indicate widespread camp infestations involving painful bites or stings and substantial nuisance. Targeted surveys are therefore needed to identify species, assess associated risks, and determine the environmental drivers of their proliferation.

The inclusion of the Western Honey Bee (*Apis mellifera* Linnaeus, 1758), Yellowjackets (genus *Vespula* Thomson, 1869), and Paper Wasps (genus *Polistes* Latreille, 1802) extends the assessment beyond disease vectors. Disturbed nests in rubble and abandoned structures, together with exposed food waste, may increase human contact. In May 2024, the accidental disturbance of a Yellowjacket nest (genus *Vespula* Thomson, 1869) by an Israeli tank in Rafah, southern Gaza Strip, triggered a swarm attack that resulted in multiple stings and the envenomation of 12 Israeli soldiers, illustrating the risks associated with nest disturbance [108] [109] (see **Figure 12**). Hymenoptera venom can induce severe systemic allergy, while repeated stings may cause substantial venom exposure [110] [111]. The German Wasp (*Vespula germanica* Fabricius, 1793) also forages actively under Mediterranean conditions and exploits humanassociated food resources [112] [113]. Although ranked below ubiquitous flies and ectoparasites, these taxa can cause life-threatening anaphylaxis or mass envenomation.

Figure 12: Yellowjackets (genus Vespula Thomson, 1869) swarm attack following accidental disturbance of their nest by an Israeli tank in Rafah, southern Gaza Strip, in May 2024, resulting in the envenomation of 12 Israeli soldiers [Source: 108].

The principal ecological drivers were mutually reinforcing. War-related displacement disrupts animal-health services and intensifies human–animal–environment interactions, increasing zoonotic risks [114]. WASH failure creates aquatic habitats and contamination; waste supports synanthropic insects and vertebrate hosts; overcrowding facilitates ectoparasite transmission; rubble shelters venomous taxa; and collapsed surveillance and healthcare delay detection and treatment. These interactions require a coordinated One Health response rather than isolated insecticide campaigns [2] [17] [40]. Priorities include source reduction, safe water storage, refuse removal, sanitation restoration, rodent and stray-animal management, improved bedding and clothing hygiene, access to pediculicides and scabicides, and clinical preparedness for bites, stings, and anaphylaxis. This approach is supported by evidence linking insect and rodent infestations to public health risks in Gaza camps and by broader conflict-associated infectiousdisease evidence [49] [59] [70].

The qualitative assessment provides operational priorities. The Housefly (*Musca domestica* Linnaeus, 1758), Oriental Latrine Fly (*Chrysomya megacephala* Fabricius, 1794), American Cockroach (*Periplaneta americana* Linnaeus, 1758), German Cockroach (*Blattella germanica* Linnaeus, 1767), Human Head Louse (*Pediculus humanus capitis* De Geer, 1778), and Human Itch or Scabies Mite (*Sarcoptes scabiei* Linnaeus, 1758) require immediate population-level control because exposure is widespread and continuous. Surveillance and source reduction should target the Northern House Mosquito (*Culex pipiens* Linnaeus, 1758) and Yellow Fever or Dengue Mosquito (*Aedes aegypti* Linnaeus, 1762) because extensive habitats may allow undetected pathogen transmission [27] [59]. Fleas, ticks, and rodent lice require integrated host– ectoparasite surveillance [40] [91], while scorpions and stinging Hymenoptera require risk communication, safe debris handling, trained nest management, and emergency referral [57] [97]. Priorities should adapt to seasonal change, displacement, waste accumulation, and service restoration.

The study has important limitations. Insecurity, repeated displacement, restricted access, and collapsed monitoring prevented standardized trapping, comparable abundance estimates, and systematic spatial coverage. Consequently, some taxa were directly documented, whereas others were considered potentially proliferating based on habitat suitability, regional occurrence, and known biology. The study therefore cannot estimate prevalence, confirm population increases or pathogen carriage, or attribute disease outbreaks to specific arthropods. Accordingly, Table 2 represents a qualitative prioritization framework rather than a quantitative risk score. Nevertheless, triangulating field observations, photographic and documentary evidence, humanitarian reports, local studies, and ecological knowledge strengthens the synthesis's plausibility and practical relevance [36] [37] [70].

Future research should address the shortage of studies on Gaza's terrestrial and aquatic invertebrates, particularly arthropods of medical and veterinary importance, despite their substantial ecological, health, and economic significance. Representative camps and shelters require sentinel surveillance, standardized adult and larval sampling, and documentation of species composition, abundance, distribution, and seasonality. Molecular testing of the Northern House Mosquito (*Culex pipiens* Linnaeus, 1758), Yellow Fever or Dengue Mosquito (*Aedes aegypti* Linnaeus, 1762), Housefly (*Musca domestica* Linnaeus, 1758), Oriental Latrine Fly (*Chrysomya megacephala* Fabricius, 1794), American Cockroach (*Periplaneta americana* Linnaeus, 1758), German Cockroach (*Blattella germanica* Linnaeus, 1767), fleas, and ticks should be integrated with clinical and environmental surveillance [59].

