Original Research Article

Study on Equine foot diseases in Assam- A North-eastern state of India

ABSTRACT

Aim: To study the prevalence of various foot disorders in riding horses and their association with immediate environmental conditions, particularly equine housing pattern as well as to establish correlations between the prevalence of diverse foot ailments and the temporal variations specific to the region.

Study design: Thepresent study is a cross-sectional observational work designed to collect data regarding various foot affections prevalent in equine population of selected locations of Assam, India.

Place of Study:4th Assam Police Battalion, Kahilipara, North-East Police Academy, Barapani, 47 Assam NCC Squadron, Khanapara and SSB horse unit, Debendra Nagar, Tezpur.

Methodology: Surveys were conducted to assess the prevalence of hoof-related conditions in horses through interviews, physical examinations and radiographic examinations. Etiological factors were investigated by recording the history of affected animals, including concentrate ration type, quantity, foot care practices, and hoof trimming routines.

Results: Thirty Five (35)out of 49 stabled horses (71.42%) exhibited various foot lesions while remaining 14 horses were detected with minor cut/abrasion.Prevalence of foot afflictions was found to be higher during the summer season (42.86%) in comparison to the winter season (28.57%). The spectrum of foot ailments documented in this study includes hoof overgrowth (57.14%), hoof cracks (20%), thrush (8.57%), suppurative sole conditions (5.71%), quittor (2.86%), laminitis (2.86%) and bulb fibromas (2.86%). Interestingly, the occurrences of various types of foot afflictions werenotably elevated in equine enclosures with concrete flooring (94.29%), as opposed to sand flooring (5.71%).Hematological analyses indicated significant alterations in various blood parameters during both summer and winter for both healthy and affected equines in Hb and mean values of RBC and WBCwith the exception of neutrophil counts. Biochemical assessments revealed noteworthy increase in mean values of serum creatinine, CK, andALP in affected horses, though AST levels remained unaffected.

Conclusion: This comprehensive investigation highlights the multifaceted interplay between equine health, housing conditions, dietary patterns, and seasonal factors in the prevalence of foot disorders in stabled horses.

Keywords: equine, foot affections, quittor, thrush, Assam

1. INTRODUCTION

Horses have been an important part of human culture since time immemorial. According to Hindu mythology, the horse is related to Lord Hayagriva- the God of '*knowledge'* and '*wisdom',* who had the body of a human and the head of a horse. Horses have been an integral part of warfare since ancient times. The first archaeological evidence of horses being used in warfare dates between 4000 and 3000 BC and the use of horses in warfare were widespread by the end of the Bronze Age. In early ages, horses were also used in ploughing the paddy field in some parts round the globe.

In present day scenario, horses are used as sporting animals in various equestrian events throughout the globe. Many sports, such as dressage and show jumping are being played. However, with the increase of equine population as a utility animal in various fields, the challenges of diseases are also increasing. Any sort of diseases or discomfort to these sensitive animals may lead to decrease in their work utility and economic losses to the owner. Traumatic injury during work and prolong standing on the hard concrete floor may lead to various type of foot affections which results in lameness. During summer season, the wet condition of the foot due to soiling with dung and urine lead to growth of numerous microorganisms.

Organisms with the morphology of *Fusobacteriumnecrophorum*were reported to cause foot affections resulting in lameness in equine (Petrov, 2013). There are a number of serious sequelae of chronic *Fusobacteriumnecrophorum*in the frog of the horny hoof resulting in offensive blackish discharge from the sulci of the frog commonly called as thrush. Apart from thrush, canker or pododermatitis is another cause of equine lameness which results in keratolysis of the hoof. Chronic manifestation of hoof infected with canker leads to verrucose proliferation (non-neoplastic) of the hoof.The present study delves into various foot ailments affecting horses.

2. MATERIALS AND METHOD

2.1 Study Design

In the present study, an investigation of 8 months was conducted on horses from various military and paramilitary equine establishments, including the 4th Assam Police Battalion, Kahilipara (26.145911, 91.755089), North-East Police Academy, Barapani(25.679846, 91.895100), 47 Assam NCC Squadron, Khanapara (26.118861, 91.816576), and the SSB horse unit in Debendra Nagar, Tezpur (26.735574, 92.824117). The study encompassed horses of diverse cross-breeds, rendering breed-specific categorization unnecessary. Extensive surveys were conducted in these regions to assess the prevalence of hoof-related conditions, with a particular focus on their correlation with seasonal variations, flooring patterns, functional roles, dietary habits, and hemato-biochemical parameters.

