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RESEARCH ARTICLE

SEROPREVALENCE AND HISTOPATHOLOGICAL LESIONS OF *MYCOPLASMA SYNOVIAE* IN BROILERS FROM DISTRICT KARAK, PAKISTAN

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ABSTRACT

Pakistan's poultry industry plays a crucial role in ensuring food security and generating income, yet infectious diseases, such as Newcastle Disease (ND), pose significant economic challenges. ND, caused by an RNA virus from the Paramyxoviridae family (A PMV-1), is diagnosed through clinical signs, post-mortem observations, and serological tests, such as the Hemagglutination Inhibition (HI) test, which is quick, economical, and reliable. This study focused on the sero-epidemiology of ND among broilers and layers in the Peshawar and Charsadda districts of Khyber Pakhtunkhwa. A total of 100 blood samples (50 from broilers and 50 from layers) were analyzed using the HI test at the Veterinary Research Institute in Peshawar. ND prevalence was 56% in broilers and 66% in layers ($p = 0.305$). No significant differences emerged between locations (Peshawar, 68%; Charsadda, 54%) or age groups, specifically those under 3 weeks (57.37%) and those over 3 weeks (42.62%) ($p > 0.05$). Clinical signs associated with greenish diarrhea were strongly linked to ND positivity (95.5%, $p = 0.000$, contingency coefficient = 0.667), whereas respiratory symptoms showed a moderate association (88.52%, $p = 0.000$, contingency coefficient = 0.623). Vaccination status was not significantly associated with ND infection ($p = 0.305$). Postmortem examinations revealed characteristic pinpoint hemorrhages in the proventriculus, trachea, and cecal tonsils. In summary, ND remains a significant threat to poultry in KPK. Greenish diarrhea is an important early indicator of disease. Continuous surveillance and further research are crucial for identifying circulating ND virus strains and enhancing control measures, ultimately mitigating economic losses.

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Introduction

Pakistan's agriculture sector accounts for 23.5% of the national GDP, with livestock being the leading subsector. Livestock contributes 63.6% of agricultural value addition and 14.97% to GDP (Finance Division, Government of Pakistan, 2025). The poultry industry is the fastest-growing part of livestock, producing over 1,000 billion broilers annually, meeting nearly 35% of the country's meat demand, and employing over 1.5 million people. However, despite its rapid expansion, the poultry sector remains highly susceptible to infectious diseases that lower productivity and profitability (FAO, 2023).

Mycoplasma synoviae (MS) is a key infectious agent in poultry, causing respiratory issues, synovitis, air sacculitis, and subclinical infections in chickens and turkeys (Feberwee et al., 2019). As a member of the Mollicutes class, MS lacks a cell wall, which makes it naturally resistant to β-lactam antibiotics and allows it to persist within host tissues (OIE, 2022). It is a small, pleomorphic bacterium with a reduced genome of about 0.8-1.0 Mb, indicating its dependence on the host for many metabolic functions. MS shows genetic variability, with different strains varying in virulence, tissue preference, and disease severity. Some strains mainly cause mild respiratory symptoms, while others lead to more serious issues, including systemic disease and synovitis (Feberwee et al., 2019; Khan et al., 2021). Additionally, antigenic and genetic variation among strains can affect immune response, diagnosis, and vaccine effectiveness.

MS spreads through various routes, including horizontal transmission via direct contact between birds, respiratory aerosols, contaminated equipment, litter, feed, and personnel, as well as

vertical transmission from infected breeder flocks to eggs and offspring (FAO, 2023; OIE, 2022). The pathogen spreads slowly within and between flocks, but its persistence in carrier birds and the prevalence of subclinical infections make eradication difficult. The infection's severity is often heightened by concurrent infections with viruses such as Newcastle disease virus (NDV), infectious bronchitis virus (IBV), avian influenza virus (AIV), Mycoplasma gallisepticum, and secondary bacterial infections, such as Escherichia coli. These contribute to chronic respiratory disease (CRD), immunosuppression, and higher mortality rates (Li et al., 2018; Hussain & Akhtar, 2020; Khan et al., 2021). The interactions among these factors make MS a significant cause of economic losses in poultry, due to poor weight gain, lower feed efficiency, increased medication costs, and condemnation at slaughter (Nawaz et al., 2022).