Geospatial mapping should identify clusters around wastewater, refuse, rubble, and animal hosts, while longitudinal studies should evaluate whether WASH restoration, waste removal, shelter improvement, and integrated vector management reduce arthropod abundance and related health outcomes [115] [116]. Comprehensive faunal and specialized taxonomic, ecological, epidemiological, and veterinary studies are also needed, particularly because invertebrates remain underrepresented in global biodiversity research [117]. Until then, this synthesis provides a baseline for precautionary, ecologically informed research and action.

5. CONCLUSION

The 20 arthropod taxa assessed reflect a conflict-modified ecological system in which WASH destruction, overcrowding, water storage, waste and rubble accumulation, vertebrate-host contact, and disrupted control services increased arthropod proliferation and human exposure. Synanthropic flies, cockroaches, head lice, and scabies mites posed the greatest cumulative concern, while mosquitoes, bed bugs, fleas, ticks, rodent lice, venomous scorpions, centipedes, bees, and wasps presented additional infectious, allergic, and envenomation risks. Although this descriptive study did not quantify abundance or confirm pathogen transmission, the findings warrant restoring WASH and waste services, improving shelter hygiene, implementing integrated vector and host management, ensuring emergency care, and establishing entomological and disease surveillance within a coordinated One Health framework.

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REFERENCES

1. Pechenik, J.A. (2014): Biology of the Invertebrates. 7th Edition, McGraw Hill, 624 pp.
2. Genchi, C. (1992). Arthropoda as zoonoses and their implications. *Veterinary Parasitology*, 44(1-2), 21–33.
3. Kampen, H., & Werner, D. (2011). Arthropod vectors and their growing importance in Europe. In *Progress in Parasitology* (pp. 259–282). Springer.
4. El-Shewy, K. (2024). Medically Important Insects. In *Medical Parasitology: A Body System Approach* (pp. 249–262). Springer Nature Switzerland.
5. Failloux, A. B., Bouattour, A., Faraj, C., Gunay, F., Haddad, N., Harrat, Z., ... & Robert, V. (2017). Surveillance of arthropod-borne viruses and their vectors in the Mediterranean and Black Sea regions within the MediLabSecure Network. *Current Tropical Medicine Reports*, 4(1), 27–39.
6. Portillo, A., Ruiz-Arrondo, I., & Oteo, J. A. (2018). Arthropods as vectors of transmissible diseases in Spain. *Medicina Clínica (English Edition)*, 151(11), 450–459.
7. Allahverdipour, H. H., & Akbarzadeh, K. (2021). Biocontrol for Arthropods of Medical and Veterinary Importance in Iran. In *Biological Control of Insect and Mite Pests in Iran: A Review from Fundamental and Applied Aspects* (pp. 579–599). Springer.
8. Paz, S., Majeed, A., & Christophides, G. K. (2021). Climate change impacts on infectious diseases in the Eastern Mediterranean and the Middle East (EMME)—risks and recommendations. *Climatic Change*, 169(3), 40.
9. Di Maio, M., & Leone Sciabolazza, V. (2021). Conflict exposure and health: Evidence from the Gaza Strip. *Health Economics*, 30(9), 2287–2295.
10. Hussein, S., Ahmed, S. K., Qurbani, K., Fareeq, A., & Essa, R. A. (2024). Infectious diseases threat amidst the war in Gaza. *Journal of Medicine, Surgery, and Public Health*, 2, 100067.
11. Fersari, T. P., & Salha, J. A. (2025). The collapse of water, sanitation, and hygiene systems in Gaza: Public health implications and global security perspectives. *Indonesian Red Crescent Humanitarian Journal*, 4(2), 117–129.
12. Robinson, J. (2005). Pests and integrated pest management in western Equatoria, southern Sudan. *International Journal of Tropical Insect Science*, 25(4), 224–235.
13. Kibret, F. (2010). *Environmental health conditions and associated health threats in Somali National Regional State eastern refugee camp; Kebribeyah, Ethiopia* (Doctoral dissertation, Addis Ababa University).
14. Checchi, F., Barnsley, G., Jamaluddine, Z., Abukmail, H., Chen, Z., Spiegel, P. B., & Majorin, F. (2025). Projecting excess mortality due to infectious diseases during a crisis: Methods and application to the Gaza Strip, 2023-2024. *medRxiv*. https://doi.org/10.1101/2025.02.14.25322194
