

A SYSTEMATIC REVIEW OF PRE-CLINICAL AND CLINICAL RESEARCH REPORTS ON SMALL RUMINANTS PUBLISHED DURING THE LAST SIX DECADES IN THE THEN EAST PAKISTAN AND IN BANGLADESH

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ABSTRACT

Background: A dozen of veterinary academic institutions offer degree courses with pre-clinical and clinical studies and conduct research works but their activities are not coordinated and unified in Bangladesh. An attempt has been made to review the pre-clinical and clinical research reports in small ruminants which would help the concerned academicians, research scientists and research funded organizations to update their knowledge of specialization and use this reference as a starting point for formulation of the future academic and research guidelines.

Objectives: The main objectives are to provide an integrated, systematic overview of all the available published research reports on the pre-clinical and clinical aspects of small ruminants to update knowledge and to identify research insights, existing gaps and future research directions.

Materials and Methods: The available research reports on pre-clinical and clinical aspects of small ruminants published mainly in journals during the last six decades in Bangladesh from 1966 to 2019 were reviewed. Data obtained were analyzed statistically based on pre-clinical and clinical subjects, host species, age, breeds, clinical prevalence and decade-wise to assess the rate of publication.

Results: Of the 665 selected articles, 621 research papers published on small ruminants during the last six decades from Bangladesh were systematically reviewed, of which 340 (54.75%) articles reported as pre-clinical and 281 (45.25%) on clinical aspects with significantly higher rates in goats ($n = 486$; 78.26%) than sheep ($n = 135$; 21.74%). Out of 126 recorded clinical diseases and disorders in small ruminants, 125 (99.21%) reported in goats and 44 (34.92%) in sheep, with 43 (34.13%) common in both goats and sheep but only pregnancy toxemia (0.79%) reported in sheep. The influence of age and breeds on the prevalence of clinical diseases and disorders associated with their morbidity and mortality are described and discussed.

Conclusions: This unified review article would serve as a guide for the veterinary medical academicians, research scientists and organizations for future studies and research directions. The disease profiles and their morbidity and mortality status in small ruminants might help the practicing veterinarians, government, human health care providers and neighboring countries who may need to take action.

Keywords: Pre-clinical, Clinical, Small ruminants, Goats, Sheep, Decades, Clinical diseases and disorders, Mortality, Case fatality, Plagiarism

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INTRODUCTION

Goats and sheep are called small ruminants and these animals are reared mainly for meat, milk, skin and wool worldwide. Small ruminants support livelihoods of the many poor households in developing countries including Bangladesh. Animal rearing and management system in developing world has rapidly changed due to high human population growth rate, increases the demand of animal proteins (meat, milk) and urbanization. In addition to provide contribution to the national GDP, small ruminants are important for food security, poverty reduction, human nutrition and employment generation in Bangladesh.¹ Goats and sheep are not only threatened by disease outbreaks but also sometime associated with droughts, floods and climate changes in Bangladesh.² There are several diseases of small ruminants associated with high morbidity and mortality and decreased productivity and production in Bangladesh. The animals of smallholder poor farmers are particularly vulnerable to these diseases because of the expense, absence or inadequate of veterinary medical services and production inputs. However, an accurate statistics are required to determine the future prospect of the goats and sheep population and their productivity. Livestock population statistics especially goat and sheep population have been erratically presented in different reports in Bangladesh. The Banglapedia document of 2014 shows about 30.33 million goats,³ whereas in 2015 document shows 14.8 million goats and 1.9 million sheep in Bangladesh.⁴ The Department of Livestock Services (DLS) estimated 25.766 million goats and 3.335 million sheep in 2016⁵ and 26.1 million goats and 3.468 million sheep in 2018.⁶ Bangladesh Bureau of Statistics (BBS) estimated 25.77 million goat population in the year 2015-16 which constitutes about 7% of the total Asiatic goat population.⁷ Some authors of the books have also reported different statistics of small ruminant population as 34.0 million goats in Bangladesh.⁸ FAO has estimated 56.4 million goats and 1.6 million sheep with goat : sheep ratio 1 : 0.02 in Bangladesh.⁹ A report showed that there is about 56000 registered goat farms available in Bangladesh where about 281000 people works directly.¹ The goat and sheep population / km² ranged from 12.4 to 359 with an average of 126.5 ± 85.1 and 0.3 to 43.0 with an average of 8.8 ± 9.3 , respectively in Bangladesh.¹⁰ The available goat breeds in Bangladesh are Black Bengal goats (90%), Jamunapari (8-9%) and rest their crosses.¹¹ Veterinary medical education is appropriately justified with dual degree (BS in Animal Science & DVM) system¹² and pre-clinical and clinical research in both the veterinary medical and human medical sciences.¹³ The main pre-clinical courses include anatomy, histology, physiology, microbiology, parasitology, pathology, pharmacology and toxicology, whereas the clinical courses include medicine, obstetrics, gynecology and surgery. The main objective of the pre-clinical education and research is to answer the basic questions whereas clinical education and research refers to studies that are done in patient bodies. Review of literature reveals that a large number of research articles on both the pre-clinical and clinical aspects of small ruminants have been published during the last six decades from Bangladesh. An overview of livestock research reports published during the twentieth century¹⁴ and a 50-year review on the prevalence of clinical diseases and disorders in cattle of Bangladesh¹⁵ have been reported but no attempts have yet been made to systematically unify and update the research reports published on goats and sheep based on pre-clinical and clinical aspects from Bangladesh. Therefore, an attempt was made to review all the available

published reports on small ruminants in Bangladesh to provide the existing status and shows the deficiencies on pre-clinical and clinical research to provide motivation for specific and appropriate future research works.

MATERIALS AND METHODS

The research reports on pre-clinical and clinical aspects of sheep and goats published mainly in journals during the last six decades from 1966 to 2019 from Bangladesh were reviewed and analyzed. Google Scholar, PubMed, Research Gate, Bangladesh Journal-online (BJO) and directory of open access journals were searched using relevant keywords to identify articles. However, the BJO website has established in 2007 and accordingly the journals and their published articles are uploaded on their webpages from 2008 without any archive of the articles published before 2008. Different libraries searched results reveals that the related journals in which articles on different aspects of livestock have been published before the year 2008 from the then East Pakistan and Bangladesh are mostly somehow displaced and lost in antiquity. Accordingly, articles which were published from 1966 to 2007 were reviewed from the BAU central library, Faculty of Veterinary Science and Faculty of Animal Husbandry libraries, personal collection sources, different journal editorial offices and even request to the authors during the two years period from 2018 to 2019. Data obtained from the different reports were statistically analyzed by using Chi-square test for significance (SPSS version 17.0).

RESULTS AND DISCUSSION

The veterinary medical education and research are mainly based on two major phases which include pre-clinical and clinical studies. The pre-clinical studies basically comprise of ① Anatomy, ② Histology, ③ Biochemistry and Physiology, ④ Microbiology, ⑤ Parasitology, ⑥ Pharmacology & Toxicology and ⑦ Pathology, whereas clinical studies include ① General and Systemic Medicine, ② Special Medicine, ③ Obstetrics & Gynecology and ④ Anesthesiology & Surgery. These discipline-wise researches are usually conducted at the academic and some extent to the research institutions all over the world including Bangladesh. Accordingly, mainly the subjects and association title based journals are being published worldwide including '*Journal of Pre-clinical and Clinical Research*' (www.jpccr.eu). Review of literature reveals that no attempt has so far been made to compile and publish any review report based on the pre-clinical and clinical sciences in both the medical and veterinary medical education and research either in Bangladesh and elsewhere. Therefore, an attempt has been made to compile all the available published research reports on goats and sheep based on pre-clinical and clinical research in Bangladesh.

Anatomical research

A total of 49 articles¹⁶⁻⁶³ on gross anatomy in small ruminants have been published during last six decades from Bangladesh, of which 46 (93.88%) reported on goats and only three (6.12%) reported in sheep (Table 1). The published anatomical research reports are mainly based on the anatomy of the different organs, accessory genital organs, distribution of nerves and arterial supply in different organs in the body (Table 1). It appears that there is a significant gap of anatomical research works between goats and sheep, which might be due to differences

Table 1. Major findings of anatomical research of goat and sheep reported during the last six decades in BD

SN Research aspects	Goat	Ref. No.	Sheep	Ref. No.
A. Organs studied				
01. Bone of forelimb	Macro-anatomy	16	-	-
02. Liver	Gross anatomy	17	-	-
03. Spleen	Gross anatomy	18	Gross anatomy	19
04. Kidney	Anatomy & effect of BW	20,21	Gross anatomy	22
05. Heart	Topographical anatomy	23	-	-
06. Rumen	Model for museum	24	-	-
07. Diaphragm	Structure of diaphragm	25	-	-
08. Salivary glands	Gross anatomy	26	-	-
09. Parotid salivary gland	Anatomy	27	-	-
10. Jugular vein	Anatomy	28	-	-
11. Perineal	Musculature	29	-	-
12. Tongue	Gross morphology	30	-	-
13. Esophagus	Morphology	31	-	-
14. Hide and skin	Defects & grade, curing method	32,33	-	-
15. Pre-natal development	Stages of development	34	-	-
16. Postnatal growth	Appendicular skeleton & muscles	35,36	-	-
17. Accessory genital glands	Post-natal development	37	-	-
18. Female reproductive tract	Gross & morphometry	38	Gross & morphometry	38
19. Uterus	Gross & histo-morphology	39	-	-
20. Cervix and vagina	Anatomy	40	-	-
21. Effects of castration	Penile and urethral development	41	-	-
22. Muscles and carcass	Gross morphological analysis	42	-	-
23. Thoracic vertebrae	Absence of floating ribs	43	-	-
24. Head region	Clinical anatomy	44	-	-
B. Distribution of nerves				
01. Ischiatic nerve	Distribution of nerve	45	-	-
02. Cardiac nerve	Cardiac innervation	46	-	-
03. Lumbar spinal nerve	Distribution of nerve	47	-	-
04. Radial, median & ulnar nerves	Distribution in the forelimb	48	-	-
05. Pudendal & caudal rectal nerves	Origin, course & distribution	49	-	-
06. Shoulder & lateral thoracic wall	Nerve innervation	50	-	-
07. Femoral, cranial, caudal nerves	Gross anatomy with distribution	51	-	-
08. Perineum	Innervation	52	-	-
09. Lumbo-sacral plexus	Innervation	53	-	-
10. Brachial plexus	Innervation	54	-	-
C. Arterial supply in organs				
01. Posterior mesentery	Circulation	55	-	-
02. Spleen	Arterial supply & its segmentation	56	-	-
03. Coronary artery	Anatomy (arterial supply)	57	-	-
04. Stomach	Arterial supply	58	-	-
05. Liver	Arterial supply of liver	59	-	-
06. Celiac & cranial artery	Mesenteric arterial supply	60	-	-
07. Perineum	Arterial supply	61	-	-
08. Esophagus	Arterial supply	62	-	-
09. Duodenum	Morphology & blood supply	63	-	-
Total (n = 49)		46 (93.88)		3 (6.12)

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between goat : sheep (ratio 1 : 0.02) population in Bangladesh.⁹ However, this huge research gap could be minimized to certain extent for the interest of the veterinary medical education and research.