Data were gathered through interviews with horse handlers and meticulous physical examinations, including visual assessments for external defects and soundness, as well as acomprehensive locomotor system examination, including gait analysis and hoof assessment through a hoof tester (Fig 1-4).

Radiographic examinations were carried out for cases that did not reveal any anomalies through initial assessments (Fig 11). The annual cycle was divided into winter and summer seasons to analyze the seasonal impact on foot conditions, while the type of stable flooring (Fig 13 & 14) and hygiene status were documented to explore their role in developing hoof ailments. Etiological factors were investigated by recording the history of affected animals, including concentrate ration type, quantity, foot care practices, and hoof trimming routines.

2.2Estimation of haemato-biochemical parameters

Blood was collected aseptically from jugular vein of apparently healthy and affected animals for haemato-biochemicalstudies. Four (4)ml of whole blood was collected putting two(2) ml in EDTA vial) and rest two (2) ml in a clot activator vial undisturbed for collection of serum.

2.3 Statistical analysis

The quantitative estimates were analyzed as per the method described by Snedecor and Cochran (2004) and SPSS 16.0 for Windows.

3. RESULTS AND DISCUSSION

3.1 Prevalence

A total of 49 (forty nine) horses were surveyed in both summer and winter, out of which 35 (71.42%) horses were found to be affected with different foot affections (Table 1). The study has revealed that the prevalence of foot affections in this managerial condition was much higher compared to the observations of Talukdar (2005) who studied 142 animals and found 27 (19.01%) of them to be affected with various claw lesions. Among the different foot affections, hoof overgrowth was the most predominant hoof lesion (57.14%) as depicted in Table 2 and Fig 5-12.Nelson and Cattell (2001) also observed that laminitis was found to be highest among other foot affections with prevalence rate 9.8 % in the culling horses and 43.5% in the culling cows (Fig 10). However, Talukdar (2005) recordedan overall prevalence rate of 22.22% in equine farm. This discrepancy in prevalence rate may be attributed to several factors, such as variations in specific conditions or environments under which the animals in the two studies were managed. It could also be influenced by differences in the methodology employed, the selection criteria for the animals, sample size or the time frame in which the studies were conducted.

The present study revealed that the prevalence of foot affections were highest during the summer season i.e., 42.86% while in winter it were decreased to 28.57% (Table 3). This might be due to the wet condition due to the high humidity of the north-eastern region of India during summer season that favours the multiplication and proliferation of numerous microorganisms. In support of that, French *et al.* (2013) reported that wet weather also reduces hygiene and dryness of hoof.

Out of the two different types of floor pattern observed under the present study, higher prevalence was found in horses housed on concrete floor i.e., 94.29%, on the contrary, the foot affections in horses housed in sand floor was much lower i.e., 5.71 % (Table 4)& (Fig. 13 &14). Floors made up of concrete were generally not properly laid with cement or the stables considered under this study were very old and due to which the surface concrete was eroded resulting in exposure of small gravels of the floor and causing damage to the solar surface. Moreover, due to breakage in the floor, the dung and urine get lodged in it and bacterial multiplication takes place. Bergsten (2010) also opined similar statement in regards to effect of flooring on claw health and lameness. However, Gooch (2013) in his investigation concluded that the concrete was the material of choice for flooring of animals for minimal

foot and leg problems. On the contrary, Blowey (2005) reported that higher quality horns are produced by animals that walk on rubber floor than on concrete.

Highest prevalence of foot affections in the present study was found in animals that were on raised on high concentrate ration (77.14%) compared the low concentrate ration (22.86%)as depicted in Table 5. Higher quantity of concentrates was given to animals to support their capability to work and also to compensate the scarcity of roughages leading to a tilt in the ratio of concentrate to roughages which might be one of the possible causes of inciting foot related problems. In support to this, Livesey and Fleming (1984) reported that 64% of cows on a high concentrate but low fiber diet developed sole ulcers leading to lameness compared with only 8% of animals receiving a high fiber ration with low concentrate.Pollitt (2004) also reported that carbohydrate rich diet can also induce laminitis leading to separation of the sensitive laminae.

