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Control Measures for Commensal Rodent Infestations in the Gaza Strip, Palestine, during Israel's Ongoing War of Genocide and Ethnic Cleansing (2023–2026)

Abdel Fattah N. Abd Rabou

Department of Biology and Biotechnology, Faculty of Science, Islamic University of Gaza, P.O.Box 108, Gaza Strip, Palestine

ABSTRACT

Commensal rodent infestations have become an increasing environmental and public-health concern in the Gaza Strip during Israel's ongoing war of genocide and ethnic cleansing (2023– 2026). Widespread destruction, accumulation of war-generated rubble and solid waste, damaged sewage and drainage systems, food insecurity, overcrowding, mass displacement, and weakened municipal services have created favorable conditions for the proliferation of rats and mice. This descriptive study examined the principal measures available for controlling the Norway Rat (Rattus norvegicus Berkenhout, 1769), Black Rat (Rattus rattus Linnaeus, 1758), and House Mouse (Mus musculus Linnaeus, 1758) under wartime conditions in the Gaza Strip. The study combined field observations in accessible areas, stakeholder interviews, market surveys, photographic documentation, and a review of relevant scientific literature. Control measures identified included environmental sanitation and habitat modification, structural exclusion and rodent-proofing, mechanical and improvised trapping, chemical control using rodenticides, biological regulation by domestic and native predators, public education, community and institutional action, and surveillance. The findings indicated that no single control method is sufficient under the prevailing humanitarian conditions. Environmental sanitation, food and water protection, removal of harborages, and structural exclusion should constitute the first line of intervention, while trapping can provide targeted control and support monitoring. Rodenticides should be restricted to persistent or severe infestations and used in secured bait stations under appropriate supervision to minimize risks to children, domestic animals, wildlife, and the environment. Protection of natural predators, community participation, institutional coordination, and regular surveillance can further strengthen control efforts. A locally adapted Integrated Pest Management (IPM) approach combining these complementary measures represents the most practical and sustainable strategy for reducing commensal rodent infestations in the Gaza Strip. Restoring waste collection, drainage, rubble management, safe access, and surveillance capacity remains essential for long-term control.

Keywords: *Commensal rodents; Norway Rat; Rattus norvegicus; Black Rat; Rattus rattus; House Mouse; Mus musculus; Rodent control; Integrated Pest Management (IPM); Displacement camps; Rodenticides; Environmental sanitation; War-generated rubble; Israel's war of genocide and ethnic cleansing (2023–2026); Gaza Strip, Palestine.*

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Corresponding Author: *Abdel Fattah N. Abd Rabou*

E-mail Address: *arabou@iugaza.edu.ps*

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1. INTRODUCTION

Commensal rodents have lived in close association with humans for thousands of years and remain among the most widespread and economically important vertebrate pests worldwide [1] [2]. The development of permanent settlements, food-storage systems, agriculture, trade, sewage networks, and densely populated cities has created ecological niches that favor their survival and expansion. Unlike many wild rodents that depend primarily on natural habitats, commensal species exploit human-modified environments where food, water, shelter, and breeding sites are continuously available [3]. Their omnivorous feeding behavior, high reproductive potential, behavioral flexibility, and ability to enter buildings through narrow openings enable them to establish persistent populations in houses, markets, warehouses, hospitals, schools, farms, foodprocessing facilities, sewers, ports, waste-disposal sites, and displacement camps [4] [5]. Consequently, rodent infestations represent a complex challenge involving public health, food security, environmental sanitation, agriculture, and urban infrastructure.

Three species account for most commensal rodent infestations associated with human settlements: The Norway Rat (*Rattus norvegicus* Berkenhout, 1769), the Black Rat (*Rattus rattus* Linnaeus, 1758), and the House Mouse (*Mus musculus* Linnaeus, 1758). Although all three species benefit from their association with humans, they differ considerably in body size, ecology, behavior, habitat preference, climbing ability, and nesting habits (Figure 1 & Table 1). The Norway Rat commonly occupies underground burrows, sewers, drainage systems, refuse sites, waterfronts, and the lower parts of buildings.

The Black Rat is an agile climber that frequently inhabits roofs, ceilings, warehouses, orchards, trees, and port facilities. The House Mouse readily establishes breeding colonies inside houses, tents, food stores, poultry farms, livestock buildings, and commercial premises. These ecological differences influence infestation patterns and responses to control measures, making accurate species identification an important prerequisite for selecting suitable trapping, baiting, exclusion, and habitat-management strategies [4]-[6].

The association between humans and commensal rodents is particularly ancient in the Levant. Archaeological evidence indicates that House Mice began exploiting ecological niches created by increasingly sedentary human communities in the region approximately 15,000 years ago [7]-[9]. Today, commensal rodents occur widely in urban, rural, coastal, and agricultural environments throughout Palestine [10]-[13]. In the Gaza Strip, they infest residential neighborhoods, refugee camps, food markets, grain stores, poultry and livestock farms, agricultural fields, sewage systems, municipal waste sites, ports, and food-processing facilities [3]. Local investigations have also demonstrated that commensal rats can harbor gastrointestinal parasites and ectoparasites of potential medical and veterinary significance [3] [10]-[16].

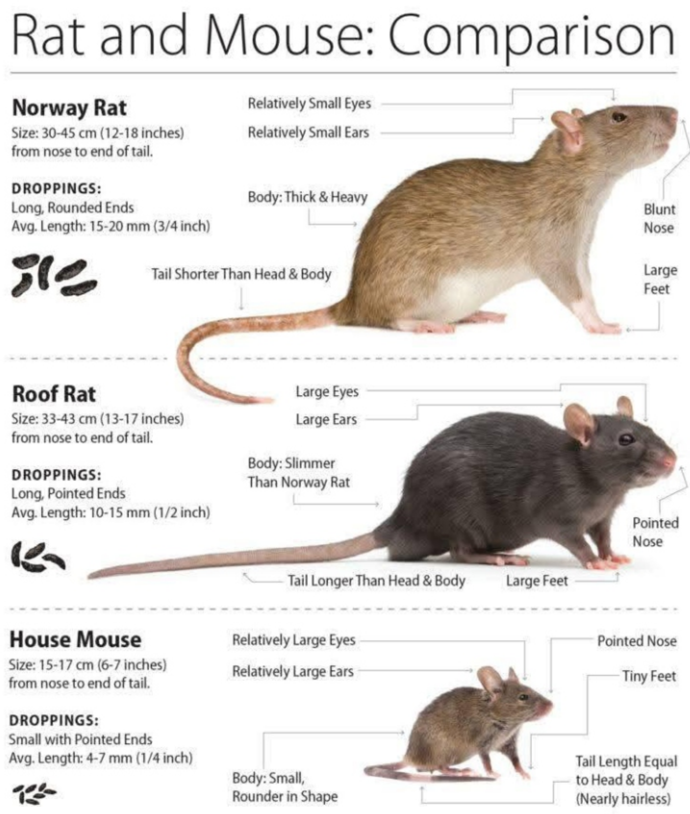

Figure 1: The Main Differences among the Three Commensal Rodent Species in the Gaza Strip [Source: https://carmelowls.org/rat-and-mice-comparison]

