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Causes of death in captive Psittaciformes in the Jaboticabal region, Brazil (2014-2024)

Matheus Zochio[1], Julia Victoria Gaspar Diez[2], Maria Estela Mendes da Silva[1], Alline Borges Salomão[1], Igor Aguiar Macchioli[1], Karin Werther[2*]

[1]Residency Program in Professional Health Area – Veterinary Medicine and Health, School of Agricultural and Veterinary Sciences (FCAV), São Paulo State University (UNESP), Jaboticabal, SP, Brazil
[2]Wildlife Pathology Service, Department of Pathology, Reproduction and One Health, School of Agricultural and Veterinary Sciences (FCAV), São Paulo State University (UNESP), Jaboticabal, SP, Brazil

[*]**Corresponding author:** karin.werther@unesp.br
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Abstract
The necropsy of pet birds is an important tool for determining the cause of death and for identifying potential zoonotic or non-zoonotic etiological agents related to fatality. This retrospective study (2014 to 2024) aims to identify the main causes of death in Psittaciformes kept under human care in the Jaboticabal/SP region, Brazil. A total of 146 necropsy cases and histopathological analyses archived at the Wildlife Pathology Service of São Paulo State University, Jaboticabal campus, were examined. The most prevalently analyzed species included *Amazona aestiva*, *Nymphicus hollandicus*, and *Ara ararauna*, with a higher prevalence of adult birds and those from household environments. Causes of death were classified into infectious and non-infectious processes. Metabolic conditions, such as atherosclerosis, were the leading cause of death (14.3%), followed by trauma and poisonings. Among infectious causes, parasites of the genus *Paratanaisia*, as well as bacterial and fungal infections, were prominent. Difficulties in isolating infectious agents and carcass autolysis limited some diagnoses. The study reinforces the importance of necropsy as a diagnostic tool and highlights the need for preventive management practices tailored to birds in households, breeding facilities, and zoos. The findings highlight the importance of monitoring pre-mortem factors and implementing targetd preventive medicine strategies to improve the well-being and longevity of captive Psittaciformes.

Keywords: parrots, necropsy, preventive medicine.

Introduction

The Psittaciformes order (Aves class) includes parrots, macaws, and parakeets (3). These birds are widely kept in human care in various settings, including households as pets, zoos, and conservation programs (2, 12). These animals face several health challenges that can impact their longevity and well-being (8, 17). Although studies on the health of captive Birds have already been conducted (4, 16, 22, 23), significant gaps remain in understanding the primary causes of death and the pathological patterns affecting these populations, especially in Brazilian contexts. In this context, we examined in the present retrospective study necropsy and histopathological analysis data collected over a decade (2014–2024) at the Wildlife Animal Pathology Service of the School of Agricultural and Veterinary Sciences, São Paulo State University, Jaboticabal, SP, Brazil. The aim was to characterize the main diseases and pathological conditions contributing to the mortality of captive Psittaciformes, providing valuable information for management and preventive medicine practices. By addressing aspects such as species prevalence, final diagnoses, and predisposing factors, this

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study provides a basis for improving the care and health management of these animals in captivity.

Material and Methods

A retrospective study of necropsy and histopathological examinations was conducted on Psittaciformes kept under human care. These cases were analyzed at the Wildlife Pathology Service (SEPAS) of the School of Agricultural and Veterinary Sciences (FCAV) of São Paulo State University (UNESP), Jaboticabal, SP, Brazil. The data were obtained from cases recorded in the laboratory archives over a 10-year period (from 2014 to 2024). Only birds living under human care were included in the study. The only exception was an *Ara ararauna* from a breeding facility dedicated to the rehabilitation and reintroduction of macaws into the wild. Birds under human care are considered pets or, in certain contexts, captive birds. This concept includes birds kept in controlled environments such as homes, aviaries, or bird enclosures. These animals may be raised for companionship, breeding, research, or species conservation. Initially, clinical history and necropsy reports were collected and compiled into a database to calculate the prevalence of affected species and to identify the main findings from necropsy examinations. The final diagnosis for each case was made by the responsible pathologist, based on clinical history, macro and microscopic lesions, and complementary examinations using special stains. The final diagnosis was classified by affected system, type of lesions, infectious agents, and detected diseases. The diagnoses were grouped into infectious and non-infectious processes. When histological lesions were pathognomonic and compatible with a specific disease process, or complementary tests allowed the identification of a specific agent, disease processes were subcategorized (e.g., viral, nutritional, or trauma-related). When an infectious or non-infectious etiology was suspected but not confirmed by histopathology or complementary tests, the disease process was classified as suggestive. Pathological processes that could not be categorized according to the primary lesion or type of exudate were deemed inconclusive. The isolation of infectious agents could not be performed in some cases due to two main factors: [1] carcasses presented autolysis, and/or [2] owners did not authorize the examination.

