

POTENTIAL RISK FACTORS ASSOCIATED WITH LARGE INTESTINAL IMPACTION IN WORKING DONKEYS AT EGYPT

Wafi AL-ANTAIF¹ , Mohamed MARZOK¹ , Yaser HAMAD² , Adel ALMUBARAK¹ , and Sabry EL-KHODERY³ 

¹By-product Department of Clinical Sciences, College of Veterinary Medicine, King Faisal University, Al-Ahsa, 31982, Saudi Arabia

²Department of Internal Medicine, Faculty of Veterinary Medicine, Omar Al-mukhtar University, Libya

³Department of Internal Medicine and Infectious Diseases, Faculty of Veterinary Medicine, Mansoura University, Mansoura 35516, Egypt

✉Emails: mmarzok@kfu.edu.sa; mmarzok1968@gmail.com

➤Supporting Information



ABSTRACT: Large intestinal impaction is a principal cause of abdominal pain in donkeys, associated with high morbidity and mortality. The objective of this study was to investigate potential risk factors associated with large intestinal impaction in working donkeys in northern Egypt. A case-control study was conducted on 75 donkeys (4–12 years, weighing 150–290 kg) between September 2020 and August 2024. Clinical, parasitological, and biochemical examinations were performed. Logistic regression was applied to identify independent predictors of impaction. Fifty-three donkeys were diagnosed with large intestinal impaction, confirmed by clinical signs and elevated serum triglycerides (224.6 ± 36.0 vs. 196.0 ± 23.0 mg/dl, $P < 0.05$). Significant risk factors included older age (>10 years; OR = 16.8, 95% CI: 8.17–33.64, $P = 0.001$), female sex ($P < 0.05$), poor body condition ($P < 0.01$), heavy workload ($P < 0.05$), dental disease ($P < 0.05$), orthopedic problems ($P < 0.05$), and feeding rice husk (OR = 39.5, 95% CI: 1.1–14.13, $P = 0.044$). Seasonal variation also increased risk (OR = 5.8, 95% CI: 1.2–27.45, $P = 0.026$). Clinically, constipation (OR = 277.8, $P < 0.0001$), anorexia (OR = 92.16, $P < 0.0001$), and absent gut sounds (OR = 61.36, $P < 0.0001$) were the strongest diagnostic indicators. Poor nutritional management, particularly rice husk feeding, advanced age, and seasonal variations are key predictors of large intestinal impaction in working donkeys in northern Egypt. Clinical vigilance, especially in geriatric animals, is essential to reduce morbidity and improve welfare.

Keywords: Colic; Epidemiology; Equine; Forages; Risk factors

INTRODUCTION

Large intestinal impaction is the dominant cause of colic in donkeys in several settings and is associated with high mortality. At a large UK sanctuary, impaction colic constituted ~55% of all colic episodes; older age, extra rations, prior colic, low weight, musculoskeletal and dental disease, and farm of origin were the significant risk factors (Cox et al., 2007). Another UK case-control study in over 2000 donkeys found increased risk with paper bedding, concentrates, reduced pasture, more careers, weight loss, recent vaccination, and dental pathology (Cox et al., 2009). Similarly, it was noted that musculoskeletal problems may reduce access to water, and cite work showing water deprivation increases large colon impaction risk in horses (Reeves et al., 1996). At Ethiopian clinics, 78.6% of donkey colic was impaction colic, strongly associated with feed change, poor-quality/coarse feed, excessive feeding without water, parasites, heavy work, age, and dental abnormalities (Tadesse and Abera, 2018).

In mixed equid cohorts, large colon impaction and cecal bloat were often attributed to erroneous feeding management (Miranda et al., 2015). In horses, it was found that increased stabling, reduced exercise, dietary changes and hay feeding are linked to large colon impaction/volvulus, paralleling donkey risk patterns (Hallowell, 2017; Giusto et al., 2021; Mathewos et al., 2021). In Brazilian equids including donkeys, feeding low-quality chopped tropical forages markedly increased colic risk (Pessoa et al., 2012). Another equine reviews and prospective studies identified high concentrate intake, low hygienic quality hay, and frequent diet changes as important colic risks (Gonçalves et al., 2002; Kaya et al., 2009; Curtis et al., 2019;).