Table 1: The Main Differences among the Three Commensal Rodent Species in the Gaza Strip

Characteristic	Norway Rat	Black Rat	House Mouse
Other common names	Brown Rat, Sewer Rat	Roof Rat, Ship Rat	Domestic Mouse
Scientific name	*Rattus norvegicus* (Berkenhout, 1769)	*Rattus rattus* (Linnaeus, 1758)	*Mus musculus* Linnaeus, 1758
Adult body length	20–28 cm	16–22 cm	6–10 cm
Tail	Shorter than head and body; thick	Longer than head and body; slender	About as long as the body; thin
Adult weight	200–500 g or more	120–250 g	12–30 g
Body build	Large and robust	Slender and agile	Small and delicate
Snout	Blunt	Pointed	Pointed
Ears	Small relative to the head	Large and prominent	Large relative to the head
Eyes	Relatively small	Large	Small but prominent
Typical colour	Brownish-grey	Black, dark brown, or grey	Greyish-brown
Droppings	Large, capsule-shaped, with blunt ends	Medium-sized, spindle-shaped, with pointed ends	Small, rod-shaped, with pointed ends
Climbing ability	Moderate	Excellent	Excellent
Swimming ability	Excellent	Moderate	Can swim but usually avoids water
Burrowing behavior	Strong burrower	Rarely burrows extensively	May make small nests or burrows
Preferred locations	Sewers, drains, ground floors, markets, waste sites and burrows	Roofs, ceilings, trees, upper floors and storage areas	Kitchens, tents, cupboards, furniture and food-storage areas
Nesting level	Mainly at or below ground level	Mainly above ground level	Near food and shelter at various levels
Food preference	Omnivorous; grains, meat and waste	Fruits, seeds, grains and vegetables	Cereals, seeds and stored foods
Typical behavior	Cautious and often avoids unfamiliar objects	Agile, cautious and highly mobile	Curious and explores unfamiliar objects
Main identification feature	Heavy body with a tail shorter than the head and body	Slender body with a tail longer than the head and body	Very small size, pointed snout and large ears

Commensal rodents are also represented in the zoological collections of Palestinian universities in the Gaza Strip. Preserved and taxidermied rodent specimens have been documented in biology museums and exhibitions at the Islamic University of Gaza, Al-Azhar University, and Al-Aqsa University [17]-[19]. The extensive zoological collection formerly housed in the Biology Department Museum at the Islamic University of Gaza included numerous mummified terrestrial and marine vertebrates, reflecting the value of university museums in documenting the local fauna [19].

Of particular interest, two unusual live commensal rodents—a House Mouse (*Mus musculus* Linnaeus, 1758) collected in 2005 and a Black Rat (*Rattus rattus* Linnaeus, 1758) collected in 2007—were brought to the Biology Department of the Islamic University of Gaza and subsequently preserved. Both specimens exhibited conspicuous morphological abnormalities suggestive of possible mutations (Figure 2); however, their genetic basis was not experimentally confirmed because specialized genetic investigations were unavailable [17].

Commensal rodents pose numerous public-health risks because they can harbor bacteria, viruses, protozoa, helminths, fungi, and ectoparasites. They have been associated with leptospirosis, salmonellosis, plague, murine typhus, rat-bite fever, lymphocytic choriomeningitis, hantavirus-associated diseases, and several parasitic infections [20]-[25]. Fleas, mites, lice, and ticks carried by rodents may also transmit pathogens between rodents, domestic animals, and humans [13] [15] [16] [22] [26]. Regional systematic reviews have documented considerable diversity of rodent-associated helminths and ectoparasites in Middle Eastern countries, emphasizing their importance at the human–animal–environment interface [27] [28].

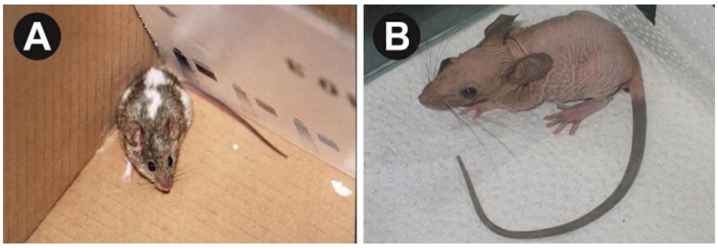

Figure 2: Two unusual commensal rodents preserved at the Biology Department, Islamic University of Gaza, showing conspicuous morphological abnormalities suggestive of possible mutations: (A) House Mouse (Mus musculus Linnaeus, 1758) and (B) Black Rat (Rattus rattus Linnaeus, 1758)

Transmission does not necessarily require direct contact with rodents. Their urine, feces, saliva, hair, nesting materials, and ectoparasites can contaminate food, drinking water, cooking utensils, household surfaces, warehouses, shelters, and animal feed [2] [20] [22]. Rodent infestations may also cause fear, psychological distress, sleep disturbance, and a reduced sense of safety, particularly when rodents enter crowded sleeping areas containing children, older adults, injured people, or immunocompromised individuals [29]. These risks become especially serious during humanitarian emergencies, when malnutrition, poor hygiene, limited medical services, and shortages of medicines increase the vulnerability of affected populations [30]-[32].

Rodents also cause considerable economic and material losses [1] [33]. They consume and contaminate stored grains, vegetables, household food, animal feed, and humanitarian relief supplies [1] [4] [33]. Their continuous gnawing damages electrical wiring, communication cables, water pipes, insulation materials, furniture, food containers, irrigation systems, and household belongings. Contamination may make food unsuitable for consumption even when the quantity directly eaten is relatively small. In agricultural environments, rodents can damage crops, seedlings, irrigation networks, poultry facilities, and livestock feed. Their impacts therefore extend beyond nuisance infestation to food insecurity, household expenditure, infrastructure deterioration, and environmental-health problems [4] [33]-[35].

Before October 2023, rodent management in the Gaza Strip depended on the combined efforts of municipalities, environmental-health departments, agricultural authorities, private pest-control operators, businesses, farmers, and households. Control activities included waste collection, sewage and drainage maintenance, removal of rodent harborages, improvement of food storage, sealing of structural openings, mechanical trapping, and selective application of anticoagulant rodenticides (Personal Observations). These measures were broadly consistent with Integrated Pest Management (IPM), which combines environmental, structural, mechanical, biological, educational, and chemical interventions [5] [6] [36] [37]. Nevertheless, their effectiveness was already limited by high population density, inadequate infrastructure, restricted resources, and repeated damage resulting from previous military escalations.

