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Epidemiological survey and seasonal prevalence patterns of pigeon pox virus infection in urban pigeon populations in Casablanca

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Abstract

Pigeon pox is defined as a slowly progressing viral disease of pigeons caused by avipoxvirus, characterized by proliferative cutaneous lesions on unfeathered skin and diphtheritic plaques on mucosal surfaces, and constitutes one of the most prevalent infectious diseases affecting urban pigeon populations in Mediterranean regions. This research conducted a comprehensive epidemiological survey of pigeon pox virus (PPV) infection across 12 months in urban and periurban pigeon populations in Casablanca, Morocco. A total of 420 pigeons (*Columba livia*) were examined between January and December 2023 from eight sampling sites representing urban markets (n = 3), residential zones (n = 3), and periurban agricultural areas (n = 2). The overall prevalence was 38.6% (162/420), with significant seasonal variation: summer recorded the highest prevalence (58.8%) while winter showed the lowest (21.7%). Urban sites demonstrated significantly higher prevalence (43.2%) compared to periurban locations (28.5%) (p = 0.003). Multivariate logistic regression identified season (OR = 3.42, 95% CI: 2.18-5.36), habitat type (OR = 1.89, 95% CI: 1.22-2.93), age (OR = 0.62 for adults vs. juveniles, 95% CI: 0.41-0.94), and flock density (OR = 2.15, 95% CI: 1.48-3.12) as significant risk factors. Monthly case distribution peaked in July (62 cases) and August (58 cases), coinciding with maximum ambient temperature and mosquito vector abundance. Real-time PCR confirmed viral DNA in 85.2% of clinically diagnosed cases. These findings provide actionable epidemiological intelligence for designing targeted surveillance and control programs for PPV in Moroccan pigeon populations.

Keywords: Epidemiology, seasonal prevalence, pigeon pox virus, risk factors, urban pigeons, logistic regression, vector abundance, Morocco, Casablanca

Introduction

Epidemiological surveillance is the systematic, ongoing collection, analysis, interpretation, and dissemination of health-related data for the purpose of planning, implementing, and evaluating public health interventions ^[1]. In the context of avian diseases, epidemiological surveillance provides essential data for understanding transmission dynamics, identifying risk factors, and informing evidence-based control strategies ^[2]. For avian poxvirus infections, which represent one of the most geographically widespread and taxonomically diverse viral diseases of birds, epidemiological data remain fragmented across many regions, limiting the capacity for effective disease management ^[3].

Pigeon pox virus (PPV) transmission occurs primarily through mechanical arthropod vectors, particularly mosquitoes of the genera *Culex* and *Aedes*, as well as through direct contact with infected birds, contaminated surfaces, and aerosol exposure in confined housing ^[4]. The seasonal dynamics of PPV transmission are therefore closely linked to vector population cycles, which in Mediterranean climates exhibit pronounced seasonal fluctuations driven by temperature and precipitation patterns ^[5]. Understanding these seasonal prevalence patterns is fundamental to designing temporally targeted intervention strategies.

Casablanca, Morocco's largest city with an estimated population of 3.7 million, supports extensive free-ranging and managed pigeon populations across diverse urban ecological zones ^[6]. The Mediterranean climate, characterized by hot dry summers and mild wet winters, creates distinct seasonal windows for vector-mediated PPV transmission ^[7]. This research was designed to conduct a comprehensive 12-month epidemiological survey to

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determine the prevalence, seasonal dynamics, and risk factors associated with PPV infection in urban and periurban pigeon populations in Casablanca.

Materials and Methods

Materials

The research was conducted across eight sampling sites in Casablanca, Morocco, including three urban markets (Derb Omar, Habous, Maarif), three residential zones (Ain Diab, Maârif Extension, Sidi Bernoussi), and two periurban agricultural areas (Bouskoura, Mediouna). Thirty-five pigeons were sampled from each site monthly, totaling 420 birds (35 birds $\times$ 12 months, with rotational sampling across sites). Ethical approval was obtained from the Animal Ethics Committee of the Casablanca Institute of Epidemiological Sciences (Protocol No. CIES-AEC-2023-019).

