OPEN ACCESS Journal of Animal Health and Production

Research Article

Comprehensive Study on Scabies in Palestinian Sheep and Goats: Epidemiology, Pathology, Serology, Control, and Zoonotic Potential

Hazem Sawalha[1], Ibraheem Nueirat[2], Iman Qoraan[3*]

Faculty of Sciences, Arab American University, Jenin, P. O. Box 240, Jenin, Palestine.

Abstract | A study was conducted to determine the incidence and impact of scabies caused by *Sarcoptes scabiei* in sheep and goats, along with its transmission rate to humans. Microscopic examination, biological and serological methods were used to identify the causative agent, in conjunction with histopathological analyses to assess the effect of the disease on host cells and the consequent damage. The results showed that the disease affects animals of all ages, causing severe itching, exudative spots, blisters, alopecia, hypersensitivity, and severe skin inflammation throughout the body. Histopathological analysis showed that the parasite affects the epidermis and dermis skin layers, causing different changes. The disease was most prevalent during winter months, regardless of the animal's age. The highest incidence was recorded among newborns, reaching 48% in sheep and 37% in goats. Among weaned and adult animals, the highest infection rates were 41% and 35% in sheep, 33% and 29% in goats, respectively. In terms of mortality, the disease killed 12% and 10% of newborns, 7% and 6% of weaned goats and sheep, respectively. Adult animals had a comparatively low mortality rate at 4% for goats and 3% for sheep. Evaluations of the effectiveness of four drugs against this disease showed that Ivermectin achieved the highest efficacy (96%), followed by diazinon (90%), permethrin (84%), and finally sulfur cream (80%). The results indicated that ivermectin is the best treatment option for this disease, while the other drugs are considered alternatives with various degrees of efficacy. On the other hand, the study demonstrated the ability of this pathogen to spread to humans through direct contact with infected livestock or their habitats. The highest incidence of human infection was 5% among milkers, followed by 2% among farmers, while infection was very low among farm workers and veterinarians.

Keywords | *Sarcoptes scabiei*, Cattle, Livestock disease, Histopathology, Zoonosis, Palestinian environment

Received | May 03, 2025; **Accepted** | August 26, 2025; **Published** | December 17, 2025
***Correspondence** | Iman Qoraan, Faculty of Medicine, Arab American University, Jenin, P. O. Box 240, Jenin, Palestine; **Email:** iman.qoraan@aaup.edu
Citation | Sawalha H, Nueirat I, Qoraan I (2026). Comprehensive study on scabies in Palestinian sheep and goats: epidemiology, pathology, serology, control, and zoonotic potential. J. Anim. Health Prod. 14(1): 01-10.
DOI | https://dx.doi.org/10.17582/journal.jahp/2026/14.1.01.10
ISSN (Online) | 2308-2801

INTRODUCTION

Livestock in general are widespread in the Palestinian environment. The most important are sheep and goats, which have played a fundamental role throughout the ages as a source of livelihood and food. Their presence in the Palestinian environment may reach about 85% of the domestic animals. Nowadays, sheep farming constitutes an important economic resource in the Palestinian economy. In the West Bank, the count of sheep and goats reached 207, 214 and 505,833 heads, respectively (Palestinian Central Bureau of Statistics, 2021).

Livestock are raised in the Palestinian environment in two ways: crowded farming or semi-extensive farming. In crowded farming, animals are raised on dedicated farms, where they depend mainly on fodder. Sometimes animals are taken out to graze for specific periods. While on semi-extensive farms, the cattle rely primarily on grazing. In the evening, they return to the pen, which protects the cattle from the sun's heat, cold, and other environmental factors.

Scabies is a contagious parasitic disease affecting sheep and goats, caused by *Sarcoptes scabiei*. The pathogen penetrates the epidermis, particularly in the thin areas of the skin, including the fingers, the wrist, the forearm, the armpits, the hips, the genitals, around the nipple, the navel, the buttocks, and the inner thighs leading to severe itching, excoriation, lichenification, extensive skin ulcers, secondary alopecia on the face and ears, and secondary skin infections in severe cases (Murthy *et al*., 2012). The pathogen spreads rapidly during crowding, affecting sheep and goats of all ages. Its effect is most pronounced among the younger ages, where it can severely affect newborns, leading to emaciation and death. However, Larger, stronger cattle have better resistance, but can still carry the infection and transmit it to others (Yasine *et al*., 2015).

In the Palestinian territories, the livestock sector is a keystone of the economy, particularly in rural areas, representing approximately 46% of Palestinian agricultural income. Sheep, goats, cattle, poultry, beekeeping, and fish farming are among the main cornerstones of this sector. The number of sheep and goats in the West Bank on October 1, 2021, was 713,330 and 231,327, respectively (Palestinian Central Bureau of Statistics, 2021). The symptoms of scabies, including severe itching accompanied by skin ulcers, deformities across most areas of the body, and poor growth of young sheep and goats, are spreading in Palestine. In addition, the disease is responsible for a substantial decline in production and significant mortality in animals, notably in newborns. Furthermore, the disease led to a considerable increase in production costs, causing huge losses for farmers, forcing some of them to switch to other activities less significant when compared to raising livestock (Coradduzza *et al*., 2024).

This study focuses on the current situation of livestock farms in Jenin Governorate, addressing the challenges posed by the spread of scabies and its impact on livestock. The core of this research is to investigate animal husbandry conditions, providing insights into developing interventions to mitigate the effects of this disease and giving advice and guidance to control disease transmission. Jenin Governorate was chosen because it is considered the Palestinian food basket and grazing land, especially in the north, due to its fertility and abundant water resources. The governorate's climate is also suitable for animal husbandry, making it an ideal location for conducting this research (Palestinian Central Bureau of Statistics, 2021). Furthermore, the study examines the possibility of disease transmission to humans, to determine the transmission rate, since some people in direct contact with the livestock have been shown to exhibit symptoms similar to scabies.