15. Muñoz-Hernández, C., & Gonzálvez, M. (2026). The role of infectious diseases and nonviolent mortality prediction in armed conflicts. *Proceedings of the Indian National Science Academy*, 92(1), 1–11.
16. Abuawad, A., Griffiths, M., Edwards, G. H., Eftekhari, A., Al-Ebweini, M., Al-Najar, H., ... & Aker, A. (2025). The ongoing environmental destruction and degradation of Gaza: The resulting public health crisis. *American Journal of Public Health*, 115(7), 1053–1061.
17. Dardona, Z., Amane, M., Dardona, A., & Boussaa, S. (2025). Health and environmental impacts of Gaza conflict (2023-2024): A review. *One Health Bulletin*, 5(1), 1–12.
18. Hamarsheh, O., & Amro, A. (2019). Epidemiology of parasitic infections in the West Bank and Gaza Strip, Palestine. *The American Journal of Tropical Medicine and Hygiene*, 102(2), 313–322.
19. Amro, A., & Hamarsheh, O. (2021). Epidemiology of Leishmaniasis in Palestine. In *Handbook of Healthcare in the Arab World* (pp. 3113–3129). Springer.
20. Abu Zaaroor, E., AlShakhra, K., & Alawneh, M. (2024). Epidemiology and Risk Factors of Cutaneous Leishmaniasis in the West Bank, Palestine: A Cross-Sectional Study. *medRxiv*. https://doi.org/10.1101/2024.11.12.24317185
21. Adawi, S.H. (2012): Presence of *Aedes albopictus* in Palestine – West Bank. *International Journal of Tropical Disease & Health*, 2(4): 301-310.
22. Adawi, S.H. and Qasem, K.R. (2018): The Fauna, Habitats and Medically Importance of Mosquito Larvae (Diptera: Culicidae) in Salfit District - Palestinian State. *Annual Research & Review in Biology*, 29(2): 1-11.
23. Abd Rabou (2005): An ecological survey and assessment of Wadi Gaza Nature Reserve, Gaza Strip – Palestine, with particular emphasis on wildlife. Ph.D. Thesis, Department of Environmental Studies, School of Life Sciences, Faculty of Science and Technology, AlNeelain University, Khartoum, Sudan, 278 pp.
24. Abd Rabou, A. N. (2011). Environmental impacts associated with the Beit Lahia wastewater treatment plant, North Gaza Strip, Palestine. *Middle-East Journal of Scientific Research*, 7(5), 746–757.
25. Al-Shawa, R.M. (2006): Head Louse infestations in Gaza governorates. *Journal of Medical Entomology*, 43(3): 505-507.
26. Yassin, M. M., Abd Rabou, A. F. N., & Al-Agha, M. R. (2006). Preliminary survey of terrestrial vertebrate fauna and people's awareness towards wildlife in the Northern Governorate of the Gaza Strip. *Al-Azhar Bulletin of Science*, 17(1-C), 17–40.
27. Abd Rabou, A. N., Yassin, M. M., Sharif, F. A., Al-Agha, M. R., Daher, K. S. A., Ali, K. S., & Hamad, D. M. (2008). Inhabitants knowledge on mosquito proliferation and control in the wetland ecosystem of Wadi Gaza, Gaza Strip, Palestine. *IUG Journal of Natural Studies*, 16(2), 15–32.
28. Alzain, B.F. (2012). *Pediculosis capitis* infestation in school children of a low socioeconomic area of the North Gaza Governorate. *Turkish Journal of Medical Sciences*, *42*(7), 1286-1291.
29. Al-Hindi, A. I., & Abu-Haddaf, E. (2013). Gastrointestinal parasites and ectoparasites biodiversity of *Rattus rattus* trapped from Khan Younis and Jabalia in Gaza strip, Palestine. *Journal of the Egyptian Society of Parasitology*, *43*(1), 259-268.
30. Al-Hindi, A. I., Abu-Draz, M., El-Zenati, A., Ali, A. A., & Dagga, A. A. (2019). Occurrence of Toxoplasmosis and other intestinal parasites among stray Cats in Khanyounis Governorate, Palestine. *IUG Journal of Natural Studies*, *27*(2).
31. Al-Hindi, A. I. (2021). Epidemiology of parasitic diseases in the Gaza Strip, Palestine: A continuing health problem. In *Handbook of Healthcare in the Arab World* (pp. 2239– 2259). Springer.
32. Ben-Naftali, O., Diamond, E., & Shofty, A. (2024). Esprit de corpse: Genocide in the shadowland of Gaza?. *Journal of Genocide Research*, 1–22.
33. Norberg, P. R. B. M., Norberg, A. N., Ferreira Filho, R. M., & Faial, L. C. M. (2024). Proposals for the forced displacement of the population from the Gaza Strip and the geopolitical spectrum of a global public health tragedy. *Journal of Global Public Health Studies*, 3(2), 89–104.

