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Descriptive Epidemiology of Mortality in Certain Species of Captive Ungulates in Pakistan

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ABSTRACT

Postmortem record of 217 captive ungulates including Black buck (31), Chinkara (20), Hog deer (116), spotted deer (35), Red Deer (04) and Rusa deer (11) submitted to the Veterinary Research Institute, Lahore, Pakistan was analyzed to determine the primary cause of mortality in these animals. The carcasses of these animals were from Lahore Wildlife Park, Lahore Zoo, Jallo Wildlife Park and Private ownerships, over a period of three years (2007-2009). The most common cause of death was trauma (20.27%), followed by parasitic diseases (15.67%), bacterial diseases (11.98%), still births (9.21%), snakebites (2.76%), gut affections (2.30%), neoplasia (1.38%) and starvation (0.92%). Among the bacterial diseases Pneumonia (8.29%) and tuberculosis (3.69%) were the most common. Analysis for parasitic infestation revealed tapeworms to be highest (11.05%), followed by roundworms (8.29%) and hemoparasitism (5.07%) (babesiosis and theileriosis). Mortality rate in young ungulates was lower as compared to adults (32.26% and 67.74% respectively). Gender wise mortality was higher in females (55.30%) as compared to males (44.70%). Furthermore, necropsies provided substantial information on etiology of death and other related epidemiological aspects.

Key words: Ungulates, Pecorans, Wildlife, Epidemiology

INTRODUCTION

Since the inception of the earth, there is an intimate relationship between man and wildlife and both are vital components of the biosphere. Pakistan is rich in animal diversity due to the presence of four types of seasons observed providing a diverse habitat to these animals. According to recent surveys there are over 109 species of small, 65 species of large mammals (Roberts, 2005), 185 species of reptiles (Khan, 2006), 22 and 4 subspecies of amphibians (Khan, 2006) and more than 650 species of birds present in Pakistan (Grimmett and Roberts, 2009). Many wildlife species however, have become extinct or are at the verge of being extinction because of the habitat destruction, overhunting, population explosion, increased mechanization and technological reforms (Ali et al., 2011).

According to Punjab Parks and Wildlife Department of Pakistan, five antelope, gazelle and deer species *viz* Nilgai (*Boselaphus tragocamelus*), Black buck (*Antilope cervicapra*), Chinkara (*Gazella bennetti*), Hog deer (*Axis porcinus*) and Chital/Spotted deer (*Axis axis*) have been moved from Schedule III (protected animals and birds) to Schedule II enabling the private sectors to breed them. This has resulted, a tremendous increase in the number of these ungulates being reared privately. These animals kept at various Government Wildlife Parks and in private farm houses die due to unknown causes and are submitted to the Veterinary Research Institute (VRI) Lahore, Pakistan, for postmortem examination to ensure the cause of death so that a protective strategy may be developed to save the rest of the animals. However, to the best of our knowledge there is no published data available regarding the causes of mortality of these ungulates in Pakistan. The objectives of the present study were to assess possible causes of mortality in certain captive ungulates, Black buck, Chinkara, Hog deer, Spotted deer, Red deer and Rusa deer through postmortem examination findings and laboratory analysis data of the carcasses submitted to VRI, Lahore, Pakistan from 2007 to 2009. This would provide the epidemiological information on causes of death in animals of different sex and ages.

MATERIALS AND METHODS

Data and routine post mortem protocols

Records from a total of 217 post-mortem examinations performed on captive Black buck (31), Chinkara (20), Hog deer (116), Spotted deer (35), Red deer (04) and Rusa deer (11) carcasses at the VRI, Lahore, Pakistan from 2007 to 2009 were analyzed. These carcasses were brought from Jallo Park (147), Lahore Wildlife Park (20) and Lahore Zoo (19) while 31 cases were from private/home owners. The animals submitted were either dead or moribund. Routine procedures performed upon the arrival of dead animals included determination of sex, age, body condition and a comprehensive post-mortem examination.

Assessment of age and physical condition

Age was assessed by inspection of tooth replacement and wear of mandible teeth (Ratcliffe and Mayle, 1992). Depending on the age the animals were

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assigned young (> 1 year) or adult (< 1 year) group. Keeping in view the deposition of adipose tissue, muscle mass and body weight, the physical condition was determined (Wahlstorm and Liberg, 1995), and the physical condition was scored as good, fair, emaciated or wounded.