Controlling MS involves a combined approach that includes biosecurity, surveillance, antimicrobial treatments, and vaccination. Vaccination is increasingly common, with both inactivated and live attenuated vaccines used in commercial poultry. Live vaccines, such as temperature-sensitive strains, can lower clinical signs and transmission by triggering protective immunity. However, they can also make serological monitoring more difficult and, if biosecurity is inadequate, may even spread between flocks. Consequently, vaccine deployment must be backed by strict management and diagnostic practices to differentiate between vaccine-induced immunity and actual infections when necessary (OIE, 2022; Feberwee et al., 2019).

Globally, MS has shown varying prevalence rates. For instance, a 42.19% seropositivity rate was observed across 21 provinces in China (Zhang et al., 2019). In Pakistan, ELISA-based studies indicated high seroprevalence, including 42.6% in Rawalpindi broiler flocks (Ali et al., 2020). Diagnostic methods mainly include serological tests like slide plate agglutination (SPA), hemagglutination inhibition (HI), and ELISA, though these can be influenced by cross-reactivity and may not always indicate active infection. Molecular techniques such as PCR offer better sensitivity and specificity, but their routine application is limited by cost and laboratory requirements (Hussain & Akhtar, 2020; Nawaz et al., 2022).

District Karak is a key poultry-producing area in Khyber Pakhtunkhwa; however, the region faces challenges, including limited routine diagnostic screening, inconsistent farm biosecurity, and increased movement of birds and poultry products between farms and markets. These factors can promote the silent spread of MS, particularly because infections may stay subclinical until worsened by environmental stress or co-infections. Despite the economic significance of poultry production in Karak, there is limited documented evidence on the local seroprevalence of MS and the related pathological changes in broiler chickens, creating a knowledge gap that hampers effective disease control planning and targeted interventions. This study aimed to assess the seroprevalence of Mycoplasma synoviae in broiler chickens in District Karak using ELISA. It also examined the disease's pathogenesis through gross and histopathological analysis of tracheal and lung tissues from naturally infected birds. The results are intended to enhance surveillance, inform preventive measures such as vaccination strategies, and help decrease production losses related to MS in the region.

Materials and methods

Study Design and Study Area

A cross-sectional study was carried out to assess the seroprevalence of Mycoplasma synoviae (MS) in broiler chickens and to examine associated gross and histopathological lesions in District Karak, Khyber Pakhtunkhwa, Pakistan (Fig. 1). District Karak is a key poultry-producing area with prevalent commercial broiler farming.

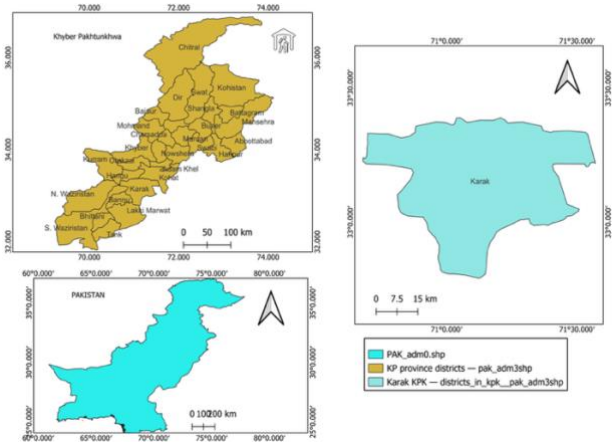


Figure 1: Map of the Sampling area created by QGIS 3.32.1.

Farm Selection and Sampling Strategy

The study included 13 commercial broiler farms selected through convenience sampling, based on accessibility and the willingness of farm owners or

managers to participate. Within each farm, birds were randomly chosen to minimize selection bias at the individual level. To estimate MS seroprevalence, 200 blood samples were collected from broiler chickens across the farms. The number of birds sampled per farm ranged from about 10 to 20, depending on flock size and sampling availability.