34. Evald, T. A., Ahlmark, N. G., Parellada, C. B., Micula, A., Johannesen, C. K., Bdier, D., ... & Schou-Juul, F. (2026). When Public Health Becomes the Weapon: Current and prospective consequences of the genocide in Gaza. *World Medical & Health Policy*, 18(2), e70071.
35. Zinszer, K., & Abuzerr, S. (2024). Water, sanitation, and hygiene insecurity and infectious disease outbreaks among internally displaced populations in Gaza: Implications of conflict-driven displacement on public health. *Journal of Water, Sanitation and Hygiene for Development*, 14(11), 1182–1192.
36. Perlman, B., Collins, S. M., & Van Den Hoek, J. (2025). Public health implications of satellite-detected widespread damage to WASH infrastructure in the Gaza Strip. *PLOS Global Public Health*, 5(2), e0004221.
37. Turkman, N., Ibrahim, M. S., Ayyad, D., Alfarra, M., & Qurie, M. (2026). Water, Sanitation, and Hygiene (WASH) crisis in Gaza: A case study of public health collapse and governance failure. *Journal of Water and Health*, 24(1), 89–102.
38. Hassoun, A., Dankar, I., & Hassan, H. F. (2025). Disrupted Systems: The war's impact on sustainable production and consumption in Gaza. In *War on Gaza: Consequences on Sustainability and Global Security* (pp. 261–273). Springer Nature Switzerland.
39. Mahdi, N., Abumeteir, H., Migdad, M., Ashour, E., Abuhadrous, I., & Hassoun, A. (2025). Powerless under siege and devastation: The struggle for clean and affordable energy in Gaza. In *War on Gaza: Consequences on Sustainability and Global Security* (pp. 95–112). Springer Nature Switzerland.
40. Abd Rabou, A.N.; Elhabiby, M.I.; Gafar, M.F.; Alfera, Y.M.; El-Hindi, M.W.; Ibrahim, Y.K.; AlBanna, M.S.; Idais, R.H.; Tanboura, A.A.; Alsalibi, T.M.; Qaraman, A.A.; Al-Agha, M.R.; Abd Rabou, M.A.; Dardona, A.W.; Shawa, S.S.; Abd Rabou, O.A.; Tayeh, B.A.; Rabah, F.K.; Abualtayef, M.T.; Abd Rabou, A.A. and Yassin, M.M. (2026): Vertebrate Pest Outbreaks in Gaza Displacement Camps under Conditions of Israeli War of Genocide and Ethnic Cleansing (2023–2026): Ecological Drivers, Public Health Risks, and Humanitarian impacts. *Journal of Diversity Studies,* 5(2): 5-22. https://doi.org/10.51470/JOD.2026.5.2.05
41. Fusto, G., Bennardo, L., Duca, E. D., Mazzuca, D., Tamburi, F., Patruno, C., & Nisticò, S. P. (2020). Spider bites of medical significance in the Mediterranean area: Misdiagnosis, clinical features and management. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 26, e20190100.
42. Dehghani, R., Fathi, B., Dehghani, M., & Mohamadzadeh, N. (2025). Venomous and poisonous arthropods in Iran, West Asia, and the Middle East: An overview of their identification, bites, stings, behavior, biology and geographical distribution. *Iranian Journal of Veterinary Science & Technology*, 17(1), 1–18.
43. Khoobdel, M., Maddahi, H., & Hatami, M. (2025). Medically significant spiders (Araneae), camel spiders (Solifugae), and centipedes (Chilopoda) of Iran: New distributional records and public health implications. *Journal of Animal Diversity*, 7(1), 57–68.
44. Dardona, Z., Amane, M., & Boussaa, S. (2025). Scabies and lice infestations in Gaza: Risk factors and public health challenges during the 2023–2024 conflict. *Egyptian Journal of Dermatology and Venerology*, 45(2), 127–133.
45. Hamamra, B., Mahamid, F., & Mayaleh, A. (2025). Childhood under siege: Battling malnutrition, disease, and despair during genocide in Gaza. *Journal of Health, Population and Nutrition*, 44(1), 321.
46. Dardona, Z., Amane, M., & Boussaa, S. (2024). Top five infectious disease outbreaks among displaced populations during the Gaza conflict 2023–2024: A comprehensive review. *Journal of Infectious Diseases and Epidemiology*, 10(9), 328.