Highest prevalence of foot diseases in the present investigation was found in animals that were engaged on various sports events (88.57%) compared to the other two categories of works involved eitherroutine work (2.86%) or kept for miscellaneous purposes (6.12%) as depicted in Table 6.The reason behind highest prevalence of foot affection under the sports category may be because of various activities like long distance walk/run on hard surface. Such activities often subject the animal to mechanical injuries leading to diseases like laminitis (Adams, 1966).

In the present study, fore foot affection (60.00%) in horses were more common than in hind foot (25.71%) (Table 7); this might be due to the fact that the horses whenever takes a jump, it always lands on the fore feet first, so there is every possibility of injury to forelimb (Adams, 1966). Another most important thing may be the reason that the horses uses their limbs in getting up and lying down which may predispose them to various foot affections. Also, hygienic status of the stables was another reason for this as less exposure time of the hind limbs to dung and urine as a result of good hygienic practices may minimize theaffections in the hind limbs. This investigation was contrary with the reports of Talukdar*et al.* (2005) and Konwar*et al.* (2015) as they opined that foot affections were less significant in fore limbs compared to the hind limbs.

3.2 Haematology

The present study revealed haemoglobin, Packed cell volume (PCV) and mean ofred cell count and white blood cell levels of the affected animals were significant highin comparison to the normal animals during summer, while showing insignificant decrease during winter season (Tables 8 and 9). Nilsson (1963) also recorded an increase in the mean Hb values& mean RBC count in animals with laminitisto that of normal animals. This transient rise in Hb &RBC values was apparently due to the acute inflammatory state of the laminae as mentioned by Sastry (2004). On contrary to that, Khalafizadeh*et al*. (2006) recorded a significant decrease in the mean Hb and RBC values in affected animals than to normal animals.Significant rise in WBC level was observed in case of animals suffering from bulb fibroma during summer as compared to the other diseases while in case of hoof wall crack, during summer and hoof over growth during winter it decreased insignificantly (Tables

8and9). Similar reports were also published by Khalafizadeh*et al*. (2006).The significant rise in WBC values might be attributed to the body's immune response against ongoing infection or inflammation within the hoof tissues. The body's immune system responds to these changes by recruiting white blood cells to the site of infection, leading to an increase in WBC count (Dabareiner*et al*., 2001). However, Hussain and his associates (2004) failed to record any significant difference in the values WBC count between the normal and mules affected with foot infection.Findings of PCV values in our study are in line with Rezazadeh *et al.* (2017) who conducted a study on Arab mules. Maximum significant rise in PCV value was observed in case of animals suffering from quittor during summer followed by hoof over growth and hoof wall crack. Fluctuations in PCV values is non-specific can be indirectly relatedwith various ongoing physiological and pathological reasons like oxidative stress, inflammatory responsesoccurringinside the hoof microenvironment (Patterson-Kane *et al*., 2018).Non significant differences were found in case of neutrophil, eosinophil and basophil both in summer and winter, however highly significant increase was found between the mean values of lymphocyte and monocyte both in summer and winter season. Whereas, when observed individually statistically significant rise were recorded in DLC values in suffering from quittor, laminitis and thrush during summer whereas during winter, insignificant decrease in neutrophil only was recorded. (Tables 8and9). Khalafizadeh*et al*. (2006) recorded significant difference between the mean values of Neutrophil and Monocyte, while non-significant difference between the mean values of Lymphocyte and Eosinophil between control and affected groups. Pouyade and Serteyn (2011) reported in their study that therewas significant increase in neutrophil values in laminitis due to release of pro-inflammatory cytokines.

3.3 Serum biochemistry

Serum enzyme values recorded highly significant rise in the mean values of the Creatinine,Creatine Kinase and Alkaline Phosphatase (ALP) inaffected animals compared to the normal animals during summer, while it was observed that slight and significant increase in the mean Creatinine values were obtained from affected animals when compared to the normal animalsduring winter but values of Creatine Kinase and Alkaline Phosphatase (ALP) were decreased insignificantly(Tables 8and 10).Similar observations were reported by O'Driscoll *et al.* (2015), Mohebbi *et al.*(2016) and Hussain*et al.* (2004). They also reported that the said values of diseased mules with acute laminitis and lameness due to sole ulcer were significantly higher when compared with those of healthy mules.The values for Aspartate amino transferase (AST)in our study showed insignificant difference between the normal values of the affected animals compared to the normal animals both in summer and winter. Significant increase in AST value was observed in animals with hoof wall crack and in thrush in summer. Yaylak*et al.*(2009) in their study had also recorded insignificant decrease in the mean AST values in affected animals compared to the normal animals. Elevated levels of Creatinine, CK, and ALP in our study horses with foot disease suggest potential muscle damage, compromised renal function, and increased bone turnover, respectively, reflecting the systemic impact of hoof pathology on various physiological processes and could be suggestive of potential biomarkers when study hoof pathology in equines (Patterson-Kane *et al*., 2018). Also, decreased AST values can be due to reduce

muscular damage due reduce mobility of horse due to pain and also due to medication against pain management that indirectly lowers AST values in blood.