Blood Sample Collection

Blood samples were aseptically drawn from the brachial (wing) vein of broiler chickens. Before venipuncture, the site was disinfected with 70% ethanol. About 2 mL of blood was collected using a sterile syringe with a 24-gauge needle. Each sample was then placed into sterile gel tubes and labeled with details such as farm code, age group, and sampling date.

Collection of Epidemiological and Clinical Data

Epidemiological and clinical data were collected at samplings using a structured proforma. This included age, flock size, feed type, mortality rate, respiratory signs, cyanotic comb, ascites, white diarrhea, and anorexia.

Serum Harvesting and Storage

Blood samples were allowed to clot before being centrifuged at 3000 rpm for 6 minutes to separate the serum. The collected sera were transferred into sterile microtubes and taken to the Virology Section, CMB, at the Veterinary Research Institute (VRI), Peshawar. They were then stored at -20°C until further serological testing.

Detection of MS Antibodies by ELISA

Serum samples were analyzed for MS-specific antibodies with a commercial indirect ELISA kit (AFFIN TECH, LTD, USA), following the manufacturer's guidelines.

Reagents were briefly brought to room temperature and then mixed thoroughly prior to use. The 4x sample diluent was prepared by combining 1 part diluent with 3 parts distilled water, yielding 30 mL diluent mixed with 90 mL water per plate. The 20x wash buffer was diluted by mixing 1 part buffer with 19 parts deionized water, resulting in 25 mL buffer mixed with 475 mL water per plate. Serum samples, positive control, and negative control were vortexed and diluted at a ratio of 2 µL serum to 800 µL diluent. Next, 100 µL of the diluted samples and controls (in duplicate) were added to specific wells. The plates were then incubated at room temperature for 30 minutes, washed three times with 300 µL wash buffer per well, and dried by blotting. After washing, 100 µL of conjugate was added to each well and incubated for 30 minutes at room temperature. The plates were then washed three times, followed by the addition of 100 µL of substrate solution to each well, which was incubated for an additional 30 minutes. The reaction was halted by adding 100 µL of the stop solution to each well. Optical density (OD) was measured at 405 nm using an ELISA plate reader (Multiskan, Thermo Scientific, USA). Results (positive/negative) were interpreted according to the kit's cut-off criteria.

Postmortem Examination and Tissue Collection

For pathological assessment, 26 naturally dead broiler chickens were collected from the study farms and underwent necropsy. Gross examination focused primarily on the respiratory organs and other major visceral organs.

Tracheal and lung tissue samples were collected immediately after necropsy and fixed in 10% neutral buffered formalin for histopathological analysis. Tissue collection was carried out using sterile disposable blades and forceps to prevent cross-contamination.

Gross Lesion Recording and Scoring Criteria

Gross lesions were documented in the trachea, lungs, spleen, liver, and abdominal cavity. A qualitative scoring system, indicating the presence or absence of observable pathological changes, was used to evaluate the lesions. Results were presented as the frequency and percentage of affected birds.

Histopathology

For histopathological analysis, fixed tissues were processed according to standard histological procedures outlined by Bancroft and Gamble (2007). In brief, tissues were dehydrated through a graded alcohol series, cleared with xylene, embedded in paraffin wax, sectioned at 4-5 µm thickness, and stained with hematoxylin and eosin (H&E).

Prepared slides were examined under a light microscope at 20 and 40x magnification for microscopic lesions, including epithelial desquamation, ciliary loss, hemorrhage, congestion, fibrosis, atelectasis, emphysema, and infiltration of inflammatory cells.

Data Analysis

Data analysis was performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics summarize seroprevalence and lesion frequency. The chi-square (χ^2) test assessed the

association between MS seropositivity and categorical variables, with significance set at $p < 0.05$.

