Vol.2, No.6, Page 492- 498, 2024 https://doi.org/10.59628/jast.v2i6.1150 ISSN 2958-9568 JAST

SUN PUBLISHER

مجلة جامعة صنعاء للعلوم التطبيقية والتكنولوجيا

Sana'a University Journal of Applied Sciences and Technology

https://journals.su.edu.ye/index.php/jast/

Prevalence, Risk Factors, and Haemato-Biochemical Changes Associated with Colic in Horses in Sana'a Province, Yemen

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Abstract

Background: Colic is a major health problem in controlled horse populations globally. It is a multifactorial and complex disorder. In Yemen, the prevalence, risk factors, and results of horse colic are unclear.
Objectives: The current study aimed to determine the prevalence, risk factors, and haemato-biochemical changes associated with colic in horses in Sana'a, Yemen.
Methods: A prospective study was conducted from September 2023 to February 2024. A total of 254 horses were examined under field conditions. Colic was identified based on physical examination, clinical symptoms, and rectal examination. A questionnaire was distributed to the horse owners to assess the risk factors while the clinical examination was performed, and blood samples were obtained to estimate the haemato-biochemical parameters in horses with colic.
Results: out of a total of 254 horses, the overall prevalence of colic in horses was found to be 11.81% (30 cases) and of these, 73.3% had spasmodic colic whereas 26.7% had impaction. The Means of respiration rate, pulse rate, and capillary refill time were significantly increased in horses affected with colic than healthy control animals ($P<0.05$). The horses with colic showed a significant association between cases with age ($p<0.098$), gender ($p<0.023$), deworming frequency ($p<0.001$), and previous exposure to colic ($p<0.001$). In hematological indices, the mean packed cell volume in horses with colic was found to be dramatically increased ($P<0.0001$), while the means of total platelet count, lymphocyte count, and neutrophil count were found to be significantly decreased ($P<0.001$). Serum biochemical indices, including aspartate aminotransferase, alanine aminotransferase, blood urea nitrogen, creatinine, glucose, albumin, total protein, and alkaline phosphate, were significantly higher in horses with colic compared to healthy controls ($P<0.0001$).
Conclusions: This is the first study that documented the prevalence of colic in horses and identified risk factors and haemato-biochemical changes associated with colic in Sana'a province, Yemen. This information is a crucial first step in understanding the impact of colic in horses and developing ways to reduce the risk of colic.

Article Info

Keywords:
Horses, Colic, Sana'a, Prevalence,Risk factors,Hematological,Biochemical

Article History:
Received: 29-July-2024,
Revised: 27-August-2024,
Accepted: 19-November-2024,
Available online: 31 December 2024.

1. INTRODUCTION

Horses in Yemen are one of the oldest breeds of horses in the world and the oldest and most expensive, owing

to the attention of Yemeni Arab breeders for excellent horses and the maintenance of their lineages and offspring, making them the best horses that exist in the world today and the finest ever. Although horse breeding is of economic, social, and cultural importance in Yemen, the equine population is small and can hardly be compared to other countries in the peninsula and Gulf. Horses are raised in some Yemeni governorates, mainly in Sana'a Province, which is considered the forefront in the number of horses compared to other governorates in Yemen.

Horses are susceptible to various illnesses. Colic (abdominal pain) is among the most common conditions affecting horses and is one of the most common causes of death [1]. Colic can be classified into two types, true colic and pseudo colic. True colic, which is related to digestive system disorders, is frequently caused by colon impaction, catarrhal enteralgia, flatulence, and gastric distension. In contrast, pseudo colic is produced by affliction of other organs of the abdominal cavity and can be linked to liver disease, kidney failure, myositis ossificans, tethering syndrome, uterine torsion, or urolithiasis [2].