Recent studies show that donkeys digest acid detergent fiber (ADF) efficiently, but poor quality, high neutral detergent fiber (NDF) have the lowest digestibility (Liu et al., 2020a,b and Yang et al., 2020). Thus NDF, grain rich, low fiber diets increase the risk of colic and other disorders (Liu et al., 2020a,b). In addition, when poorly digestible and coarse fibers are fed without adequate water before/after work, the risk of impaction colic increases (Tadesse and Abera, 2018).

Seasonal incidence of impaction colic indicated that the dry season increases the risk of occurrence (Pessoa et al., 2012). In working horse populations, limited access to water and the summer/dry season substantially increase the incidence of colic, including impaction (Pessoa et al., 2012; Fikri et al., 2024).

In Egypt, limited studies have been conducted on the clinical and clinicopathological features of large intestinal impaction in donkeys (Attia et al., 2018; Bohassan et al., 2025). However, the epidemiological studies on such disease conditions are scarce. Therefore, the objective of this case-control study was to investigate the risk factors associated with large intestinal impaction in donkeys at Dakahlia governorate, Egypt.

MATERIALS AND METHODS

Donkeys

A total of 75 donkeys (*Equus asinus*) were included in a case-control study. The age of the examined donkeys ranged from 4-12 years, and their weight ranged from 150-290 kg. This study was carried out from September 2020 to August 2024. As this was a case-control study, the source of diseased donkeys was admitted cases at the Veterinary Teaching Hospital of Mansoura University, cases referred by veterinarians, and cases identified through calls from owners requesting examination of their donkeys. Control donkeys were selected randomly after identifying donkeys and determining their distribution across the administrative localities of Dakahlia Governorate. The case and control donkeys were finally selected based on the clinical criteria accompanied by elevated triglyceride levels ($> 200\text{mg/dl}$).

Study area

The present study was carried out in Dakahlia Governorate, which is located in the northern part of Egypt, and was selected for this epidemiological investigation. Dakahlia Governorate is located northeast of Cairo. Its area is approximately 3,500 square kilometers (1,400 mi^2).

Questionnaire

A questionnaire was constructed to include data concerned with age, sex, feeding practice, management system, and presence of other diseases. The hypothesized risk factors were categorized and fully described (Table 1). The construction of the questionnaire was completed before initiation of the study based on the knowledge about the disease in previous reports and the corresponding management practice in the study area. The questionnaire was approved by all authors, and two authors were responsible for data curation.

Table 1 - Categorization and description of the proposed risk factors associated with large intestinal impaction in working donkeys

Factor	Level
Age	1-5 years =1; >5-10 years=2; > 10 years=3
Season	Winter = 1; Spring = 2; Summer = 3; Fall = 4
Sex	Male = 1; Female = 2
Type of roughage	Wheat hay = 0; Horse bean hay = 1
Feeding on green fodders	Feed on green fodder = 1; Doesn't feed = 0
Presence of gastrointestinal parasites	No = 0; Yes = 1
Dental diseases	Present = 1; Absent = 0
Previous colic	Present = 1; Absent = 0
Work (heavy load)	light = 0; Hard = 1
Body condition	>2 (Good) = 1; $\leq$ Poor = 0
Adding rice husk to feed stuff	No = 0; Yes = 1
Access to water per day	One time = 0; Free access= 1
Orthopedic diseases	Present = 0; Absent = 1

Clinical examination

Competent clinical history and physical examination of each donkey under investigation was carried out according to the previous standard protocols to reach the correct diagnosis (Constable et al., 2016). Objective of the study was to specify the large intestinal impaction via rectal examination and localization of the abnormalities. Impaction of the colon and or cecum was the final inclusion criteria for the clinical cases. The clinical examination of all cases was conducted by the same author to avoid subjective variation in the clinical findings.