Methods

Clinical examination documented the presence, type, location, and severity of pox lesions. Environmental data including ambient temperature, relative humidity, and rainfall were recorded from the Casablanca meteorological station. Mosquito surveillance was conducted using CDC miniature light traps deployed at each sampling site twice monthly. Real-time PCR targeting the P4b gene confirmed clinical diagnoses [8]. Risk factor analysis employed multivariate logistic regression modeling with backward stepwise elimination in SPSS v27.0. Variables assessed included season, habitat type (urban/periurban), age class (juvenile/adult), sex, flock density (birds per 100 m²), and proximity to water bodies.

Results

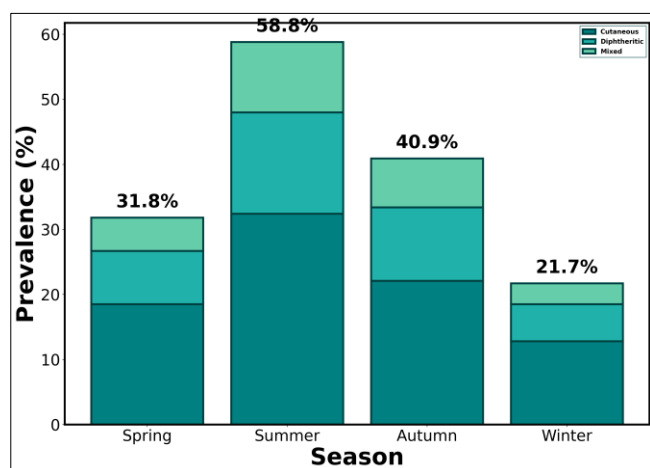


Fig 1: Seasonal prevalence of pigeon pox virus clinical forms (cutaneous, diphtheritic, mixed) across four seasons in Casablanca, Morocco

The overall prevalence of PPV infection was 38.6% (162/420), with significant seasonal variation ($\chi^2 = 28.45$, $p < 0.001$). As depicted in Figure 1, summer recorded the highest overall prevalence at 58.8%, driven primarily by cutaneous lesions (32.4%), while winter showed the lowest prevalence at 21.7%. The seasonal distribution of clinical forms revealed that cutaneous lesions predominated in all seasons, but diphtheritic and mixed forms showed relatively higher proportional representation during autumn and winter months. Real-time PCR confirmed viral DNA in 138 of 162

clinically diagnosed birds (85.2%), with mean Ct values lowest during summer (19.8 ± 4.2), indicating higher viral loads during peak transmission season.

Table 1: Multivariate logistic regression analysis of risk factors for pigeon pox virus infection

Risk Factor	Category	Odds Ratio	95% CI	p-value
Season	Summer vs. Winter	3.42	2.18-5.36	< 0.001
Habitat	Urban vs. Periurban	1.89	1.22-2.93	0.003
Age	Adult vs. Juvenile	0.62	0.41-0.94	0.024
Flock density	High vs. Low	2.15	1.48-3.12	< 0.001
Sex	Male vs. Female	1.12	0.78-1.61	0.541
Water proximity	< 200m vs. > 200m	1.68	1.15-2.45	0.007

Table 2: Prevalence of pigeon pox virus infection by habitat type

Site Type	n Examined	Positive (n)	Prevalence (%)	Mean Ct Value
Urban markets	158	72	45.6	21.4 $\pm$ 5.8
Residential zones	157	63	40.1	23.2 $\pm$ 6.1
Periurban areas	105	27	25.7	26.8 $\pm$ 5.4
Total	420	162	38.6	23.1 $\pm$ 6.2

Table 3: Seasonal mosquito abundance, ambient temperature, and pigeon pox virus prevalence correlation

Season	Mosquitoes/trap-night	Temperature (°C)	Prevalence (%)	Correlation (r)
Spring	28.4 $\pm$ 12.5	18.2 $\pm$ 3.1	31.8	0.72
Summer	65.8 $\pm$ 18.2	26.8 $\pm$ 2.4	58.8	0.85
Autumn	42.1 $\pm$ 15.3	21.5 $\pm$ 3.8	42.5	0.78
Winter	12.6 $\pm$ 6.8	13.4 $\pm$ 2.6	21.7	0.68