Horse colics are a global problem. Regarding cases that are identified in the field rather than those that are sent for specialized care, the incidence rate for the condition ranges from 3.5 to 10.6 cases per 100 horse years, although individual farms may have rates as high as 30 or higher [3]. This study was based on data obtained from the National Animal Health Monitoring System (NAHMS). According to a survey, every 100 horses will experience 4.2 colic occurrences each year [4]. Many horses and management-level risk factors have been identified to be associated with the chance of colic, including sex, age, breed, previous colic episodes, internal parasites, feeding habits, feed type changes, and lack of exercise [5–8]. Understanding the factors associated with an increased risk of abdominal pain (colic) is important for both horse owners and veterinarians. Knowledge of risk factors can help identify animals at increased risk and influence management options to lessen or prevent colic [9]. A horse's hematological profile and blood chemistry can also be evaluated to determine the etiology of colic. Clinical and laboratory studies are used not only to diagnose but also to predict the prognosis of colic. Early identification and referral of colicky horses are crucial for achieving satisfactory results [2]. To the best of our knowledge, colic in horses and its risk factors associated have not been studied in Yemen, and this study is considered the first. Therefore, the present study aimed to determine the prevalence risk factors, and hemato-biochemical changes associated with colic in horses in Sana'a, Yemen.

2. MATERIALS AND METHODS

2.1. Study period and location

This study was carried out from September 2023 to February 2024 in Sana'a province, which is located in the north-central region of Yemen at a height of 2300 m above sea level, at 14°45′-16°5′ latitude and 43°30′-45°5′ longitude. Sana'a has an average monthly temperature of 15-25 °C, 35% humidity in June, and 52% humidity in April. Annual rainfall ranges from 117.6 mm in the north to 281.8 mm in the south [10].

2.2. Data collection

This prospective study randomly enrolled 254 horses from equestrian clubs and horse owners in Sana'a Province, Yemen. The Horses were examined under field conditions to determine the prevalence of risk factors and haemato-biochemical changes associated with colic. Colic in horses was diagnosed based on animal history, and clinical signs of abdominal pain. Colicky horses were examined for capillary refill time, pulse rate, respiratory rate, and rectal temperature. The abdomen was auscultated (presence or absence of borborygmi sounds) and rectal palpation was conducted as a classification of colic type. The owners also filled out a questionnaire on potential risk factors, including breed, age, gender, deworming frequency, feeding on green fodder, and previous exposure to colic.

2.3. Haemato-biochemical parameters

Blood samples were collected from 45 horses (30 horses that manifested signs of colic and 15 healthy horses served as control animals). Blood was obtained from the jugular vein of each colic case and control animal and placed in two separate tubes (one with and one without anticoagulant). The samples were labeled and transported in an ice pack to the laboratory for the measurement of hemato-biochemical parameters. Hematological parameters, including total erythrocyte count (TEC), packed cell volume (PCV), hemoglobin (Hb), total platelet count (TPC), total leukocyte count (TLC), and differential leukocyte count (DLC) (Neutrophils, Basophils, Eosinophils, Monocytes, and Lymphocytes) were estimated as per Feldman et al. [11]. Blood samples without anticoagulant were centrifuged at 3500 rpm for 10 min and serum was harvested and stored at minus 20ºC until analysis of biochemical parameters. Serum alanine aminotransferase (ALT), serum aspartate aminotransferase (AST), serum total protein (TP), blood urea nitrogen (BUN), serum creatinine (CREA), serum albumin (ALB), serum glucose (GLU), serum alkaline phosphate (ALKP), and blood lactate (LAC) were measured using the auto-biochemistry analyzer index test manufactured by IDEXX Laboratories in Maine, United States.

2.4. Statistical analysis

All acquired data were imported into Microsoft Office Excel 2010 and analyzed using the SPSS 20 edition. The variables from the questionnaire were translated into nominal criteria. A Chi-square test was used to examine the independent data for each criterion linked to colic. Data of vital parameters (rectal temperature, RR, HR, and CRT), and hematological and biochemical parameters (healthy and colicky group) were expressed as mean ± standard error (SE) and then analyzed using Student's t-test to analyze significant differences between the healthy and colicky group. Values were considered significantly different at $p<0.05$.