Histological research

A total of 20 articles⁶⁴⁻⁸³ have been published on histological research in goats but no such research reports could be traced on sheep in the available literature in Bangladesh (Table 2). Therefore, this observation could draw a notice for the histological scientists to contribute on the histological research in sheep in Bangladesh.

Table 2. Major findings of histological research of small ruminants reported during the last six decades in BD					
SN	Organs studied	Goats	Ref. No.	Sheep	Ref. No.
01.	Spleen	Microscopic studies	64	-	-
02.	Sweat gland (skin)	Histology	65	-	-
03.	Different skin glands	Comparative histology	66	-	-
04.	Salivary gland	Histology & histo-chemistry	67	-	-
05.	Penis	Fibrous component of penis	68	-	-
06.	Skin	Distribution of mast cells	69	-	-
		Histological evaluation	70	-	-
07.	Mammary gland	Histology of arterial wall	71	-	-
08.	Coronary artery	Histological studies	72	-	-
09.	Urethral process	Histology urethral process	73	-	-
10.	Anato-histological tools	Causes of infertility	74	-	-
11.	Uterine wall at early pregnancy	Morphological changes	75	-	-
12.	Female genital organs	Biometry	76	-	-
13.	Ovary	Morphologic & morphometric	77	-	-
14.	Tongue	Histo-morphological observation	78	-	-
15.	Esophagus	Histology	79	-	-
16.	Duodenum	Histology & histo-chemistry	80	-	-
17.	Pancreases	Histology	81	-	-
18.	Skin collagen fibers	Treated with NaCl & tetracycline	82	-	-
19.	Postnatal muscle development	Histo-morphological studies	83	-	-
Total			20 (100)		0

Biochemistry and physiological research

The biochemistry and physiological research reports published from Bangladesh are grouped into three categories which include ① General physiology, ② Haemato-biochemical studies, and ③ Reproductive physiology in small ruminants (Table 3). A total of six reports on general physiology,⁸⁴⁻⁸⁹ 20 reports on haemato-biochemical studies⁹⁰⁻¹⁰⁹ and 48 reports on production and reproductive physiology¹¹⁰⁻¹⁵⁷ have been published on small ruminants from Bangladesh (Table 3). Of the total 76 articles, of which 48 (63.16%) published on goats and 28 (36.84%) on sheep with two (2.63%) articles included both the goat and sheep research results (Table 3).

Microbiological research

Review of published microbiological research reports showed that three categories of microbiological research have been conducted in goats and sheep in Bangladesh which include

Table 3. Major findings of the biochemistry and physiological research of goats and sheep in Bangladesh

SN Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. General physiology				
01. Apparently healthy	Temp., pulse & respiration	84-86	-	-
02. Effect of season	-	-	Birth weight of lambs	87
03. Growth performance	Different genetic groups	88	-	-
04. General performance	Semi-intensive & scavenging	89	-	-
B. Hemato-biochemical studies				
01. Haematology	Apparently healthy	90-92	Cross-bred, season	93-96
02. Cyclic heat stress	-	-	Physical & blood values	97
03. Apparently healthy	Intra-vascular blood volume	98	-	-
04. Splenectomised	Effects on haematology	99	-	-
05. Haematological values	Effects of haematonics	100	-	-
06. Blood Ca and P levels	Pregnancy & lactation	101	Normal levels	102
07. Serum proteins	TSP, albumin, globulin	103	-	-
08. Serum transferrins	-	-	Polymorphisms	104
09. Liver function test	-	105	-	-
10. Pancreas	Biochemical analysis	106	-	-
11. Haemato-biochemicals	-	-	Reference values (local)	107
12. Transition period	-	-	Hormonal profiles	108
13. Serum electrolyte conc.	-	-	Evaluation of electrolytes	109
D. Reproductive physiology				
01. Reproductive activity	Performance & biometry	110,111	Hormonal control	112
02. Productive and /or reproductive	Comparative performance	113-115	Comparative performance	116
	Black Bengal goats & crosses	117-119	Indigenous ewes	120
	Semi-intensive management	121-124	-	-
	Activation of oocytes	125	-	-
	Semi-intensive & extensive	126-128	Semi-intensive & intensive	129
	Jamunapari goat, hilly goats	130,131	-	-
	Under farming conditions	132	Smallholder farmers	133
03. Direct selection response	Coastal regions	134	-	-
	Growth & lactation trait	135	-	-
	Effect of dexamethasone	136	-	-
04. Oestrus cycle length	Detection	137	-	-
	Changes in vaginal mucus	138	Changes in vaginal mucus	138
	Cellular infiltration in vagina	139	Cytology & progesterone	140
05. Oestrus cycle / status	-	-	Reproductive performance	141
06. Baseline study on ram	-	-	Lamb production	143
07. Heritability estimates	Birth weight of kids	142	-	-
08. Growth & reproduction	Performance under farms	144	-	-
09. Pregnancy diagnosis	Physical and chemical test	145	Physical and chemical test	145
10. Smallholder goats	Morphometry & performance	146	-	-
11. Non-genetic effects	Productive traits	147	-	-
12. Genotypic & phenotypic	Reproductive traits	148,149*	Phenotypic characteristics	150
13. Native & Lohi cross	-	-	Gestation & lambing	151
	-	-	BW & sexual maturity	152,153
14. Wool quality of sheep	-	-	Ranney & Parendale	154,155
15. Improved feeding	-	-	Haematology & puberty	156
16. Effect of conc. feed	Reproductive performances	157	-	-
Total (n = 76)		48 (63.16)	28 (36.84)	

*Same article published in two different journals 116

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(a) Bacterial infections, (b) Viral infections and (c) Cellular prion protein (Table 4). Out of the 31 research reports, 23 (74.19%) reported in goats and eight (25.81%) in sheep (Table 4). The *Escherichia coli* and *Campylobacter jejuni* of goats and *E. coli* and *Salmonellae* of sheep have been isolated and characterized.^{158-169,171}

Sero-molecular diagnosis of brucellosis in goats and sheep have been reported.¹⁷⁰ Bacterial pathogens have also been isolated and identified in samples of upper respiratory tract (pneumonia), buccal and intestinal samples and pneumo-enteritis affected goats and samples of slaughtered yards and meat stalls.¹⁷²⁻¹⁷⁶ Bacterial agents associated with diarrhea and skin lesions in both the goats and sheep have been isolated and characterized with some antibiogram studies.¹⁷⁷⁻¹⁷⁹ Bacteria of the respiratory tract of sheep have also been isolated and identified.¹⁸⁰ Among the virus diseases, the genetic characterization of PPR in goats,^{181,182} isolation and characterization of contagious ecthyma (CE) in both the goats and sheep¹⁸³ and epidemiology and phylogenetic studies on CE in goats¹⁸⁴ have been reported from Bangladesh.¹⁸¹⁻¹⁸⁴ Molecular detection of cellular prion protein in goats have also been reported.¹⁸⁵

Table 4. Major findings of microbiological research in goats and sheep reported during six decades in BD					
SN	Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. Bacterial infections					
01.	<i>Escherichia coli</i>	Isolation & characterization	158	Cultural & biochemical tests	159
		Molecular & antibiogram profiles	160	Molecular & antibiogram	161
		Isolation and antibiogram profiles	162	-	-
		Isolation & multi-drug resistant	163	-	-
02.	SNFSTP <i>E. coli</i>	Prevalence & antibiogram profiles	164-168	-	-
03.	Salmonellae	-	-	Isolation & characterization	169
04.	Brucellosis	Sero-molecular diagnosis	170	Sero-molecular diagnosis	170
05.	<i>Campylobacter jejuni</i>	Isolation studies	171	-	-
06.	Bacterial pathogens	Isolation from URT (pneumonia)	172,173	-	-
07.	Buccal & intestinal	Identification of bacteria	174	-	-
08.	Pneumo-enteritis	Bacteriopathology & antibiogram	175	-	-
09.	Sanitary quality	Slaughter yards & meat stalls	176	-	-
10.	Diarrheic cases	Isolation & Identification of agents	177	Bacteria & antibiogram	178
11.	Skin lesions	Characterization of bacteria	179	Characterization of bacteria	179
12.	Respiratory tract	-	-	Identification of bacteria	180
B. Viral infections					
01.	PPR virus	Genetic characterization	181,182	-	-
02.	Contagious ecthyma	Isolation & characterization	183	Isolation & characterization	183
		Epidemiology & phylogenetic	184	-	-
C. Cellular prion protein					
		Molecular detection	185	-	-
Total (n = 31)			23 (74.19)	8 (25.81)	

SNFSTP = Sorbitol non-fermenting shiga toxin-producing

URT = Upper respiratory tract

Parasitological research

A total of 71 research reports have been published on parasitic infection and infestation in small ruminants, of which significantly more reports have been published in goats (n = 59; 83.10%) than sheep (n = 12 ; 16.90%) with 5 (07.04%) common reports both in goats and sheep (Table 5).¹⁸⁶⁻²⁵⁰ These research reports were divided based on four branches of parasitology which include (a) General parasitic infection, (b) Helminthes, (c) Protozoa and (d) Arthropod parasites (Table 5). Articles on gastro-intestinal helminthes, protozoa and arthropod parasites have been published in both goats and sheep whereas articles on trematodes, nematodes, cestodes and protozoan parasites reported in goats (Table 5). The prevalence of Amphistomes,²⁰⁷ *Fasciola gigantica*²⁰⁸ and Schistosomes,²⁰⁹ epg count and seasonal influence on GIN,^{210,211} *Haemonchus contortus*,²¹²⁻²¹⁸ *Oesophagostomum columbianum*,²¹⁹ Trichuris,^{220,221} Strongyles²²² and Trichostrongylus²²³ use of larvicides²²⁴ and *Moniezia expansa*,²²⁵ metacestodes,^{226,227} *Echinococcus granulosus*²²⁸ and larval taenids²²⁹ cestode parasites have been reported only in goats (Table 5). The protozoan infection includes *Leishmania donovani*,^{230,231} *Giardia intestinalis*,²³² *Cryptosporidium xiaoi*²³³ and coccidian infection^{234,235} including fatal coccidiosis²³⁶ have been reported in goats. The prevalence of lice and tick infestations have been reported in both the goats and sheep in Bangladesh^{237-240,244-246} but *Oestrus ovis*²⁴¹⁻²⁴³ and ear mites²⁴⁸ only reported in goats (Table 5). Parasites and parasitic diseases are widely prevalent mainly due to poor animal husbandry practices at smallholder farmer level in Bangladesh. Parasites and parasitic diseases are likely to continue to be difficult to control under the current management system (scavenging) of livestock and thus, new scientific knowledge will be needed to enhance control effects in Bangladesh.