Complete eradication of commensal rodents is rarely achievable because surviving animals can reproduce rapidly and recolonize treated areas whenever food, water, and shelter remain available [6] [36]. Modern rodent management therefore focuses on sustainable population suppression and reduction of human exposure. IPM seeks to reduce the environmental carrying capacity for rodents through sanitation, habitat modification, structural exclusion, surveillance, trapping, community participation, and carefully targeted use of rodenticides when necessary [5] [34] [37] [38]. This approach is generally more sustainable than dependence on chemical control alone and reduces the risks of accidental poisoning, environmental contamination, secondary poisoning of wildlife, and rodenticide resistance [39]-[41]. The detection of anticoagulant resistance mutations in rodents elsewhere in the region further demonstrates the importance of responsible rodenticide use [41]-[43].

Since October 2023, Israel's ongoing war of genocide and ethnic cleansing (2023-2026) has caused unprecedented humanitarian and environmental destruction throughout the Gaza Strip. Residential neighborhoods, agricultural lands, markets, food warehouses, hospitals, water wells, sewage networks, roads, and municipal waste-management systems have been extensively damaged or destroyed [3] [26] [44]. The displacement of the overwhelming majority of the population into overcrowded camps, tents, schools, damaged buildings, and improvised shelters has radically altered patterns of human habitation and sanitation. Massive quantities of household refuse, food residues, wastewater, demolition debris, and abandoned materials have accumulated near populated areas, while routine collection and safe disposal have been severely disrupted [44]-[47].

These war-generated conditions provide rodents with abundant food, water, shelter, and breeding sites [3]. The enormous volume of war-generated rubble, estimated at more than 68 million tonnes, has created a highly favorable environment for the shelter, reproduction, population growth, and proliferation of commensal rodents [3] (Figure 3). Demolition debris offers numerous protected nesting cavities, while its porous and structurally complex nature reduces rodents' exposure to natural predators, including mammalian carnivores, birds of prey, and reptiles, thereby further facilitating their increasing spread. Damaged sewage systems provide water and movement corridors, accumulated refuse supplies abundant food, and abandoned buildings create relatively undisturbed harborages. Open food-distribution points, community kitchens, informal markets, and inadequately protected household food supplies may further concentrate rodent activity near displaced populations. At the same time, many families live in tents or damaged structures that cannot be adequately sealed. Food and water are often stored in makeshift containers, while waste may accumulate close to living and cooking areas. Such conditions facilitate the contamination of food, utensils, bedding, and water supplies with rodent urine and feces.

Figure 3: More than 68 million tonnes of war-generated rubble have created ideal shelter and breeding habitats for commensal rodents, promoting their rapid proliferation

Field-based evidence has documented widespread infestations of mice and medically important arthropods in Gaza Strip displacement camps, where overcrowding, poor sanitation, accumulated waste, inadequate food storage, and deteriorating environmental conditions have increased the risks of pest-associated and infectious diseases [26] [48]. Recent assessments of vertebrate pest outbreaks have similarly identified commensal rodents as important components of the broader public-health, environmental, and humanitarian crisis affecting displaced communities in the Gaza Strip [3]. The problem is further intensified by the collapse of water, sanitation, hygiene, healthcare, and disease-surveillance systems, which has reduced the capacity to prevent, diagnose, and manage infectious diseases [31] [45] [49].

At the same time, the operational capacity to control rodents has been severely constrained by shortages of fuel, vehicles, rodenticides, traps, bait stations, protective equipment, and trained personnel. Damaged roads and continuing military operations restrict access to affected areas, while repeated population displacement makes sustained monitoring difficult [3]. Unregulated use of toxic materials can also endanger children, domestic animals, wildlife, and the wider environment. These constraints underline the need for interventions that are safe, inexpensive, locally available, and adaptable to rapidly changing humanitarian conditions.

Despite extensive international literature on commensal rodents and IPM, relatively little attention has been given to practical rodent management during prolonged wars. Most established recommendations assume functioning municipal services, stable access to infested sites, reliable supply chains, trained personnel, and continuous monitoring. These assumptions do not reflect conditions in the Gaza Strip, where infrastructure collapse, mass displacement, resource scarcity, environmental destruction, and ongoing military operations occur simultaneously [3]. Although recent studies have documented vertebrate pest outbreaks, mice and arthropod infestations, WASH deterioration, and infectious-disease risks in Gaza, a comprehensive assessment focused specifically on feasible control measures for commensal rodents under current conditions remains lacking [3] [26] [48]. Accordingly, the present study examines the principal measures available for controlling the Norway Rat (*Rattus norvegicus* Berkenhout, 1769), the Black Rat (*Rattus rattus* Linnaeus, 1758), and the House Mouse (*Mus musculus* Linnaeus, 1758) as commensal rodents in the Gaza Strip during Israel's ongoing war of genocide and ethnic cleansing (2023–2026), with particular emphasis on displacement camps and war-affected communities. It evaluates the applicability of environmental sanitation, habitat modification, structural exclusion, mechanical trapping, biological regulation, selective chemical control, surveillance, public education, and community participation under conditions of severe material and operational constraint. By identifying practical, affordable, and evidence-based interventions adapted to the humanitarian reality of the Gaza Strip, the study seeks to reduce rodent infestations, protect food and water supplies, minimize rodent-associated health risks, improve environmental sanitation, and strengthen community resilience during the continuing emergency.

2. METHODOLOGY

Study Area

The Gaza Strip is a narrow coastal territory in southwestern Palestine covering approximately 365 km^2 (Figure 4) and comprising five governorates: North Gaza, Gaza, Deir Al-Balah, Khan Younis, and Rafah. Before October 2023, it supported more than 2.4 million inhabitants under conditions of high population density, economic restrictions, and inadequate infrastructure. During the Israel's Ongoing War of Genocide and Ethnic Cleansing (2023–2026), widespread destruction, repeated displacement, economic collapse, and disruption of water, sewage, and waste-management services created favorable conditions for commensal rodents [3] [44] [48].

Figure 4: Geographic location of the Gaza Strip within Palestine along the southeastern Mediterranean coast

Study Methods

This descriptive study combined field observations, stakeholder interviews, and a review of relevant literature. Field visits were conducted in accessible areas of the Gaza Strip, including displacement camps, residential neighborhoods, markets, food stores, farms, waste-accumulation sites, and damaged buildings (Figure 5). Signs of rodent infestation, such as sightings, droppings, burrows, gnaw marks, contaminated food, and damaged containers, were documented whenever encountered. Local markets and shops were also visited to identify available traps, rodenticides, bait materials, and other control products. Informal interviews were conducted with municipal and environmental-health personnel, pest-control workers, traders, farmers, food vendors, displaced residents, and other relevant stakeholders to investigate infestation patterns, commonly used control practices, material availability, costs, effectiveness, and implementation constraints.