MATERIALS AND METHODS

Study site

The study was conducted in Meithalun (32°20′57″N 35°16′24″E), a town located in the Jenin Governorate of Palestine, in the northern West Bank, 26 kilometers south of Jenin city. The town is characterized by an abundance of sheep and goat farms, some of which were randomly selected for the study (Palestinian Central Bureau of Statistics, 2018).

Disease diagnosis and sample collection

Medium-sized assaf sheep (*Ovis aries*) and shami goat (*Capra hircus*) farms were randomly selected to represent the animal husbandry situation in the study area. The symptoms of a hairless patch on the nose, ears, limbs, and lower abdomen, severe itching, loss of appetite, wasting, and decreased milk production, were used to characterize the disease tentatively. Using sterile scalpels and tweezers, scrapings from the hairless patches of the nose, ear, and lower abdomen were collected carefully. The samples were placed in Falcon tubes with formalin to preserve the tissues and transported to the laboratory for further examination. For histopathological analysis, samples were taken from the anterior part of the nose of diseased and healthy adult sheep.

Microscopic examination

Samples of the collected crusts were prepared and examined under a microscope to identify the pathogen (Taylor *et al*., 2016). The Leica ATC 2000 Microscope was used in the Microbiology Laboratory/Faculty of Science/Arab American University of Palestine (AAUP).

Serological detection

Indirect enzyme-linked immunosorbent assay (I-ELISA) test was performed in the Microbiology Laboratory/Faculty of Science/AAUP according to Rodríguez-Cadenas *et al*. (2010), with some modifications described below. To prepare the crude saline extract antigen, parasites were collected from an infected sheep, killed by freezing, and washed with phosphate-buffered saline (PBS) to remove impurities. The parasites were placed in a test tube and mechanically ground by shaking them with glass beads for 30 minutes on a shaker. The resulting protein was then suspended in PBS and centrifuged at 2000 g for 10 minutes. The supernatant was collected as the final protein-containing extract and used as the antigen in the assay. The sera were obtained from animals experimentally infected with scabies and diluted to 1 in 200. Samples were tested in triplicate, and plates were read at 450 nm using an ELISA-Reader (Burgess *et al*., 2012; Nunn *et al*., 2011). ELISA test materials were provided by Dr. Kameel Sawalha/Aston University/UK.

Histopathological analysis

All histopathological analyses were performed in the Histopathology laboratory/Faculty of Allied Health Sciences/AAUP. The method of Kinley *et al.* (2013) was adopted with the modifications noted below.

Tissue processing

Fixation, grossing, dehydration, clearing, infiltration, embedding, sectioning, staining, and mounting were performed sequentially for tissue preparation using an automated tissue processor (Leica TP 1020 Atomic Tissue Processor).

Samples were fixed with 10% formalin, then immersed sequentially in 75% and 95% ethanol to remove water and achieve dehydration. The tissues were immersed in absolute xylene for one hour to clean and remove alcohol and fat residues. To fill the empty spaces after fat removal, liquid paraffin was used for embedding using a TBS88 paraffin embedding system thermal unit. The tissues were cut into 5 nm thick slices using an automated microtome, then immersed in a water bath for 20 seconds.

Tissue staining

Both hematoxylin and eosin were used to stain the tissues. Thus, tissues were successively immersed in xylene (3 min), absolute alcohol (3 min), 95% alcohol (3 min), tap water (1 min), hematoxylin stain (5 min), tap water (1 min), 0.1 M hydrochloric acid (1 min), tap water (1 min), eosin (1 min), 95% alcohol (1 min) and xylene (3 min).

Disease incidence

The incidence of the disease was studied through monthly visits to sheep and goat pens and random sample collection over a year. A total of 250 blood samples were collected randomly from animals of various ages. The samples were transported to the Microbiology Laboratory for ELISA testing, which was chosen for its sensitivity and specificity in detecting the disease (Sawalha *et al*., 2024). In addition, visual examination of animals with scabies symptoms was also performed to confirm the findings.

Mortality rate and disease control

The study approach was implemented in two ways: the initial method included conducting personal interviews with sheep and goat farmers to obtain the necessary information related to the study, while the second involved performing extensive visits to sheep and goat farms and directly observing the effectiveness of different control strategies. The mortality rate was calculated as a percentage of the total herd. The ELISA test is also used to screen recently dead animals for the presence of antibodies against crude salt extract antigens (Sawalha *et al*., 2024).

Disease spread on humans

Regular visits to the farms were made to monitor for any signs of human scabies in all people who come into contact with the animals, including farm workers, farmers, milkers, and veterinarians. Samples were taken with a sterile scalpel from the site of infection by applying a small amount of mineral oil to the skin and then gently scraping from the active lesions and the margins. The sample was collected on a glass slide and microscopically examined for the parasite (Grable, 2018). In addition, blood samples were tested using ELISA as mentioned above.

Statistical analysis

Statistical analysis was performed using the two-sample test of proportions (TSTP) to compare treatment items. The results were analyzed using a statistical significance level of α = 0.05. Calculations were performed according to the following equations (Lind *et al*., 2005).

$$z = \frac{(\hat{P}_1 - \hat{P}_2)}{\sqrt{\hat{P}(1-\hat{P})(\frac{1}{n_1}+\frac{1}{n_2})}}$$

Two–Proportion Z-test, pooled for H0: P1= P2

$$\hat{P} = \frac{X_1 + X_2}{n_1 + n_2}$$

n= sample size, n_1= sample 1 size, n= sample 2 size, P_1= proportion 1, P_2= proportion 2

RESULTS

Disease diagnoses

The disease was defined based on the symptoms appearing on the nose, ears, limbs, and lower abdomen, shown in Figure 1. Infected sites showed a hairless patch with exudative and pruritic skin lesions on the top of the nose, ears, limbs, and lower abdomen. In addition, scaly patches and white dead skin that formed a layer over the skin, causing severe itching, were also present. A reduction in the animal's ability to eat, severe emaciation, and decreased milk production were noted.