Pharmacological and toxicological research

Out of 29 published reports on pharmacological and toxicological research, 22 (75.76%) published on pharmacological and 7 (24.14%) on toxicological articles (Table 6). Of the 29 reports, 16 (55.17%) published in goats and 13 (44.83%) in sheep (Table 6). Although the pharmacological and toxicological research reports on small ruminants are limited, but both the goats and sheep have been used for these research. It appears that the pharmacological research is mainly based on the comparative anthelmintic efficacy trials of trade anthelmintic drugs with that of some medicinal plants in small ruminants (Table 6). Table 6 shows that the different trade products of ivermectin have also been used against different types of gastro-intestinal nematodes, trematodes (paramphistomum) and ectoparasites.²⁵¹⁻²⁷² Some herbal plants those have anthelmintic activities against parasites especially neem leaves and seeds, pine apple leaves, garlic, ata leaves and others have been used to compare their anthelmintic efficacy with trade anthelmintic including levamisole, fenbendazole, albendazole, combined product Nilzan[®] (Coopers) and even ivermectin products (Table 6). It is well recognized that the ivermectin is an effective paracitocides against both endo-and ecto-parasites, but it is economically and effectively used against parasites invade the organs and tissues especially in mange mites, lungworm, filariasis, humpsore and also parasites resistance to trade anthelmintics. The established pharmacological ethic of ivermectin would not encourage the clinician and practitioner to prescribe toxic and expensive ivermectin drug against gastro-intestinal parasites where economically effective anthelmintics are easily available in local market.

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Table 5. Major findings of parasitological research of goats and sheep reported during last six decades in BD

SN	Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. General parasitic infection					
01.	Parasites	Prevalence	*186,187,188	-	-
02.	GI parasites	Prevalence, anthelmintic trial	189-194	-	-
03.	Helminthes & Protozoa	Prevalence	195	Prevalence	195
04.	Helminthes & Arthropoda	-	-	Seasonal prevalence	196
05.	Pulmonary parasites	Prevalence	197	-	-
06.	Feeding system	Influence parasitism	198	-	-
B. Helminthes					
01.	GI helminthes	Survey & prevalence	199-201	Prevalence	199,200,201-205
02.	Abomasal helminthes	Epidemiology	206	-	-
① Trematodes					
01.	Amphistomes	Prevalence	207	-	-
02.	<i>Fasciola gigantica</i>	Distribution & parasite size	208	-	-
03.	Schistosomes	Male schistosomes infection alone	209	-	-
② Nematodes					
01.	Fecal egg count (epg)	Aid in detecting GIN population	210	-	-
02.	GI nematodes (farm)	Seasonal influence on prevalence	211	-	-
03.	<i>Haemonchus contortus</i>	Genetic diversity & fecal EPG	212,213	-	-
		Seasonal distribution	214,215	-	-
		Efficacy of Ivermectin & larvicides	216,217	-	-
		Resistance to anthelmintics	218	-	-
04.	<i>O. columbianum</i>	Incidence	219	-	-
05.	Trichuris infection	Prevalence & pathological effects	220,221	-	-
06.	Strongyle infection	Season & geographical location	222	-	-
07.	<i>Trichostrongylus</i> spp.	Prevalence & <i>in vitro</i> culture	223	-	-
08.	Larvicidal action	Control of free-living stages	224	-	-
③ Cestodes					
01.	<i>Moniezia expansa</i>	Incidence	225	-	-
02.	Metacestodes	Prevalence	226,227	-	-
03.	<i>E. granulosus</i>	Identification & characterization	228	-	-
04.	Larval taenids	Prevalence	229	-	-
C. Protozoan infection					
01.	<i>Leishmania donovani</i>	Reservoir host, molecular detection	230,231	-	-
02.	<i>Giardia intestinalis</i>	Molecular characterization	232	-	-
03.	<i>Cryptosporidium xiaoi</i>	Molecular characterization	233	-	-
04.	Coccidia infection	Incidence, age & season	234,235	-	-
05.	Fatal coccidiosis	<i>Eimeria ninakohlyakimovae</i>	236	-	-
D. Arthropods parasites					
01.	Ectoparasites	Prevalence	237,238	Prevalence	239
02.	Survey of lice	Prevalence	240	Prevalence	240
03.	<i>Oestrus ovis</i>	Prevalence, Occurrence of larvae	241-243	-	-
04.	Tick fauna	Prevalence	244-246	Prevalence	246
05.	Tick and protozoa	Prevalence & tick borne protozoa	247	-	-
06.	Ear mites	Prevalence	248	-	-
07.	<i>Linguatula serrata</i>	Occurrence of lymph	249	-	-
08.	Infectious diseases	Predisposition to ectoparasitic lesions	250	-	-
Total (n = 71)			59 (83.10)		12 (16.90)

*Same articles (186 & 187) published in two different journals

Very limited toxicological research have been conducted in small ruminants in Bangladesh which are mostly confined on induction of poisoning with furadan in goat²⁷³ and malathion in sheep^{274,275} with their serum enzymatic changes (Table 6). The clinical and biochemical changes of sulfonamides and trimethoprim in sheep²⁷⁶ and effect of formalin in male reproduction in goats²⁷⁷ have been reported (Table 6). The effect of natural exposure of chronic arsenic poisoning in goats especially on spermatogenesis²⁷⁸ and hematology and histo-architecture changes²⁷⁹ have been reported (Table 6).

Table 6. Major findings of pharmacological and toxicological research in goats and sheep in Bangladesh				
SN Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. Trade anthelmintic trials				
01. Ivermectin & diazinon	-	-	Against ectoparasites	251
02. Ivermectin (poor on)	GIN & ectoparasites	252	Against ectoparasites	253,254
03. Efficacy of Levamid [®]	-	-	GIN & paramphistomiasis	255
04. Albendazole, Fenvet [®] and Ivomec [®]	Comparative efficacy against GIN	256-258	-	-
05. Tetramisole, thiabendazole, Rumentin	Comparative anthelmintic efficacy	259	-	-
B. Herbal anthelmintic trials				
01. Efficacy of neem seeds	GI nematodes	260	GI nematodes	261
02. Plant leaves & levamisole	-	-	GI nematodes	262
03. Efficacy of herbs	-	-	GI nematodes	263
04. Efficacy of herbs & Nilzan [®]	-	-	Against trematodiasis	263,264
05. Effect of garlic	GIP, BW & haematology	265	-	-
06. Pineapple leaves & Fenbendazole	Efficacy against GIN	266	Efficacy against Strongylid	267
07. Indigenous plants (<i>in vitro</i>)	Anthelmintic effect (GIN)	268	-	-
08. Herbs & Ivermectin	Efficacy against skin lesions	269	-	-
09. Ata leaf extract	Efficacy against ticks	270	-	-
10. Medicinal plants	Efficacy against GIN	271	-	-
11. Albendazole & neem leaves	-	-	Against haemonchosis	272
C. Toxicological research				
01. Furdan induced poisoning	Dutura and atropine sulfate therapy	273	-	-
02. Malathion poisoning	-	-	Effects on enzymes	274,275
03. Sulfonamide(S) & STM	[STM = S & Trimethoprim]	-	Clinical & biochemicals	276
04. Effect of formalin	Male reproduction	277	-	-
05. Chronic arsenic poisoning	Spermatogenesis	278	-	-
	Hematology & histo-architecture changes	279	-	-
Total (n = 29)		16 (55.17)		13(44.83)

Pathological research

A total of 64 research articles on pathological aspects have been published on small ruminants in Bangladesh of which 59 (92.19%) reported in goats and only 5 (7.81%) in sheep (Table 7). These reported pathological findings are categorized into five groups: (a) Gross pathology, (b) Histopathology, (c) Parasitologic pathology, (d) Infectious disease pathology and

(e) Clinical pathology (Table 7). Pathological diagnosis of diseases of different systems and organs based on gross lesions of slaughter small ruminants have been reported.²⁸⁰ The pathological diseases of respiratory system including bacterio-pathology,²⁸¹⁻²⁸⁶ digestive system including liver diseases,²⁸⁷⁻²⁸⁹ urinary system including etio-pathology of kidney diseases,²⁹⁰⁻²⁹² cardio-vascular system including heart,^{293,294} reproductive system including etio-pathology of ovarian follicles,²⁹⁵⁻²⁹⁹ and pathological diagnosis of chronic arsenic poisoning in male and female reproductive organs mostly in goats have been reported,³⁰⁰⁻³⁰² whereas only one report could be traced in sheep with pathology of liver diseases.²⁸⁹

The histologic alterations in the liver of goats affected with *Fasciola gigantica* have been reported^{303,304} but similar report has not yet been published in sheep from Bangladesh (Table 7).

A total of 27 research reports on the prevalence and pathological investigation of parasitic diseases and infections have been published on small ruminants, of which 22 (81.48%) in goats and only four (14.82%) in sheep with a single article included both goat and sheep (Table 7). The prevalence and pathology of intestinal helminthes,³⁰⁵ correlation of fecal EPG and pathology of *F. gigantica* infection,³⁰⁶⁻³⁰⁸ histopathology and hematology of *Haemonchus contortus*,³⁰⁹ abortion and neonatal mortality caused by *Toxoplasma gondii*,³¹⁰ occurrence of fatal sarcocystosis,³¹¹ prevalence of hydatid disease in slaughter goats³¹²⁻³²⁰ and sheep,^{318, 321,322} clinico-pathological changes of coenurosis^{323,324} and epidemiology and pathology of ectoparasitic infection³²⁵ in goats have been reported (Table 7). The histopathology and hematology of *H. contortus*³⁰⁹ in both goats and sheep have only been documented from Bangladesh (Table 7).

Among the infectious diseases, clinical PPR has only been reported in goats but not in sheep (Table 7). The molecular diagnosis of PPR with gene target,³²⁶ viro-pathology and histochemistry,³²⁷ clinico-pathological investigation,^{328,329} viro-molecular and pathology³³⁰ and detection of RT-PCR positive PPR in slaughter goats³³¹ have been reported from Bangladesh.

There are 10 research articles have been published on clinical pathological studies in goats but none in sheep (Table 7). The effects of caprine fascioliasis on haematology,^{332,333} haemato-biochemical changes³³⁴ and anthelmintic effects on haematology³³⁵ have been reported (Table 7). The haemato-biochemical changes caused by intestinal parasites^{336,337} and PPR,^{338,339} blood calcium and phosphorus status in urolithiasis³⁴⁰ and clinico-pathological investigation of urethral rupture³⁴¹ in goats have been reported (Table 7).