Results

Seroprevalence of *Mycoplasma synoviae* in broilers

A total of 200 serum samples were collected from 13 commercial broiler farms in District Karak and tested for Mycoplasma synoviae (MS) antibodies using an indirect ELISA. Of these, 41 birds (20.5%) tested seropositive, while 159 (79.5%) were seronegative. These results suggest that exposure to MS is relatively common among broiler flocks in the area (Fig. 2).

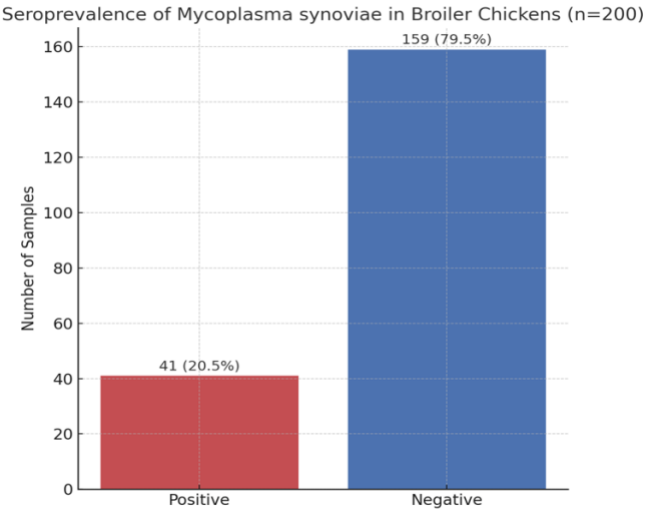


Fig. 2: Seroprevalence of MS in broilers in the district Karak by ELISA.

Association of Age and Flock Size with MS Seropositivity

The relationship between bird age and MS seropositivity was examined. Birds older than 3 weeks showed a higher seropositivity rate (35/150; 23%) compared to birds younger than 3 weeks (6/50; 12%). However, chi-square analysis revealed that this difference was not statistically significant ($p > 0.05$), indicating that age did not affect MS exposure in the studied population (Table 1). Similarly, flock size was evaluated as a potential risk factor. Farms with fewer than 2000 birds had 10/40 (25%) seropositive samples, while farms with 2000 or more birds showed a lower seropositivity rate (31/160; 19%). Despite this difference in numbers, flock size was also not significantly associated with MS seropositivity ($p > 0.05$) (Table 1).

Table 1: Seroprevalence of *Mycoplasma synoviae* in relation to the age of the birds and the flock size of the farm in the district of Karak.

Variables	Categories (n)	Positive (%)	P-value
Age	<3weeks (n=50)	12	0.086
	>3weeks (n=150)	23	
Flock size	< 2000	25	0.431
	> 2000	19	

Association of Mortality Rate and Feed Type with MS Seropositivity

Farms were categorized based on mortality rate into two groups: <15% and ≥15%. In farms with mortality <15%, MS antibodies were detected in 33/145 (22%) birds. In comparison, farms with mortality ≥15% showed seropositivity in 8/55 (18%) birds. Statistical testing revealed no significant association between mortality rate and MS seropositivity ($p = 0.199$; $p > 0.05$) (Table 2). The influence of feed type on MS exposure was also investigated. Birds from farms using Feed 1 showed a seropositivity rate of 14/85 (16%), whereas those receiving Feed 2 showed a higher seropositivity rate (24/115; 32%). Although the proportion appeared higher in Feed 2 farms, the association was not statistically significant ($p = 0.161$; $p > 0.05$) (Table 2).

Table 2: Relationship of mortality rate and feed type on the occurrence of *Mycoplasma synoviae* detected through ELISA

Variables	Categories	Positive (%)	P. value
Mortality	< 15% (n=145)	22	0.199
	> 15% (n=55)	14	
Feed	Feed 1 (n=85)	16	0.161
	Feed 2 (n=1150	32	

Association of Respiratory Signs and Cyanotic Comb with MS Seropositivity

Clinical signs were evaluated to determine whether visible illness patterns were linked to MS exposure. Birds showing respiratory signs had a seropositivity rate of 37/170 (21%), while birds without respiratory signs showed a lower seropositivity rate (4/30; 13%). The relationship between respiratory signs and MS seropositivity was weak, with a contingency coefficient of 0.292, indicating only a minor association (Table 3).