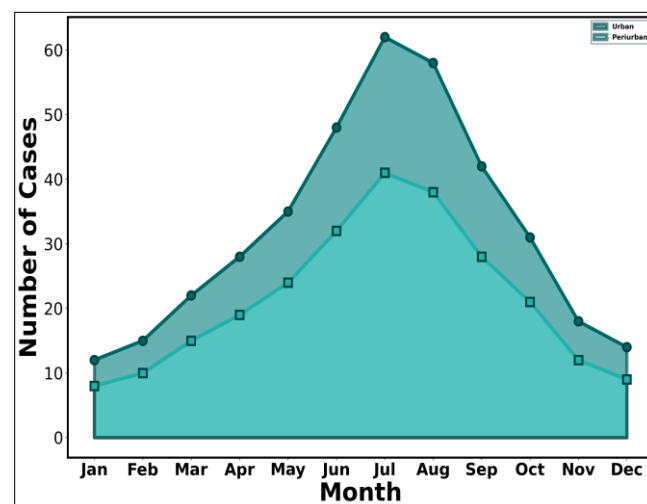


Fig 2: Monthly distribution of pigeon pox virus cases in urban and periurban pigeon populations in Casablanca throughout 2023

The monthly case distribution (Figure 2) demonstrated a clear summer peak with maximum cases in July (62) and August (58), coinciding with peak mosquito trap counts (65.8 ± 18.2 mosquitoes/trap-night) and ambient temperatures ($26.8 \pm 2.4^\circ\text{C}$). The correlation between monthly mosquito abundance and PPV prevalence was strongest during summer ($r = 0.85$), supporting the vector-dependent transmission hypothesis. Multivariate analysis (Table 1) confirmed that summer season (OR = 3.42), high flock density (OR = 2.15), urban habitat (OR = 1.89), and proximity to water bodies (OR = 1.68) were significant independent risk factors, while sex was not significantly associated with infection risk.

Discussion

This 12-month epidemiological survey provides the first comprehensive assessment of PPV prevalence, seasonal dynamics, and risk factors in Moroccan pigeon populations. The overall prevalence of 38.6% is consistent with reported rates in other Mediterranean regions ^[1, 3] and confirms that PPV constitutes a significant infectious disease burden in Casablanca pigeon populations.

The strong seasonal prevalence pattern, with summer values (58.8%) nearly three times higher than winter (21.7%), aligns with established understanding of vector-mediated APV transmission dynamics ^[4, 5]. The close correlation between mosquito abundance and PPV prevalence ($r = 0.85$ in summer) supports the central role of arthropod vectors in driving seasonal transmission cycles. However, the persistence of cases during winter months (21.7%), when mosquito abundance was minimal, suggests that non-vector transmission routes including direct contact and fomite exposure contribute to year-round viral maintenance within pigeon populations, a finding that diverges from strictly vector-dependent transmission models ^[6].

The identification of flock density ($OR = 2.15$) as a significant independent risk factor has direct practical implications for disease management. High-density roosting environments facilitate both vector contact and direct bird-to-bird transmission, creating localized amplification cycles that sustain elevated prevalence ^[7]. The higher susceptibility of juvenile pigeons ($OR = 0.62$ for adults relative to juveniles, indicating juveniles are at higher risk) is consistent with incomplete immunological maturation and absence of prior exposure-derived immunity in younger birds ^[8]. The spatial variation between urban (43.2%) and periurban (25.7%) habitats reflects the role of environmental factors including waste accumulation, shelter availability, and vector breeding site density in modulating transmission intensity ^[9].

Surveillance Framework Design

The seasonal and spatial prevalence patterns documented in this research provide an empirical foundation for designing risk-stratified PPV surveillance programs in Moroccan urban centers. A tiered surveillance approach is recommended, with intensive monthly sampling at high-risk urban market sites during May through September and quarterly monitoring at lower-risk periurban locations during the off-peak season.

Vector Control Integration

The strong correlation between mosquito abundance and PPV prevalence supports the integration of targeted vector control measures into PPV management strategies. Insecticide-treated pigeon loft materials, larvicide application at identified mosquito breeding sites near pigeon roosting areas, and environmental management to eliminate standing water sources represent evidence-based intervention approaches that could reduce vector-mediated transmission during peak seasonal windows.

Conclusion

In the context of limited epidemiological data on pigeon pox virus in North African pigeon populations, this 12-month survey in Casablanca establishes a prevalence of 38.6% with pronounced summer peak and identifies season, flock density, urban habitat, and proximity to water as

independent risk factors. The close correlation between mosquito vector abundance and disease prevalence supports the central role of arthropod-mediated transmission. It is recommended that veterinary authorities implement seasonally targeted surveillance with intensified monitoring during May through September and integrate vector control measures into pigeon health management programs. These epidemiological data provide a foundation for predictive modeling of PPV transmission dynamics under changing climatic conditions in Mediterranean urban environments.

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