Primary diagnosis of mortality

Primarily, the cause of death was based on the post-mortem examination findings coupled with other bacteriological and parasitological laboratory tests wherever needed. The major causes of death assumed on the basis of postmortem examination were starvation, gut affections (ruminal impaction and intestinal obstruction), trauma, bacterial infections, parasitic diseases (roundworms, tapeworms, liverflukes, coccidiosis and hemoparasitism), stillbirths, snakebites and neoplasia. Autolyzed carcasses were deemed unfit for post-mortem examination and cause of death in these ungulates was categorized as unknown.

Parasitological analysis

For parasitological study the fecal samples collected directly from rectum and the gut ingesta were analysed using direct microscopy through direct smear method, fecal flotation and sedimentation techniques (Mahfooz et al., 2008). Hemoparasitic study was performed through Giemsa's staining technique (Alonso Aguirre et al., 1999).

Bacteriological analysis

For bacteriological examination the samples of morbid material suggestive of disease conditions were cultured on nutrient agar, blood agar and MaConkey agar simultaneously in aseptic environment. Unidentified organisms were discarded while the remaining samples were further processed for etiological agents of pneumonia and tuberculosis. *Mycobacterium tuberculosis* was confirmed through acid fast staining and specific culture and identification (Fitzgerald et al., 2000). Similarly etiological agent of pneumonia, *Streptococcus pneumonaie* was identified through traditional physiological method including colony morphology, gram staining and alpha hemolytic activity on blood agar (Faklam and Carey, 1985).

Data analysis

For analysis purpose, geographic, age wise (young and adult) and gender wise (male and female) attributes of mortality were assessed and presented in percentages.

RESULTS

The highest and lowest number of carcasses submitted in this study period was Hog deer (116) and Red deer (4) respectively. Geographically 147 (67.74%), 20 (9.22%) and 19 (8.76%) cases were submitted from Jallo Park, Lahore Wildlife Park and Lahore Zoo, respectively. The number of privately/home captive animal carcasses was 31 (14.28%).

Overall mortality factors identified in the wildlife ungulates in the present study are presented in Table 1. Traumatic injuries were found to be highly prevalent (20.27%) followed by parasitic diseases (15.67%). Traumatic injuries were predominantly caused by antler punctures from other animals and barbed wires used for their confinement. Lowest mortality was noticed to be due to starvation as only 2 animals (0.92%) died of starvation. Species wise data indicated highest traumatic mortalities in Rusa deer (45.45%) followed by Black buck (25.80%) and Red deer (25%).

Gender wise distribution of the data revealed that on the whole, a total of 120 (55.30%) and 97 (44.70%) carcasses of females and males were examined, respectively (Table 2), indicating a higher death loss in females as compared to males. In males highest frequency of death (23.71%) was due to parasitic infestation followed by trauma (20.62%). Age wise distribution indicated submission of 70 (32.26%) young and 147 adult (67.74%) carcasses (Table 3) indicating a higher death rate in adults. In the young ones stillbirth was recorded as the prime cause of death (28.57%) followed by bacterial infection (20.00%). However, in adults the traumatic injuries were the highest (28.57%) followed by parasitic infestation (17.69%).

Physical condition scores of the submitted carcasses was 3 (1.38%) in good, 46 (21.20%) in fair, 60 (27.65%) emaciated and 31 (14.28%) in wounded condition. Due to delay submission and autolysis changes a total of 77 (35.48%) cases were deemed unfit for post mortem analysis. The results of parasitic and bacterial analysis on the submitted carcasses are presented in Table 4. Amongst the parasitic diseases, tapeworms were found to be highest (11.05%), followed by roundworms (8.29%) and hemoparasites (5.07%) (babesiosis and theileriosis). Highest incidence of roundworms was noted in Chinkara deer (20.00%), while for tapeworms the highest incidence was in Rusa deer (27.27%). No liver flukes were recorded in any of the carcasses. Hemoparasitism was highest in Red deer (50.00%). In bacterial analysis, 8.29% cases of pneumonia and 8 cases of tuberculosis (3.69%) were reported. The etiologic agents were *Streptococcus pneumonaie* and *Mycobacterium tuberculosis* respectively. The highest percentage of 27.27 (3/11) was recorded for bacterial infection in Rusa deer which included 18.18% for pneumonia alone.