47. Dardona, Z., Amane, M., & Boussaa, S. (2024). Assessing the epidemiological status and awareness level of hepatitis A virus among displaced populations in southern Gaza during the 2023-2024 conflict. *Microbes and Infectious Diseases*, 5(4), 412–424.
48. Ashour, Y., AbuJlambo, A., & Hassoun, A. (2025). Gaza's health emergency: Unprecedented humanitarian impact of the recent war on public health. In *War on Gaza: Consequences on Sustainability and Global Security* (pp. 43–58). Springer Nature Switzerland.
49. Boussaa, S., Dardona, Z., & Amane, M. (2025). Challenges and risk factors for infectious diseases in Gaza due to the current conflict. *Eastern Mediterranean Health Journal*, 31(2), 127–133.
50. Badawi, A.I. (1994): Arthropods of medical and veterinary importance in Saudi Arabia. 1st Edition, Deanship of Library Affairs, King Saud University, Riyadh, Saudi Arabia, 266pp (*In Arabic*).
51. Qumsiyeh, M. (2016). Invertebrate Fauna of Wadi Al-Quff Protected Area, Palestine. *Jordan Journal of Natural History*, 3, 80–92.
52. Tabbabi, A., Rhim, A., & Daaboub, J. (2017). Review of medical arthropods in Tunisia. *International Journal of Fauna and Biological Studies*, 4, 102–108.
53. Sharoot, M. A., Naji, B. A. A., & AbdulKarim, A. T. (2024). Iraq's swamps and surrounding pests. *Eximia*, 13, 450–465.
54. Shoukry, N. M., & Morsy, T. A. (2011). Arthropod borne diseases at Toshka, Upper Egypt. *World Journal of Zoology*, 6(2), 126–133.
55. Rady, M. H., Farag, S., & Morsy, A. T. (2025). A systematic review on arthropods biting man and animals causing allergy and transmitting infectious diseases: Is it risky to Egypt with climatic changes and immigrants?. *Journal of the Egyptian Society of Parasitology*, 55(1), 137–150.
56. Goddard, J. (2012): Physician's guide to arthropods of medical importance. 6th Edition, CRC press, 535 pp.
57. Amr, Z.S.; Abu Baker M.A.; Al-Saraireh, M. and Warrell, A.D. (2021): Scorpions and scorpion sting envenoming (scorpionism) in the Arab countries of the Middle East. *Toxicon*, 191: 83–103.
58. Omeragić, J., Kapo, N., Škapur, V., Goletić, Š., Softić, A., Šaljić, E., & Goletić, T. (2024). Arthropods of Veterinary Importance. In *Epizootics-Outbreaks of Animal Disease*. IntechOpen.
59. Abuzerr, S., Zinszer, K., & Mahmoud, H. (2025). Healthcare collapse and disease spread: A qualitative study of challenges in Gaza Strip. *BMC Public Health*, 25(1), 589.
60. Alashi, H., Dergaa, I., Rejeb, M.A., Aboumarzouk, O.M., & El-Omri, A. (2024). The silent epidemic in the shadows of war: Urgent calls for ceasefire and international action against MDROs in Gaza Strip (Palestine). *New Asian Journal of Medicine*, 2(2), 1–4.
61. Irfan, B., Lulu, I., Hamawy, A., Shammala, A. A., Kullab, S., Fawaz, M., ... & Saleh, K. J. (2025). Combating infections under siege: Healthcare challenges amidst the military assault in Gaza. *World Medical & Health Policy*, 17(1), 188–213.
62. Farhadi, N., Yarahmadi, A., & Afkhami, H. (2026). Infectious Diseases and Antimicrobial Resistance in the Gaza Strip: Epidemiological Drivers, Health System Disruptions, and Global Implications: A Narrative Review. *Health Science Reports*, *9*(5), e72074.
63. Shorrab, A., Nassef, M., Subhi, A., Giwa, B., & Buheji, M. (2024). Health in the crossfireanalyzing and mitigating the multifaceted health risks of the 2023 war on Gaza. *Public Health Research*, 14(1), 1–11.
64. United Nations Office for the Coordination of Humanitarian Affairs. (2025). *Humanitarian Situation Update: Gaza Strip*. New York: OCHA.
65. World Health Organization. (2017). *Global vector control response 2017–2030*. World Health Organization. https://www.who.int/publications/i/item/9789241512978