Parasitological examination

Fecal examination was conducted to explore gastrointestinal nematodes following the standard techniques. Briefly, a thorough gross inspection was performed on each sample to identify the parasite. Meanwhile, the same sample was subjected to examination by microscopy to identify parasite stages. A portion of every fecal sample was subjected to conventional concentration floatation and sedimentation procedures (Soulsby, 1982).

Blood samples

Blood samples were collected from the jugular vein aseptically using disposable needles and vacutainer tubes. Blood samples were kept on ice and transported directly to the laboratory. Approximately 5 ml of blood was collected into plain vacutainer tubes before treatment. Samples were centrifuged within 30 minutes of collection. Serum was stored at -80°C until analysis. Triglycerides were measured at the Mansoura University Veterinary Clinical Laboratory using a commercial enzymatic assay (Spinreact, Spain) on a spectrophotometer. Triglycerides levels were measured according to the standard technique (Pongratz et al., 2016).

Statistical analysis

All data analyses were carried out using a commercial statistical software program (IBM, SPSS for Windows, Version 21.0, USA). Association between the occurrence of large intestinal impaction and the assumed risk factors were studied using logistic regression. Before starting logistic regression, descriptive statistics were applied to declare the frequency of occurrence of large intestinal impaction with frequency of associated risk factors. A bivariate logistic regression model was carried out. In this method, the dependent dichotomous variable was the status of the donkeys (with large intestinal impaction or without). But the independent variables were the postulated risk factors. Factors with significance at $P < 0.2$ were chosen for further multivariate logistic regression model. The results were each expressed as p-value and odds ratio (OR) with a 95% confidence interval (CI 95%). A chi-square (χ^2) of linear analysis was applied to identify the possible association between large intestinal impaction and the variables of clinical findings. When the variables had more than two categories, Chi-square of linear trend with Mantel-Haenszel test was used and the results were significant at $P < 0.05$.

RESULTS

A total of 53 donkeys diagnosed with large intestinal impaction were identified based on the clinical findings and evidence of associated hyperlipidemia. The diagnosis was based on clinical signs and an increase in serum triglyceride levels. The serum triglycerides level was significantly increased in donkeys with large intestinal impaction compared with controls (224.6 ± 36.0 vs. 196.0 ± 23.0 mg/dl, $P < 0.05$).

Analysis of risk factors showed that age, sex, diet composition, body condition, and workload were significantly associated with large intestinal impaction in donkeys. Donkeys older than 10 years were at markedly higher risk ($\chi^2 = 49.91$, $P < 0.001$). Females were more frequently affected than males ($P < 0.05$). Feeding rice husk ($P < 0.05$), poor-quality roughage ($P < 0.05$), dental disease ($P < 0.05$), orthopedic problems ($P < 0.05$), heavy work ($P < 0.05$), and poor body condition ($P < 0.01$) were all significant risk factors. Other factors such as season, previous colic, water access, and parasitic infection showed weaker or borderline associations (Table 2).

Table 2 - Classification of individual donkeys as affected with large intestinal impaction or normal in respect to different risk factors

Risk factor	Category	Impaction	None Impaction	P-value	Chi square
Age (Year)	< 5	3	20	< 0.001	49.91
	>5-10	7	2		
	> 10	43	0		
Sex	Male	17	13	0.03	4.72
	Female	36	9		
Season	Winter	7	4	0.17	4.69
	Spring	10	8		
	Summer	10	5		
	Fall	26	5		
Add rice husk to feed	No	17	18	0.012	6.38
	Add	36	8		
Roughage	Wheat hay (good)	19	14	0.027	4.87
	Horse bean hay (Bad)	34	8		
Green fodders	Yes	21	14	0.058	3.6
	No	32	8		
Dental Diseases	No	20	13	0.030	4.8
	Yes	33	9		
Orthopedic disease	No	20	14	0.040	4.2
	Yes	33	8		
Heavy work	No	17	15	0.012	6.38
	Yes	36	7		
Previous colic	No	21	14	0.058	3.6
	Yes	32	8		
Body condition	Good	18	15	0.007	7.38
	Poor	35	7		
Water	Frequent (Free access)	20	14	0.40	4.2
	Limited (once /day)	33	8		
Gastrointestinal parasites (Nematodes)	Negative	22	14	0.081	3.0
	Positive	31	8		