3. RESULTS

3.1. Prevalence and associated risk factors

Out of 254 horses, 30 were diagnosed with colic. The overall prevalence of colic in horses was found to be 11.81%. Of these, spasmodic and impactive colic were observed in 22 (73.3%) and eight (26.7%) cases, respectively. The majority of these horses showed behavioral symptoms of abdominal pain, such as curling the upper lip (93.3%), kicking at the abdomen (66.7%), staring at the belly (83.3%), pawing on the ground (96.7%), and rolling (73.3%). Physical indications for colic included abdominal distention (13.3%), intestinal sounds (43.3%), and poor appetite (40%) Table 1.

Table 1. Distribution of clinical signs of colic in horses

Variables	Colic horses	
	(n = 30)	%
Abdominal pain		
Curling upper lips	28	93.3
Kicking at the belly	20	66.7
Looking at the belly	25	83.3
Paw at the ground	29	96.7
Rolling	22	73.3
Abdominal distension		
Absent	26	86.7
Present	4	13.3
Intestinal sound		
Absent	17	56.7
Present	13	43.3
Appetite		
Off food	14	46.7
Poor	11	36.7
Good	5	16.6

There was a slight decrease in the mean rectal temperature (RT) of the colic-affected horses, but there was no statistically significant difference between the mean rectal temperature of the colic-affected horses and healthy control horses (Table 2). While, there were significant increases ($P<0.05$) in the means of respiration rate (RR) (36.21±1.83), pulse rate (PR) (51.13±1.87), and capillary refill time (CRT) (2.86±0.11) in horses suffering from colic than the healthy control horses (Table 2).

The results of chi-square analyses showed that colic was significantly associated with age ($\chi 2$= 4.632; $p<0.098$), male sex ($\chi 2$= 5.107; $p<0.023$), deworming frequency ($\chi 2$= 8.326; $p < 0.001$) and previous exposure to colic ($\chi 2$= 8.965; $p < 0.001$) as risk factors. In contrast, colic showed no significant association with breed or feeding on green fodders (Table 3).

3.2. Haemato-biochemical indices

Regarding the hematological values of the colicky and healthy control horses, the results showed, that the mean packed cell volume (PCV) of colic-affected horses was significantly higher (65.18±1.68) ($P<0.0001$) than that of the healthy control group (37.01±0.61). Furthermore, the mean values of total platelet count (TPC) (199.20±4.40), neutrophils (4.39±0.17), and lymphocyte count (3.18±0.14) were significantly lower in colic-affected horses than in healthy controls. The levels of hemoglobin, total erythrocyte count (TEC), total leukocyte count (TLC), eosinophil count, and monocyte count were not significantly different between the colicky and healthy control horses. (Table 4).

Concerning the biochemical values the result showed that there was a highly significant increase in the means of the serum aspartate aminotransferase (AST) (366.73±11.76), serum alanine aminotransferase (ALT) (42.33±1.88), blood urea nitrogen (BUN) (38.37±1.50), serum creatinine (CREA) (2.23±0.07), serum glucose (GLU) (157.97±4.26), serum albumin (ALB) (3.87±0.11), serum total protein (TP) (8.19±0.28) and serum alkaline phosphate (ALKP) (575.43±27.47) levels ($P<0.0001$) in horses affected with colic than healthy control were (170.47±0.42), (9.82±0.47), (20.59±0.87), (1.28±0.06), (80.47±2.47), (2.80±0.13), (2.80±0.13), (6.75±0.17) and (191.40±3.70) respectively (Table 5).

4. DISCUSSION

The present study determined the prevalence of colic in horses, as well as risk factors and haemato-biochemical alterations related to it in Sana'a province, Yemen. In this study, the overall prevalence of colic in horses was 11.81%. These findings are in agreement with those of Nagar and Sharma [8] (11.42%). In contrast, lower prevalence rates of colic have been documented by Mehdi and Mohammed [12] (8.6%), Azizunnesa et al. [13] (7.19%), and Worku et al. [14] (10.3%). Radostits et al. [15] and Traub-Dargatz et al. [16] reported 2 - 30% and 3.5 - 26% prevalence of colic in horses, respectively. These differences might be attributed to variances in horse types and management approaches, as well as to various study methodologies.