Regarding cyanotic comb, 41/180 (22%) birds without cyanosis tested positive, whereas no seropositive cases were recorded among birds showing cyanotic comb. Correlation analysis showed a weak association between cyanotic comb and MS seropositivity (correlation coefficient = 0.17) (Table 3).

Table 3: Relationship of different respiratory signs/cyanotic combs to the occurrence of disease

Variables	Categories	Percentage	Contingency coefficient test	Relationship
Respiratory sign	Yes (n=170)	21	0.074	Weak/No
	No (n=30)	13		
Cyanotic Comb	Yes (n=0)	0	0.045%	Weak/No
	No (n=180)	22		

Association of Digestive Signs (Ascites and Whitish Diarrhea) with MS Seropositivity

The relationship between MS exposure and digestive/systemic signs was also examined. Birds presenting with ascites showed a seropositivity rate of 7/35 (28%), compared with 34/175 (19%) in birds without ascites. The association between ascites and MS seropositivity remained weak, with a contingency coefficient of 0.321 (Table 4). In whitish diarrhea, MS antibodies were detected in 3/20 (15%) birds, compared with 38/180 (21%) in birds without diarrhea. Correlation findings suggested a weak relationship between white diarrhea and MS seropositivity (correlation coefficient = 0.521) (Table 4).

Table 4. Relationship of digestive signs with the occurrence of disease of *Mycoplasma synoviae*.

Variables	Categories	Percentage	Contingency coefficient	Relationship
Ascites	Yes (n=35)	28%	0.070	Weak/No
	No(n=175)	19%		
White Diarrhea	Yes (n=20)	15%	0.045	Weak/No
	No (n=180)	21%		

Association of anorexic symptoms with MS infection.

Anorexia was assessed as an indicator of poor health status and possible MS exposure. Birds showing anorexia had a relatively higher seropositivity rate (4/10; 40%) compared to birds without anorexia (37/190; 19%). Despite the increased percentage, statistical evaluation indicated only a weak association between anorexia and MS seropositivity (contingency coefficient = 0.117) (Table 5).

Table 5: Relationship of anorexic signs with the occurrence of disease.

Variable	Categories	Percentage	Contingency coefficient	Relationship
Anorexic Signs	Yes (n=10)	40%	0.110	Weak/No
	No(n=190)	19%		

Gross pathological changes

Necropsy was performed on 26 broiler chickens collected from the study farms. Gross lesions were predominantly observed in the respiratory system, particularly the trachea and lungs, although systemic involvement was also noted. The most frequently observed gross lesions included lung consolidation (76%), tracheal hemorrhages (46%), synovitis (38%), splenomegaly (30%), and liver congestion (26%). Overall, the gross pathological picture was suggestive of respiratory tract involvement, with evidence of systemic effects in a subset of cases.

Histopathology

Microscopic examination of formalin-fixed tracheal and lung tissues revealed characteristic inflammatory and degenerative changes. Tracheal sections commonly showed hemorrhage, epithelial desquamation, and leukocytic infiltration, indicating marked mucosal damage and inflammatory response (Fig. 3, 4, 5). In lung tissues, inflammatory changes were observed, consistent with respiratory pathology. These microscopic lesions support the involvement of MS in respiratory tissue damage and correlate with the gross findings observed during necropsy.