Table 1. Overall prevalence

Animals surveyed	Number of animals affected	Overall prevalence (%)
49	35	**71.42**

Table 2 Prevalence (%) of various foot affections (**n=35**)

Sl. no.	Type of affections observed	Number of Animals affected	Positive prevalence (%)
1	Hoof overgrowth	20	57.14
2	Hoof wall crack	7	20.00
3	Thrush	3	8.57
4	Suppurative sole	2	5.71
5	Quittor	1	2.86
6	Laminitis	1	2.86
7	Bulb fibroma	1	2.86

Table 3 Season

Sl. no.	Season	No. of animals affected	Prevalence (%)
1.	Winter (Nov-Dec-Jan-Feb)	14	28.57
2.	Summer(Feb-March-April-May)	21	42.86

Table 4. Floor pattern

Sl. No.	Floor pattern	No. of animals affected	Prevalence (%)
1.	Concrete	33	94.29
2.	Sand	2	5.71

Table 5. Feeding practice

Sl. No.	Type of feed	No. of animals affected	Prevalence (%)
1.	High concentrate (low fibre)	27	77.14
2.	Low concentrate (high fibre)	8	22.86

Table 6. Utility/work (n=35)

Sl. No	Types of work	No. of animals affected	Prevalence (%)
1	Sports	31	88.57
2	Working	1	2.86
3	Miscellaneous	3	8.57

Table 7. Appendages (n=35)

Sl. No.	Foot/appendage	No. of animals affected	Prevalence (%))
1.	Fore	21	60.00
2.	Hind	9	25.71
3.	Both	5	14.29

Table 8. Blood profile of apparently healthy and affected animals

Parameters	Apparently healthy				Affected			
	Summer		Winter		Summer		Winter	
	Mean	+SE	Mean	+SE	Mean	+SE	Mean	+SE
Hb (g/dl)	10.48	0.04^{B}	10.08	0.02^{B}	13.79	0.70^{A}	8.33	0.14^{C}
RBC(106/cu mm)	7.17	0.05^{B}	7.12	0.03^{B}	9.04	0.37^{A}	5.80	0.22^{C}
WBC(103/cu mm)	7.18	0.13^{B}	7.75	0.13^{B}	8.72	0.48^{C}	7.47	0.60^{B}
PCV %	31.90	0.42^{C}	38.54	1.10^{B}	44.08	1.12^{A}	23.63	0.77^{D}
Neutrophil (%)	60.38	0.94^{A}	58.78	0.84^{A}	53.10	3.66^{A}	52.16	5.37^{A}
Lymphocyte (%)	25.13	0.71^{B}	28.24	0.78^{B}	44.59	3.02^{A}	28.21	3.89^{B}
Monocyte (%)	2.88	0.13^{B}	3.81	0.23^{B}	10.53	1.24^{A}	6.92	1.30^{A}
Eosinophil (%)	2.20	0.21^{B}	1.50	0.13^{B}	3.88	0.15^{A}	2.64	0.21^{A}
Basophil (%)	0.46	0.06^{B}	0.83	0.08^{A}	0.88	0.11^{A}	0.88	0.12^{A}
Creatinine (mg/dl)	1.12	0.03^{B}	1.31	0.07^{B}	2.91	0.14^{A}	1.40	0.12^{B}
Creatine Kinase (U/L)	50.93	1.23^{D}	122.65	3.46^{C}	243.34	22.06^{A}	185.52	9.90^{B}
AST(U/L)	206.19	7.56^{A}	212.65	8.46^{A}	156.74	13.48^{B}	146.83	13.14^{B}
ALP(U/L)	90.48	2.87^{C}	140.32	5.74^{C}	492.92	54.55^{A}	318.96	16.01^{B}

Script after figure is the result of Turkey's post hoc HSD test presented row wise ($\alpha=0.05;Q=2.64252$). Letter not similar are significantly different.

