Relative Risk and Odds Ratio of Risk Factors Associated with Digestive Diseases in Ganjam Goats of Odisha

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ABSTRACT

A two-year study on the morbidity and mortality in Ganjam goats of Odisha associated with digestive diseases was carried out in Ganjam district of Odisha and the effects of year, season, sex, age group and rearing management on morbidity and mortality rates due to these diseases were examined using suitable statistical techniques. Morbidity and mortality data of 5845 Ganjam goats of 71 goat keepers and 5205 Ganjam goats of 104 goat keepers from four clusters of Ganjam district were recorded from April 2018 to March 2019 and April 2019 to March 2020, respectively, each year divided into three seasons: summer (March-June), rainy (July-October) and winter (November-February). These goats reared under both range system and semi-intensive rearing system were divided into three groups: kids (0-3 months), young stocks (3-12 months) and adults (above one year) based on age. Overall morbidity and mortality due to digestive diseases were higher in 2018-19 (11.3%, 1.6%) as compared to 2019-20 (8.2%, 0.7%). Morbidity was the highest in young ones followed by kids and adults whereas mortality was the highest in kids followed by young ones and adults. In rainy season, morbidity was the highest followed by summer and winter. However, mortality occurred mostly in summer followed by rainy and winter season. Both morbidity and mortality were more prominent in male goats than females. Morbidity and mortality in Ganjam goats reared in range system were higher as compared to those reared in semi-intensive system.

HIGHLIGHTS

◎ Rainy and Summer season had higher relative risk of morbidity and mortality of digestive diseases compared Winter season.
◎ Kids and young age groups had higher risk of morbidity and mortality for digestive diseases.
◎ Semi-intensive system of management had lower risk of morbidity due to digestive diseases.

Keywords: Risk factors, odds ratio, digestive diseases, Morbidity, Mortality, relative risk

Goats play an important role in the food and nutritional security of the rural poor especially in the rain-fed regions where crop production is uncertain, and rearing large ruminants is restricted by acute scarcity of feed and fodder. Goat rearing has distinct economic and managerial advantages over other livestock because of its less initial investment, low input requirement, higher prolificacy, early sexual maturity, and ease in marketing. The landless agricultural labourers, marginal and small farmers in the country are mostly associated with goat rearing. Goat rearing, which is one of the most widely adopted

livestock activities in India, has the potential to emerge as a very good source of income and employment for the rural people especially in the less favoured environments. However, to harness this potential, the productivity and profitability of existing goat production systems need to be improved substantially. Shortage of feed in quantity and quality, poor management lead to high incidence of diseases, low productivity and poor reproduction (Mahmud *et al.,* 2015). Among the wide range of diseases that affect goats, digestive diseases are one of the major diseases responsible for goat morbidity and mortality losses. The digestive system disorders in small ruminants cover a group of important diseases and are responsible for large economic losses. Digestive diseases of goat include non-infectious diseases like metabolic and nutritional deficiency diseases and infectious diseases like parasitic diseases and diseases caused due to pathogens like PPR, HS, FMD, enterotoxaemia, goat pox. The morbidity and mortality of goats affect the economic gain of the goat farmers through annual sale of goats. In India, few studies have been done on the incidence of digestive disorders in goats (Lira *et al*., 2013; Chaudhary and Singh, 2014; Upadhyay *et al.*, 2015; Pawaiya *et al*., 2017). Morbidity and mortality rates in Ganjam goats due to different diseases have been reported by Karna *et al.* (2020b); but no reports are available regarding morbidity and mortality of Ganjam goat in field condition particularly due to digestive diseases. Considering the relative scarcity of studies on the epidemiology of digestive diseases in goats the objective of this work was to document the morbidity and mortality pattern of Ganjam goats due to diseases affecting the digestive system from April 2018 to March 2020 and determine possible risk factors for exposure to digestive diseases in Ganjam goats of Odisha under field condition.

MATERIALS AND METHODS

Study area

Four clusters such as Chhatrapur, Rambha, Khallikote and Jirabadi of the All India Coordinated Research Project on goat improvement operating in the Ganjam District in Odisha were selected for study. Ganjam district is located at 19.35º - 19.92ºN and 84.98º -85.12ºE. The temperature experienced in these areas ranges from 37ºC to 39ºC and

10.8º C to 11.5º C, respectively and annual rainfall ranges from 1577mm to 1597mm (Karna *et al.* 2020a). Humidity is high throughout the year, average being 75 %. The research work was carried out in Ganjam district in the state of Odisha during April 2018 to March, 2020.