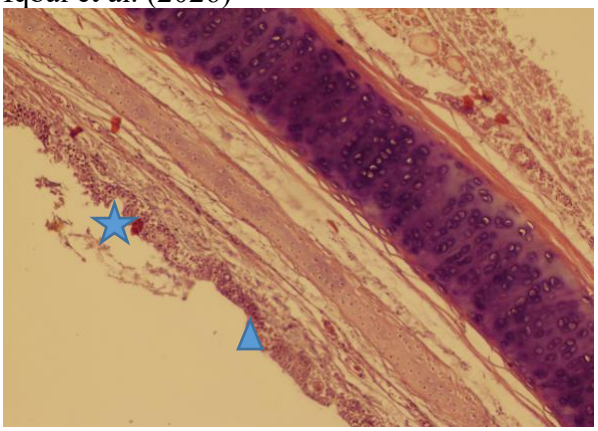
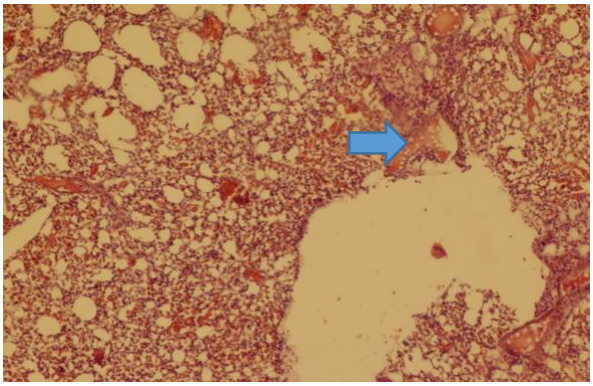


Fig. 3: Section of trachea showing desquamation of ciliated epithelium and leukocytic infiltration.



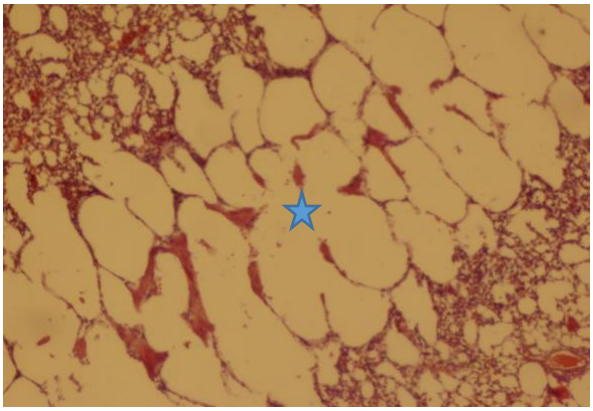


Fig. 4 and 5. The section of lungs showing emphysema and increased intra-alveolar septa, atelectasis, and leukocytic infiltration.

Discussion

Mycoplasma synoviae (MS) is widely recognized as one of the most important bacterial pathogens of poultry, contributing to respiratory disease, synovitis, reduced performance, and considerable economic losses in commercial production systems. In the present study, the overall seroprevalence of MS in broiler chickens from District Karak was 20.5%, confirming that MS is circulating in the region and that broiler flocks are being exposed to this pathogen under field conditions. This finding is comparable with reports from other districts of Khyber Pakhtunkhwa, where Rehman et al. (2018) reported seroprevalence ranging from 11.88% to 23.33% using the slide plate agglutination test, and Shoaib et al. (2019) documented a prevalence of 10% in Rawalpindi broilers. However, the seroprevalence recorded in this study is clearly lower than values reported in other settings, including 42.6% in Rawalpindi (Ali et al., 2020) and approximately 41-42% in China (Xue et al., 2017; Zhang et al., 2019), suggesting that geographical and farm-level differences play a significant role in shaping MS epidemiology.

The comparatively lower seroprevalence in District Karak may be explained by several interrelated factors. One likely reason is variation in poultry production intensity and flock density between regions. Areas with more concentrated commercial poultry farming tend to experience greater pathogen circulation due to frequent bird movement, shared transportation routes, greater contact between farms, and increased opportunities for indirect transmission through contaminated equipment, personnel, and farm inputs. In contrast, District Karak may have relatively lower poultry clustering and reduced inter-farm connectivity compared to major poultry belts, which could limit horizontal spread and result in lower overall exposure levels. Differences in biosecurity practices may also contribute. Even small improvements in routine hygiene, farm separation, ventilation, and reduction of overcrowding can decrease respiratory pathogen transmission, including MS, particularly because mycoplasma spread is often slow but persistent in flocks. Furthermore, differences in flock type and production cycle length may influence seroprevalence estimates. Broiler chickens have short rearing periods, and antibody development depends on the timing of exposure and the immune response; therefore, sampling birds before full seroconversion or during early infection stages could yield lower seropositivity rates than studies involving older birds, breeders, or multi-age production systems. In addition, regional variation in vaccination practices may influence the antibody levels detected. In some areas, the use of live attenuated vaccines or exposure to vaccine strains may increase serological positivity, while limited vaccine usage may result in seropositivity reflecting primarily natural field infection. Finally, methodological differences between studies,