Figure 5: The author conducted field visits and stakeholder interviews in accessible areas of the Gaza Strip, including displacement camps in the Al-Mawasi coastal ecosystem and other residential neighborhoods, to assess commensal rodent infestations and document the control measures adopted by displaced Gazans

The collected information was supported by scientific literature on commensal rodents and Integrated Pest Management (IPM). Control measures were classified into sanitation, habitat modification, structural exclusion, trapping, biological regulation, chemical control, surveillance, and community participation. Their suitability was evaluated according to effectiveness, affordability, local availability, safety, and feasibility under wartime conditions.

3. RESULTS

Field visits to accessible areas of the Gaza Strip, observations in displacement camps, residential neighborhoods, markets, shops, food stores, farms, waste-accumulation sites, and damaged buildings, together with interviews with municipal personnel, traders, farmers, pest-control workers, food vendors, and displaced residents, revealed the use or availability of several methods for controlling commensal rodents. These methods were classified into cultural and environmental, physical and mechanical, chemical, biological, behavioral and educational, community and institutional, and surveillance-based control measures.

1. Cultural and Environmental Control

Cultural and environmental control represented the most widely applicable preventive approach. Common practices included cleaning living and cooking areas, removing spilled food and household waste, protecting drinking water, and storing food and animal feed in tightly closed containers (**Figure 6**). Residents and traders also attempted to elevate food packages above floor level and inspect stored commodities regularly for droppings, gnaw marks, and damaged packaging. Other practices included removing cardboard, fabrics, damaged furniture, wood piles, discarded containers, dense vegetation, and other materials that could provide rodents with nesting and hiding sites. Cleaning areas surrounding tents, houses, shops, community kitchens, poultry facilities, and livestock shelters was particularly important for reducing rodent access to food and shelter. The effectiveness of environmental control was severely constrained by accumulated refuse, damaged sewage systems, water shortages, overcrowding, demolition rubble, disrupted waste collection, and the limited availability of secure food-storage containers. Consequently, household sanitation alone was often insufficient where the surrounding environment continued to provide abundant food, water, and harborages.

Figure 6: Cultural and environmental control practices used by displaced residents—including sanitation and elevated, sealed food storage—to reduce commensal rodent infestations despite surrounding rubble and refuse

2. Physical and Mechanical Control

2.1. Structural Exclusion and Rodent-Proofing

Structural exclusion was identified as one of the safest and most sustainable preventive methods. It included tightly closing houses, tents, shops, kitchens, and food-storage areas; repairing damaged doors and windows; and sealing cracks, holes, and gaps in walls, floors, roofs, and foundations. Openings around water pipes, electrical cables, ventilation points, drains, and sewage connections were also considered important entry routes requiring closure. In houses and relatively stable buildings, cement, bricks, stones, sheet metal, durable wire mesh, and door sweeps could be used to prevent entry. Weak materials such as thin plastic, fabric, cardboard, or soft wood provided only temporary protection because rats and mice could gnaw through them. In tents and improvised shelters, residents repaired torn fabric, secured tent edges firmly to the ground, and reinforced lower sections using wire mesh, wood, metal sheets, stones, sandbags, or other available materials. Tent entrances were kept closed whenever possible, particularly during the night, while food-storage sections were separated from sleeping areas (Figure 7). Rodent burrows located near houses, tents, kitchens, food stores, and animal shelters were identified and closed using soil, stones, cement, or other suitable materials. Burrow closure was more effective when conducted after determining whether the burrow was active and after controlling the rodents occupying it.

Figure 7: Displaced people in Gaza Strip displacement camps repaired and reinforced tents, sealed entrances, and separated food-storage areas to prevent commensal rodent entry

2.2. Mechanical Trapping

Mechanical traps were among the main direct-control tools available to households and traders. They included snap traps, cage traps, multiple-capture traps, and locally manufactured trapping devices (Figure 8). Humane tunnel-type live traps provide an additional non-toxic option for capturing and monitoring House Mice (*Mus musculus* Linnaeus, 1758) (Figure 9). Typically made of durable plastic, these traps use a gravity-activated seesaw mechanism that closes the entrance when a mouse enters to reach the bait, allowing live capture with minimal injury. Their enclosed design also reduces direct contact and makes them suitable for field surveys, biological sampling, and integrated pest management. Bread, dates, cheese, meat, fish, grains, and other available foods were used as attractants.

Traps were generally positioned along walls, behind furniture, close to food stores, near burrow entrances, and in locations where droppings, tracks, gnaw marks, or direct sightings had been recorded. Their effectiveness depended on using sufficient numbers, selecting appropriate bait, placing traps correctly, and inspecting them regularly. Cage traps enabled the live capture of rodents but required safe handling and humane disposal. When appropriately sized and positioned, snap traps could kill rodents rapidly by striking the head, neck, or spinal column or by constricting the thorax. Traps contaminated with blood, urine, feces, or carcass material required careful cleaning and disinfection before reuse.

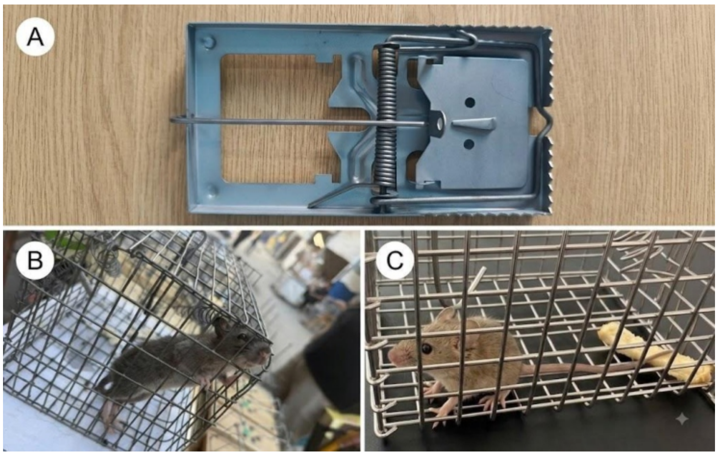

Figure 8: Mechanical traps commonly used for the direct control of commensal rodents (rats and mice) in the Gaza Strip: (A) Snap trap and (B, C) Cage traps

Figure 9: A humane tunnel-type live trap that uses a gravity-activated seesaw mechanism to capture House Mice (Mus musculus Linnaeus, 1758) alive without toxic baits or physical injury

2.3. Glue Boards and Adhesive Traps

Figure 10: Glue boards or sticky traps are generally more effective for capturing small House Mice (Mus musculus Linnaeus, 1758) than larger Rats (Rattus spp.) in the Gaza Strip

Glue boards were commonly available for capturing House Mice inside houses, tents, kitchens, shops, and food stores (Figure 10). They were inexpensive and easy to deploy but became less effective when covered by dust, sand, water, oil, or food residues. Their effectiveness against large rats was also limited. Adhesive traps could cause prolonged animal suffering and might unintentionally capture lizards, snakes, birds, or other non-target animals. They therefore required frequent inspection and careful placement away from children, domestic animals, and wildlife.