Results

Species

Throughout the study, 146 birds underwent necropsy, of which 34.2% belonged to the *Amazona* genus. The most represented species within this genus and in the study was *A. aestiva* (26.7%), followed by *A. amazonica* (5.4%). The second most prevalent species in the study was *Nymphicus hollandicus* (23.2%), followed by *Ara ararauna,* which was the third most common species (12.3%). An additional 12 identified genera accounted for 30.1% of the total birds analyzed. Among these, the three most prevalent genera were *Melopsittacus* (6.1%), *Brotogeris* (5.4%), and *Psittacula* (4.7%).

Age

Regarding the age of the birds, 40.4% had an undetermined age due to the absence of information in the necropsy records. The remaining birds were classified as chicks (4.7%) for those under 3 months old. Depending on the bird genus, juveniles (16.4%) were considered animals older than 3 months but younger than 5 years, adults (36.9%) for birds between 5 and 50 years old, and geriatric (1.3%) for those over 50 years old.

Origin

The birds were classified into three categories of origin for this study: household birds (67.8%), zoo birds (22.6%), and birds from breeding facilities (9.5%).

Time of Year

The month with the highest recorded bird mortality was March (13%), followed by August and September (both 12.3%), and July (11.6%). The months with the lowest number of deaths were January and December (both 2.7%) (Fig. 1).

Sex

The identification of sex was not possible for 2.7% of the birds. Among the identified birds, 54.7% were males and 42.4% were females.

Final diagnosis

Figure 2 presents the distribution of diagnoses reported in this study. Among the 146 cases analyzed, 18.4% were inconclusive, with 25.9% attributed to severe autolysis, while the cause of death remained undetermined in the remaining cases. Among the conclusive diagnoses, 60.2% were of non-infectious origin. The primary cause of death was metabolic, accounting for 23.8% of cases, with atherosclerosis being the most prevalent condition (57.1%) (Figs. 3A, 3B), followed by gout (33.3%) (Fig. 3E). Trauma was the leading cause of death in 14.7% of cases, with 30.7% resulting from domestic dog attacks. Trauma inflicted by another

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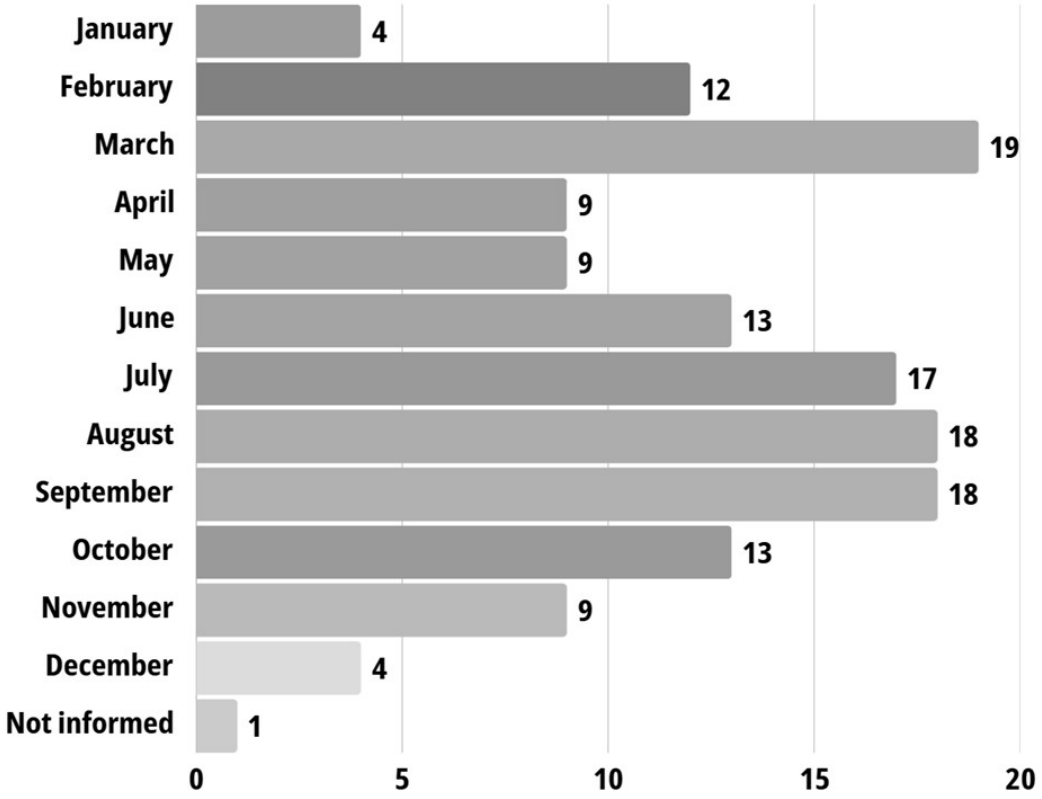