including ELISA kit type, cut-off values, sampling framework, and the selection of farms with known respiratory disease history, can influence prevalence estimates and may partially explain why some regions report higher seroprevalence.

In the current study, the epidemiological and clinical factors investigated, including age, flock size, mortality rate, feed type, respiratory signs, cyanotic comb, ascites, white diarrhea, and anorexia, were not significantly associated with MS seropositivity ($p > 0.05$). Although birds older than three weeks showed a numerically higher seropositivity rate than younger birds (23% vs. 12%), the association was not statistically significant, suggesting that age alone may not be a strong predictor of MS exposure in the studied broiler population. This may be due to the multifactorial nature of respiratory disease in poultry and the complex interaction of environmental stressors, management practices, and concurrent infections. Similarly, the lack of significant associations with flock size, mortality, and feed type suggests that MS exposure in this region may be influenced more by overall farm-level biosecurity and infection pressure than by individual factors evaluated in isolation. The weak association between respiratory signs and MS seropositivity further underscores that clinical presentation alone cannot reliably indicate MS infection. Respiratory disease in poultry is commonly caused by mixed infections involving IBV, NDV, AIV, *Mycoplasma gallisepticum*, and secondary bacterial pathogens, which can mask or overlap with MS-associated signs. Therefore, serological testing remains essential for flock-level monitoring, particularly in areas where molecular confirmation is not routinely available.

Gross pathological examination of naturally dead birds revealed lesions predominantly affecting the respiratory system, including lung consolidation, tracheal hemorrhages, and congestion, along with systemic changes such as splenomegaly and liver congestion. These observations are consistent with the known pathogenesis of MS, in which damage to the respiratory epithelium predisposes birds to inflammation and secondary infections, leading to more pronounced lesions under field conditions. The high frequency of lung consolidation supports respiratory compromise, while splenic and hepatic changes suggest systemic inflammatory effects, particularly when birds are exposed to multiple pathogens or environmental stress. Histopathological findings further supported respiratory involvement, with tracheal tissues showing epithelial desquamation, hemorrhage, and leukocytic infiltration. Such lesions are characteristic of mycoplasma-associated respiratory pathology and reflect mucosal damage and inflammatory response, as reported previously by Bagal et al. (2019) and Feberwee et al. (2019). Taken together, the combination of serological positivity and consistent pathological lesions supports the conclusion that MS is an active and relevant pathogen affecting broiler health in District Karak.

Overall, the findings of this study confirm that MS is present in broiler flocks in District Karak at a moderate level, and that infection is associated with gross and microscopic respiratory lesions. Although the seroprevalence is lower than that reported from some other regions, the detection of antibodies in one-fifth of the sampled birds remains epidemiologically significant, as MS can persist through carrier birds and spread silently between flocks. These results highlight the need for regular surveillance, improved biosecurity, and effective prevention strategies, including consideration of vaccination programs and periodic molecular confirmation, to minimize the impact of MS on poultry health and productivity in Khyber Pakhtunkhwa.

Conclusion

This study confirms that *Mycoplasma synoviae* is present in broiler flocks in District Karak, Khyber Pakhtunkhwa, Pakistan, with a seroprevalence of 20.5% detected using indirect ELISA. Observations from gross and histopathological examinations revealed typical respiratory lesions, confirming MS's pathogenic role in field conditions. These findings emphasize the importance of regular surveillance, enhanced biosecurity measures, and prompt diagnostic screening to minimize MS-related production losses in the area.