2.4. Improvised Traps

Shortages and high prices of commercial traps encouraged the use of locally manufactured devices, including buckets, deep containers, boxes, wire cages, falling-door traps such as the bucket flip-and-slide mouse trap (Figure 11), water-container traps, and other devices constructed from available household materials. Although their designs and effectiveness varied considerably, these improvised traps provided inexpensive alternatives when commercial products were unavailable. They were most effective when designed to prevent rodent escape and inspected frequently. Water-filled devices posed drowning hazards and therefore required careful placement to protect children and non-target animals.

Figure 11: The Bucket Flip-and-Slide Mouse Trap is an improvised device featuring a trapdoor that tilts or flips downward, primarily designed to capture mice [Source: https://www.backwoodshome.com/build-your-own-repeating-mouse-trap/]

2.5. Direct Physical and Manual Killing

Direct physical killing was occasionally practiced when rats or mice were encountered in enclosed rooms, tents, shops, food stores, or other confined spaces. Residents sometimes restricted rodent movement using brooms, sticks, boards, furniture, containers, or other objects and then killed the animals by striking or crushing them. Rodents were also captured beneath containers or killed after being confined in buckets, pits, rooms, or improvised traps. This method was inexpensive and provided an immediate response to visible rodents, especially when traps and rodenticides were unavailable. Nevertheless, it controlled only individual animals and did not affect hidden rodents, nests, or young. Chasing rodents could also increase the risk of bites, scratches, contact with urine and feces, and exposure to fleas, mites, or other ectoparasites. Rodents should not be handled with bare hands. Gloves, closed footwear, and appropriate tools are required during capture, killing, collection, and disposal. Carcasses should be placed in sealed bags or suitable containers, and contaminated surfaces should be cleaned and disinfected. Dry sweeping of rodent feces or nesting materials should be avoided because it may disperse contaminated dust.

2.6. Burrow Destruction and Flooding

Physical destruction, filling, or flooding of rodent burrows was occasionally used around houses, farms, markets, and waste sites (Figure 12). These practices could reduce shelter availability or force rodents from their burrows, allowing them to be trapped or killed. Burrow treatment was unsuitable near unstable buildings, sewage networks, electrical installations, or occupied shelters where flooding or soil disturbance could cause additional damage. Closing burrows without controlling the rodents could also force them to establish new burrows or enter nearby houses and tents.

Figure 12: AI-generated illustration of flooding rodent burrows, a physical control method occasionally used around houses, tents, farms, and markets in the Gaza Strip. Note the rats escaping from their burrows to avoid drowning

3. Chemical Control: Poison Baits and Rodenticides

Chemical control included commercially prepared rodenticides formulated as treated grains, pellets, pastes, powders, or wax blocks. These products were applied, when available, in houses, shops, markets, warehouses, farms, poultry facilities, sewage-affected areas, and displacement camps. Commercial formulations might contain anticoagulants or acute toxicants. During the early stages of the Israeli war on the Gaza Strip, rodenticides became extremely scarce. Meanwhile, commensal rodent populations increased substantially because of widespread destruction and the accumulation of more than 68 million tonnes of rubble, together with uncollected solid waste and refuse, damaged sewage systems, food residues, overcrowding, and other environmental factors that provided abundant food and shelter.

Figure 13: Chemical control of commensal rodents in the Gaza Strip primarily involves various imported rodenticides and poison baits, which are widely advertised on social media during the ongoing Israeli war. However, many Gazans report limited effectiveness, particularly in light of the exceptionally large populations of commensal rats and mice

More recently, advertisements for various rodenticides and poison baits have become increasingly common on social media (Figure 13). Nevertheless, many residents could not afford these products because of their high prices, while others complained of limited effectiveness against the exceptionally large and rapidly increasing rodent populations. Some residents described the rodents as "multiplying like hell," reflecting public frustration and the perceived inability to halt their exponential spread. Products available through markets and social-media sellers varied considerably in price, formulation, labeling, quality, and reported effectiveness.

In some cases, residents prepared poisoned food baits using pesticides or other toxic materials because registered products were scarce or unaffordable. Such practices increased the risks of incorrect dosing, food contamination, and accidental poisoning. Poison baits placed openly on plates, paper, floors, or near food and water were particularly hazardous. Safer application required secured, clearly marked bait stations that prevented access by children, domestic animals, birds, and other non-target organisms. Baits also required regular inspection to assess consumption, deterioration, and evidence of rodent activity. Chemical control alone could not provide sustainable population suppression while food, water, and shelter remained abundant.

Repeated or inappropriate application could also promote bait avoidance, accidental exposure, environmental contamination, secondary poisoning of predators, and rodenticide resistance.

4. Biological Control

Biological control involved the contribution of domestic and wild predators to rodent suppression. Domestic cats (*Felis catus* Linnaeus, 1758) were commonly kept or tolerated around houses, tents, farms, markets, shops, food-storage facilities, poultry units, and displacement camps (Figure 14). Their presence could deter or capture mice and young rats, although their effectiveness varied considerably. Native predators—including Barn Owls (*Tyto alba* Scopoli, 1769), Long-eared Owls (*Asio otus* Linnaeus, 1758), Common Kestrels (*Falco tinnunculus* Linnaeus, 1758), Long-legged Buzzards (*Buteo rufinus* Cretzschmar, 1829), Common Buzzards (*Buteo buteo* Linnaeus, 1758), Black-winged Kites (*Elanus caeruleus* Desfontaines, 1789), snakes such as the Syrian Black Snake, locally known as "*Arbeed*" (*Dolichophis jugularis* Linnaeus, 1758), and the Montpellier Snake, locally known as "*Af'a Al-Fi'ran*" (*Malpolon monspessulanus* Hermann, 1804), Egyptian Mongooses (*Herpestes ichneumon* Linnaeus, 1758), and Red Foxes (*Vulpes vulpes* Linnaeus, 1758)—may naturally contribute to regulating rodent populations (Figure 15). Protecting these predators and avoiding their unnecessary killing could support rodent management, particularly in agricultural and peri-urban environments. Nevertheless, biological control alone was insufficient to eliminate established rodent infestations in densely populated areas. Domestic cats could also be exposed to rodent-borne pathogens, ectoparasites, or secondary poisoning after consuming poisoned rodents. Biological control should therefore complement sanitation, rodent-proofing, trapping, and the safe use of rodenticides rather than replace these measures.