Figure 1. Psittaciformes deaths recorded between 2014 and 2024 distributed by months of the year

Psittaciformes (Fig. 3F) also had an incidence of 30.7%. Moreover, one case was caused by an automobile accident, and another was due to a domestic accident involving the owner. Other trauma-related deaths had no defined cause. Cases of poisoning accounted for 13.6% of the diagnoses, with 50% caused by the ingestion of a ferromagnetic foreign body, 25% by hemosiderosis (Fig. 3G), 16.6% due to a bee sting, and two other cases suspected of paint poisoning. Furthermore, 5.6% of deaths were linked to digestive disorders, with 72.7% attributed to hepatopathy. Other causes included 7.9% due to respiratory problems with no defined infectious cause, 7.9% due to renal issues, 5.6% due to reproductive disorders, 2.2% as a result of surgical procedures, and 1.1% related to cardiac conditions associated with aging.

Infectious causes accounted for 21.2% of deaths, with 45.1% of these cases being of parasitic origin. *Paratanaisia sp.* (Fig. 3H) was the most prevalent parasite, found in 28.5% of cases, followed by *Sarcocystis sp.* (Figs. 3C, 3D) with 21.4%. Bacterial infections accounted for 29% of cases, fungal infections for 16.1%, and viral infections for 9.6%. Regarding birds from breeding facilities, 50% of death cases were due to atherosclerosis. Among zoo-origin birds, infectious diseases were the leading cause of death (45.4%), with *Paratanaisia sp.* present in 75% of cases. Cases of cryptococcosis, sarcocystosis, and clostridioses had a 100% incidence in these Psittaciformes. Among household birds, there was only one case of chlamydiosis, while 100% of neoplasia cases occurred in this group. The main cause of death in household birds was trauma (10.1%), followed by atherosclerosis and poisoning.

Discussion

Standardizing an age range to classify birds as elderly presents challenges. While some studies consider adulthood to span from 5 to 48 years without categorizing elderly birds (13), others base their definition on average life expectancy, defining elderly birds as those that exceed it (8, 24). An alternative proposal suggests classifying *Agapornis* and *Melopsitaccus* as elderly at 6 years, N*ymphycus* at 12 years, and large psittacines such as *Amazona*, *Ara*, and *Psittacus* at 30 years (19). In our study, we had a *Psittacara leucophthalmus* that was 23 years old and classified as an adult, showing a significant accumulation of lipofuscin inside the cardiomyocytes. Lipofuscin (age pigment) is a lipoprotein that accumulates as residual bodies in secondary lysosomes, particularly in long-lived post-mitotic cells such as neurons and cardiac myocytes (10, 25). This finding suggests the need to adjust the age classification standard, as well as serving as a guide for birds that arrive at the laboratory without age information.