General and systemic medicine

Out of 24 research reports published on general and systemic caprine and ovine medicine, of which 20 (83.33%) reported in goats and only four (16.67%) in sheep (Table 8). The establishment of health management package of sheep³⁴² and therapeutic evaluation of lymphadenitis in goats³⁴³ were recorded as problems of general medicine (Table 8). The prevalence and clinical assessment of acidosis,^{344,345} effect of sodium on acidosis,³⁴⁶ efficacy of simethicone in bloat³⁴⁷ and differential diagnosis of diarrhea caused by PPR and fascioliasis³⁴⁸ have been reported as disorders of the digestive tract of goats (Table 8). The occurrence of aspiration pneumonia,³⁴⁹ clinico-epidemiological studies on pneumonia^{350,351} and respiratory

Table 7. Major findings of pathological research of goats and sheep reported during last six decades in BD

SN	Pathological aspects	Goats	Ref. No.	Sheep	Ref. No.
A. Gross pathology (mainly slaughtered animals)					
01.	Diseases diagnosed	Pathological diseases	280	-	-
02.	Respiratory system	Respiratory diseases	281	-	-
		Etio-pathology	282	-	-
	Pneumonic lungs	<i>P. haemolytica</i> isolation	283	-	-
		Lung diseases & causal bacteria	284	-	-
		Bacterio-pathology	285,286	-	-
03.	Digestive system	Liver diseases / pathology	287,288	Liver diseases/pathology	289
04.	Urinary system	Pathological conditions	290	-	-
		Kidney pathology	291	-	-
		Etio-pathological investigation	292	-	-
05.	Cardio-vascular system	Pathological investigation	293	-	-
06.	Heart of slaughter goats	Pathological investigation	294	-	-
07.	Reproductive system	Morphometric-ovarian follicles	295	-	-
		Etio-pathological conditions	296-299	-	-
08.	Chronic arsenic poisoning	Changes in uterus	300	-	-
		Epididymis & ductus deferens	301	-	-
		Histo-architecture of gonads	302	-	-
B. Histopathology					
01.	<i>Fasciola gigantica</i>	Histologic alterations in the liver	303,304	-	-
C. Parasitic pathology					
01.	Intestinal helminthes	Prevalence and pathology	305	-	-
02.	<i>Fasciola gigantica</i>	Correlation with EPG	306	-	-
		Pathological studies	307,308	-	-
03.	<i>Haemonchus contortus</i>	Histopathology & haematology	309	Histopathology & haematology	309
04.	<i>Toxoplasma gondii</i>	Abortion & neonatal mortality	310	-	-
05.	Fatal sarcocystosis	Occurrence	311	-	-
06.	Hydatid disease on PM	Prevalence	312-320	Prevalence	318,321,322
07.	Coenurosis	Clinico-pathological changes	323,324	-	-
08.	Ectoparasitic infestation	Epidemiology and pathology	325	-	-
D. Infectious disease pathology					
01.	PPR	Molecular diagnosis- gene target	326	-	-
		Viro-pathology & histochemistry	327	-	-
		Clinico-pathological investigation	328,329	-	-
		Viro-molecular and pathology	330	-	-
		PLN (slaughter goats) RT-PCR+ve	331	-	-
E. Clinical pathology					
01.	<i>Fasciola gigantica</i>	Effects on haematology	332,333	-	-
		Haemato-biochemical changes	334	-	-
		Anthelmintic effects on hematology	335	-	-
02.	Intestinal parasites	Haemato-biochemical changes	336,337	-	-
03.	PPR	Hemato-biochemical studies	338,339	-	-
04.	Urolithiasis	Blood Ca and P level status	340	-	-
05.	Urethral rupture	Clinico-pathological investigation	341	-	-
Total (n = 64)			59 (92.19)		5 (07.81)

Pre-clinical and clinical research of small ruminants

disorders similar to lungworm infections³⁵² have been reported as disorders of the respiratory system of goats (Table 8). The prevalence,³⁵³ effects of feed and feed additive³⁵⁴ and sodium supplement on the incidence of urolithiasis³⁵⁵ have been reported in the urinary system disorders in goats (Table 8). The uses of diclofenac sodium in the treatment of myositis³⁵⁶ and clinico-hematological effect of induced myositis³⁵⁷ have been reported in goats but similar report on the muscular system could not be traced in sheep (Table 8). The prevalence to treatment of the skin diseases have been reported on both the goats³⁵⁸⁻³⁶¹ and sheep.³⁶²⁻³⁶⁴ The occurrence of concurrent eczema and myiasis was treated with Himax[®] skin ointment (Indian Herbs) in goats.³⁶⁵

Table 8. Major research findings of caprine and ovine general and systemic medicine published during the last six decades in Bangladesh

SN Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. General medicine				
01. Health management	Package	-	Establishment	342
02. Lymphadenitis	Evaluation of remedy	343	-	-
B. Systemic medicine				
a. Digestive system				
01. Acidosis(lactic)	Prevalence & clinical assessment	344,345	-	-
	Effect of sodium on acidosis	346	-	-
02. Bloat (Tympany)	Efficacy of simethicone	347	-	-
03. Diarrhea	PPR & fascioliasis differences	348	-	-
b. Respiratory system				
01. Aspiration pneumonia	Case report	349	-	-
02. Pneumonia	Clinical and epidemiology	350,351	-	-
03. Respiratory disorders	Similar to lung worm infections	352	-	-
c. Urinary system				
01. Urolithiasis	Prevalence	353	-	-
	Feed & feed additive	354	-	-
	Effect of Na supplement	355	-	-
d. Muscular system				
01. Myositis treatment	Diclofenac sodium	356	-	-
02. Induced myositis	Clinico-hematological effect	357	-	-
e. Skin diseases and disorders				
01. Skin diseases	Prevalence to treatment	358-361	Prevalence to treatment	362-364
02. Eczema with myiasis	Treatment with Himax [®]	365	-	-
Total (n = 24)		20 (83.33)		4 (16.67)

Epidemiology, clinical and preventive medicine

A total of six categories of diseases like ① Parasitic diseases, ② Bacterial diseases, ③ Virus diseases, ④ Rickettsial diseases, ⑤ Fungal diseases and ⑥ Metabolic diseases have been reported in small ruminants in 120 research articles in Bangladesh (Table 9). The overall prevalence and problems,^{366,367} epidemiological investigation,^{368,369} anthelmintic efficacy^{370,371}

and effects of iron supplement³⁷² against gastro-intestinal parasites in goats and sheep have been reported (Table 9).

The epidemiological investigation of amphistomiasis,³⁷³ prevalence, epidemiology, haemato-biochemical changes, anthelmintic efficacy and control of fascioliasis,³⁷⁴⁻³⁸² prevalence, haematological effects, anthelmintic efficacy and resistance of GI nematodiasis,³⁸³⁻³⁹⁰ risk factor for prevalence of haemonchosis,^{391,392} prevalence of oesophagostomiasis,³⁹³ and epidemiology of monieziasis³⁹⁴ have been reported in small ruminants (Table 9). Among the protozoan diseases, only sero-prevalence of toxoplasmosis in both goats^{396,397} and sheep^{396,397} and associated with abnormal reproduction only in goats³⁹⁵ have been reported (Table 9). Out of five articles published on arthropod diseases in small ruminants, of which only one reported on the efficacy of fenitrothion and cypermethrin against psoroptic and pediculosis mites in sheep.⁴⁰¹ The four articles which include asphyxial death associated with *Oestrus ovis* and its diagnosis and treatment,^{398,399} clinico-pathological studies on psoroptic mange⁴⁰⁰ and prevalence of otoacariasis⁴⁰² have been reported only in goats (Table 9).

The efficacy of different antibiotics against bacterial diseases of goats has been reported (Table 9).⁴⁰³ A total of 40 research articles reported different aspects of nine bacterial diseases in small ruminants (Table 9). The characterization of anthrax vaccine,⁴⁰⁴ sero-prevalence of brucellosis in goats⁴⁰⁵⁻⁴¹⁵ and sheep^{406,415-418} and economic impact of brucellosis in goats and sheep,⁴¹⁹ surveillance of brucellosis in aborted cases,^{420,421} risk factors and prevalence⁴²² and relation with husbandry practices⁴²³ in goats have been reported (Table 9). The clinical and experimental eneterotoxaemia,⁴²⁵⁻⁴²⁸ therapeutic evaluation⁴³⁰ and clinical management⁴³¹ of Infectious keratoconjunctivitis reported in goats but not in sheep (Table 9). Treatment of dermatophilosis with alum and zinc⁴²⁴ and prevalence of foot-rot⁴²⁹ only reported in sheep but not in goats (Table 9). The prevalence of sub-clinical (SCM) and clinical mastitis (CM)^{432,433} with their risk factors and therapy,^{434,435} bacterial pathogens,⁴³⁶ epidemiology and pathogens of SCM,^{437,438} treatment of CM,⁴³⁹ coliform mastitis and antibiogram⁴⁴⁰ have been reported only in goats but not in sheep (Table 9). The epidemiology and antibiogram studies on caprine salmonellosis⁴⁴¹ have been reported only in goats, whereas the prevalence of bovine and avian tuberculosis have been reported in both the goats and sheep.⁴⁴²

A total of 37 research reports published on the prevalence of five virus diseases in small ruminants which includes Contagious ecthyma, Capripox, PPR, Virus diarrhea, and Rotavirus diarrhea (Table 9). All the recorded virus diseases have been reported in goats except the sero-prevalence and immunization of PPR which have been reported in both the goats^{446,452-456} and sheep^{446,453,454} (Table 9). The epidemiology and clinico-therapeutic management of Contagious ecthyma,^{443,444} prevalence and risk factors of capripox,^{443,445} different aspects including sero-prevalence, epidemiology, outbreaks, clinico-pathological and therapeutic management and vaccines for control of PPR,⁴⁴⁶⁻⁴⁷⁷ haematological studies on virus diarrhea⁴⁷⁸ and prevalence of Rotavirus diarrhea⁴⁷⁹ have been reported in goats (Table 9).

The sero-prevalence of *Coxiella burnetii* in goats and ticks^{480,481} and sero-molecular investigation in goats⁴⁸² and sheep⁴⁸² have been reported (Table 9). The causal fungal agents of dermatomycosis⁴⁸³ and occurrence of clinical hypocalcemia⁴⁸⁴ have only been reported in goats but not in sheep (Table 9).