Table 1 Primary disease diagnosis in 217 captive ungulates*

Animals (n=217)	Starvation	Gut affections	Trauma	Bacterial infections	Parasitic diseases	Stillbirths	Snakebites	Neoplasia	Unknown
Blackbuck (n=31)	1 (3.22)	1 (3.22)	8 (25.80)	3 (9.67)	6 (19.35)	1 (3.22)	2 (6.45)	2 (6.45)	7 (22.58)
Chinchaga (n=20)	0	1 (5.00)	2 (10.00)	3 (15.00)	4 (20.00)	1 (5.00)	0	1 (5.00)	8 (40.00)
Hog deer (n=116)	1 (0.86)	3 (2.59)	25 (21.55)	14 (12.07)	11 (9.48)	6 (5.17)	3 (2.59)	0	53 (45.69)
Spotted deer (n=35)	0	0	3 (8.57)	3 (8.57)	10 (28.57)	10 (28.57)	1 (2.86)	0	8 (22.86)
Red deer (n=04)	0	0	1 (25.00)	0	2 (50.00)	0	0	0	1 (25.00)
Rusa deer (n=11)	0	0	5 (45.45)	3 (27.27)	1 (9.09)	2 (18.18)	0	0	0
Total	**2 (0.92)**	**5 (2.30)**	**44 (20.27)**	**26 (11.98)**	**34 (15.67)**	**20 (9.21)**	**6 (2.76)**	**3 (1.38)**	**77 (35.48)**

*Values in parenthesis are percentages.

Table 2 Gender wise primary disease diagnosis in 217 captive ungulates*

Animals (n=217)		Starvation	Gut affections	Trauma	Bacterial infections	Parasitic diseases	Stillbirths	Snakebites	Neoplasia	Unknown
Blackbuck\ (n=31)	Male (n=13)	1 (7.69)	0	2 (15.38)	2 (15.38)	4 (30.76)	1 (7.69)	0	1 (7.69)	2 (15.38)
	Female (n=18)	0	1 (5.55)	6 (33.33)	1 (5.55)	2 (11.11)	0	2 (11.11)	1 (5.55)	5 (27.77)
Chinkara (n=20)	Male (n=6)	0	1 (16.66)	0	1 (16.66)	3 (50.00)	0	0	0	1 (16.66)
	Female (n=14)	0	0	2 (14.28)	2 (14.28)	1 (7.14)	1 (7.14)	0	1 (7.14)	7 (50.00)
Hog deer (n=116)	Male (n=52)	1 (1.92)	2 (3.84)	11 (21.15)	8 (15.38)	8 (15.38)	1 (1.92)	1 (1.92)	0	20 (38.46)
	Female (n=64)	0	1 (1.56)	14 (21.87)	6 (9.37)	3 (4.69)	5 (7.81)	2 (3.12)	0	33 (51.56)
Spotted deer (n=35)	Male (n=16)	0	0	2 (12.5)	2 (12.5)	7 (43.75)	0	0	0	5 (31.25)
	Female (n=19)	0	0	1 (5.26)	1 (5.26)	3 (15.78)	10 (52.63)	1 (5.26)	0	3 (15.78)
Red deer (n=4)	Male (n=2)	0	0	1 (50.00)	0	0	0	0	0	1 (50.00)
	Female (n=2)	0	0	0	0	2 (100.00)	0	0	0	0

Rusa deer (n=11)	Male (n=8)	0	0	4 (50.00)	2 (25.00)	1 (12.5)	1 (12.5)	0	0	0
	Female (n=3)	0	1 (33.33)	1 (33.33)	1 (33.33)	0	1 (33.33)	0	0	0
Total	**Male (n=97)**	**2 (2.97)**	**3 (3.09)**	**20 (20.62)**	**15 (15.46)**	**23 (23.71)**	**3 (3.09)**	**1 (1.03)**	**1 (1.03)**	**29 (29.90)**
	Female (n=120)	**0**	**2 (1.66)**	**24 (20.00)**	**11 (9.17)**	**11 (9.17)**	**17 (14.17)**	**5 (4.17)**	**2 (1.66)**	**48 (40.00)**

*Values in parenthesis are percentages.