Animals

Total of 5845 Ganjam goats of 71 goat keepers belonging to twenty villages and 5205 Ganjam goats of 104 goat keepers belonging to twenty-six villages were observed for the study in 2018-19 and 2019-20, respectively. Morbidity and mortality data due to digestive diseases were collected on the basis of year, age, sex, season and rearing management from all the selected goat farmers of Chhatrapur, Rambha and Khallikote blocks of Ganjam district of Odisha for the period of two years from April 2018 to March 2020.

Managemental practices

Mostly two types of rearing system are practised by Golla farmers for rearing Ganjam goats i.e. Range system and Semi-intensive system. The goats reared under range system are not provided any supplementary feed as the goat farmers send these goats to distant jungles of 20-25 km away from home in search for browsing material. The flock size varies from 100 to 500. Ganjam goats usually rely on browsing poor quality herbs, shrubs, tree leaves, matured grass and dry fallen leaves in the range forest of native tract. Goats kept under semi-intensive condition are fed green pasture grasses, tree leaves, paddy straw with supplementation of concentrates.

Herd health care

Goats were vaccinated against HS, PPR, Goat pox and administered with anthelmintics. Control measures against diseases were undertaken with appropriate drugs/ measures.

Experimental design

Data on number of morbidity and mortality due to digestive disease were classified as per their respective year of disease, season, age and sex of animal and managemental practices. The season-wise morbidity and mortality was

divided into three seasons, i.e., summer season (March to June), rainy season (July to October) and winter season (November to February). Age-wise morbidity and mortality was classified into different age groups viz., kids (0-3 months), young ones (3-12 months) and adults (above one year).

STATISTICAL ANALYSIS

Morbidity of digestive diseases was estimated as the ratio of the number goats falling sick due to digestive diseases to the total number of goats under risk for that period. Mortality in goats due to digestive diseases was estimated as the ratio of the goats dying due to digestive diseases to the total number of goats under risk for the period i.e. year and season. The association of risk factors viz. year and season of exposure, sex and age group categories of the animals and the types of management of goats with morbidity and mortality were analysed applying Chi-square test using R software (version 4.0.5). The logistic regression models were fitted for risk factors such as year of observation, season, sex, age group and rearing management of goats. Relative risks and odds ratio of morbidity and mortality in these goats was analysed using a univariate and multivariate logistic regression analysis model that was carried out in R software (version 4.0.5). The multivariate logistic regression model equation had Y as dependent variable. Y is the logarithm of odds of goats being affected with digestive diseases (morbidity) or death due to digestive diseases (mortality).

$$Y = Log\left(\frac{P}{1-P}\right)$$
$$= \beta_0 + \beta_1(Year) + \beta_2(Season) + \beta_3(Sex) +$$
$$\beta_4(Age\ group) + \beta_5(Management)$$

where, P = probability of Goats diseased /dead (P(dead/diseased) = 1) due to digestive diseases. β0, β1……,β5: parameter values of regression coefficients of predictor variables. The graphs of the confidence interval of the odds ratio of the risk attributable to various factors are produced using the final fit package in R software (version 4.0.5). The odds ratio of morbidity and mortality taking only one risk factor (uni-variable) are presented in table 2 and table 4 respectively. The odds ratios of morbidity and mortality for various risk factors for digestive diseases simultaneously(multi-variable) along with the

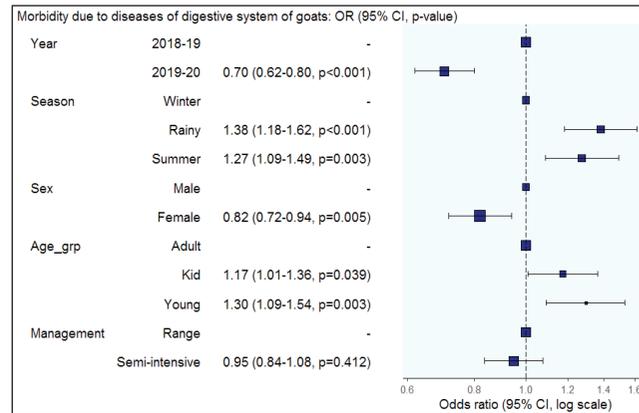95% confidence interval are presented in Fig. 1 and 2 respectively.