The reproductive period of *A. aestiva* occurs between August and December (6). Only two birds died due to reproductive issues during this period, with no specific

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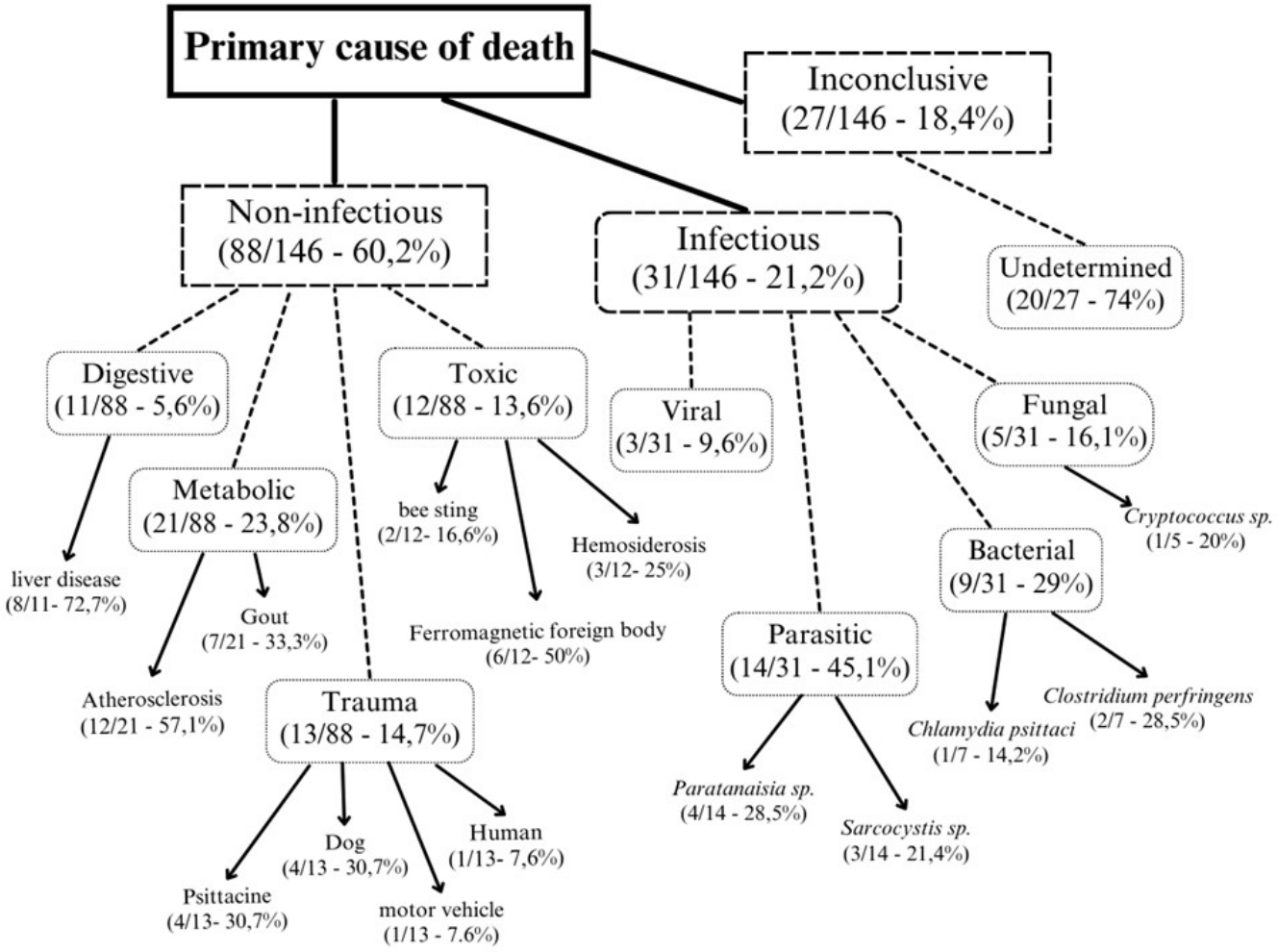

Figure 2. Main final diagnoses of Psittaciformes examined at SEPAS/FCAV between the years 2014 and 2024.