Microscopic examination

Laboratory examination of the pathogen showed that it was an eyeless, burrowing, obligate ectoparasite mite with four pairs of legs (two pairs in front and two pairs in back). The mite was identified by its oval, ventrally flattened, and dorsally convex, turtle-like bodies and numerous skin spines. The dorsal surface of the body is covered with transverse lines and a central patch of triangular scales (Figure 2).

Figure 1: Clinical presentation of *S. scabiei* in sheep. Infected sheep with scabies exhibit spots, scales, and dead, white skin on the front of the nose and ears, along with hairless patches and exudative, pruritic skin lesions. A: Exudative skin lesions; B: Alopecia on the ear; C: Hairless patches with pruritus on the nose.

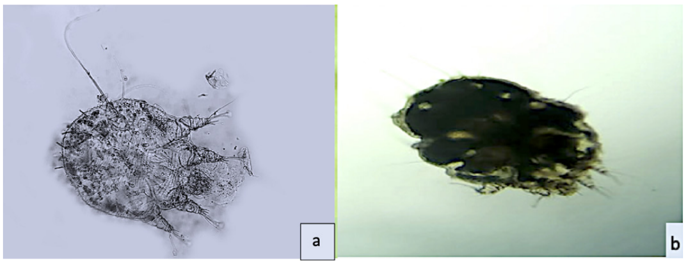

Figure 2: Microscopic image of *S. scabiei*. (a) shows a ventral view of the mite with a relatively small body size about 0.45 mm long, oval-shaped body with sclerotized legs and mouthparts (400x), (b) shows a dorsal view of the mite(100x).

Serological detection

The ELISA method was precise, accurate, and rapid in identifying the pathogen and detecting infected animals. Using Para-nitrophenyl phosphate, disodium salt, hexahydrate substrate gave a dark yellow soluble end product in the alkaline phosphatase-based ELISA assay, enabling a clear distinction between infected and uninfected samples (Figure 3). Furthermore, using an ELISA reader, the absorbance of the infected samples at 450 nm was greater than both the threshold points and the critical line absorbance of samples from healthy tissue. The critical line was calculated by doubling the average absorbance values of the uninfected samples (Figure 4).

Histopathological analysis in animals

Acute histopathological changes reveal the formation of thick scales due to the mite's attack on the surface of the keratinized layer. Severe degenerative and necrotic changes within the epidermal layers with marked keratinization were also observed. The crusts were associated with lakes of serum and infiltrated red blood cells, and inflammatory infiltrates extended into the dermis. Tunneling formed by the mite in the stratum corneum of the epidermis manifested in the upper layer as a cleft epidermis, acanthosis, and spongiosis with a dense dermal infiltrate of eosinophils. A diffuse infiltrate of perivascular lymphocytes and superficial histiocytes, accompanied by neutrophils and eosinophils, was evident in the dermis. There was squamous hyperplasia characterized by epidermal projections in the dermis that overlapped with dermal papillae (Murshed *et al*., 2021; Siddig and Hay, 2021) (Figure 5).

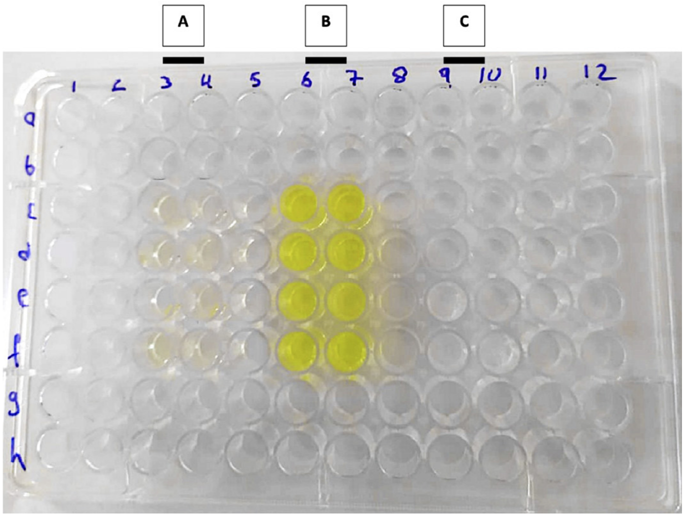

Figure 3: Indirect ELISA test results for antibodies against *S. scabiei* in animal samples. Positive results show a dark yellow reaction of the antiserum with the crude antigens prepared from infected animals. A: Buffer sample; B: Infected animal; C: Uninfected animal.

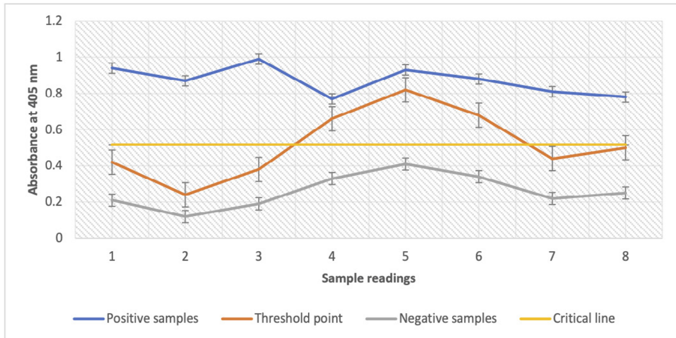

Figure 4: ELISA readings for positive and negative controls. All readings above the threshold point and critical line are positive; readings below these points are negative.

Disease incidence

The clinical picture consistent with *Sarcoptes scabiei* was higher in sheep when compared to goats at all ages. The high disease incidence was seen among newborn sheep and goats, peaking at 48% and 37%, respectively. Weaned sheep and goat were in the second order with infection rates reaching 41% and 35%, respectively. For the adult group, the incidence rate was relatively low, reaching 35% for sheep and 29% for goats (Figures 6 and 7).

The results also showed that the disease incidence increases steadily during two periods of the year: The first, from January to April, and the second, from September to December, showing the highest infection rate among sheep and goats of all age groups. However, there is a noticeable decline in the incidence of infection between May to August.