Table 9. Major research findings on the epidemiology, clinical and preventive medicine of goats and sheep reported during the last six decades in Bangladesh

SN Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. Parasitic diseases				
1. Parasitic diseases	Overall prevalence, problems	366,367	Problems	367
2. GI parasites	Epidemiological studies	368,369	Epidemiological studies	368,369
3. Anthelmintic efficacy	Effect on production & blood values	370	Efficacy against GIN	371
4. Effect of iron therapy	Effect on blood values & body wt.	372	-	-
a. Helminthitic diseases				
1. Amphistomiasis	Epidemiological investigation	373,374	-	373
2. Fascioliasis	Haemato-biochemicals & therapy	375	Haemato-biochemical effects	375
	Anthelmintic efficacy(bwt)	377-379	Evaluation of allergic test	376
	Risk factors & space-time clusters	380	Factors & space-time clusters	380
	Prevalence & economic impact	381	-	-
	Epidemiology & control	382	Epidemiology & control	382
3. GI nematodiasis	Prevalence	383	-	-
	Evaluation of anthelmintics	384-387*	Comparative efficacy	388
	Haematology & anthelmintics	389	-	-
	Anthelmintic resistance in GIN	390	Anthelmintic resistance	390
4. Haemonchosis	Risk factors for prevalence	391,392	-	-
5. Oesophagostomiasis	Prevalence	393	-	-
6. Monieziasis	Epidemiology	394	-	-
b. Protozoan diseases				
1. Toxoplasmosis	Abnormal reproduction	395	-	-
	Sero-prevalence	396,397	Sero-prevalence	396,397
c. Arthropod diseases				
1. Oestrus ovis	Asphyxial death (pneumonia)	398	-	-
	Diagnosis and treatment	399	-	-
2. Psoroptic (Ps) mange	Clinico-pathological studies	400	-	-
3. Ps & Pediculosis	-	-	Fenitrothion & Cypermethrin	401
4. Otoacariasis	Prevalence	402	-	-
B. Bacterial diseases				
1. Different antibiotics	Efficacy in bacterial diseases	403	-	-
2. Anthrax	Characterization of anthrax vaccine	404	-	-
3. Brucellosis	Sero-prevalence (SP)	405-415	Seroprevalence	406,407,409-4011, 413,415-418
	Economic impact	419	Economic impact	419
	Surveillance in aborted cases	420,421	-	-
	Risk factors & prevalence	422	-	-
	Relation with husbandry practices	423	-	-
4. Dermatophilosis	-	-	Treatment with alum & zinc	424
5. Enterotoxaemia	Experimental with its treatment	425	-	-
	Prevalence, signs, PM & etiology	426	-	-
	Detection of toxinotypes	427	-	-
	IR against beta and epsilon toxoids	428	-	-
6. Foot-rot	-	-	Prevalence	429
7. Infectious kerato-conjunctivitis (IKC)	Therapeutic evaluation	430	-	-
	Clinical management	431	-	-

SN Research aspects	Goats	Ref. No.	Sheep	Ref. No.
8. Mastitis	Clinical and sub-clinical (SCM)	432,433	-	-
	Clinical, risk factors, therapy	434,435	-	-
	Bacterial pathogens (BP)	436	-	-
	Epidemiology & pathogens (SCM)	437,438	-	-
	Treatment of clinical cases	439	-	-
	Coliform mastitis & antibiogram	440	-	-
9. Salmonellosis	Epidemiology & antibiogram	441	-	-
10. Bovine & Avian TB	Prevalence	442	Prevalence	442
C. Virus diseases				
1. Contagious ecthyma	Clinico-epidemiological studies	443	-	-
	Clinico-therapeutic management	444	-	-
2. Capripox	Prevalence & risk factors	443,445	-	-
3. PPR	SP & immunization	446	SP & immunization	446
	Clinico-pathology & treatment	447-449	-	-
	Epidemiology & therapy	450	-	-
	Sero-epidemiology	451	-	-
	Sero-prevalence	452-456	Sero-prevalence	453,454
	Prevalence & risk factors	457,458	-	-
	Development of Mab based ELISA	459	-	-
	Prevalence & therapy	460-465	-	-
	Management of outbreaks	466-468	-	-
	Acquired & MDA	469	-	-
	Molecular epidemiology	470	-	-
	Risk factors & space time clusters	471	-	-
PPR + RP live vaccine	Comparative efficacy trial	472	-	-
Inactivated vaccine	Development of vaccine	473	-	-
Thermostable vaccines	IR & sero-monitoring-survey	474-476	-	-
Tissue culture vaccine	Antibodies response	477	-	-
4. Virus diarrhea	Haematological studies	478	-	-
5. Rotavirus diarrhea	Prevalence	479	-	-
D. Rickettsial diseases				
1. <i>Coxiella burnetii</i>	Sero-prevalence in goats & ticks	480,481	-	-
	Sero-molecular evidence	482	Sero-molecular evidence	482
E. Fungal diseases				
1. Dermatomycosis	Distribution of causal fungi	483	-	-
F. Metabolic diseases				
1. Hypocalcaemia	Occurrence of clinical cases	484	-	-
G. Other studies				
1. Anthroppo-clinical	Anti-microbial prescription pattern	485	-	-
Total (n = 144)		112 (77.78)		32 (22.22)

*Same articles (Nos. 384 & 385) and (Nos. 386 & 387) have been published in two different journals

Gynaeco-obstetrical studies

The gynaeco-obstetrical research reports on small ruminants can be categorized into two groups, e.g., (a) Reproductive disorders and (b) Semen and artificial insemination (Table 10). The occurrence of Ringwomb,⁴⁸⁶ estrus synchronization,⁴⁸⁷⁻⁴⁸⁹ embryo production by using

Pre-clinical and clinical research in small ruminants

Table 10. Major research findings on gynaeco-obstetrical disorders and artificial insemination in goats and sheep reported during the last six decades in Bangladesh

SN	Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. Reproductive disorders					
01.	Reproductive disorders	Ringwomb occurrence	486	-	-
		Estrus synchronization	487-489	PMS to induce breeding activity	490
				Estrus synchronization (ES)	491,492
				Comparative ES	493
02.	Embryo production	MOET technique	494	-	-
		Surgical embryo recovery	495	-	-
03.	Pre-&-pubertal oocytes	Maturation & fertilization	496	-	-
04.	Treated sponge*	-	-	Embryo yields and quality	497
05.	Uterine prolapse	Therapeutic management	498	-	-
B. Semen and artificial insemination (AI)					
01.	Sperm / Spermogramic	Optimum sperm output	499	Influence of age	500
				Spermatozoa in urine	501
02.	Semen bacteriology	-	-	Bacterial contamination	502
03.	Quality characterization	Characteristics of semen	503	Season & characterization	504-506
04.	Conc. supplementation	-	-	Effect on semen quality	507
05.	Effect of egg yolk %	-	-	Effect on chilled semen	508
06.	Comparison of extenders	Quality of goat semen	509	Effect on semen & pregnancy rate	510,511
		Uses of EYC & Tris	512	Merits of EYC & whole milk	513
		Cryopreserved semen	515	Skim milk & Tris-citrate	514
07.	Spermatozoa separation	-	-	Modified swim up method	516
08.	Preservation of semen	Effects of glycerol doses	517,518	Effects of glycerol percentage	519
		Use in AI	520	Cryopreservation of ram semen	521
09.	Duration of preservation	Affects quality of semen	522	-	-
10.	Fertilizing capacity	Different conc. egg yolk	523	Transfer of vitrified embryos	524
11.	Evaluation of semen	-	-	Selection of breeding ram	525
12.	Effect of preservation	-	-	Quality of frozen semen	526
13.	Quantitative study	-	-	Size of ram spermatozoa	527
14.	AI with frozen semen	-	-	Status & factors of CR	528-530
Total (n = 40)			18 (45.0)		22 (55.0)

MOET = Multiple ovulation and embryo transfer

*Sponge treated with cloprostenol and flurogestone acetate

MOET technique,⁴⁹⁴ surgical embryo recovery,⁴⁹⁵ pre-pubertal oocytes maturation and fertilization⁴⁹⁶ and therapeutic management of uterine prolapse⁴⁹⁸ have been reported in goats (Table 10). The pregnant mare serum (PMS) used to induce breeding activities,⁴⁹⁰ estrus synchronization (ES),^{491,492} comparative ES,⁴⁹³ and sponge treated with cloprostenol and flurogestone acetate to detect the effects on embryo yield and quality⁴⁹⁷ have been reported in ewes (Table 10).

Table 10 shows that 32 research articles on semen and artificial insemination (AI) in small ruminants have been published with higher percentage reported in sheep (n = 22; 68.75%) in comparison to goats (n = 10; 31.25%). The optimum semen output,⁴⁹⁹ semen quality,⁵⁰³ effects

of extenders,^{509,512} cryopreservation,⁵¹⁵ duration of preservation,^{517,518} AI,⁵²⁰ and effects of different concentration of egg yolk⁵²³ have been studied with goat semen (Table 10). The influence and effects of age,⁵⁰⁰ season,⁵⁰⁴⁻⁵⁰⁶ feeding concentrate supplementation,⁵⁰⁷ different extenders,^{513,514} preservation⁵¹⁹ and cryopreservation⁵²¹ have been studied in ram semen (Table 10). In addition, spermatozoa in urine,⁵⁰¹ bacterial contamination,⁵⁰² spermatozoa separation,⁵¹⁶ transfer of vitrified embryos,⁵²⁴ selection of breeding ram,⁵²⁵ size of ram spermatozoa⁵²⁷ and status and factors of conception rate of AI with frozen semen⁵²⁸⁻⁵³⁰ have also been reported with ram semen (Table 10).

Anesthesiology and surgery

A total of 73 research reports have been published on anesthesiology and surgery aspects, of which 23 reported in analgesic and anesthesiology, six in congenital anomalies and 44 in surgical disorders of small ruminants (Table 11). Of the 73 reports, only 8 (10.96%) reported in sheep and 65 (89.04%) in goats (Table 11).

The effect of pre-medication on rumen motility and pH,⁵³¹ effectiveness of intravenous limb analgesia,⁵³³ anesthetic and sedative effects on clinical and blood picture,⁵³⁴ cranial and caudal epidural analgesia,^{536,537} anesthetic effects on haematology,^{538,539} gastro-esophageal reflux in chloral hydrate and magnesium sulfate anesthesia,^{540,541} anatomical site of paravertebral anesthesia,⁵⁴² produced shock in paravertebral anesthesia⁵⁴³ high epidural analgesia,^{547,548} combined effects of sedation and analgesia,⁵⁴⁹ comparative efficacies of different analgesics,⁵⁵⁰ comparative effects of volatile anesthetic agents⁵⁵² and general anesthesia by using Propofol (Diprivan)⁵⁵³ have been reported in goats (Table 11). The clinical effects of tranquilizers and sedatives,⁵³² clinico-hematological changes in anesthesia and sedation,⁵³⁵ intra-luminal pressure at pre-anesthesia starvation and anaesthetized status,^{544,545} pre-medical effects of anaesthetics,⁵⁴⁶ and caudal epidural analgesia,⁵⁵¹ have been reported in sheep (Table 11). It is well established fact that the physicians and anesthetists often first experienced on animals and the development and standardize the technique and anesthetics for both human and animal practices. Many of the same drugs for premedication, induction and maintenance of anesthesia are used in both the human and veterinary medical surgery. There are species specific effects of some of the anesthetics that commonly used in both human and animal practices. However, analgesic and anesthetic techniques are required when specific diagnostic procedures and painful surgery are to be performed. Moreover, the analgesia and anesthesia are essential to make the surgical procedures easier and improve animal and surgeon safety including animal welfare.