condition being more prevalent. The overall data suggest that increased mortality may be associated with the warmer and drier months of the year (11, 14), leading to greater animal fragility. The primary finding of this study was the high incidence of atherosclerosis, which is consistent with the existing literature. Atherosclerosis is the most frequently reported condition in *A. aestiva* (19), with an incidence of up to 91.8% in these birds (1, 7). In our study, 91.6% (24) of the diagnosed cases occurred in *A. aestiva*, with only one case in *A. ararauna*. Atherosclerosis is an age-related condition, mainly observed in birds between 20 and 30 years old, and is more frequently reported in females (1). Although we did not perform a statistical analysis regarding sex and age, 58.3% of cases were identified in females, and the birds' ages ranged from 5 to 28 years.

Regarding poisoning, the main toxic condition observed was associated with the ingestion of a ferromagnetic foreign body found during necropsy, as reported in previous studies (18). We attribute these findings to the often-inadequate enclosures for birds and the habit of allowing them to roam freely and unsupervised in household environments, increasing the risk of foreign body ingestion. An interesting characteristic of this study was the absence of polytetrafluoroethylene (PTFE) poisoning cases in household birds (13, 15). This condition results from inhaling toxic fumes from Teflon-coated cookware, with its main histological finding being necrotizing and hemorrhagic pneumonitis accompanied by severe edema (21). This absence suggests an improvement in the management of these birds.

Infectious and parasitic causes were underrepresented in the isolations, potentially due to low demand for complementary tests or post-mortem autolysis, a challenge previously reported in the literature (8, 13). In two specimens of *Ara ararauna* originating from the same zoological garden, necrotic enteritis associated with *Clostridium perfringens* was observed. However, the absence of further investigation made it impossible to determine whether the event represented an outbreak, as described in earlier studies (9). Among parasitic diseases, *Paratanaisia sp.* infection was the most notable. These digenetic trematodes affect the upper urinary tract of various bird species (5, 20). This parasite was predominantly found in Psittaciformes from zoos, but one case was also

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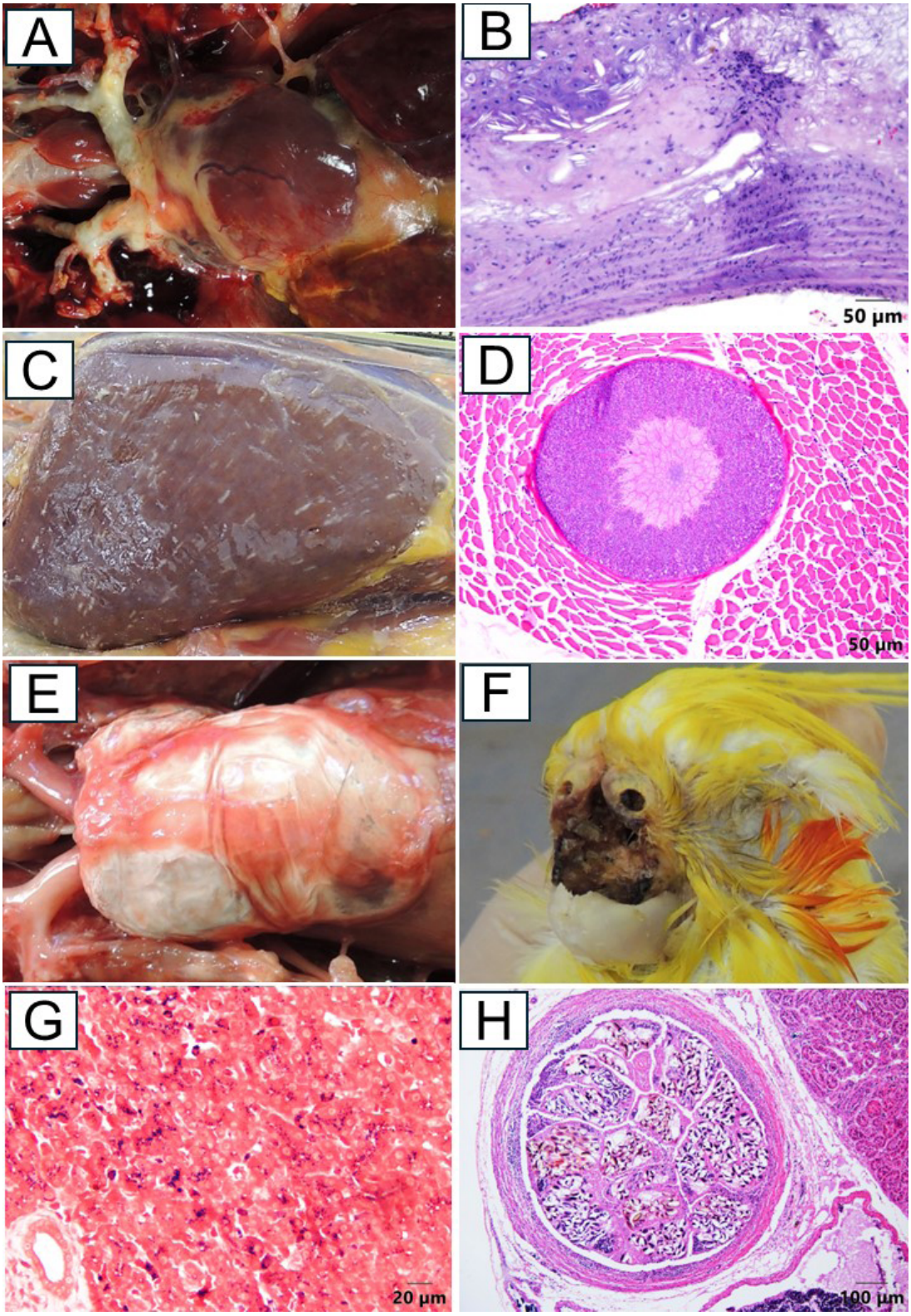