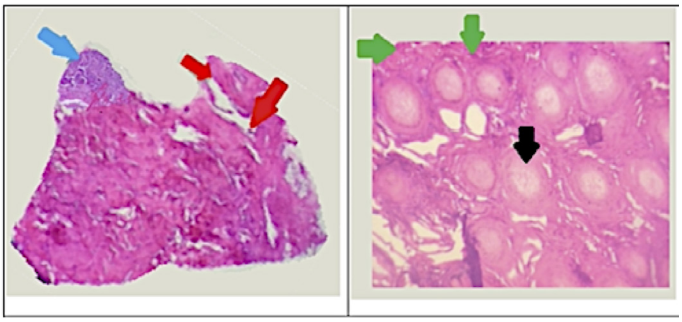

Figure 5: Histopathological characteristics of zoonotic Sarcoptic lesions.
A section of crusts collected from an infected sheep was stained with hematoxylin and eosin stains and examined under 40x magnification. The picture on the left represents infected samples, showing tunnels in the stratum of the epidermis (Red arrows), and parakeratotic hyperkeratosis characterized by increased stratum corneum thickness and excessive production of scales, followed by infiltration into the epidermis (Blue arrow). The picture on the right represents healthy tissue exhibiting a typical structure of stratified keratinized squamous epithelium. The outer layer (stratum corneum) appears firm and cohesive, indicating normal keratinization (Green arrows). Sweat and sebaceous glands appear normal in structure and distribution (Black arrows). There are no signs of epidermal hyperplasia, scaling, crusting, or inflammatory cell infiltration. The skin structure is intact, and there is no evidence of mite or tissue infestation (personal communication with Dr. Khaled Qabaha, AAUP/Palestine).

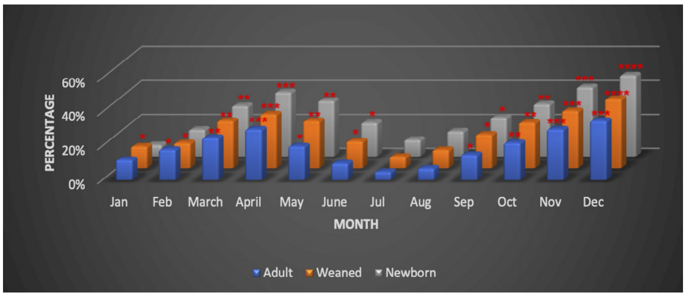

Figure 6: Disease incidence in adult, weaned, and newborn sheep from January to December. Statistical analysis shows the significant differences between the treatments as indicated by asterisks.

On the other hand, the results indicated that the disease led to the death of sheep and goats at varying rates and across all ages. The highest mortality rate reached 12% and 10% for newborn goats and sheep, respectively, which declined to the lowest of 2% for both animals in July and August. For weaned animals, the highest mortality rate was 7% and 6%, which declined to the lowest rate of 2% for goats and sheep. Mortality rates were the lowest among adult animals, which increased in January at 4% and 3% for goats and sheep, respectively, before declining to less than 1% in July (Figures 8 and 9).

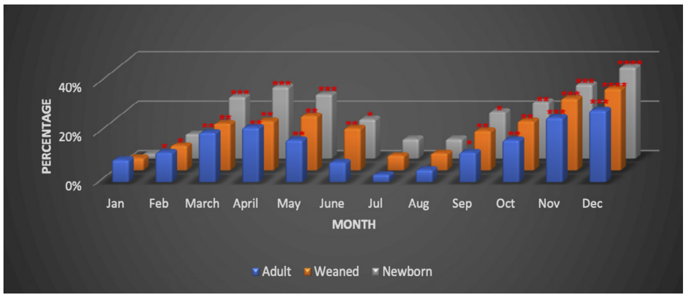

Figure 7: Disease incidence in adult, weaned, and newborn goat from January to December. Statistical analysis reveals significant differences between the treatments, as indicated by asterisks.

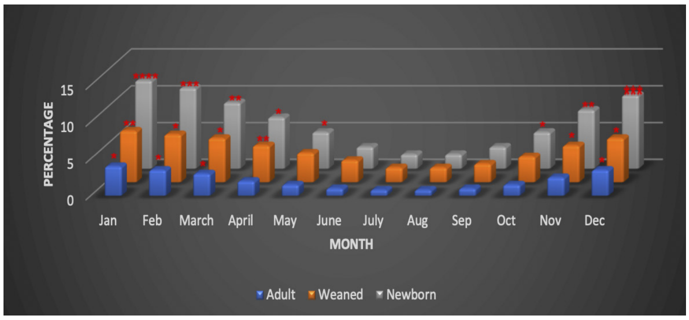

Figure 8: Mortality rate in adult, weaned, and newborn goat from January to December. Statistical analysis reveals significant differences between the treatments, as indicated by asterisks.

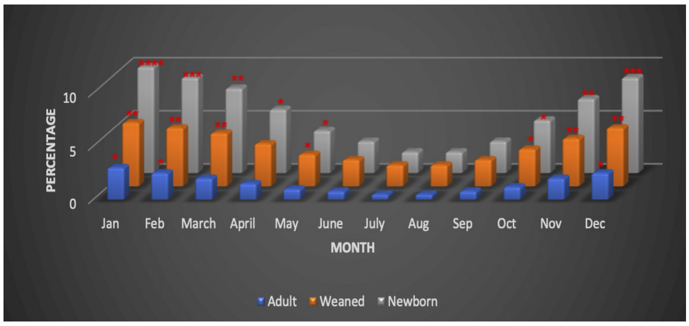

Figure 9: Mortality rate in adult, weaned, and newborn sheep from January to December. Statistical analysis shows the significant differences between the treatments as indicated by asterisks.

Disease control

The results showed the effectiveness of all drugs in eliminating the disease, with some variation in the effect. Ivermectin was the best drug with a 96% success rate. Diazinon achieved a 90% success rate, followed by permethrin and sulfur, with 84% and 80% efficacy rates, respectively. These high rates are due to the direct effect of these drugs on the parasite, eliminating it and preventing it from reproducing (Figure 10).