Fig. 1: Odds Ratio plot of risk factors for Morbidity of diseases of digestive system in Ganjam goats
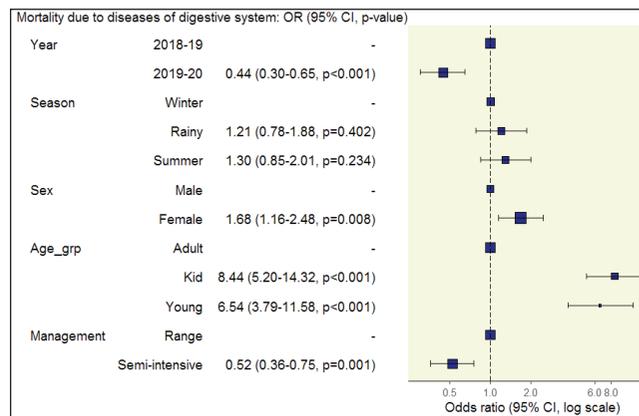

Fig. 2: Odds Ratio plot of risk factors for mortality due to diseases of digestive system in Ganjam goats

RESULTS AND DISCUSSION

Morbidity pattern

Morbidity pattern associated with digestive diseases in goats for the two-year observation period is presented in Table 1. The average morbidity rate due to digestive diseases during the two-year observation period was found to be 9.85 %. In ascending year-wise order, the overall morbidity of goats due to digestive diseases decreased progressively with the highest morbidity of 11.3% (546/5845) occurring during 2018-19, which gradually

Table 1: Morbidity pattern in Ganjam Goats for Digestive diseases

Factors	Levels	Total	Diseased	%	Relative Risk (95% CI)	p-value
Year	2018-19	5845	662	11.3	Reference	<0.001
	2019-20	5205	426	8.2	0.72 (0.64-0.81)	
Season	Winter	3876	317	8.2	Reference	<0.001
	Rainy	3571	400	11.2	1.37 (1.19-1.57)	
	Summer	3603	371	10.3	1.26 (1.09-1.45)	
Sex	Male	3468	398	11.5	Reference	<0.001
	Female	7582	690	9.1	0.79 (0.70-0.89)	
Age group	Adult	6021	531	8.8	Reference	<0.001
	Kid	3109	334	10.7	1.22 (1.07-1.38)	
	Young	1920	223	11.6	1.31 (1.14-1.53)	
Manage-ment	Range	5526	562	10.2	Reference	0.266
	Semi-intensive	5524	526	9.5	0.93 (0.83-1.04)	

Table 2: Odds Ratio of risk factors due to Digestive Diseases of morbidity of Ganjam Goats

Factors	Levels	Normal	Diseased	Odds Ratio (univariable, 95% CI)	p-value
Year	2018-19	5183	662	Reference	—
	2019-20	4779	426	0.70 (0.61-0.79)	<0.001
Season	Winter	3559	317	Reference	—
	Rainy	3171	400	1.42 (1.21-1.65)	<0.001
	Summer	3232	371	1.29 (1.10-1.51)	p=0.002
Sex	Male	3070	398	Reference	—
	Female	6892	690	0.77 (0.68-0.88)	<0.001
Age group	Adult	5490	531	Reference	—
	Kid	2775	334	1.24 (1.08-1.44)	p=0.003
	Young	1697	223	1.36 (1.15-1.60)	<0.001
Manage-ment	Range	4964	562	Reference	—
	Semi-intensive	4998	526	0.93 (0.82-1.05)	p=0.253

decreased to the lowest of 8.2% (238/5205) during 2019–2020. It was observed that the overall morbidity specifically due to digestive diseases during the two-year period were not equally distributed (p < 0.001), and there was high association between years in consideration and morbidity occurred. Similar studies were also conducted by Lira *et al.* (2013), Chaudhary and Singh (2014) and Tifashe *et al*. (2017) where the overall morbidity due to digestive diseases were found to be 71.7%, 1.56% and 6.6%, respectively. The analysis of morbidity rate revealed that it had significant (p<0.001) association with season. The incidence of digestive diseases was observed more in rainy season (11.2%) followed by summer (10.3%) and winter (8.2%). Similar observations were also made