The final logistic regression model identified age, rice husk in diet, and season as independent predictors of impaction (Table 3). Older donkeys had an odds ratio (OR) of 16.8 (95% CI: 8.17–33.64, $P = 0.001$). Feeding rice husk increased the odds of impaction by 39.5 (95% CI: 1.1–14.13, $p=0.044$). Seasonal variation also played a role, with an OR of 5.8 (95% CI: 1.2–27.45, $P = 0.026$).

Clinically, Table 4 shows the association between large intestinal impaction and clinical signs. All affected donkeys showed depression (100%) and most exhibited abdominal distension (92.45%), anorexia (90.65%), constipation (94.33%), absent gut sounds (88.67%), tachypnea (79.24%), and tachycardia (81.13%). Constipation was the strongest diagnostic indicator (OR = 277.8, 95% CI: 49.15–1080, $P < 0.0001$), followed by anorexia (OR=92.16, 95% CI: 23.27–317.6, $P < 0.0001$) and absent gut sounds (OR = 61.36, 95% CI: 17.99–179.7, $P < 0.0001$). Mucous membrane changes were observed but not statistically significant ($P = 0.24$).

Table 3 - Final logistic regression model for the potential risk factors associated with large intestinal impaction in donkeys

Variable	β	S.E.	Wald	P-value	OR	CI at 95%
Age	5.111	1.536	11.078	0.001	16.8	8.17-33.64
Add rice husk to diet	3.677	1.825	4.060	0.044	39.52	1.1-14.13
Season	1.759	0.793	4.926	0.026	5.8	1.2-27.45
Constant	-18.607	6.506	8.179	0.004	0	–

B: Regression coefficient; S.E.: standard error; OR: Odds ratio; CI at 95%: Confidence interval

Table 4 - Clinical findings associated with large intestinal impaction in donkeys.

Clinical signs	Frequency (n=53)	%	P-value	OR	CI at 95%
Depression	53	100	< 0.0001		
Recumbency	43	81.13	< 0.0001	12.84	24.28-
Abdominal distension	49	92.45	<0.0001		
Appetite					
Anorexia	48	90.65	<0.0001	92.16	23.27 - 317.6
Inappetant	5	9.35			
Gut sound					
Absent	47	88.67	<0.0001	61.36	17.99 to 179.7
Present (weak)	6	11.33			
Defecation					
Constipation	50	94.33	<0.0001	277.8	49.15 - 1080
Normal fecal balls	3	5.67			
Respiratory rate (cycle/min)					
Tachypnea (23 ± 7)	42	79.24	0.001	10.44	4.187 - 25.41
Normal (14±4.0)	13	20.76			
Heart rate (Beat/min)					
Tachycardia (95 ± 8)	43	81.13	0.001	12.84	4.94 - 29.85
Normal (60 ± 11)	12	18.87			
Mucous membrane					
Pale	30	56.6	0.24	1.7	0.79 - 3.74
Brick red	23	33.4			

DISCUSSION

Large intestinal impaction in equids has received considerable attention because the disease adversely affects performance and may be life-threatening. Various investigations have indicated numerous risk factors associated with large intestinal impaction in donkeys worldwide (Cox et al., 2007; Worku et al., 2017). However, additional risk factors may be identified due to differences in management practices. Therefore, our investigation provides a case-control study of the factors associated with large intestinal impaction in donkeys in northern Egypt.