66. Biale, H.; Geden, C.J. and Chiel, E. (2020): Heat adaptation of the House Fly (Diptera: Muscidae) and its associated parasitoids in Israel. *Journal of Medical Entomology*, *57*(1): 113-121.
67. Levine, O.S., and Levine, M.M. (1991): Houseflies (*Musca domestica*) as mechanical vectors of shigellosis. *Reviews of infectious diseases*, 13(4): 688-696.
68. Kenawy, M. A., Amer, H. S., Lotfy, N. M., Khamis, N., & Abdel-Hamid, Y. M. (2014). Insects associated with hospital environment in Egypt with special reference to the medically important species. *Journal of the Egyptian Society of Parasitology*, 44(3), 665–676.
69. Dardona, Z., Amane, M., Dardona, A., & Boussaa, S. (2024). House flies and their role in transmitting infectious diseases: Focusing on parasitic infectious diseases. *Revue Des Sciences Infirmières Et Techniques De Santé*, 3(1), 55–72.
70. Dardona, Z., & Boussaa, S. (2025). Insect and mice infestations in Gaza displacement camps: A field-based study on vector-borne diseases amid the 2023–2025 Gaza war. *Public Health Challenges*, 4(4), e70127.
71. Al-Hindi, A. I., Shaldoum, F., Mezied, N., & Alreefi, M. (2025). Prevalence and associated risk factors of intestinal parasites among sanitation workers and work conditions at Gaza Municipality. *Baghdad Journal of Biochemistry and Applied Biological Sciences*, 6(2), 109–116.
72. Umoren, O. D., Friday, K. C., Chukwuma, O. D., Akinbola, S., & Onyeaghala, C. (2026). Cockroach and rat infestations in selected households: Case study of Bariga Local Council Development Area (LCDA), Lagos State, Nigeria. *Munis Entomology & Zoology, 21*(1), 361–372.
73. Ajero, C.M.U.; Ukaga, C.N. and Ebirim, C. (2011): The role of Cockroaches (*Blatta orientalis* and *Periplaneta americana*) in mechanical transmission of parasites in households in Owerri, South East Nigeria. *Nigerian Journal of Parasitology*, 32(2):
74. Alzain, B.F. (2013): Cockroaches: Transmission of medically important parasites. *ARPN Journal of Science and Technology*, *3*(5): 533-537.
75. Okpara, E.M. and Amos, N. (2019): Cockroach-borne human parasites of public health concern: A synoptic account of the literature. *Journal of Entomology and Zoology Studies*, 7(3): 1507-1510
76. Yaro, C. (2015): Evaluation of the role of cockroaches as carriers of medically important parasites in two distinct communities in Zaria, Nigeria. *Journal* of *Global Science Research*, *2*(2), 114-119.
77. Dihmane, A., Aniba, R., Raqraq, H., Ressmi, A., Chouati, T., Abi, O., ... & Barguigua, A. (2025). Moroccan Hospital Cockroaches: Carriers of Multidrug-Resistant Gram-Negative Bacteria. *EcoHealth*, 22(2), 185–199.
78. Olagunju, E. A. (2023). Is the presence of mosquitoes an indicator of poor environmental sanitation? Journal of Water and Health, 21(3), 385–401.
79. Safi, J. and El-Nahhal, Y. (1996): Mosquito Populations in Gaza Strip and Biocontrol by Bti. *Second En Gedi Conference on Bacterial Control of Agricultural Insect Pests and Vectors of Human Diseases*, August 12-16. Shoresh, Jerusalem
80. Alzain, B.F. (2019): Terminating the problem of mosquitoes in Gaza Strip by using alga. *International Journal of Advanced Research, 7*(10): 1118-1127.
81. Aish, A., Al-Atrash, Y., & Abu Qamar, M. (2017). The impact of climate change on child health in the Gaza Strip, Palestine. In *Proceedings of the International Conference on Climate Change and its Impact on Public Health* (p. 146). Al-Azhar University.
82. Romi, R. (2010). Arthropod borne diseases in Italy: From a neglected matter to an emerging health problem. *Annali dell'Istituto Superiore di Sanità*, 46, 436–443.