Figure 14: Domestic cats (Felis catus Linnaeus, 1758) are commonly kept or tolerated around houses, tents, and displacement camps in the Gaza Strip to control House Mice (Mus musculus Linnaeus, 1758) and potentially capture juvenile rats

Figure 15: Native predators that may contribute naturally to regulating commensal rodent populations in the Gaza Strip include: (A) Red Fox (Vulpes vulpes Linnaeus, 1758); (B) Egyptian Mongoose (Herpestes ichneumon Linnaeus, 1758); (C) Barn Owl (Tyto alba Scopoli, 1769); (D) Black-winged Kite (Elanus caeruleus Desfontaines, 1789); (E) Syrian Black Snake (Dolichophis jugularis Linnaeus, 1758); and (F) Montpellier Snake (Malpolon monspessulanus Hermann, 1804)

5. Behavioral and Educational Control

Behavioral control included daily practices undertaken by households, traders, farmers, and displaced residents to reduce rodent attraction and human exposure. These practices included closing food containers, cleaning spilled food, avoiding waste accumulation, inspecting stored commodities, keeping tent and house entrances closed, placing traps correctly, and preventing children from approaching traps or toxic baits. Public education was important for explaining how to recognize infestation signs, safely handle traps, protect food and water, dispose of carcasses, and report severely infested sites. Awareness activities were also needed to discourage bare-handed handling, indiscriminate poisoning, unsafe bait placement, and the use of fire, fuel, smoke, fumigants, or hazardous chemical mixtures. Clear instructions could be delivered by municipalities, environmental-health workers, humanitarian organizations, community volunteers, market administrations, health professionals, and local media. Simple illustrated guidance would be particularly useful for displaced families living under difficult conditions.

6. Community and Institutional Control

Municipal and institutional measures traditionally included waste collection, sewage and drainage maintenance, cleaning campaigns, treatment of markets and public facilities, distribution or application of rodenticides, and inspection of heavily infested locations.

Municipalities, environmental-health departments, market administrations, agricultural authorities, humanitarian organizations, and pest-control workers represented the main institutional stakeholders. During the Israeli war, these activities were severely restricted by damaged roads and infrastructure, repeated displacement, unsafe access, and shortages of fuel, vehicles, equipment, traps, rodenticides, protective materials, and trained personnel. Nevertheless, several institutional actors cooperated to import appreciable quantities of rodenticides to help curb the steadily increasing rodent populations associated with the massive accumulation of solid waste and war-generated rubble [50]. However, treatment of individual sites was often followed by reinfestation from neighboring waste accumulations, rubble, sewage, or abandoned buildings, limiting the effectiveness of isolated chemical interventions. Community participation therefore became increasingly important. Coordinated cleaning campaigns, shared waste-storage points, collective food protection, reporting systems, and community-based distribution of traps and secure bait stations could improve control when municipal capacity was limited.

7. Surveillance and Monitoring

Surveillance depended on recognizing and recording direct rodent sightings and indirect evidence such as droppings, footprints, gnaw marks, grease marks, burrows, nests, damaged packages, unusual nighttime noises, and trap or bait activity. Markets, community kitchens, fooddistribution points, warehouses, hospitals, schools, sewage systems, waste sites, and densely populated camps represented priority locations for monitoring. Monitoring should document the location, date, probable rodent species, observed signs, estimated infestation level, control method used, trap success, bait consumption, and evidence of reinfestation. Repeated inspection was necessary because the absence of visible rodents did not necessarily indicate successful control. Community reporting and simple surveillance records could help municipalities and humanitarian organizations identify infestation hotspots and direct limited control materials toward the most affected locations.

8. Integrated Pest Management

The findings indicated that no single method could provide effective and sustainable rodent control under the prevailing wartime conditions. Integrated Pest Management represented the most appropriate approach because it combined cultural, environmental, physical, mechanical, biological, chemical, educational, institutional, and surveillance measures. The first line of intervention should include sanitation, food and water protection, removal of harborages, structural repair, and rodent-proofing of tents and buildings. The second line should include surveillance, mechanical trapping, and direct treatment of identified infestation sites. Chemical control should be reserved for persistent or severe infestations and conducted with secure bait stations and appropriate supervision. Fumigation should be limited to exceptional situations managed by qualified and officially authorized personnel. Community education, stakeholder coordination, repeated monitoring, and evaluation should accompany all interventions. Such integration reduces dependence on rodenticides, limits risks to people and non-target animals, and improves the sustainability of rodent control in displacement camps and other war-affected communities of the Gaza Strip.

4. DISCUSSION

The findings show that commensal-rodent control in the Gaza Strip during Israel's ongoing war of genocide and ethnic cleansing (2023–2026) is not simply a matter of choosing a trap or poison. It is mainly an environmental and public-health problem caused by rubble, accumulated waste, damaged sewage and drainage systems, mass displacement, unsafe food storage, and weakened municipal services. Recent studies from the Gaza Strip have reported major damage to environmental and WASH infrastructure, worsening public-health conditions, and increased infestations of mice and other vertebrate pests in displacement camps [3] [44] [47] [48]. These conditions provide rodents with food, water, and shelter and help explain why household control often produces only temporary results. Rodent populations can recover through continued breeding or movement from nearby rubble, waste sites, sewers, markets, and abandoned buildings [6]. Therefore, repeated infestation after local treatment does not always mean that the trap or poison has failed. Environmental sanitation and habitat management should form the basis of control. Removing food remains and nesting materials, protecting water sources, storing food in raised and sealed containers, and improving waste storage can make homes, tents, shops, and food facilities less suitable for rodents. Rodent-management studies consistently recommend combining sanitation and habitat modification with other measures rather than relying on poisons alone [51]. Household-based evidence from Lagos, Nigeria, similarly linked high rat infestation with poor sanitation practices and limited pest-control measures, while emphasizing food protection, improved household hygiene, and trapping as important components of control [52]. In the Gaza Strip, however, families may lack strong storage containers and sufficient water for cleaning, while municipal waste collection may be irregular or completely absent [44] [47]. Responsibility for control cannot therefore be placed on displaced Gazan families alone. Household sanitation must be supported by collective waste removal, drainage repair, rubble management, and protection of food-storage and distribution sites. Evidence from other resource-limited settings also indicates that coordinated habitat management is more reliable than isolated action [37] [53]. Structural exclusion is an important non-toxic measure because it reduces contact between rodents and people even when rodents remain common outdoors. Cement, metal sheets, strong wire mesh, door sweeps, and durable repairs may offer long-term protection in stable buildings. By contrast, fabric, cardboard, and soft wood are easily damaged or gnawed. Complete rodentproofing is often impossible in damaged houses and tents. In displacement camps, reinforcing tent edges, closing entrances when possible, and separating stored food from sleeping areas should therefore be viewed as practical ways to reduce exposure. Exclusion measures should also reflect the species involved. Ground-level gaps, drains, sewers, and burrows are important for Norway Rats; roofs, ceilings, trees, cables, and other raised routes are more relevant to Black Rats; and the smaller House Mouse can enter through openings that exclude larger rats. Regional studies show that rodent communities and habitat use differ among locations [16] [54]-[56]. In North Sinai, Egypt, Farid et al. [57] similarly demonstrated that commensal rodent abundance and species composition varied with locality and season, with the Norway Rat being the dominant species, emphasizing the importance of considering local ecological conditions when planning rodent management.