Of the six published available reports on congenital anomalies, double monster kids,^{554,555} surgical repair,⁵⁵⁶ atresia ani,⁵⁵⁷ overall prevalence,⁵⁵⁸ and congenital scrotal hernia⁵⁵⁹ have been reported in goats but no such reports could be traced in sheep (Table 11). Reporting and documenting congenital defects is essential to determine their frequency and overall prevalence for their prevention. Congenital defects are mainly caused by genetic and environmental teratogens. The genetic abnormalities with their carrier state is detectable with the aid of enzymes and surface protein markers which can be eliminated through selective breeding.

Out of 44 surgical research reports, only two (4.55%) reports on modified technique of ruminal fistula^{564,565} have been reported in sheep whereas 42 (95.45%) reports made on caprine

Table 11. Major research findings on the anesthesiology and surgical disorders in goats and sheep reported during the last six decades in Bangladesh

SN	Research aspects	Goats	Ref. No.	Sheep	Ref. No.
A. Analgesic & Anesthesiology					
01.	Effect of pre-medication	Ruminal motility & pH	531	-	-
02.	Tranquilizers & sedatives	-	-	Clinical effects	532
03.	Intravenous limb analgesia	Effectiveness	533	-	-
04.	Certain anesthetic + sedative	Effects on clinical & blood	534	Clinico-hematology	535
05.	Local analgesics & ketamine	Cranial epidural analgesia	536	-	-
		Caudal epidural analgesia	537	-	-
06.	Anaesthetic combinations	Hematological changes	538,539	-	-
07.	Chloral hydrate + MgSO ₄	Gastro-esophageal reflux	540,541	-	-
08.	Paravertebral anesthesia	Anatomical site	542	-	-
09.	Paravertebral anesthesia	Produced shock	543	-	-
10.	Starvation at pre-anesthesia	-	-	Intra-luminal pressure	544
11.	Anesthetized status	-	-	Intraluminal pressure	545
12.	Effects of anaesthetics	-	-	Premedication effects	546
13.	Analgesic & anesthetics	High epidural analgesia	547,548	-	-
14.	Sedation & analgesia	Combined effects	549	-	-
15.	Comparative efficacies	Different analgesics	550	-	-
16.	Lignocaine +Bupivacaine	-	-	Caudal epidural analgesia	551
17.	Comparative effects	Volatile anesthetic agents	552	-	-
18.	General anaesthesia	Use of Propofol	553	-	-
B. Congenital anomalies					
01.	Congenital defects (CD)	Double monster kids	554,555	-	-
		Surgical repair of CD	556	-	-
		Atresia ani	557	-	-
		Overall prevalence of CD	558	-	-
		Congenital scrotal hernia	559	-	-
C. Surgical research					
01.	Surgical affections	Occurrence	560	-	-
02.	Bloat management	Therapeutic & surgical	561	-	-
03.	Effects of castration	Hematology & cholesterol	562	-	-
		Serum testosterone conc.	563	-	-
04.	Ruminal fistulation	-	-	Modified technique	564,565
05.	Complete fracture	Use of Thomas splint	566	-	-
06.	Limb fracture	Surgical management	567	-	-
07.	Ruminal stasis	Associated with ascites	568	-	-
08.	Rupture of urinary bladder	Surgical repair	569	-	-
09.	Urolithiasis (obstructive)	Surgical treatment	570,571	-	-
10.	Ventral abdominal hernia	Surgical management	572	-	-
11.	Coenurosis	Incidence	573-575*	-	-
		Radiological diagnosis	576	-	-
		Surgical treatment	577-580*	-	-
		Neural & extra-neural	581-584	-	-
		Extra-neural & treatment	585,586	-	-
12.	Echinococcosis	Abdominal cysts	587	-	-
13.	Gangrenous mastitis	Surgical management	588	-	-

SN	Research aspects	Goats	Ref. No.	Sheep	Ref. No.
14.	Wound (healing) treatment	Herbal extract & antibiotics	589	-	-
		Indigenous medicinal plants	590,591	-	-
		Role of omentum	592	-	-
		Role of platelet plasma gel	593	-	-
		Role of PRP in bone healing	594	-	-
		Skin grafting for wound	595	-	-
		Muscle transposition	596	-	-
		Ultrasonographic monitoring	597	-	-
		Effect of penicillin	598	-	-
		Ethanolic extract of curcumin	599	-	-
		Morphological changes healing	600	-	-
15.	Expt. induced wound	Clinico-hematological effects	601	-	-
16.	Myiasis	Prevalence	602	-	-
17.	Cystoplasty	Autogenous grafts	603	-	-
Overall (n = 73)			65 (89.4%)		8 (10.96)

*573 & 574 and 578 & 579 similar articles published in two different journals

IPR & LOS = Intra-luminal pressure of rumen and lower esophageal sphincter

LHCl = Lignocaine hydrochloride

BHCl = Bupivacaine hydrochloride

PRP = Platelet-rich plasma

surgery (Table 11). These include occurrence of surgical affections,⁵⁶⁰ therapeutic and surgical management of bloat,⁵⁶¹ effects of castration on hematology and hormones,^{562,563} use of Thomas splint in complete fracture,⁵⁶⁶ surgical management of limb fracture,⁵⁶⁷ ruminal stasis associated with ascites,⁵⁶⁸ surgical repair of rupture urinary bladder,⁵⁶⁹ surgical treatment of obstructive urolithiasis,^{570,571} surgical management of ventral abdominal hernia,⁵⁷² reports on coenurosis comprise of incidence,⁵⁷³⁻⁵⁷⁵ radiological diagnosis,⁵⁷⁶ surgical treatment,⁵⁷⁷⁻⁵⁸⁰ neural and extra-neural⁵⁸¹⁻⁵⁸⁴ and extra-neural and treatment,^{585,586} the abdominal echinococcus cysts,⁵⁸⁷ surgical management of gangrenous mastitis,⁵⁸⁸ different methods of wound treatment,⁵⁸⁹⁻⁶⁰⁰ clinico-hematological effects of experimental wound treatment,⁶⁰¹ prevalence of myiasis⁶⁰² and autogenous graft of cystoplasty.⁶⁰³

Prevalence of clinical diseases and disorders

A total of 126 clinical diseases and disorders have been reported in small ruminants, of which 125 (99.21%) reported in goats and only 44 (34.92%) in sheep (Table 12). Out of 44 clinical diseases and disorders of sheep, 43 (34.13%) reported both in goats and sheep whereas only one (0.79%) disease (pregnancy toxemia) reported only in sheep (Table 12). The overall reported clinical diseases and disorders in small ruminants are grouped into three categories on the basis of treatment required which include ① Medicinal, ② Gynaeco-obstetrical and ③ Surgical cases (Table 12). Table 12 shows that the overall prevalence of clinical diseases and disorders in small ruminants constituted significantly ($p < 0.0001$) highest percentage of medical (goats 97.34% & sheep 99.58%) in comparison to gynaeco-obstetrical (goat 00.65% & sheep 00.13%) and surgical (goat 2.01% & sheep 00.29%) cases. These results are in support with the earlier primary reports on small ruminants^{250,607,613,615,631} and even in cattle.¹⁵

Table 12. Comparison on the prevalence of different types of clinical diseases and disorders between goats and sheep reported during the last six decades in Bangladesh

S/ N Diseases / disorders	Goat			Reference Nos.	Sheep			Ref. Nos.
	No. of reports	No. of cases	Prevalence No. (%)		No. of reports	No. of cases	Prevalence No. (%)	
01 Abortion ²	13	17275	0493 (02.85)	1 =	01	0679*	07 (1.03)	614
02 Abscess ³	14	17839	0403 (02.26)	2 =	01	2126	32 (1.51)	358
03 Acidosis ¹	04	02013	0068 (03.38)	3 =	-	-	-	-
04 Actinobacillosis ¹	01	00657	0001 (00.15)	605	-	-	-	-
05 Actinomycosis ¹	02	03037	0039 (01.28)	608,609	-	-	-	-
06 Agalactia / LF ¹	03	08111	0090 (01.11)	296,604,613	-	-	-	-
07 Amphistomiasis ¹	03	01234	0415 (33.63)	208,373,624	02	0527	113 (21.44)	373,624
08 Anaplasmosis ¹	01	02013	0050 (02.48)	609	-	-	-	-
09 Anestrus ²	06	07148	0273 (03.82)	4 =	-	-	-	-
10 Anorexia ¹	10	06988	0541 (07.74)	5 =	01	0044	014 (31.82)	613
11 Anthrax ¹	01	1545831	0602 (00.04)	628	01	141707	045 (00.03)	628
12 Arthritis ¹	08	11510	0167 (01.45)	6 =	-	-	-	-
13 Aspiration pneumo ¹	02	01404	0004 (00.28)	349,604	-	-	-	-
14 Atresia ani ³	05	03041	0040 (01.32)	7 =	-	-	-	-
15 Babesiosis ¹	04	11399	0167 (01.47)	8 =	-	-	-	-
16 Balanoposthitis ¹	01	01282	0006 (00.47)	613	-	-	-	-
17 Balantidiosis ¹	01	01110	0061 (05.50)	199	-	-	-	-
18 Bacterial diarrhea ¹	02	00120	0065 (54.17)	178,632	-	-	-	-
19 Bee sting ¹	02	01730	0002 (00.12)	613,622	-	-	-	-
20 Bloat ¹	22	32684	0829 (02.54)	9 =	01	0044	001(02.27)	613
21 Bottle-jaw ¹	01	01282	0011 (00.86)	613	-	-	-	-
22 Black quarter ¹	02	07287	0066 (00.91)	615,631	-	-	-	-
23 CAE ¹	01	00114	0004 (03.51)	612	-	-	-	-
24 Castration (C) ³	06	09709	1215 (12.51)	10 =	01	0044	001 (02.27)	613
25 C complication ³	01	00305	0001 (00.33)	621	-	-	-	-
26 Cataract ³	01	10815	0029 (00.27)	620	-	-	-	-
27 Cervicitis ²	02	04070	0023 (00.57)	604,606	-	-	-	-
28 Chorioptosis ¹	01	05073	0143 (02.82)	358	01	2126	071 (3.34)	362
29 Coccidiosis ¹	14	16871	0497 (02.95)	11 =	02	0216	032 (14.82)	235,635
30 Colibacillosis ¹	05	07284	0433 (05.94)	12 =	02	0110	069 (62.73)*	179,654
31 Congenital defects ³	07	05385	0031 (00.58)	13 =	-	-	-	-
32 Conjunctivitis ¹	07	15710	0555 (03.53)	14 =	-	-	-	-
33 Contagious ecthyma ¹	15	29739	0682 (02.29)	15 =	-	-	-	-
34 Corneal opacity ³	12	17438	0733 (04.20)	16 =	-	-	-	-
35 Dehorning ³	01	01282	0001 (00.08)	613	-	-	-	-
36 Demodicosis ¹	01	05073	0026 (00.51)	358	-	-	-	-
37 Dermatitis ¹	09	23600	0619 (02.62)	17 =	01	0044	001 (02.27)	613
38 Dermatophilosis ¹	01	05073	0193 (03.80)	358	01	2126	252 (11.85)	362
39 Dermatophytosis ¹	05	16512	0318 (01.93)	18 =	01	2126	010 (00.47)	362
40 Diarrhea ¹	23	28587	2966 (10.38)	19 =	02	0089	013 (14.61)	604,613
41 Dictyocaulosis ¹	01	02400	0003 (00.13)	281	-	-	-	-
42 Digestive disorders ¹	04	03226	0609 (18.88)	20 =	-	-	-	-