by Dohare *et al.* (2013) in goats of Chambal division of Madhya Pradesh where morbidity due to diarrhoea causing digestive diseases was more in summer (50%) and rainy (40%) as compared to winter (12.2%). However, results obtained from the study conducted by Tifashe *et al.* (2017) showed higher morbidity of goats in autumn (36%) followed by 31.8%, 27.3%, 4.5% during spring, winter and summer, respectively. Sex-wise morbidity pattern in goat population during the study period of 2018-20 showed significant difference (p < 0.001) between male and female goats suffering from digestive diseases. Similar observations were made by Chaudhary and Singh (2014) whereas study conducted by Tifashe *et al.* (2017) showed that morbidity due to digestive disease was higher

in females (10%) than in males (8%). Age-wise analysis of morbidity in goats revealed that overall morbidity rate was highest in young ones (11.6 %) followed by kids (10.7%) and adults (8.8%). Morbidity percentages due to digestive diseases in different age groups differed significantly (p<0.001). Similar observations were made by Chaudhary and Singh (2014) while Tifashe *et al.* (2017) found that kids had less morbidity than adults. Analysis based on rearing management revealed that goats depending on range system (10.2%) for nutrition showed higher morbidity as compared to goats depending on semi-intensive system (9.5%).

The logistic regression analysis with respect to digestive diseases showed significance (p< 0.001) between year, season, sex, and age (Table 2). Ganjam goats were at a lower risk of getting infected with digestive diseases in 2019-20 (OR=0.70) than in 2018-19. Season-wise, goats were at a higher risk of morbidity in acquiring digestive diseases in rainy season (OR= 1.42) and summer season (OR=1.29) than in winter. Young stocks (OR= 1.36) and kids (OR= 1.24) were at higher risk of morbidity than adults. Female goats (OR= 0.77) were at lower risk of morbidity than male. Similar results were also obtained by Chaudhary and Singh 2014 from the logistic regression analysis of morbidity due to digestive diseases with respect to age and sex. Ganjam goats reared in range system were at higher risk of morbidity than those reared in semi-intensive system (OR=0.93) though it was statistically not significant.

Mortality pattern

Mortality of goats associated with digestive diseases from 2018-20 are presented in Table 3. The average mortality rate due to digestive diseases during the two-year observation period was found to be 1.18 %. A total of 94(1.6%) goats and 37(0.7%) goats died due to digestive diseases out of a population of total 5845 goats in 2018-19 and 5205 goats in 2019-20, respectively. Statistical analysis revealed that total mortality on account of digestive diseases were not equally distributed through the years, and there was significantly high association (p < 0.001) between the years in consideration and mortality of goats. The overall mortality of goats decreased progressively with the highest mortality occurring during 2018-19 (1.6%), which gradually decreased during 2019–2020 (0.7%).

The mortality due to digestive diseases was observed more in summer (1.3%) and rainy season (1.3%) than in winter (1%). In season-wise analysis the association of mortality rate with season was found to be non-significant (p<0.001). Sex-wise mortality pattern in goat population during the study period of 2018-20 revealed that mortality rate in male and female goats that died from digestive diseases were similar during the given time period. Age-wise analysis showed that overall mortality was highest in kids (2.4%) followed by young ones (1.9%) and adults (0.3%). It was observed that the kids (0–3 months) were highly affected (p < 0.001) with digestive diseases leading to death, whereas goats of young (6–12 months) and adult age groups were comparatively less affected (p < 0.001). Thus, age was found to be an important factor contributing to the mortality due to digestive diseases. Analysis based on rearing management revealed that goats depending on range system (1.6%) for nutrition were observed to show higher mortality as compared to goats depending on semi-intensive system (0.8%). Similar studies were conducted in goats by Pawaiya *et al.* (2017) for a period of 25 years where overall mortality due to alimentary diseases was 7.67% and significant differences could not be found for sex-wise and season-wise mortality patterns in goats. However, mortality in the kids (0–3 months) and adult (>12 months) were found to be equal and highly significant compared to young ones (3-6 months & 6-12 months). Upadhyay *et al.* (2015) in his study over a period of 12 years found that overall mortality due to digestive diseases was 3.51% and highest mortality occurred in rainy season followed by winter and summer. Observations made by Chaudhary and Singh (2014) in their study showed overall mortality of 0.91% in goats due to digestive diseases.