The final multivariate logistic regression model of this study identified age, rice husk supplementation, and season as independent predictors of large intestinal impaction in working donkeys in Dakahlia Governorate, Egypt. The strong effect of older age in this study agrees with earlier donkey studies from the UK and Egypt, where older animals were consistently at higher risk of impaction colic (Cox et al., 2007, 2009; Fikri et al., 2024). Age likely reflects several converging processes rather than a single mechanism. Older donkeys more often have chronic dental disease, lower body weight or poorer body condition, and reduced musculoskeletal function, all of which can impair feed comminution, reduce grazing or drinking access, and predispose animals to reduced gut motility (Constable et al., 2016). More generally, age-related reductions in

intestinal motility and barrier function have been demonstrated in other species, supporting the biological plausibility of increased impaction susceptibility in older working equids.

The addition of rice husk to the feed of donkeys showed a significant association with large intestinal impaction. Rice husk, a by-product of rice milling, is characterized by low crude protein (2–4%) and high lignocellulosic fiber (35–45%) with substantial silica content (15–22%), which severely limits its digestibility and nutritional value in animal feed (Vadiveloo et al., 2009; Jung et al., 2026). Its high fiber and silica content make it unsuitable for monogastric animals, while ruminants may utilize it only after chemical or biological treatment (Kuan et al., 2012). Reviews of dietary fiber in monogastric emphasize that physicochemical fiber traits (solubility, fermentability, and hydration) determine water holding, digesta consistency, transit, and microbial fermentation (Ermmers et al., 2023). Therefore, these compositional constraints make untreated rice husk unsuitable as a primary feedstuff, particularly for monogastric animals, due to poor palatability and potential gastrointestinal irritation (Tan and Norhaizan, 2020). Even in ruminants, its feeding value remains inferior to other rice by-products such as rice bran, which provides higher protein and energy levels (Jung et al., 2026).

Interestingly, no previous studies have reported beneficial effects of rice husk supplementation in monogastric animals. However, Chemical treatments have demonstrated improvements in digestibility by disrupting lignin and enhancing nitrogen availability for rumen microbes (Wei et al., 2025). Biological treatments have also shown promise in degrading lignin and increasing in vitro digestibility (Wang et al., 2020).

The final model retained season as an independent predictor, and autumn recorded the highest prevalence of the disease. This finding may be due to the combined effect of hard work, supplementation with poor-quality roughage and reduced water intake. Previous studies in working equids have shown higher colic frequency during hotter or drier periods, when water intake may be inadequate and available forage becomes drier or less digestible (Cox et al., 2009).

In semiarid equids including donkeys, colic frequency was higher in the dry season linked to poorer forage, more concentrate feeding, and more foreign-body exposure (Pessoa et al., 2012). In UK donkeys, limited pasture access and concentrate feeding were associated with higher impaction risk (Cox et al., 2009). Interestingly, normal horses show seasonal microbiota shifts associated with season forage supplementation, and weather, which may provide plausible gut-level pathway (Salem et al., 2018).

Although the final multivariate model included only three potential factors, univariate analysis showed several predictors including poor-quality roughage, dental disease, orthopedic problems, heavy work, poor body condition, and female sex. This finding is consistent with previous studies (Pessoa et al., 2012; Blikslager, 2019). The associations with dental disease, orthopedic problems, heavy work, and poor body condition are also plausible and align with previous evidence, even though they did not persist in the final model. Dental disease has repeatedly been associated with donkey impaction colic in UK populations and has also been identified as a colic risk marker in working horses (Fikri et al., 2023).

Orthopedic or musculoskeletal problems may reduce exercise regularity or hinder access to water and feed, while heavy work can exacerbate dehydration and feeding irregularity in working animals (Hassen et al., 2022). Poor body condition is especially notable because it is linked not only to colic risk but also to parasitic infestation and poorer general management in donkeys (Beriso et al., 2023; Kebede et al., 2024).

Parasitism showed only a weak or borderline association with impaction in this study. Unfortunately, in the present study, gastrointestinal parasite infection was assessed only as positive or negative. Therefore, that result should be interpreted cautiously rather than dismissed, because gastrointestinal parasites are extremely common in working donkeys across Africa, with reported prevalence ranging from 71.8% to 100% in recent Ethiopian studies and a 99% prevalence reported in a large earlier survey (Getachew et al., 2009; Fesseha et al., 2022).