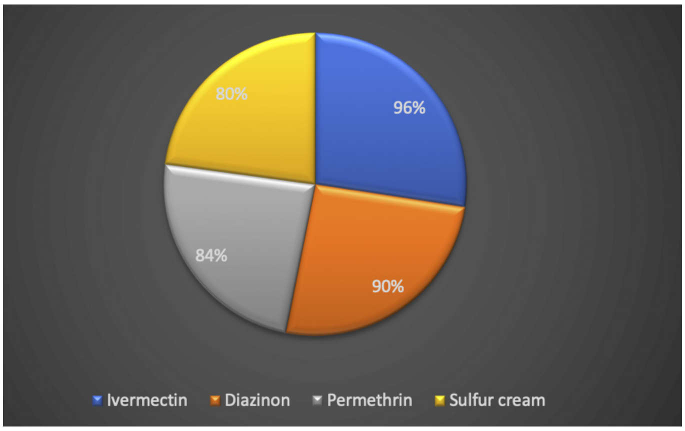

Figure 10: The effectiveness of different medications on scabies.
Statistical analysis shows the effectiveness of drugs used to treat animal scabies.

Disease spread on humans

This study confirmed that transmission of *S. scabiei* from sheep to humans occurs at limited rates, with infection detected in only 5% of milking workers and 2% of farmers, and very few cases recorded among veterinarians or other workers (Figure 11). Symptoms include severe itching (pruritis), especially at night, and the appearance of vesiculopapular rash, mostly in areas with contact with animals such as hands, palms, and legs (Figure 12).

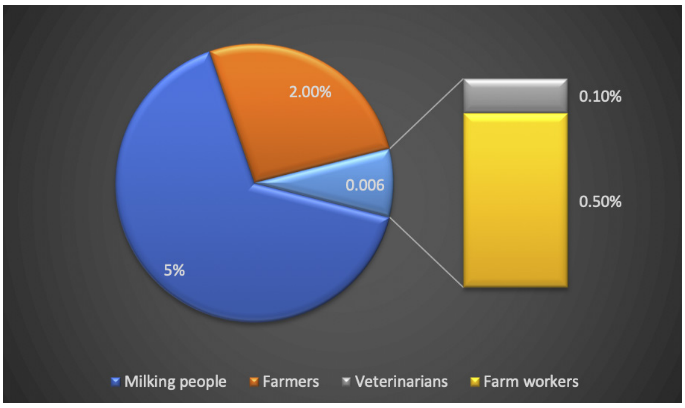

Figure 11: Spread of the disease on humans.
Distribution of infection among different animal handling workers.

Figure 12: Clinical presentation of *S. scabiei* in human.
The image shows vesiculopapular lesions and a skin rash on the hand and the palm of an infected patient with scabies.

This study highlights the importance of health awareness and training on occupational safety procedures, especially for workers who come into direct contact with animals. The findings also call for periodic awareness programs on diseases transmitted to humans from animals and ways to prevent them. Provoke regular screening of workers, especially those who exhibit suspicious skin symptoms. It also emphasizes the need for expanding future studies to include larger samples and diverse farms from different regions, considering animal husbandry conditions, and the level of healthcare in each area. Furthermore, these findings confirm the need for effective preventive interventions to reduce the transmission of parasites from animals to humans and to improve the working environment for workers in the livestock sector.

DISCUSSION

Zoonotic scabies continues to be a disease problem in both animals and humans. In our study, all infected sheep and goats presented with signs of skin lesions, resulting from intense scratching and itching of the affected areas. Skin damage is mostly seen around the ears and the nose, which also shows sites of scaly skin and alopecia. Crusty and thickened regions due to hyperkeratosis and acanthosis are seen. Also, there are areas with epidermal tunnel formation and infiltration of inflammatory cells that may lead to complications in body systems besides anemia (Murth *et al*., 2012; Falohun *et al*., 2015). Skin lesions appeared as a result of infestation by *S. scabiei* mite. The ectoparasite is identified by microscopic examination of scrap samples collected from infested animals. The ventral and dorsal views of the parasite are consistent with the study findings given by Matsuda *et al*. (2024) and Arlian (1989).

On the other hand, infection by the *S. scabiei* mite is confirmed by an indirect ELISA test, giving higher absorbance in the test samples from infected animals and humans when compared to non-infected samples. These findings reflect the effectiveness of indirect ELISA to detect antibodies against *Sarcoptes scabiei* antigens in both human and animal sera, demonstrating clear discriminative power. In addition, the zoonotic link between antigens in both infected humans and cattle is indicated by the cross-reactivity reflected in the reaction using serum samples from both infected organisms. The use of laboratory animals to generate mite-specific antibodies that have demonstrated cross-reactivity with human and animal serum enhances the applicability and usefulness of this method in comparative studies between host species. Furthermore, recently published studies have demonstrated the usefulness of this method in determining the extent of disease surveillance across different species (Villa *et al*., 2023; Lee *et al*., 2024).

Links Researchers

The lowest incidence of infection was recorded in adult animals compared to other age groups. This is attributed to the fact that adult sheep and goats (over one year old) typically spend extended periods on natural pasture, avoiding crowded, unsanitary pens that are rich in pathogens. Young animals, however, spend all their time indoors. The disease incidence varied according to age, with the infection spreading most frequently and sequentially among newborn sheep, weaned sheep, adult sheep, newborn goats, weaned goats, and adult goats. This finding is due to the weak immune systems of newborns or weaned goats. In addition, the high prevalence in newborns is attributed to their acquisition of the pathogen by direct contact from their mothers during breastfeeding. In this regard, other studies support our findings. Salifou *et al.* (2013) reported that *S. scabiei* was a devastating disease in small ruminants in Benin, West Africa, affecting goats and sheep, with prevalence rates of 39.6% and 4.2%, respectively. A study by Khalaf-Allah *et al.* (2020) in Menoufia Governorate showed that the prevalence rate of scabies in sheep was 24.5% and in goats, 23.33%. Additionally, Fisseha *et al.* (2021) reported that *S. scabiei* affected 23.7% of goats in the Mali region of Ethiopia. According to the study, the goats with poor health were more affected by mites (43.6%), compared to those with good health (17.3%).