Figure 3. Macroscopic examination and photomicrographs of microscopic findings in Psittaciformes: A) great vessels of the heart of an *A. aestiva* with atherosclerosis; B) arteriosclerosis in the aorta of *A. aestiva*, H&E, 20x; C) pectoral muscle of *P. krameri* with numerous *Sarcocystis* sp. cysts; D) *Sarcocystis* sp. cysts in the pectoral muscle of *Psittacula krameri*, H&E, 20x; E) visceral uric gout in the heart of *A. aestiva*; F) *N. hollandicus* with total rhinotheca avulsion due to an attack by an *A. aestiva*; G) liver of *Amazona leucocephala* with hemosiderin (blue pigment), Prussian Blue, 40x; H) *Paratanaisia* sp. in the collecting tubule of a kidney of *A. aestiva*, H&E, 10x.

reported in a household *A. aestiva*. The primary factor contributing to the higher infection rate in zoo birds is the high population density associated with multi-species enclosures, where there is direct contact with wild birds and intermediate hosts of the parasite.

The results of this study highlight the importance of the One Health approach in avian medicine, particularly in age classification, sanitary management, and disease prevention. The high incidence of atherosclerosis and poisoning underscores the need for stricter protocols for nutritional and environmental monitoring, both in captivity and in domestic settings. Additionally, the occurrence of parasitic infections in zoos emphasizes the relevance of epidemiological control in high-density animal populations.

Implementing One Health-based guidelines can optimize diagnosis, prevention, and management of these conditions, contributing to animal health and reducing potential zoonotic risks. This study provided a comprehensive overview of the causes of death in Psittaciformes kept under human care in the Jaboticabal region, Brazil, over a 10-year period (2014–2024). The findings highlighted the relevance of metabolic conditions, such as atherosclerosis, and infectious causes, such as *Paratanaisia* parasites, in the mortality of these birds. The study also emphasized the importance of necropsy as an essential tool for identifying diagnoses and guiding preventive management practices. The data obtained reinforce the need to improve the medical history, anamnesis, and monitoring of the health conditions of captive birds, as well as to expand studies on the influence of pre-mortem factors on mortality. Additionally, they emphasize the importance of tailored preventive medicine strategies adapted to the diverse origins and environments in which these birds reside, including households, breeding facilities, and zoos.

Ultimately, this study contributes to the development of a database that can support veterinary clinicians and Brazilian institutions in implementing targeted actions for the conservation, management, and welfare of Psittaciformes, thereby promoting greater longevity and quality of life for these species in captivity.

Conflict of Interest

The authors declare no competing interests.

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