Table 3 Age wise primary disease diagnosis in 217 captive ungulates*

Animals (n=217)		**Starvation**	**Gut affections**	**Trauma**	**Bacterial infections**	**Parasitic diseases**	**Stillbirths**	**Snakebites**	**Neoplasia**	**Unknown**
Blackbuck (n=31)	Young (n=06)	1 (16.66)	0	0	1 (16.66)	2 (33.33)	1 (16.66)	1 (16.66)	0	0
	Adult (n=25)	0	1 (4.00)	8 (32.00)	2 (8.00)	4 (16.00)	0	1 (4.00)	2 (8.00)	7 (28.00)
Chinkara (n=20)	Young (n=07)	0	0	0	2 (28.57)	2 (28.57)	1 (14.28)	0	0	2 (28.57)
	Adult (n=13)	0	1 (7.69)	2 (15.38)	1 (7.69)	2 (15.38)	0	0	1 (7.69)	6 (46.15)
Hog deer (n=116)	Young (n=34)	1 (2.94)	0	2 (5.88)	9 (26.47)	1 (2.94)	6 (17.65)	0	0	15 (44.12)
	Adult (n=82)	0	3 (3.65)	23 (28.04)	5 (6.09)	10 (12.19)	0	3 (3.65)	0	38 (46.34)
Spotted deer (n=35)	Young (n=19)	0	0	0	1 (5.26)	3 (15.78)	10 (52.63)	0	0	5 (26.31)
	Adult (n=16)	0	0	3 (18.75)	2 (12.5)	7 (43.75)	0	1 (6.25)	0	3 (18.75)
Red deer (n=4)	Young (n=1)	0	0	0	0	0	0	0	0	1 (100)
	Adult (n=3)	0	0	1 (33.33)	0	2 (66.66)	0	0	0	0
Rusa deer (n=11)	Young (n=3)	0	0	0	1 (33.33)	0	2 (66.66)	0	0	0
	Adult (n=8)	0	0	5 (62.5)	2 (25.00)	1 (12.5)	0	0	0	0
Total	**Young (n=70)**	**2 (2.86)**	**0**	**2 (2.86)**	**14 (20.00)**	**8 (11.43)**	**20 (28.57)**	**1 (1.43)**	**0**	**23 (32.86)**
	Adult (n=147)	**0**	**5 (3.40)**	**42 (28.57)**	**12 (8.16)**	**26 (17.69)**	**0**	**5 (3.40)**	**3 (4.28)**	**54 (36.73)**

*Values in parenthesis are percentages.

Table 4 Prevalence of parasitic and bacteriologic disorders in 217 captive ungulates*

Animals	Parasitologically Positive				Bacteriologically positive	
	RW (%)	TW (%)	Cocci (%)	Hemo parasite (%)	Pneumonia	Tuberculosis
Blackbuck (n=31)	6 (19.35)	4 (12.90)	1 (3.25)	1 (3.23)	2 (6.45)	1 (3.22)
Chinkara (n=20)	4 (20.0)	1 (5.00)	3 (15.0)	0	3 (15)	0
Hog deer (n=116)	2 (1.72)	8 (6.89)	1 (0.86)	6 (5.17)	10 (8.62)	4 (3.44)
Spotted deer (n=35)	4 (11.43)	8 (22.85)	3 (8.57)	1 (2.85)	1 (2.85)	2 (5.71)
Red deer (n=4)	0	0	0	2 (50.0)	0	0
Rusa deer (n=11)	2 (18.18)	3 (27.27)	1 (9.09)	1 (9.09)	2 (18.18)	1 (9.09)
Total	**18 (8.29)**	**24 (11.05)**	**9 (4.15)**	**11 (5.07)**	**18 (8.29)**	**8 (3.69)**

*Values in parenthesis are percentages RW= Roundworms; TW= Tapeworms, Cocci= Unidentified cocci

DISCUSSION

Pakistan, in the last five years has witnessed a soaring trend in rearing of various wildlife ungulates (gazelles and deer) at a private level. However, to the best of our knowledge no work regarding the epidemiology of mortality in these animals has yet been reported. Scanty work published is on certain other aspects such as endoparasites (Hayat et al., 1998) and enterotoxaemia in deer (Khan et al., 2008).

The present study documents the causes of mortality in 217 captive ungulates. Maximum number of cases was brought from Jallo Park, Lahore and least from private owners. Jallo Park is a public recreational and wildlife park. On the other hand, the private owners of these animals usually keep a few animals as captive and do not care for cause of death. Furthermore, the lack of awareness regarding the facility of post mortem being provided by the VRI to private owners may also be the probable cause of less number of cases reported. The private owners, for the most part are individuals who keep animals on small scale for profit or pleasure (Beetz, 2005). The role of private ownership in captive breeding of many animals in Pakistan can be enhanced by provision of awareness of management and husbandry, emergency handling, captive environmental enrichment and government furnished facilities. (Reynold et al., 2005; Sajjad et al., 2011). All such enrichment can be done to private sector through Governmental regulations, mass awareness campaigns (electronic and social media) and especially through formation of a private-public-research sector nexus.