S/ N Diseases / disorders	Goat			Reference Nos.	Sheep			Ref. Nos.
	No. of reports	No. of cases	Prevalence No. (%)		No. of reports	No. of cases	Prevalence No. (%)	
43 Dog bite/Rabies ¹	11	1571117	4672 (00.30)	21 =	02	141751	4902 (03.46)	613,628
44 Dysentery ¹	07	04790	0083 (01.73)	22 =	01	0045	009 (20.00)	604
45 Dystocia ²	13	22031	0383 (01.74)	23 =	01	0679	015 (02.21)	614
46 Ectoparasitism ¹	15	16015	2070 (12.93)	24 =	-	-	-	-
47 Eczema ¹	01	00380	0006 (01.58)	618	-	-	-	-
48 Endometritis ²	01	00222	0001 (00.45)	607	-	-	-	-
49 Enterotoxaemia ¹	04	18654	0692 (03.71)	25 =	-	-	-	-
50 Eye disorders ¹	04	07039	0163 (02.32)	26 =	01	0044	003 (06.82)	613
51 Fascioliosis ¹	21	433061	2517 (00.58)	27 =	04	46880	137 (00.29)	28 =
52 Fever ¹	16	19621	1875 (09.56)	29 =	-	-	-	-
53 Filariasis ¹	01	02139	0001 (00.05)	250	-	-	-	-
54 Flea ¹	01	00165	0008 (04.85)	238	-	-	-	-
55 FMD ¹	04	1564727	24981 (01.60)	30 =	01	141707	1980 (1.40)	628
56 Foot rot ¹	12	31076	1041 (03.35)	31 =	02	0703	038 (05.41)	429,630
57 Fracture / Injury ³	07	06704	0471 (07.03)	32 =	01	0044	003 (06.82)	613
58 Gid disease ³	18	30387	0432 (01.42)	33 =	-	-	-	-
59 GI parasites ¹	28	37046	6644 (18.09)	34 =	10	1175	927 (78.89)	35 =
60 Goat pox ¹	06	17924	0257 (01.43)	36 =	-	-	-	-
61 Haemonchosis ¹	02	01392	0857 (61.57)	216,392	-	-	-	-
62 Hernia ³	04	03037	0017 (00.56)	37 =	-	-	-	-
63 HS ¹	03R*	1546111	0071 (0.005)	628,633,634	01	141707	005 (0.004)	628
64 Humpsore ¹	03	01002	0019 (01.90)	615,617,621	-	-	-	-
65 Hypocalcaemia ¹	01	00143	0014 (09.79)	484	-	-	-	-
66 Impaction ¹	01	01282	0015 (01.17)	613	-	-	-	-
67 Indigestion ¹	04	13948	0540 (03.87)	39 =	-	-	-	-
68 Keratoconjunctivitis ¹	04	08636	0198 (02.29)	40 =	-	-	-	-
69 Ketosis ¹	02	11037	0033 (00.30)	607,620	-	-	-	-
70 Lameness ³	03	03730	0151 (04.05)	608,613,625	-	-	-	-
71 Leishmaniasis ¹	01	00093	0002 (02.15)	287	-	-	-	-
72 Lice infestation ¹	06	09083	0375 (04.13)	41 =	03	2270	1937 (85.33)	42 =
73 Listeriosis ¹	01	02013	0009 (00.45)	609	-	-	-	-
74 Malnutrition ¹	07	05932	0165 (02.78)	43 =	-	-	-	-
75 Mange mites ¹	13	19655	0729 (03.71)	44 =	01	0044	01 (02.27)	613
76 Mastitis ¹	30	47879	1199 (02.50)	45 =	01	0679	002 (00.29)	614
77 Metacestodes ³	04	06508	1787 (27.46)	46 =	-	-	-	-
78 Metritis ²	05	06343	0142 (02.24)	47 =	-	-	-	-
79 Milk fever ¹	02	12225	0117 (00.96)	296,631	-	-	-	-
80 Monieziasis ¹	02	06659	0140 (02.10)	202,631	-	-	-	-
81 Myiasis ¹	17	15201	0968 (06.37)	48 =	01	0016	01 (06.25)	630
82 Navel-ill ¹	07	06612	0758 (11.46)	49 =	-	-	-	-
83 Orchitis ²	02	03082	0010 (00.32)	606,619	-	-	-	-
84 Otitis ¹	01	01403	0002 (00.14)	604	-	-	-	-
85 Overgrown hoof ³	02	01491	0015 (01.01)	613,617	-	-	-	-
86 Paramphistomiasis ¹	09	04450	0911 (20.47)	50 =	01	0190	84 (44.21)	643
87 Pink eye ¹	01	00305	0007 (02.29)	621	-	-	-	-
88 Pneumonia ¹	29	40198	3657 (09.10)	51 =	02	0089	005 (05.62)	604.613

Pre-clinical and clinical research in small ruminants

S/ N Diseases / disorders	Goat			Reference Nos.	Sheep			Ref. Nos.
	No. of reports	No. of cases	Prevalence No. (%)		No. of reports	No. of cases	Prevalence No. (%)	
89 Poisoning ¹	03	02019	0006 (00.30)	604,622,639	-	-	-	-
90 Posterior paralysis ¹	01	10815	0036 (00.33)	620	-	-	-	-
91 Post-p hemorrhage ²	01	05426	0082 (01.51)	296	-	-	-	-
92 PPR ¹	45	1603334	243364(15.18)	52 =	01	141707	12904 (09.11)	628
93 Pregnancy toxemia ¹	-	-	-	-	03	10859	083 (00.76)	53 =
94 Psoroptosis ¹	04	05211	0030 (00.58)	54 =	02	2126	364 (17.12)	362,364
95 Pyometra ²	04	05093	0015 (00.29)	55 =	01	0679	002 (00.29)	614
96 Repeat breeding ²	07	05647	0028 (00.50)	56 =	-	-	-	-
97 Respiratory disorders ¹	07	18112	1343 (07.41)	57 =	-	-	-	-
98 Reproductive dis. ²	03	04377	0123 (02.81)	614,618,623	-	-	-	-
99 Retained placenta ²	12	22441	0265 (01.18)	58 =	02	723	7 (00.97)	613,614
100 Rheumatism ¹	01	10815	0079 (00.73)	620	-	-	-	-
101 Rotavirus ¹	02	00743	0058 (07.81)	479,655	-	-	-	-
102 Salmonellosis ¹	02	00094	0012 (12.77)*	441,651	01	0063	009 (14.29)	169
103 Sarcoptosis ¹	01	05073	0051 (01.01)	358	-	-	-	-
104 Schistosomiasis ¹	03	0648	0080 (12.35)	210,288,652	01	0190	007 (03.68)	643
105 Seborrhea sicca ¹	01	05073	0108 (02.13)	358	01	2126	062 (02.92)	362
106 Shipping fever ¹	02	02290	0083 (03.62)	609,616	-	-	-	-
107 Skin diseases ¹	07	10394	1559 (15.00)	59 =	-	-	-	-
108 Sternal alopecia ¹	01	05073	0257 (05.07)	358	-	-	-	-
109 Stillbirth ²	01	00222	0001 (00.45)	607	-	-	-	-
110 Subcutaneous cyst ³	06	04508	0118 (02.62)	60 =	-	-	-	-
111 S/C nodules ³	01	05073	0002 (00.04)	358	-	-	-	-
112 Teat crack ³	02	03623	0116 (03.20)	608,630	-	-	-	-
113 Teat fistula ³	01	00222	0002 (00.90)	607	-	-	-	-
114 Tetanus ¹	16	34657	0273 (00.79)	61 =	-	-	-	-
115 Tick infestation ¹	06	08729	0494 (05.66)	62 =	01	2126	027 (01.30)	362
116 Toxoascariasis ¹	01	02139	0002 (00.09)	250	-	-	-	-
117 Trichuris infection ¹	02	00201	0075 (37.30)	221,222	02	250	19 (07.60)	222,643
118 Trombiculid mite ¹	01	05073	0286 (05.64)	358	01	2126	037 (00.73)	362
119 Urinary disorders ¹	06	20418	0509 (02.49)	63 =	-	-	-	-
120 Urolithiasis ³	19	19931	0552 (02.77)	64 =	-	-	-	-
121 Uterine prolapse ²	07	03942	0148 (03.75)	65 =	01	0044	001 (02.27)	613
122 Vaginal prolapse ²	03	03048	0062 (02.03)	607,616,630	-	-	-	-
123 Vulvo-vaginitis ²	01	05426	0051 (00.94)	296	-	-	-	-
124 Wart ¹	02	05561	0022 (01.00)	358,615	-	-	-	-
125 Wound & injury ³	06	07096	0393 (05.54)	66 =	03	2186	033 (01.51)	67 =
126 Zinc deficiency ¹	01	01403	0015 (01.07)	604	01	0045	002 (00.14)	604
A. Medicinal cases ¹	549	9035842	314770 (97.34)*		60	788756	24166 (99.58)**	
B. Gynaeco-obstetrics ²	081	115793	002100 (00.65)		06	002804	00032 (00.13)	
C. Surgical cases ³	120	151420	006509 (02.01)		06	004400	00069 (00.29)	
Overall	750	9303055	323379 (03.48)		72	795960	24267 (03.05)	