In addition, the incidence of the disease varied across the year, peaking in April and December, for all age groups. This high incidence can be attributed to the fact that these periods are colder in Palestine, during which animals, especially newborns, tend to approach closer to each other, raising the likelihood of infection transmission and spread through direct contact (Buczek *et al.*, 2006). On the other hand, the decrease in incidence during the middle of the year is due to the relatively warm and hot weather representing spring and summer periods in the Palestinian environment. Animals go out to graze in open fields during spring and summer under direct sunlight, keeping them apart from each other and away from infected pens, reducing the possibility of infection. Moreover, exposing animals to direct sunlight weakens the pathogen and reduces its spread (Gubbins, 2005; Nixon *et al.*, 2021).

From another perspective, the results revealed that the disease is more prevalent among sheep than goats. These findings may be due to the nature and characteristics of each animal. Sheep have thick wool, which provides an ideal environment for the pathogen to grow, unlike goats, which have thin hair. Sheep also live in close flocks, allowing direct contact, while goats prefer independence and individual movement. Furthermore, sheep skin is more sensitive and moister, facilitating parasite penetration compared to dry goat skin, which hinders the pathogen's penetration. In a study conducted in Iraq, *S. scabiei* was confirmed among sheep, and the disease was considered endemic in sheep-rearing areas (Dawood *et al.*, 2013). In Pakistan, Biu and Wakawa (2004) confirmed that scabies prevalence was higher during the rainy season compared to the drier and hotter months. In addition, Purcherea and Boulakroune (1986) revealed an increase in mite infestation during the winter months (77%) compared to other seasons.

The mortality rate also revealed variations, giving the highest rates among newborns during the cold season when compared to the other age groups. Our results are consistent with other findings of other research published elsewhere. In a study conducted in a mountainous area of northern Greece, a herd of goats of a local breed (*Capra prisca*) was severely infected with sarcoptic mange. Over three months, starting at the end of winter, the farmer observed a rapid spread of the disease affecting almost all the goats in the herd, accompanied by symptoms of intense itching, ultimately leading to the death of 400 out of 700 goats (57%) (Giadinis *et al.*, 2011). It was also reported that the mortality rates among various wild ruminants, including Barbary sheep (*Ammotragus lervia*) in Israel, were significantly higher in animals less than 4 months old and over 8 years old, accounting for 65% of deaths across all age groups (Yeruham *et al.*, 1996).

Drugs commonly used to treat infection by *Sarcoptes scabiei* revealed variations in their effectiveness, with ivermectin being the most effective, especially in advanced cases. The drug binds to glutamate chloride channels, increasing the permeability of the parasitic cell membrane, thereby stabilizing and ultimately eliminating the parasites (Atif *et al.*, 2017). On the other hand, Permethrin works by disrupting sodium transport across nerve membranes in arthropods. This mechanism induces depolarization, leading to respiratory paralysis in treated arthropods, making permethrin an effective treatment for scabies (Simonart and Hoai, 2024). Topical treatments, such as diazinon and sulfur, are effective in mild cases or as supportive measures. Combining medications while considering preventative approaches, such as improving hygiene and reducing overcrowding, is essential for optimal results (Abdel-Raheem *et al.*, 2016).

Accordingly, it can be inferred that animal husbandry practices have played a crucial role in the spread of scabies among sheep and goats. Keeping livestock in enclosed pens with poor ventilation and sun exposure, lacking sanitation, and improper handling of animal manure contribute to the spread of such infection. These practices may be due to the lack of resources or expertise to ensure optimal animal husbandry, or a consequence of political conditions in Palestine that have imposed a reality reflected in the limited use of space for building pens and limited animal husbandry practices. As a result of these practices and according to the current study, the disease has spread widely among sheep and goats at varying rates, regardless of their age.

In addition, there are indirect causes that may exacerbate the disease. Unsanitary conditions inside barns, such as high humidity resulting from water leaks and the accumulation of manure, as well as inadequate veterinary care, facilitate the growth of bacteria and fungi and weaken the animal's immunity, making it more susceptible to infection. These factors are often accompanied by malnutrition, exacerbating the problem and increasing the mortality rate, causing significant economic losses for farmers. Therefore, following good hygiene practices, such as regular cleaning and disinfecting barns, adequate ventilation, providing balanced nutrition, and isolating diseased animals, is essential to control this disease.

Workers with infected animals also showed signs of infection with variable levels. Infection manifested as itching, skin rash, and papulovesicular lesions appeared shortly after contact with the infested animals. Itching exacerbates during the night. These findings support that sarcoptic mange can infect humans and are consistent with the findings from Moroni *et al*. (2022). The mite infects humans but is unable to complete its life cycle in the human body, causing temporary symptoms that disappear within a short period (Hardy *et al*., 2017; Koç and Açıkel, 2023). These findings indicate that the most important factor in parasite transmission is the intensity and duration of direct contact with the infected animal, explaining the higher infection rates among milking workers compared to farmers or veterinarians. Milking workers are exposed to daily and prolonged direct contact with the udder and skin, making them more susceptible to infection. The results of this study were consistent with another research conducted by Dawood *et al*. (2013), which revealed that this parasite is transmitted from sheep to farm workers at different rates depending on the degree of their contact with the animal, reaching a maximum of 22.2% among farmers.

On the other hand, the low infection rate among farmers may be attributed to the fact that their work does not require direct, constant contact with sheep, but rather involves farming, grazing, and general supervision. Regarding veterinarians, their adherence to personal protective measures, such as wearing gloves and protective coats, and regular disinfection, is likely an important factor in reducing the risk of infection. Furthermore, their awareness of the nature of contagious skin diseases and their modes of transmission may prompt them to exercise extreme caution when handling infected animals.