Table 2. Mean ± S.E. value of clinical parameters in colicky and healthy control horse

Parameters	Colicky horses (n=30)		Healthy control horses (n=15)		P Value
	Mean ±S.E.	Range	Mean ±S.E.	Range	
Rectal temperature (°C)	38.17 ±0.85	37.22-38.94	38.28 ±0.81	37.78-38.44	0.8
Respiration rate (per min.) *	36.21 ±1.83	19-48	17 ±0.98	12-19	0.021
Pulse rate (per minute) *	51.13 ±1.87	42-71	34 ±1.28	30-39	0.014
Capillary refill time (per sec) *	2.86 ±0.11	2-5	1.72 ±0.19	1-2	0.023

*Significant difference (P<0.05).

Table 3. Evaluation of risk factors for colic in horses

Variables	Non colic horses (n=224)	Colic horses (n=30)	χ^2	p-value
Breed				
Arabian	82	9	0.505	0.776
African	33	5		
Mixed	109	16		
Age				
<5 years	71	6	4.632	0.098*
5-10 years	124	16		
>10 years	29	8		
Gender				
Male	93	19	5.107	0.023*
Female	131	11		
Deworming frequency				
No	74	18	8.326	0.001*
Yes	150	12		
Feeding on green fodders				
No	81	14	1.247	0.264
Yes	143	16		
Previous exposure to colic				
Absent	132	9	8.965	0.001*
Present	92	21		

In the current study, spasmodic and impactive colic were observed in 73.3 % and 26.7% of cases, respectively. Similar findings were reported by Nagar and Sharma [8], Sameeh et al. [17], and Gitari et al. [18]. The conclusion that spasmodic colic is the most prevalent type in this study is consistent with the general report on the frequency of colic in horses, which indicates that the most common form is the one of unknown origin, followed by gas colic [16]. Spasmodic colic is reported to constitute 69-72% of all colic in the general population of horses [5]. According to reports, spasmodic colic accounts for 69-72% of all colic in the overall horse population. The prevalence of impaction colic in this study was 26.7%, which was lower than the predicted 30% in the overall equine population. However, it occurs when there is more than one risk factor, such as the type of feed, lack of water, altered intestinal motility, old age, and parasites[19].

Previous scoring systems for behavioral evaluations of discomfort linked with stomach pain have included the evaluation of particular actions such as rolling, flank movements, or kicking [20]. This study found that all pain/behavior assessments (kicking, pawing, flank-watching, attempts to lie down, and demeanor) (Table 1). The results of this study are similar to those of earlier studies on the significance of pain/behavior in detecting colic in horses, but it also emphasizes that this is important in the early stages of the condition.

In our study, horses with colic showed significantly higher mean respiration rate (RR), pulse rate (PR), and capillary refill time (CRT) than healthy control horses (P<0.05) (Table 2). Similar results have been reported by Azizunnesa et al. [13] Alsaad and Abid [21], Langdon et al. [22], Khosa et al. [23], and Sharma et al. [24]. The mean rectal temperature (RT) of the colic-affected horses decreased slightly, but, there was no statistically significant difference between the mean rectal temperature of the colic-affected horses and the healthy control horses (Table 2). Similar results were observed by Azizunnesa et al. [13] and Sharma et al. [24]. The slightly lower rectal temperature in colic might be attributed to a shock state caused by acute pain [15]. A higher respiration rate in colic may be associated with discomfort and metabolic acidosis, whereas a higher pulse rate is associated with pain, hemoconcentration, reduced venous return, vascular volume, cardiovascular response, and toxemia [25]. Vascular stasis frequently results im longer capillary refill times [26].