Recommendations

This study emphasizes the importance of regular surveillance and enhanced biosecurity measures to control *Mycoplasma synoviae* in broiler flocks. Using molecular diagnostics alongside ELISA

periodically is recommended for accurate detection, while vaccination and farmer awareness programs can further reduce the disease's impact. An integrated health management plan, including careful antimicrobial use and prevention of secondary infections, is vital to reduce economic losses and protect poultry productivity.

Authors Contributions:

Conceptualization, U.S, F.A.K, HUR; Methodology, M.I, U.S, M.S, M.S; Data curation & Formal analysis, M.I, M.S, S.S.A.S, S.A; Investigation & Resources, M.I, M.S, A.U.R, N, H.U.R; Writing original draft, M.I, H.U.R; Writing, review & editing, H.U.R, S.S.A.S; Visualization, M.S, A.U.R; Supervision & Project administration, U.S, F.A.K, & H.U.R.

All authors have read and approved the final version of the manuscript.

Conflict of interest

The authors state that they have no known conflicts of interest or personal relationships that could have biased the work presented in this paper.

References

Ali, R., A. Ahmad & A. Yousaf. 2020. Seroprevalence of Mycoplasma synoviae in commercial poultry farms of Rawalpindi, Pakistan. Journal of Animal Health and Production. 8(2):52-57.

Bagal, U. R., S. A. Khan & M. Y. Wani. 2019. Pathological changes associated with Mycoplasma synoviae infection in commercial poultry. Veterinary World. 12(4):620-625.

Bancroft, J.D. & M. Gamble. 2007. Theory and Practice of Histological Techniques (6th edn.). Churchill Livingstone Elsevier, UK.

FAO (Food and Agriculture Organization of the United Nations). 2023. Poultry sector review in Pakistan. FAO, Rome.

Feberwee, A., W. J. M. Landman & T. S. Vries. 2019. Clinical and pathological effects of Mycoplasma synoviae infection in poultry. Avian Pathology. 48(5):433-445.

Finance Division, Government of Pakistan. 2025. Pakistan Economic Survey 2024–25: Highlights. Ministry of Finance, Islamabad.

Hussain, A. & F. Akhtar. 2020. Major bacterial diseases in poultry: An overview. Pakistan Veterinary Journal. 40(2):123-130.

Khan, M. S., S. Shah & M. Rauf. 2021. Prevalence and control of poultry Mycoplasmosis in Pakistan. Journal of Animal Health and Production. 9(3):275-283.

Li, Y., X. Liu, H. Chen & K. Zhao. 2018. Co-infection of Mycoplasma synoviae and Mycoplasma gallisepticum in commercial poultry: Impacts on pathology and production. Poultry Science. 97(6):2051-2059.

Michael, A., G. A. T. Ogundipe & O. B. Adedeji. 2016. Seroprevalence of Mycoplasma synoviae antibodies in commercial poultry farms. Tropical Animal Health and Production. 48(6):1123-1129.

Nawaz, M., A. Khan & R. Gul. 2022. Economic impact of Mycoplasma synoviae infection on commercial poultry farms. Pakistan Journal of Zoology. 54(1):215-222.

OIE (World Organization for Animal Health). 2022. World animal health information system (WAHIS) – Avian diseases. OIE, Paris.

Rehman, A., R. Ali & A. Yousaf. 2018. Seroprevalence of Mycoplasma synoviae in broiler flocks of Khyber Pakhtunkhwa, Pakistan. Pakistan Veterinary Journal. 38(4):456-460.

Shoaib, M., M. A. Khan & S. Ahmed. 2019. Seroprevalence of Mycoplasma synoviae in broiler chickens in Rawalpindi, Pakistan. Journal of Animal and Plant Sciences. 29(5):1321-1326.

Xue, J., Q. Zhang & L. Zhao. 2017. Prevalence and risk factors of Mycoplasma synoviae in commercial poultry flocks in China. Avian Pathology. 46(2):239-245.

Zhang, N., D. Zhang, Q. Xie & F. Chen. 2019. Prevalence and molecular characterization of Mycoplasma synoviae in Chinese poultry flocks. Avian Pathology. 48(3):205-212