Table 9. Analysis of variance of Hb , RBC ,WBC ,PCV and DLC

Source	df	Mean Square

		Hb (g/dl)	RBC(106/cumm)	WBC(103/cumm)	PCV (%)	Neutrophil (%)	Lymphocyte (%)	Monocyte (%)	Eosinophil (%)	Basophil (%)
Animal	34	1.74	0.45	1.4	30.67	129.45	65.53	9.33	0.79	0.14
		(.89 ^{NS})	(.981 ^{NS})	(.963 ^{NS})	(.062 ^{NS})	(.526 ^{NS})	(.848 ^{NS})	(.780 ^{NS})	(.406 ^{NS})	(.923 ^{NS})
Season	1	184.11	59.27	1.88	1049.94	91.09	716.76	19.05	23.18	0.98
		(<.001**)	(<.001**)	(.387 ^{NS})	(<.001**)	(.412 ^{NS})	(.007**)	(.212 ^{NS})	(<.001**)	(.036*)
Affected	1	9.12	0.96	8.72	13.74	1126.09	2210.81	574.36	30.16	0.98
		(.064 ^{NS})	(.298 ^{NS})	(.065 ^{NS})	(.404 ^{NS})	(.005**)	(<.001**)	(<.001**)	(<.001**)	(.036*)
Season × Affected	1	137.47	53.5	16.45	3598.09	69.66	1.65	0.7	69.66	1.65
		(<.001**)	(<.001**)	(.012*)	(<.001**)	(.019*)	(.139 ^{NS})	(.075 ^{NS})	(.019*)	(.139 ^{NS})
Error	60	2.57	0.88	2.47	19.48	133.21	90.95	11.95	0.74	0.21

Figure within parenthesis indicates P-value. P-value < .05 is significant; P-value < .01 is highly significant ; P-value > .05 is not significant.

Table 10. Analysis of variance of Creatinine, CK, AST and ALP

Source	df	Creatinine (mg/dl)	Creatine Kinase (U/L)	AST(U/L)	ALP(U/L)
Animal	34	0.16	2265.02	2899.76	10208.3
		(.700^{NS})	(.697 ^{NS})	(.210 ^{NS})	(.936 ^{NS})
Season	1	8.94	1994.78	598.19	58994.1
		(<.001**)	(.391 ^{NS})	(.611 ^{NS})	(.064 ^{NS})
Affected	1	14.25	295382	65136.4	1560741
		(<.001**)	(<.001**)	(<.001**)	(<.001**)
Season × Affected	1	16.04	77519.8	1796.56	225035
		(<.001**)	(<.001**)	(.38 ^{NS})	(<.001**)
Error	60	0.19	2676.78	2292	16578.6

Figure within parenthesis indicates P-value. P-value < .05 is significant; P-value < .01 is highly significant; P-value > .05 is not significant.

Fig 1: Lame horse subjected to walk

Fig 2: Application of hoof tester

Fig 3: Percussion of hoof

Fig 4: Measuring of coronary band

Fig 5: Hoof overgrowth

Fig 6: Hoof wall crack

Fig 7: Thrush

Fig 8: Suppurative sole

Fig 9: Quittor

Fig 10: Laminitis showing circular rings on hoof wall

Fig 11: Laminitis (3rd phalanx rotation

Fig 12: Bulb fibroma

Fig 13: Sand floor

Fig 14: Concrete floor

4. CONCLUSION

The present investigation encompassing 49 equine subjects within the military and paramilitary establishments of the North-East region of India, a total of 35 cases involving diverse foot afflictions were diligently examined. Among these, hoof over-growth emerged as the most prevalent malady, followed in incidence by hoof wall cracks, thrush, suppurative sole conditions, quittor, laminitis, and bulb fibromas. Notably, equines subsisting on a diet predominantly composed of high-concentrate

rations exhibited a heightened susceptibility to these foot ailments when compared to their counterparts with diets primarily composed of roughages. Furthermore, the exacerbation of such conditions was found to be associated with the suboptimal maintenance of equine living environments, particularly manifesting as unhygienic concrete flooring. In conjunction with the clinical findings, hematological and biochemical analyses unveiled a noteworthy elevation in various blood indices and serum concentrations of creatinine, (CK) and ALP values, shedding light on the systemic ramifications of these foot afflictions. This research underscores the imperative need for holistic equine health management and maintenance practices, aiming to mitigate the incidence and severity of foot disorders in equine populations.

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