The overall logistic regression analysis of mortality data revealed significant (p<0.001) difference between year, age groups and rearing management (Table 4). Ganjam goats were at a lower risk of mortality due to digestive diseases in 2019-20 (OR=0.44) than in 2018-19. The analysis showed that kids (OR= 7.42) and young stocks (OR= 5.73) were at higher risk of mortality than adults while there was no significant difference in mortality in male and female goats (OR= 1.00). Season-wise, goats were at a higher risk of mortality due to digestive diseases in rainy season (OR= 1.01) and summer season (OR=0.27) than in winter. The overall logistic regression analysis of mortality data based on rearing management revealed that goats reared

Table 3: Mortality pattern in Ganjam Goats for Digestive Diseases

Factors	Levels	Total	Dead	%	Relative Risk (95% CI)	p-value
Year	2018-19	5845	94	1.6	Reference	<0.001
	2019-20	5205	37	0.7	0.44 (0.30-0.64)	
Season	Winter	3876	38	1.0	Reference	<0.001
	Rainy	3571	45	1.3	1.28 (0.84-1.97)	
	Summer	3603	48	1.3	1.36 (0.89-2.07)	
Sex	Male	3468	41	1.2	Reference	<0.001
	Female	7582	90	1.2	1.00 (0.69-1.45)	
Age group	Adult	6021	20	0.3	Reference	<0.001
	Kid	3109	75	2.4	7.26 (4.44-11.87)	
	Young	1920	36	1.9	5.64 (3.28-9.72)	
Manage-ment	Range	5526	87	1.6	Reference	<0.001
	Semi-intensive	5524	44	0.8	0.50 (0.35-0.73)	

Table 4: Odds Ratio of risk factors due to Digestive Diseases of mortality of Ganjam Goats

Factors	Levels	Normal	Dead	Odds Ratio (uni-variable, 95% CI)	p-value
Year	2018-19	5751	94	Reference	
	2019-20	5168	37	0.44 (0.30-0.64)	<0.001
Season	Winter	3838	38	Reference	
	Rainy	3526	45	1.29 (0.84-2.00)	p=0.252
	Summer	3555	48	1.36 (0.89-2.10)	p=0.155
Sex	Male	3427	41	Reference	
	Female	7492	90	1.00 (0.70-1.47)	p=0.983
Age group	Adult	6001	20	Reference	
	Kid	3034	75	7.42 (4.61-12.49)	<0.001
	Young	1884	36	5.73 (3.35-10.11)	<0.001
Manage-ment	Range	5439	87	Reference	
	Semi-intensive	5480	44	0.50 (0.35-0.72)	<0.001

in range system were at higher risk of mortality than those reared in semi-intensive system (OR=0.77). The logistic regression analysis done by Chaudhary and Singh (2014) showed that kids and young stocks were at higher risk of mortality due to digestive diseases than adults and males were at higher risk of mortality than females.

CONCLUSION

This study confirms that overall morbidity and mortality rate due to digestive diseases averaged 9.85 % and 1.18%, respectively during the two-year observation period. Morbidity and mortality observed were higher in 2018-19 as compared to 2019-20. Morbidity rates were higher

in rainy season followed by summer and winter whereas mortality mostly occurred in summer followed by rainy season and winter. Young ones showed higher morbidity followed by kids and adults whereas mortality was higher in kids than in young ones and adults. Males had significantly higher morbidity as compared to females whereas mortality pattern was similar in both sexes. After adjusting for all other risk factors the odds of mortality in females were 68 percent higher than that of males. Goats reared in range system were at a higher risk of acquiring digestive diseases as compared to those reared in semi-intensive system. After adjusting for all the risk factors, the odds of mortality was almost half that of the range system. The year and season were significantly associated with

the morbidity of goats due to digestive diseases whereas mortality showed significant association with year and age group. Rainy and Summer season posed higher risk for morbidity and mortality of digestive diseases as compared to the Winter season. Kids and young age groups had 7.2 and 5.6 times the risk of mortality due to digestive diseases observed for the adults.

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