83. Alzuheir, I., Fayyad, A., Jalboush, N., Abdallah, R., Abutarbush, S., Gharaibeh, M., ... & Helal, B. A. (2021). Seroprevalence and risk factors of West Nile virus infection in veterinarians and horses in Northern Palestine. *Veterinary World*, *14*(5), 1241.
84. Al-Shawa, R.M. (2008): *Pediculus capitis* infestation according to sex and social factors in Gaza Governorate. *IUG Journal of Natural Studies*, 16(1): 75-83.
85. Vahabi, A., Shemshad, K., Sayyadi, M., Biglarian, A., Vahabi, B., Sayyad, S., Shemshad, M., & Rafinejad, J. (2012). Prevalence and risk factors of *Pediculus humanus capitis* (Anoplura: Pediculidae) in primary schools in Sanandaj City, Kurdistan Province, Iran. *Tropical Biomedicine, 29*(2), 207–211.
86. Ali, F.M. and Hama, A.A. (2018): Prevalence of head pediculosis among refugees in Sulaimani Governorate/Kurdistan-Iraq. *Iraqi Journal of Science*, 59(2): 1012-1018.
87. Ibrahim, H.M.S. and Mohamed, H.O.A. (2020): Prevalence and associated factors of *Pediculus humanus capitis* infestation among primary schoolchildren in Sebha, Libya. *Journal of Pure & Applied Sciences*, *19*(5): 132-138.
88. Baghdadi, H. B., Omer, E. O., Metwally, D. M., & Abdel-Gaber, R. (2021). Prevalence of head lice (*Pediculus humanus capitis*) infestation among schools workers in the Eastern Region, Saudi Arabia. *Saudi Journal of Biological Sciences*, *28*(10), 5662-5666.
89. Rodriguez-Sanchez, I. P., Martínez, M. L. J., Ahuja, M. D. L. R., Dzul-Manzanilla, F. A., Correa-Morales, F., Flores, A. E., ... & Trujillo-Rodríguez, G. (2026). Prevalence and associated factors of head lice (*Pediculus humanus capitis*) among schoolchildren in Mérida (Yucatán) and Monterrey (Nuevo León), Mexico. *Parasite Epidemiology and Control*, e00519.
90. Yakhchali, M. and Bahramnejad, K. (2015): A survey of *Pulex irritans* (Linnaeus 1758, Siphonaptera: Pulicidae) infestation in sheep and residential areas in Kurdistan Province, Iran. *Iranian Journal of Veterinary Science and Technology*, *7*(1): 40-47.
91. Islam, M. M., Farag, E., Eltom, K., Hassan, M. M., Bansal, D., Schaffner, F., ... & MkhizeKwitshana, Z. (2021). Rodent ectoparasites in the Middle East: A systematic review and meta-analysis. *Pathogens*, *10*(2), 139.
92. Ereqat, S., Nasereddin, A., Vayssier-Taussat, M., Abdelkader, A., Al-Jawabreh, A., Zaid, T., ... & Abdeen, Z. (2016). Molecular evidence of *Bartonella* species in ixodid ticks and domestic animals in Palestine. *Frontiers in Microbiology*, 7, 1217.
93. Azrag, R. S., Bakhiet, S. M., Mhmoud, N. A., Almalik, A. M., Mohamed, A. H., & Fahal, A. H. (2021). A possible role for ticks in the transmission of *Madurella mycetomatis* in a mycetoma-endemic village in Sudan. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 115(4), 364–374.
94. Faruqi, S. (2024): Heat waves and war bring out snakes and scorpions in Gaza's refugee camps. TRT World, https://www.trtworld.com/magazine/heat-waves-and-war-bring-out-snakes-andscorpions-in-gazas-refugee-camps-18182759
95. Amr, Z.S. (2000): Jordan Country Study on Biological Diversity: Arthropods of Medical Importance in Jordan. United Nations Environment Program (UNEP), 66pp.
96. Qumsiyeh, M.; Salman, I.; Salsaa, M. and Amr Z. (2013): Records of scorpions from the Palestinian Territories, with the first chromosomal data (Arachnida: Scorpiones). *Zoology in the Middle East*, 59: 70–76.
97. Handal, E.N.; Abu Serhan, M.; Qumsiyeh, M.B.; Hani, R.B.; Warrell, D.A. and Amr, Z.S. (2023): Epidemiology of scorpion stings in the West Bank, Occupied Palestinian Territory. *Eastern Mediterranean Health Journal*, 29(12): 937-943.
98. Adawi, S.H. (2016): The scorpion sting: Epidemiology, clinical symptoms, treatment, surveillance and reporting obstacles in the Salfit District (West Bank) (2014-2015). *International Journal of Tropical Disease and Health*. 14(3):1-10.