In the current study, colic was found to be significantly associated with age. Horses aged 5 to 10 years old had a higher incidence of colic (73.58%), followed by horses under 5 years old (16.98%) and horses over 10 years old (9.43%) (Table 3). Similar findings were reported by Nagar and Sharma [8] and Enbavelan et al. [27]. Geriatric horses are more prone to impactive colic owing to inadequate dentition and reduced intestinal motility [28]. While, other studies reported no association between age and colic [6, 29]. This study also showed significant differences between sexes in the occurrence of colic. The occurrence of colic was higher in males (63.3) than in females (36.7) (Table 3). Similar findings were reported by Nagar and Sharma [8], Purnama et al. [30], and Fikri, et al. [31]. Male horses are widely used for transportation and agricultural. Female horses, however, are predominantly bred [32], implying that colic risk is linked to overexertion and varying feeding patterns. However, other studies showed no significant difference between the sexes in the occurrence of colic [12]. In our study, there was (60%) of colic horses were not deworming frequently, and (40%) were deworming frequently (Table 3). Worm infections can arise as single or multiple

Table 4. Mean ± S.E. value of hematological parameters in colicky and healthy control horses

Parameters	Colicky horses (n=30)		Healthy control horses (n=15)		P Value
	Mean ±S.E.	Range	Mean ±S.E.	Range	
Packed cell volume (%) **	65.18±1.68	31.7-81.2	37.01±0.61	32.2-41.2	0.0001
Hemoglobin (g/dl)	15.1±1.07	11.4-17.5	12.65±0.8	11.2-15.3	0.132
Total erythrocyte count (10^6 /L)	10.14±0.37	6.7-12.5	8.62±0.25	7.2-9.2	0.211
Total platelet count (10^3/L) **	199.20±4.40	132-251	243.47±11.54	180-345	0.0001
Total leukocyte count (10^3 /L)	8.67±0.31	5.3-13.3	8.47±0.30	7.4-12.4	0.69
Differential leukocyte count					
Neutrophils (10^3 /L) **	4.39±0.17	3.1-6.3	6.56±0.28	5.1-8.9	0.001
Eosinophils (10^3 /L)	0.18±0.02	0-0.5	0.14±0.02	0-0.3	0.35
Basophils (10^3/L)	0.07±0.01	0-0.3	0.03±0.01	0.02	0.14
Lymphocytes (10^3/L) *	3.18±0.14	2.1-5.1	3.78±0.19	3.1-5.1	0.01
Monocyte (10^3 /L)	0.36±0.03	0-0.7	0.35±0.37	0-0.6	0.86

**Highly significant difference (P<0.0001).

Table 5. Mean ± S.E. value of biochemical parameters in colicky and healthy control group

Parameters	Colicky horses (n=30)		Healthy control horses (n=15)		P Value
	Mean ±S. E	Range	Mean ±S. E	Range	
Serum aspartate amino transferase (µ/L) **	366.73±11.76	227-511	170.47±0.42	131-205	0.0001
Serum alanine aminotransferase (µ/L) **	42.33±1.88	18-59	9.82±0.47	5.4-10.3	0.0001
Blood urea nitrogen (mg/dl) **	38.37±1.50	19-59	20.59±0.87	16-26.1	0.0001
Serum creatinine (mg/dl) **	2.23±0.07	1.2-2.9	1.28±0.06	1-1.7	0.0001
Serum glucose (mg/dl) **	157.97±4.26	117-191	80.47±2.47	70-97	0.0001
Serum albumin (g/dl) **	3.87±0.11	2.1-4.7	2.80±0.13	2.1-3.8	0.0001
Serum total protein (g/dl) **	8.19±0.28	5.1-10.4	6.75±0.17	5.9-7.9	0.001
Serum alkaline phosphate (µ/L) **	575.43±27.47	399-1054	191.40±3.70	171-213	0.0001

** Highly significant difference (P<0.0001).

infections. Due to variances in immunity to worm infestation, each animal experiences different forms of illness [33]. Deworming plays a significant role in reducing the incidence of mixed infections. Horses afflicted with many types of worms may have weakened immune system [34]. In this study, (70%) of colic horses had a history of previous exposure to colic. A history of colic episodes was associated with recurring episodes. The frequency of recurrent colic is five times higher than that previously observed for all episodes, which confirms previously published findings that horses with a history of colic are at a higher risk of additional bouts of colic [35].