Water limitation itself was not a significant independent predictor in this dataset, but that should not be interpreted as evidence of no effect. Other equine studies have linked reduced water availability to increased colic risk, including a multicenter case-control study showing higher risk when horses lacked continuous outdoor water access, and field studies of working horses identifying limited daily water access as a major risk factor (Kaneene et al., 1997). The lack of statistical significance here may reflect sample size, exposure misclassification, or collinearity with season, workload, and feed type rather than a true absence of association.

Regarding clinical findings, the results of the present study are typical of large intestinal impaction in donkeys. These findings are in accordance with reduced intestinal transit and accumulation of dry ingesta (Mendoza et al., 2018). Colic in donkeys associated with large intestinal impaction is often underdiagnosed because they show subtle and less dramatic signs compared with those observed in horses. Their stoic nature means careful observation is essential (Mendoza et al., 2018).

Affected donkeys typically presented with depression, dullness, reduced appetite, and prolonged periods of recumbency rather than overt rolling or violent behavior. Gastrointestinal indicators include decreased fecal output, small or dry fecal balls, abdominal distension, and reduced or absent gut sounds. In the present study, pain-related behaviors such as flank watching, mild pawing, or intermittent kicking at the belly were not observed, which is consistent with the findings of previous reports (Constable et al., 2016). Systemic changes, including tachycardia, and dehydration, were common in the present study, while anorexia predisposes donkeys to hyperlipemia, which complicates the clinical picture and worsens the prognosis (Bohassan et al., 2025). Because donkeys mask pain, subtle changes in demeanor, appetite, and fecal output

are often the most reliable early indicators of colic, underscoring the importance of vigilant monitoring and prompt veterinary intervention.

Several limitations may temper the conclusion of this study. First, the sample size was modest, and the case-control design is efficient for risk-factor screening but vulnerable to selection bias and residual confounding (Hillyer et al., 2010). Second, some exposures such as water access, feed quality, and workload are difficult to standardize in owner-reported field studies, and retrospective or observational colic studies often have incomplete recording of potentially important management variables (Molla, 2017; Miklavcic et al., 2024). Finally, donkey production systems differ markedly by ecology, purpose, and husbandry; therefore, risk estimates from northern Egypt should not be assumed to generalize unchanged to pastoral, commercial, or sanctuary populations (Asteraye et al., 2025). However, in Egypt, the donkey management system is closely similar to wide areas in the world. Accordingly, the findings are feasible and acceptable, especially in the MENA region.

CONCLUSION

The results of the present case-control study underscore that poor nutritional management, age, and seasonal variation are potential risk factors for large intestinal impaction in working donkeys. Adding poorly digestible nutrients as rice husk to the diet of donkeys may substantially increase the risk of impaction, especially in geriatric animals. Clinical vigilance, particularly in geriatric donkeys, is important to reduce morbidity and improve welfare in working donkey populations. Equine practitioners should consider nutritional risk factors when confronted with cases with large intestinal impaction.

DECLARATIONS

Corresponding author

Correspondence and requests for materials should be addressed to Mohamed Marzok: mmarzok@kfu.edu.sa; ORCID: 0000-0002-7961-1247

Data availability

Data are available on request.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1038/s41598-023-29360-y>.

Authors' contribution

W. Al-Antaif: Conceptualization, methodology, visualization, data curation, writing—original draft.

M. Marzok: Methodology, formal analysis, investigation, writing—review & editing. yaser hamad: software, data curation, investigation, visualization.

A. Almubarak: Software, formal analysis, visualization, funding acquisition, supervision.

S. El-khodery: Conceptualization, methodology, supervision, writing—review & editing.

All authors have read and agreed to the published version of the manuscript.

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Ethical regulations

The authors complied with the ARRIVE guidelines and or the Interdisciplinary Principles and Guidelines for the Use of Animals in Research, Testing, and Education by Mansoura University Animal Care and Use Committee (MU-ACUC-Vet.Med.14.07.2020).

Competing Interests

Authors declare that there is no conflict of interest.

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