This study highlights the importance of health awareness and training on occupational safety procedures, especially for workers who come into direct contact with animals. The findings also call for periodic awareness programs on diseases transmitted to humans from animals and ways to prevent them. Provoke regular screening of workers, especially those who exhibit suspicious skin symptoms. It also emphasizes the need for expanding future studies to include larger samples and diverse farms from different regions, considering animal husbandry conditions, and the level of healthcare in each area. Furthermore, these findings confirm the need for effective preventive interventions to reduce the transmission of parasites from animals to humans and to improve the working environment for workers in the livestock sector.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the study confirmed the widespread prevalence of scabies in sheep and goat farms, affecting them regardless of age and causing significant production loss, with notable sensitivity in young animals. Signs included severe itching, ulcers, alopecia, hypersensitivity, emaciation, and production loss. The disease also caused mortality in all ages, particularly in newborn goats and sheep. Histopathological analysis revealed significant abnormalities in the infected epidermis and dermis layers. These findings are important for understanding the disease mechanism and formulating targeted therapies. Microscopic examination and ELISA have been proven highly effective in detecting the pathogen and indicating infection. High rates of disease incidence and death during the winter highlight the need for increased awareness and proactive measures during this time. Studies on the drugs used for treating the infection proved their effectiveness, with ivermectin showing superior effect.

Generally, this research provides a basic understanding of the impact of scabies, offering a strategic framework for disease management and control. It is essential to harness these findings to enhance livestock welfare, which will improve the farmers' economic stability and ensure the sustainability of this sector. Future studies should focus on improving treatment protocols and preventive strategies to reduce the incidence and severity of scabies in the area.

ACKNOWLEDGMENTS

We would like to thank Dr. Khaled Qabaha and Mr. Sakher Abu Zahra, Histopathology laboratory/AAUP, for their support. We also extend our sincere gratitude to Dr. Kameel Sawalha from Aston University, UK, for providing laboratory materials. We extend our thanks to Dr. Tareq Rabaya from the Directorate of Veterinary Services, Ministry of Agriculture, for his assistance in evaluating infected animals and collecting samples.

NOVELTY STATEMENT

This study investigated the severe symptoms of animal scabies caused by *S. scabiei* in skin, determined infection rates in newborn sheep and peak mortality in newborn goats, and identified critical strategic interventions during periods of infection peak.

AUTHOR'S CONTRIBUTION

HS and IQ: Conceptualization, methodology, writing, review, and editing.
IN: Methodology, conceptualization, investigation.
All authors reviewed the final version of the manuscript and approved it for publication in the Journal of Animal Production and Health.

Author's declaration

We confirm that all figures in the manuscript are our property.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

Data availability

The data supporting the findings of this study are available from the corresponding authors upon request.

Generative AI and AI-assisted technology statement

Artificial intelligence tools were used only for grammar correction and sentnece editing. The authors affirm that all scientific content,data analysis,interpretations,and conclusions are solely their own

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Abdel-Raheem T, Méabed E, Nasef G, Abdel-Wahed W (2016). Efficacy, acceptability and cost effectiveness of four therapeutic agents for treatment of scabies. J. Dermatol. Treat., 27(5): 1-7. https://doi.org/10.3109/09546634.2016.1151855

Arlin L (1989). Biology, host relations, and epidemiology of *Sarcoptes scabiei*. Ann. Rev. Entomol., 34(1): 139-161. https://doi.org/10.1146/annurev.ento.34.1.139

Atif M, Estrada-Mondragon A, Nguyen B, Lynch J, Keramidas A (2017). Effects of glutamate and ivermectin on single glutamate-gated chloride channels of the parasitic nematode *H. contortus*. PLoS Pathog., pp. 1-30. https://doi.org/10.1371/journal.ppat.1006663

Biu A, Wakawa M (2004). Chorioptes mange infestation in cattle in Borno State, Nigeria. Pakistan Vet. J., 24(3): 155-156.

Buczek A, Pabis B, Bartosik K, Stanislawek IM, Salata M, Pabis A (2006). Epidemiological study of scabies in different environmental conditions in central Poland. Ann. Epidemiol., 16(6): 423428. https://doi.org/10.1016/j.annepidem.2005.06.058

Burgess S, Innocent G, Nunn F, Frew D, Kenyon F, Nisbet A, Huntley J (2012). The use of a *Psoroptes ovis* serodiagnostic test for the analysis of a natural outbreak of sheep scab. Parasit. Vectors, 5: 7. http://www.parasitesandvectors.com/content/5/1/7. https://doi.org/10.1186/1756-3305-5-7

Coradduzza E, Scarpa F, Rocchigiani AM, Cacciotto C, Lostia G, Fiori MS, Rodriguez VY, De Pascali AM, Brandolini M, Azzena I, Locci C (2024). The global evolutionary history of Orf virus in sheep and goats revealed by whole genomes data. Viruses, 16(1): 158. https://doi.org/10.3390/v16010158

Dawood K, Al-Zamili A, Jassim G, Alwan M (2013). Parasitological study of scabies in sheep and humans. Med. J. Basrah Univ., 31(2): 89-95. https://doi.org/10.33762/mjbu.2013.90724

Falohun O, Ayinde S, ThankGod O, Olaiya O (2015). Sarcoptic mange infestation in West Africa Dwarf goat herd in Ibadan, South West Nigeria. World J. Agric. Res., 3(1): 24–27.

Fesseha H, Etana E, Mathewos M (2021). Mange Mites of Goats in Malle District of South Omo Zone, Southern Ethiopia. Vet. Med. Res. Rep., 12: 159–168. https://doi.org/10.2147/VMRR.S312360

Giadinis N, Farmaki R, Papaioannou N, Papadopoulos E, Karatzias H, Koutinas A (2011). Moxidectin efficacy in a goat herd with chronic and generalized sarcoptic mange. Vet. Med. Int., 2011: 476348. https://doi.org/10.4061/2011/476348

Grable S (2018). Diagnostic methods for the dermatology patient. Navta J., pp. 38-45.

Gubbins S (2005). A modelling framework to describe the spread of scrapie between sheep flocks in Great Britain. Prev. Vet. Med., 67: 143–155. https://doi.org/10.1016/j.prevetmed.2004.08.007

Hardy M, Engelman D, Steer A (2017). Scabies: A clinical update. Aust. Fam. Phys., 46: 264–268.