Control should therefore be adapted to the suspected species and site rather than applied in the same way everywhere.

Mechanical trapping is a useful second line of control when rodenticides are unavailable, expensive, or unsafe. Snap traps can quickly remove individual rodents, while cage, multiplecapture, tunnel-type, and improvised traps can support both control and monitoring. Their success depends on using enough traps, placing them along rodent pathways, selecting suitable bait, checking them often, and maintaining them properly [5] [58]. Rats may avoid new objects at first, so pre-baiting and careful placement may improve capture. House Mice are usually more willing to investigate unfamiliar traps. Locally made devices are especially useful during shortages, but weak construction and water-filled designs may create safety and animal-welfare problems. Glue boards also have important limitations: dust and moisture reduce their effectiveness, and captured animals may suffer for long periods. Snap traps or well-designed live traps should therefore be preferred where possible, with clear instructions for frequent inspection, safe handling, carcass disposal, and disinfection. Captured rodents may also provide specimens for species identification and parasite or pathogen surveillance [14] [15].

Rodenticides remain useful for severe or persistent infestations, but importing or distributing poison is not a complete solution. Poison-based programs may fail when only part of an infested area is treated or when surrounding habitats allow rapid reinvasion. For example, sewer baiting does not always reduce rodent activity at the surface [39]. Differences in the reported quality and effectiveness of products in the Gaza Strip may result from poor placement, damaged products, competing foods, bait avoidance, incomplete coverage, reinvasion, or physiological resistance. Egyptian studies have found different responses to active ingredients, bait formulations, and carriers [59]-[61], while anticoagulant-resistance mutations have been detected in Lebanon [42]. This does not prove resistance in the Gaza Strip, but it supports future susceptibility testing and avoiding repeated, unsupervised use of the same active ingredient. Open poison is particularly dangerous in crowded displacement camps because children, domestic animals, birds, and native predators may be exposed. Chemical control should therefore use registered products with clear Arabic labels, tamper-resistant bait stations, records of bait use, carcass collection where possible, and professional supervision. These precautions can improve control while reducing the release of rodenticides into the environment [41] [43].

Natural predators can support rodent control but cannot replace sanitation, exclusion, and trapping. Domestic cats may catch House Mice and young rats, while owls, raptors, snakes, mongooses, and foxes may help reduce rodents in agricultural, coastal, and peri-urban habitats. Owls can also show considerable dietary and behavioral flexibility in human-modified and urban environments, allowing some species to exploit locally abundant prey, including commensal rats and House Mice [62]. Gaza Strip studies confirm the presence of several of these predators and terrestrial mammalian fauna are also well documented more broadly in Palestine [11] [63]-[69], and regional studies show that rodents are important prey for Barn Owls [70] [71]. More recently, Bontzorlos et al. [72] highlighted the Barn Owl (*Tyto alba* Scopoli, 1769) as a promising nature-based solution for rodent pest control across Mediterranean and other agroecosystems, emphasizing its strong dependence on small mammals, particularly rodents, and its potential to reduce reliance on chemical rodenticides.

Long-term experience with Barn Owl nest-box programs has also demonstrated their practical acceptance by farmers; Peleg et al. [73] reported that farmers who were more satisfied with Barn Owl-based biological control maintained more nest boxes and breeding owls and reported greater reductions in rodent damage. However, Barn Owls are generalist predators, and their use as biological-control agents may also affect nontarget small mammals, including rare or endangered rodent species occurring near agricultural or natural habitats. Therefore, programs designed to increase Barn Owl populations, particularly through artificial nest boxes, should consider local biodiversity and potential impacts on nontarget prey [74]. Protecting native predators is better than killing them indiscriminately, especially because habitat destruction and secondary rodenticide poisoning may reduce their numbers.

Many forms of wildlife are deliberately killed by displaced people out of fear or because of limited awareness of their ecological benefits, as they are often mistakenly perceived as harmful or dangerous [63]. Recent examples documented during 2026 include the killing of Red Foxes (*Vulpes vulpes* Linnaeus, 1758), Egyptian Mongooses (*Herpestes ichneumon* Linnaeus, 1758), various wild birds (Class Aves), and reptiles such as the Desert Monitor (*Varanus griseus* Daudin, 1803) and snakes, regardless of whether they are venomous or non-venomous. These include non-venomous species such as the Syrian Black Snake (*Dolichophis jugularis* Linnaeus, 1758), as well as venomous species such as the Palestine Viper (*Daboia palaestinae* Werner, 1938). Amphibians, including frogs such as the Levant Water Frog (*Pelophylax bedriagae* Camerano, 1882), may also be killed because of fear or misconceptions regarding their ecological roles [3]. Such indiscriminate killing may reduce populations of beneficial wildlife that naturally contributes to controlling rodents, insects, and other potential pests (Figure 16). However, large numbers of domestic or stray cats in crowded camps may create other animal-health, sanitation, and zoonotic risks. Predators also cannot overcome the unusually high supply of food and shelter created by rubble and waste. Biological control should therefore be treated as a supporting part of integrated pest management (IPM), not as an independent solution (Figure 17).

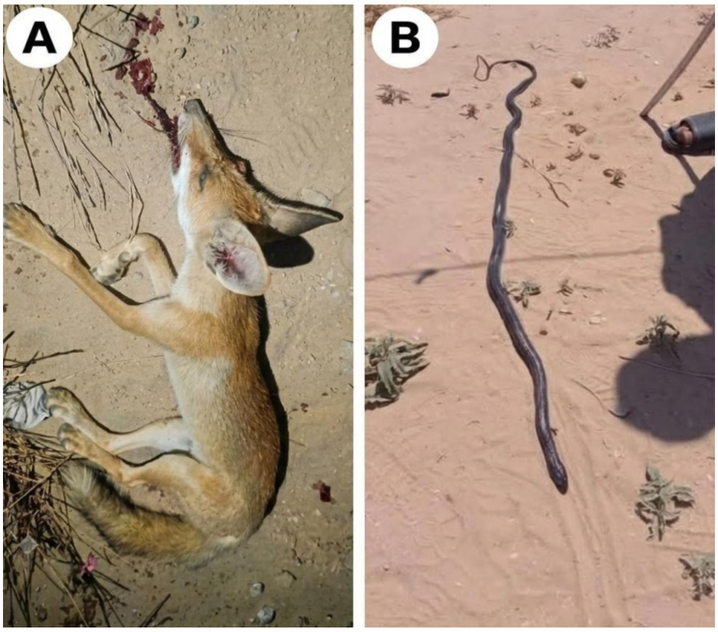

Figure 16: Protecting native predators, which are natural enemies of many pests, including commensal rodents, is preferable to indiscriminate killing: (A) Red Fox (Vulpes vulpes Linnaeus, 1758); and (B) Syrian Black Snake (Dolichophis jugularis Linnaeus, 1758), both killed in the Gaza Strip in 2026