In this study, the mean PCV value increased significantly (P<0.001), while the mean values of TPL, neutrophil, and total lymphocyte count decreased significantly (Table 4). Similar findings have been reported by Alssad and Abid [21], Sharma et al. [24], and Yadav et al. [36]. In addition, neutrophil, eosinophil, monocyte, and total leukocyte count (TLC) did not change significantly (Table 4). Similar results were reported by Sharma et al. [24], Yadav et al. [36], and Orsini et al. [37].

Increased packed cell volume in colic is most likely attributable to stress or excitement leading to splenic constriction [38], dehydration, and hypovolemia leading to decreased plasma [39]. the packed cell volume is an important prognostic indicator for the outcome of hospitalized colic cases [40]. In general, the chances of survival often decline with increasing packed cell capacity.

Horses with colic display petechial hemorrhages in their mucous membranes and a prolonged capillary refilling time, both of which are indicative of thrombocytopenia [41]. Bone marrow depression can also result in a decrease in platelet counts [42]. Furthermore, this might be due to the production of endogenous mediators such as platelet-activating factors in diseases [43].

In the current study, serum levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), blood urea nitrogen (BUN), creatinine (CREA), glucose (GLU), albumin (ALB), total protein (TP) and alkaline phosphate (ALKP) were significantly higher in the colic-affected horses than in the control animals (P<0.0001) (Table 5). Similar findings were reported by Alsaad and Abid [21]; Langdon et al. [22]; Khosa et al. [23]; Sharma et al. [24]; Yadav et al. [36] and Orsini et al. [37].

The significant increase in serum AST levels was most likely caused by muscle activity, discomfort, and tension. Although there was a statistically significant increase in the activity of serum ALT, because its activity is rather low in horses, its value is not of great consequence for any conclusion in equines [44].

Serum creatinine and blood urea nitrogen levels are helpful markers of hydration and renal function [15]. Prerenal azotemia is frequent in colic-ridden horses, and in more severe cases, this condition can lead to acute renal failure. . In hypovolemia, a reduction in renal perfusion may result in an increase in blood urea nitrogen and serum creatinine levels [39].The higher serum creatinine levels in the colic group might be attributed to decreased

renal blood flow caused by dehydration, endotoxemia, and NSAID treatment. Serum creatinine is an essential biomarker of organ and tissue perfusion because serum creatinine levels drop as organ and tissue perfusion increase [38]. Blood urea nitrogen concentration might potentially be utilized as a prognostic indicator in horse colic [36]. Blood glucose may be an important prognostic indicator to consider when addressing impaction colic [45]. Hyperglycemia is frequent in horses with colic and is associated with a poor prognosis. In contrast, hypoglycemia is seldom found in older colic horses. Endotoxins, which are absorbed across the weakened intestinal mucosa, induce insulin resistance and hence, increase blood glucose levels [46]. The release of both adrenaline and glucocorticoids during pain causes hyperglycemia [47]. The increase in total protein levels in the serum is ascribed to hemoconcentration, dehydration, and hypovolemia caused by unequal loss of plasma water [22]. The probability of survival decreased as serum total protein levels rose [48]. This is also a useful measure of tissue perfusion. This also influences the effectiveness of fluid treatment [38]. Serum alkaline phosphate activity is elevated in horses with colic [15].

5. CONCLUSION

This is the first study to document the prevalence of colic in horses and identify the risk factors and haemato-biochemical changes associated with colic in Sana'a province, Yemen. It was concluded that the overall prevalence of colic in horses was found to be 11.81%, mainly spasmodic colic (73.3%) and impaction colic (26.7%). Risk factors associated with colic mainly include age, male sex, deworming frequency, and previous exposure to colic. The values of hematological indicators, except for PCV, total platelet count, and neutrophil count, were not significantly different between the colicky and healthy horses. Serum biochemical markers such as AST, ALT, BUN, CREA, GLU, ALB, TP, and ALKP were found to be considerably elevated in horses with colic. This knowledge is a crucial first step in understanding the impact of colic in horses and in developing ways to reduce the risk of colic. We recommend performing further studies on a larger number of risk factors and therapeutic management practices for horses with colic to establish ideal preventive measures.

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