Khalafallah S, Metawea Y, El-Sayad E (2020). Epidemiology and control of mange in sheep and goat in Menofia Governorate. Benha Vet. Med. J., 39: 111-116. https://doi.org/10.21608/bvmj.2020.53293.1313

Kinley G, Schmitt C, Stephens-Devalle J (2013). A case of contagious ecthyma (Orf virus) in a nonmanipulated laboratory Dorset sheep (*Ovis aries*). Hindawi Publishing Corporation Case Rep. Vet. Med., 210854: 5. https://doi.org/10.1155/2013/210854

Koç H, Açıkel S (2023). Scabies: Clinical signs, the diagnosis and current treatment. Arch. Curr. Med. Res., 4(2): 62-69. https://doi.org/10.47482/acmr.1244299

Lee S, Kim G, Kim S, Jheong W, Jeong D (2024). Genetic and serological survey of sarcoptic mange (Sarcoptes scabiei) in wild boars (*Sus scrofa*) in South Korea. Animals, 14(23): 3490. https://doi.org/10.3390/ani14233490

Lind D, Marchal W, Wathen S (2005). Statistical techniques in business and economics, twelfth edition, McGraw-Hill Irwin, New York, pp. 262-263.

Matsuda H, Morishita M, Akita K (2024). Optical microscopic study on a novel morphological classification method of multiple diagnostic features of *Sarcoptes scabiei* var. *hominis*. Parasitology, 151(2): 180–188.

Moroni B, Rossi L, Bernigaud C, Guillot J (2022). Zoonotic episodes of scabies: A global overview. Pathogens, 11(2): 213. https://doi.org/10.3390/pathogens11020213

Murshed M, Al-Quraishy S, Mares M (2021). Survey of mange mite infesting sheep in Riyadh region, Saudi Arabia. Saudi J. Biol. Sci., pp. 1-6. https://doi.org/10.1016/j.sjbs.2021.09.019

Murthy G, Nagesha A, Gowda K (2012). Therapeutic management of sarcoptic mange in a sheep flock. J. Parasit. Dis., 37(2): 281–282. https://doi.org/10.1007/s12639-012-0157-5

Nixon E, Brooks-Pollock E, Wall R (2021). Sheep scab transmission: A spatially explicit dynamic metapopulation model. Vet. Res., 52: 54. https://doi.org/10.1186/s13567-021-00924-y

Nunn F, Burgess S, Innocent G, Nisbet A, Bates P, Huntley J (2011). Development of a serodiagnostic test for sheep scab using recombinant protein Psoo2. Mol. Cell Probes, 25: 212-218. https://doi.org/10.1016/j.mcp.2011.09.002

Palestinian Central Bureau of Statistics (2018). Population, Housing and Establishment Census 2017 Census Final Results in The West Bank–Summary (Population and Housing). Ramallah–Palestine. https://www.pcbs.gov.ps/Downloads/book2364-1.pdf.

Palestinian Central Bureau of Statistics (2021). Palestine in Figures 2020. Ramallah–Palestine; book2557.pdf (pcbs.gov.ps).

Purcherea A, Boulakroune A (1986). Sarcoptic mange in sheep, 1. Epidemiological, clinical and pathogenic aspects. 2. Therapy lucrai Stiintifice Institatul Agronomic "Nicolae Balcescu" Med. Vet., 29: 55-65.

Rodríguez-Cadenas F, Carbajal-González M, Fregeneda-Grandes J, Aller-Gancedo J, Rojo-Vázquez F (2010). Clinical evaluation and antibody responses in sheep after primary and secondary experimental challenges with the mange mite *Sarcoptes scabiei* var. ovis. Vet. Immunol. Immunopathol., 133(2-3): 109-116. https://doi.org/10.1016/j.vetimm.2009.07.004

Salifou S, Attindéhou S, Folakè C, Salifou A, Pangui L (2013). Prevalence and zoonotic aspects of small ruminant mange in the lateritic and waterlogged zones, southern Benin. Rev. Bras. Parasitol. Vet., Jaboticabal., 22(2): 243-247. https://doi.org/10.1590/S1984-29612013000200043

Sawalha H, Abu-Alrub M, Abu-Alrub B, Kmail A (2024). Epidemiology and diagnostic insights into Orf virus infection in Palestinian sheep and goats: A histopathological and serological study. J. Anim. Health Prod., 12(4): 601-609. https://doi.org/10.17582/journal.jahp/2024/12.s1.145.156

Siddig E, Hay R (2021). Laboratory-based diagnosis of scabies: A review of the current status. Trans. R. Soc. Trop. Med. Hyg., 116(1): 4–9. https://doi.org/10.1093/trstmh/trab049

Simonart T, Hoai X (2024). Escalating threat of drug-resistant human scabies: Current insights and future directions. J. Clin. Med., 13(18): 551. https://doi.org/10.3390/jcm13185511

Taylor, M. A., Coop, R. L., and Wall, R. L. (2016). Veterinary Parasitology (4th ed.). Wiley-Blackwell.

Villa L, Allievi C, Gazzonis A L, Ventura G, Gradassi M, Zanzani S, Manfredi M (2023). Serological prevalence of *Toxoplasma gondii*, *Neospora caninum*, and *Sarcoptes scabiei* var. *suis* in Wild Boars (*Sus scrofa*) Hunted in a Highly Anthropized Area in Italy. Animals, 13(11): 1730. https://doi.org/10.3390/ani13111730

Yasine A, Kumsa B, Hailu Y, Ayana D (2015). Mites of sheep and goats in Oromia Zone of Amhara Region, North Eastern Ethiopia: Species, prevalence and farmers awareness. BMC Vet. Res., 11: 122. https://doi.org/10.1186/s12917-015-0433-6

Yeruham I, Rosen S, Hadani A, Nyska A (1996). Sarcoptic mange in wild ruminants in zoological gardens in Israel. J. Wildl. Dis., 32(1): 57–61. https://doi.org/10.7589/0090-3558-32.1.57