Figure 17: Biological control serves as a complementary component of integrated pest management (IPM) rather than a stand-alone control measure [Source: https://www.birdguides.com/news/flying-mouse-traps-clean-up-fields/]

Public education is essential for the safe use of all control methods. Residents need simple guidance on recognizing rodent activity, placing traps along movement routes, protecting food and water, avoiding direct contact with rodents and their waste, wet-cleaning contaminated areas, and disposing of carcasses safely. This is important because rodents in the Gaza Strip have been found to carry gastrointestinal parasites and ectoparasites [14]. Similarly, Bahgat [75] documented diverse ectoparasites—including fleas, lice, mites, and ticks—on rodents captured inside and outside houses in Ismailia Governorate, Egypt, highlighting the potential importance of rodent ectoparasites in human-modified environments. More recent Egyptian surveys have likewise documented rodent-associated ectoparasites in animal farms in Minia Governorate [76] and in Toukh District, Qalyubia Governorate [77], further emphasizing the importance of monitoring ectoparasites alongside rodent populations. Studies elsewhere in the Middle East have reported helminths, ectoparasites, bacteria, and other zoonotic agents associated with rodents [23]-[25] [28] [78] [79]. Public awareness is equally important; a recent cross-sectional survey in North-Central Algeria assessed community knowledge of rodent-borne zoonoses, particularly leptospirosis, highlighting the need for greater public education about rodentassociated health risks [79]. The present study did not test pathogens and cannot conclude that infestation alone caused disease. Forced displacement, overcrowding, destruction of health infrastructure and deteriorating living conditions may further amplify infectious-disease risks among affected populations in the Gaza Strip [80]. Nevertheless, overcrowding, poor sanitation, disrupted healthcare, and other war-related deterioration in living conditions may substantially increase vulnerability to infectious diseases and the consequences of unsafe exposure [31] [45] [81] [82].

Risk communication is also needed to discourage unsafe practices such as killing rodents without protection, placing poison openly, or using fuel, fire, smoke, and improvised fumigants. Community participation may improve acceptance, reporting, and consistent application of control measures [29] [83].

Nature-conservation initiatives may also provide opportunities for environmental cooperation and community engagement; Mohr et al. [84], using the Barn Owl (*Tyto alba* Scopoli, 1769) as an example, emphasized the potential of shared conservation objectives to promote environmental bridge-building across communities. Short illustrated instructions and practical demonstrations may be more useful than long written materials for families living under severe stress and with limited access to formal information.

The findings also show that control must be coordinated across neighboring sites and institutions. Treating one tent, shop, market stall, or sewer opening while nearby shelters and food sources remain untreated is likely to be followed by rapid reinfestation. This agrees with research showing that rodents move among connected premises [6] [33]. Priority areas should include displacement camps, community kitchens, food-distribution points, markets, warehouses, hospitals, schools, waste accumulations, and damaged sewage networks. A practical program could combine hotspot mapping, synchronized cleaning, food and water protection, exclusion, trapping, and limited targeted baiting, followed by regular inspection.

Simple registers of sightings, droppings, burrows, trap captures, bait consumption, and repeated activity could help direct scarce staff and materials to the most affected sites. Population-based monitoring is also important because estimates of rodent abundance and changes in population dynamics can provide a useful basis for planning and evaluating control interventions, as demonstrated by Ahmed and Mohallal [85] in their study of rodents in the Western Desert of Egypt. Such monitoring is consistent with wider calls to strengthen WASH and diseasesurveillance capacity in the Gaza Strip [47] [86]. Because infestation levels and access conditions may change quickly, success should be measured by lasting reductions in signs of activity and human exposure, not only by the number of rodents trapped or poisoned during a single campaign.

Overall, the findings support a tiered integrated peat management (IPM) strategy suited to humanitarian conditions. Immediate, low-cost actions should protect food, water, children, and sleeping areas. Site-level measures should remove shelter and food sources, close entry points, and use appropriate traps. Institutional measures should restore waste collection and drainage, manage rubble, organize surveillance, and reserve rodenticides for secure and supervised treatment of persistent hotspots. This approach combines environmental, physical, behavioral, biological, and chemical methods and reduces dependence on repeated poisoning [5] [35] [41]. The value of combining complementary rodent-management methods rather than relying on a single intervention has also been demonstrated in agricultural systems, where integrated approaches were recommended for sustainable vole population management in alfalfa fields [87]. Long-term control in the Gaza Strip will still require safe access, fuel, transport, equipment, trained workers, and cooperation among municipalities, humanitarian agencies, market administrations, health services, pest-control workers, and affected communities [30] [88].

This study has several limitations. It was descriptive, access was restricted by insecurity and repeated displacement, and observations were limited to accessible sites. Infestation levels, trapping success, bait consumption, rodenticide ingredients, and treatment outcomes were not measured through a standard experimental design.

Species identification relied mainly on sightings and field signs rather than systematic trapping, detailed examination, or molecular confirmation. Stakeholder reports may also have been influenced by memory and personal perception. The study can therefore describe the available practices and their practical suitability, but it cannot compare or rank their effectiveness.

Future research should establish standard monitoring sites, identify captured rodents to species level, test susceptibility to commonly used rodenticides, evaluate locally made traps, and map infestations in relation to rubble, waste, sewage, food facilities, and displacement density. Surveillance of pathogens and ectoparasites is also needed because studies from the Gaza Strip, the wider region, and other war-affected settings have shown that commensal rodents and other small mammals may harbor medically important parasites, microorganisms, and zoonotic agents of potential public-health significance [14] [25] [28] [89]-[91[. In Iraq, rodents were reported to harbor zoonotic and nonzoonotic endoparasites [90], while House Mice (*Mus musculus* Linnaeus, 1758) in Erbil were found to carry both ectoparasites and endoparasites [92]. In Afghanistan, House Mice dominated small-mammal communities at military bases, and small mammals were identified as reservoirs for several zoonotic agents [93] [94]. However, the occurrence, prevalence, and transmission of such infectious agents under the current conditions of the Gaza Strip must be demonstrated directly and should not be assumed from findings reported elsewhere.

5. CONCLUSION

Commensal-rodent infestations in the Gaza Strip during Israel's ongoing war of genocide and ethnic cleansing (2023–2026) have been driven by rubble, waste accumulation, sewage disruption, food insecurity, overcrowding, damaged buildings, and weakened municipal services. Effective control requires a locally adapted integrated pest management (IPM) approach combining sanitation, structural exclusion, trapping, careful rodenticide use, predator protection, community participation, and surveillance. Coordinated action across households, displacement camps, markets, and institutions is essential to reduce reinfestation and protect people, food supplies, domestic animals, and wildlife. Restoring waste collection, drainage, rubble management, and surveillance remains fundamental. Further studies are needed to assess infestation levels, rodent species, control effectiveness, rodenticide resistance, and rodent-borne pathogens.

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