Overall mortality factor assessment revealed that maximum number of deaths occurred due to trauma. Most of the previous work done (Alonso-Aguirre et al., 1999; Woodbury et al., 2005) depicts trauma as the major cause of death in captive wildlife. However, the nature, degree, type and cause of trauma were different. In our study, trauma was found to be mostly associated with antler punctures from other animals and barbed wires used for the confinement of the animals. The captivity module (number of males per herd) and captivity forms need to be re-assessed in Pakistan. The 2 cases of starvation in the study were the young ones. This may be attributed to maternal neglect (Pople et al., 2001).

Gender wise distribution revealed a higher death loss in females as compared to males. Similar results were reported in Roe deer by Alonso Aguirre et al. (1999). However, Woodbury et al. (2005) reported the mortality rates of 2.4 and 2.7% for female and male farmed elks, respectively. The variations among results of different studies can be due to variation in captivity modules, handling protocols being practiced and species differences (Hattel et al., 2004). Trauma was found to be highest mortality factor both in males and in females in the present study. These results coincide with previously published reports for Roe deer (Alonso- Aguirre et al., 1999), farmed elks (Hattel et al., 2004) and white-tailed deer (Woodbury et al., 2005) which revealed traumatic injuries to be highest mortality factors both for females and males. However, the type and cause of trauma might be different for each study owing to varying captive environment and handling protocols.

Age wise distribution revealed a higher death loss in adults as compared to young ones. However, Hattel et al. (2004) and Woodbury et al. (2005) reported high

mortality rates in neonatal and young calves as compared to adults. Their work indicated first year of life of captive ungulates to be especially critical. Variable results in our study regarding the age wise distribution of mortality factors may be correlated to variation in herd size, captivity modules and number of males being kept in a herd (Pople et al., 2001). Trauma as a major cause of mortality in adults has also been verified by previously published data (Hattel et al., 2004; Woodbury et al., 2005).

In the present study, assessment of physical condition of submitted carcasses revealed that highest cases were emaciated. Alonso-Aguirre et al. (1999), while working on mortality factors of Roe deer, reported a higher percentage of 57.17 (530/927) for emaciated animals and 22.76 (211/927) for good body condition. However, lower number of ungulates with good body condition in the present study may be because of poor management and husbandry protocols. Frequency of emaciation was higher in the young ones as compared to adults which seem to be due to abandonment of neonates by their dams, a common trend observed in captive ungulates females (Pople et al., 2001). Dystocia and human interference at the time of parturition are the predisposing factors that lead to the calf rejection by their dams.

The parasitic analysis revealed highest number of cases for tapeworms, followed by roundworms and hemoparasitism (babesiosis and theileriosis) while no liver flukes were noticed in the study. According to Woodbury et al. (2005), most common parasites in carcasses of farmed elks were liver-flukes (26/75 or 34.7%). However, hemoparasitism was at the bottom of the list of many earlier work published (Alonso-Aguirre et al., 1999; Pople et al., 2001), which support the findings of present study.

Bacterial analysis depicted pneumonia and tuberculosis as prevalent bacterial diseases. The etiologic agents isolated were S*treptococcus pneumoniae* and *Mycobacterium tuberculosis*, respectively. Hattel et al. (2004) also observed pneumonia as a major cause of mortality in White Tailed deer (39/160). However, the causative agents recorded were *Arcanobacterium pyogenes* and *Fusobacterium necrophorum.* Similarly, Alonso-Aguirre et al. (1999) also reported pneumonia as the primary bacterial infection in deer (77/985) with varying etiologic agents. The difference in etiologic agents for the same problem in different studies may be due to variable weather conditions, heterogeneity of habitats and geographically related epidemiologic variations (Nixon et al., 2001).

In conclusion, highest mortality factor in wildlife captive ungulates is trauma, followed by parasitic and bacterial infections of tapeworms and pneumonia, respectively. Furthermore, necropsies provide information on etiology of death, bio-dynamics of species and information on zoonotic aspects.

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