99. Dudin, A.A.; Rambaud-Cousson, A.; Thalji, A. Juabeh, I.I. and Abu-Libdeh, B. (1991): Scorpion sting in children in the Jerusalem area: A review of 54 cases. *Annals of Tropical Pediatrics*, 11(3): 217–223.

100. Sofer S, Shalev H, Weizman Z, Shahak E, Gueron M (1991). "Acute pancreatitis in children following envenomation by the yellow scorpion Leiurus quinquestriatus". *Toxicon*. **29** (1): 125–8.

101. Ismail, S.A. (1995): Clinical patterns of scorpion stings at El-Quawayah General Hospital Riyadh Region, Saudi Arabia. *Saudi Medical Journal*, 16: 312–314.

102. Amr, Z.S.; Al-Zou'bi, R.; Abdo, N, and Bani Hani, R. (2017): Scorpion stings in Jordan: An update. *Wilderness & Environmental Medicine*. 28(3): 207–212.

103. Zonstein, S. and Marusik, Y.M. (2013): Checklist of the spiders (Araneae) of Israel. *Zootaxa*, 3671(1): 1-127.

104. Shakhatreh, M., Amr, Z., & Baker, M. A. (2021). Spiders of Jordan: A preliminary study. *Turkish Journal of Bioscience and Collections*, 5(1), 1–11.

105. Vonshak, M., & Ionescu-Hirsch, A. (2009). A checklist of the ants of Israel (Hymenoptera: Formicidae). *Israel Journal of Entomology, 39*, 33–55.

106. Vonshak, M., Dayan, T., Ionescu-Hirsch, A., Freidberg, A., & Hefetz, A. (2010). The little fire ant *Wasmannia auropunctata*: A new invasive species in the Middle East and its impact on the local arthropod fauna. *Biological Invasions, 12*(6), 1825–1837. https://doi.org/10.1007/s10530-009-9593-2

107. Montgomery, M. P., Vanderwoude, C., Lintermans, M., & Lynch, A. J. J. (2022). The Little Fire Ant (Hymenoptera: Formicidae): A global perspective. *Annals of the Entomological Society of America, 115*(6), 427–448. https://doi.org/10.1093/aesa/saac016

108. Fabian, E. & Horovitz, M. (2024): 12 soldiers stung by wasp swarm after tank runs over nest in southern Gaza. The Times of Israel (May 10, 2024), https://www.timesofisrael.com/12-soldiers-stung-by-wasp-swarm-after-tank-runsover-nest-in-southern-gaza/

109. Abd Rabou, A. N., Al-Harazeen, H. R., Abu Alajeen, R. A., Rafeea, A. A., Al-Sweirki, S. H., Hassouna, H. A., ... & Khalaf, N. A. (2025). Spotlights on a Desert Lynx (*Caracal caracal* Schreber, 1776) attacking Israeli soldiers in the Negev Desert, Palestine. *Journal of Entomology and Zoology Studies*, 13(3), 5–13.

110. Lockey, R. F., Turkeltaub, P. C., Baird-Warren, I. A., Olive, C. A., Olive, E. S., Peppe, B. C., & Bukantz, S. C. (1988). The Hymenoptera venom study I, 1979–1982: Demographics and history-sting data. *Journal of Allergy and Clinical Immunology, 82*(3 Pt 1), 370–381. https://doi.org/10.1016/0091-6749(88)90008-5

111. Albanesi, M., Nico, A., Sinisi, A., Giliberti, L., Rossi, M. P., Rossini, M., Kourtis, G., Rucco, A. S., Loconte, F., Muolo, L., Zurlo, M., Di Bona, D., Caiaffa, M. F., & Macchia, L. (2018). A 13-year real-life study on efficacy, safety and biological effects of *Vespula* venom immunotherapy. *Clinical and Molecular Allergy, 16*, Article 2. https://doi.org/10.1186/s12948-017-0079-y

112. Spradbery, J.P. and Maywald, G.F. (1992). The distribution of the European or German Wasp, *Vespula germanica* (F.) (Hymenoptera: Vespidae), in Australia: Past, present and future. *Australian journal of zoology*, 40(5): 495-510.

113. Kasper, M.L.; Reeson, A.F.; Mackay, D.A. and Austin, A.D. (2008): Environmental factors influencing daily foraging activity of *Vespula germanica* (Hymenoptera, Vespidae) in Mediterranean Australia. *Insectes Sociaux*, *55*: 288-295.

114. Salajegheh Tazerji, S., Magalhães Duarte, P., Gharieb, R., Szarpak, L., Pruc, M., Rahman, M. T., ... & Shehata, A. A. (2025). Migratory wave due to conflicts: Risk of increased infection from zoonotic diseases. *Transboundary and Emerging Diseases*, 2025(1), 5571316.

115. World Health Organization. (2025). *Health conditions in the occupied Palestinian territory, including East Jerusalem: Report by the Director-General* (Document A78/15). Seventy-eighth World Health Assembly. https://apps.who.int/gb/ebwha/pdf_files/WHA78/A78_15-en.pdf

116. Fournet, F., Jourdain, F., Bonnet, E., Degroote, S., & Ridde, V. (2018). Effective surveillance systems for vector-borne diseases in urban settings and translation of the data into action: A scoping review. *Infectious Diseases of Poverty, 7*, Article 99. https://doi.org/10.1186/s40249-018-0473-9

117. Titley, M. A., Snaddon, J. L., & Turner, E. C. (2017). Scientific research on animal biodiversity is systematically biased towards vertebrates and temperate regions. *PLOS ONE, 12*(12), e0189577. https://doi.org/10.1371/journal.pone.0189577