* $\chi^2 = 1260.718$ & significance at ($p < 0.0001$)

** $\chi^2 = 67.754$ & significance at ($p < 0.001$)

Total diseases (goats + sheep) =126 Total (goats): 125 (99.21)

Common both in goats & sheep: 43 (34.13)

R*Same data in two articles

Total (sheep): 44 (34.92)

Only in sheep: 01(0.79)

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 66 = 605, 608, 610, 613, 622, 630
 67 = 362, 613, 630

Among the clinical prevalence of medicinal diseases and disorders, the highest infection rates were found with parasitic diseases which include amphistomiasis (goat 33.63% & sheep 21.44%), ectoparasitism (goat 12.93%), gastro-intestinal parasites (goat 18.09% & sheep 78.89%), haemonchosis (goat 61.57%), metacestodes (goat 27.46%), paramphistomiasis (goat 20.47% & sheep 44.21%), schistosomiasis (goat 12.35% & sheep 3.68%) and Trichuris infection (goat 37.30% & sheep 7.60%), followed by infectious diseases which include bacterial diarrhea (goat 54.17%), colibacillosis (goat 5.94% & sheep 62.73%), Navel-ill (goat 11.46%) and then systemic disorders include anorexia (goat 7.74% & sheep 31.82%), diarrhea (goat 10.38% & sheep 14.61%), fever (goat 9.56%), indigestion (goat 3.87%), pneumonia (goat 9.10% & sheep 5.62%) have been reported as predominant clinical cases in small ruminants (Table 12). These findings indicate that the therapeutic and control measure against parasitic diseases are not adequate in small ruminants whereas it seems that vaccination against some infectious diseases in goat and sheep might have role to maintain the infectious diseases at lower level than parasitic diseases in Bangladesh.

Gynaeco-obstetrical disorders

The major gynaeco-obstetrical disorders affecting both the female goats and sheep include abortion (goat 2.85% & sheep 1.03%), dystocia (goat 1.74% & sheep 2.21%), uterine prolapse (goat 3.75% & sheep 2.27%) and retained placenta (goat 1.18% & sheep 00.97%) whereas anestrus (3.82%), metritis (2.24%) and vaginal prolapse (2.03%) have been reported only in goats (Table 12).

Surgical affections and disorders

The major clinical surgical disorders reported from Bangladesh include abscess (2.26%), corneal opacity (4.20%), fracture (7.03%), gid disease (1.42%), lameness (4.05%), overgrown hoof (1.01%), obstructive urolithiasis (2.77%) and wound (5.54%) in goats but only abscess (1.51%) and fracture (6.82%) have been reported in sheep (Table 12).

Abscess is a collection of pus that hollows out a cavity in the tissues by destroying and expanding them which can be differentiated from other swelling by exploratory puncture that reveals synovial fluid in bursitis, serous fluid in cysts, blood in hematoma, nothing or intestinal content in hernia. Hernia is the protrusion of an organ or tissue through an opening like the inguinal canal or femoral canal. Any trauma caused by horn thrust, kick and violent contact with blunt objects or by an abdominal distension due to pregnancy or straining parturition may lead to ventral abdominal hernia. Improper closure of umbilicus at birth due to hypoplasia of the abdominal muscles resulted in umbilical hernia.

The population of the clinical cases recorded in both goat and sheep reflected the total normal population of goats and sheep at a ratio of 1:0.02 in Banhladesh.⁹ This ratio has also correlated with the population of clinical cases of goats and sheep recorded in different reports. However, the overall prevalence of clinical diseases and disorders analyzed based on available clinical case records did not differ significantly between goats (3.48%) and sheep (3.05%) which indicates no significant differences on overall susceptibility between goats and sheep to clinical diseases and disorders.

Overall pre-clinical and clinical research status

The pre-clinical research reports can be categorized into seven (Serial No. 1 to 7) and clinical research into four (Serial Nos. 8 to11) groups (Table 13). Out of total 621 published reports on pre-clinical and clinical research in small ruminants, of which significantly higher percentage

Table 13. Overall status of pre-clinical and clinical research reports on small ruminants

S/N Research subjects	No. (%) of published reports		
	Goats	Sheep	Total
01. Anatomy	46 (09.47)	03 (02.22)	49 (07.89)
02. Histology	20 (04.12)	0	20 (03.22)
03. Biochemistry & Physiology	48 (09.88)	28 (20.74)	76 (12.24)
04. Microbiology	23 (04.73)	08 (05.93)	31 (04.99)
05. Parasitology	59 (12.14)	12 (08.89)	71 (11.43)
06. Pharmacology & Toxicology	16 (03.29)	13 (09.63)	29 (04.67)
07. Pathology	59 (12.14)	05 (03.70)	64 (10.31)
Total (pre-clinical research)	271 (55.76)^a	69 (51.11)^b	340 (54.75)
08. General & Systemic Medicine	20 (04.12)	04 (02.96)	24 (03.86)
09. Epidemiology, Clinical & PM	112 (23.05)	32 (23.70)	144 (23.19)
Sub-total (medicine research)	132 (27.16)	36 (26.67)	168 (27.05)
10. Gynaeco-obstetrics	18 (03.70)	22 (16.30)	40 (06.44)
11. Anesthesiology and Surgery	65 (13.37)	08 (05.93)	73 (11.76)
Total clinical research	215 (44.24)^a	66 (48.89)^b	281 (45.25)
Total (pre-clinical & clinical)	486 (78.26)	135 (21.74)	621 (100)

PM = Preventive medicine a & b superscripts = $\chi^2 = 0.922$ & p value 0.337
Insignificant difference

reported in goats (n = 486; 78.26%) comparison to sheep (n = 135; 21.74%). The pre-clinical is considered a cornerstone in human and veterinary medical education and research, as this pre-clinical science discipline provides a vital foundation on which to build the knowledge of the clinical practice of medicine.

Age and breed-wise prevalence

The age and breed factors of goats have been used to detect their influence on the prevalence of clinical diseases and disorders (Table 14). The overall age-wise analysis of clinical diseases and disorders of 14716 goats revealed that significantly ($p < 0.0001$) higher prevalence of 65.26% (n = 9603) reported in adult goats in comparison to 27.55% (n = 4054) in kids and 7.20% (n = 1059) in growing goats (Table 14). Breed-wise analysis of the prevalence of diseases and disorders showed significantly ($p < 0.0001$) higher prevalence of 53.91% (n = 4146) in Black Bengal goats (BBG) in comparison to Jamunapari 36.97% (n = 2843) and lowest of 9.12% (n = 701) in local and crossbred goats (Table 14). These observations are in conformity with the earlier report of higher prevalence of clinical diseases and disorder in adult (62.5%) and BBG (89.16%) in comparison to young (37.5%) and Jamunapari (10.83%) goats.⁶²⁷ However, some authors reported the prevalence of anestrus, fascioliasis, PPR, and urolithiasis in all the three age groups (kids, growing and adult) of goats (Table 14) that might be due to erroneously grouping of goats based on different length of age used by different authors.^{130,245,250,604,605,611}

Breed-wise prevalence of clinical diseases and disorders might influence the population of the different available breeds of goats in which BBG constitutes 90%, Jamunapari 8 to 9% and rest their crosses.¹¹ However, the higher prevalence of some diseases like anaplasmosis, arthritis, coccidiosis, foot-rot, infectious keratoconjunctivitis, respiratory disorders and tetanus have been reported in Jamunapari than BBG and their cross-bred goats (Table 14) which might be due to more susceptibility of Jamunapari breed than other breeds of goats.²⁵⁰

Table 14. Age and breed-wise prevalence of clinical diseases and disorders in goats in Bangladesh

S/ N	Diseases / disorders	Age-wise prevalence				Reference Nos.	Breed-wise prevalence				Reference Nos.
		Kids	Growing	Adult	Total		BBG	JP	L/C	Total	
01	Abortion	-	-	-	-	-	370	21	10	401	1 =
02	Abscess	49	25	148	222	2 =	-	-	-	-	-
03	Actinomycosis	11	-	17	028	609	05	17	6	028	609
04	Anaplasmosis	14	-	36	050	609	06	28	16	050	609
05	Anestrus	13	28	46	087	611	28	30	29	087	611
06	Arthritis	26	18	057	101	3 =	42	70	06	118	3 =
07	Bloat	85	61	296	442	4 =	67	39	23	129	4 =
08	Coccidiosis	194	22	33	249	5 =	15	38	05	058	5 =
09	Conjunctivitis	122	42	347	511	605, 610, 620	-	-	-	-	-
10	Contagious E	111	11	34	156	6 =	33	17	05	055	6 =
11	Corneal opacity	05	01	465	471	7 =	01	01	0	002	7 =
12	Dermatitis	04	0	328	332	609, 620	75	50	04	129	250,608,609
13	Dermatophytosis	16	0	23	039	609	31	41	06	078	250, 609

S/ N Diseases / disorders	Age-wise prevalence				Reference Nos.	Breed-wise prevalence				Reference Nos.
	Kids	Growing	Adult	Total		BBG	JP	L/C	Total	
14 Diarrhea	559	157	1134	1850	8 =	306	272	42	620	8 =
15 Dystocia	-	-	-	-	-	139	04	02	145	611,614,619
16 Ectoparasitism	18	23	12	053	611	23	21	13	057	611
17 Fascioliasis	08	25	25	058	348,612	24	06	03	033	348,612
18 Fever	266	15	864	1145	9 =	09	10	0	019	608
19 Foot rot	21	04	222	247	10 =	11	29	07	047	250,609,611
20 Gid disease	-	-	143	143	619,620	57	08	0	065	11 =
21 GI parasites	538	113	1205	1856	12 =	325	332	104	761	250,611,645
22 KCV	12	0	58	070	609	18	58	16	092	250,609
23 Mange mite	22	01	236	259	612,620	43	22	0	065	250,608
24 Mastitis	-	-	-	-	-	113	95	29	237	13 =
25 Metritis	-	-	-	-	-	45	63	06	114	250,609
26 Myiasis	82	-	209	291	611,619	54	14	-	068	250,608,619
27 Pneumonia	680	105	751	1536	14 =	590	257	28	875	15 =
28 PPR	726	169	2004	2899	16 =	1258	777	157	2192	17 =
29 Respiratory diso	305	94	566	965	18 =	284	369	87	740	250,609,611
30 Skin diseases	48	35	36	119	19 =	19	17	18	054	611
31 Tetanus	53	-	77	130	609,611,620	18	24	05	047	250,609,611
32 Urolithiasis	18	16	27	61	611,619,642	40	17	14	071	20 =
33 Urinary infection	48	94	204	346	21 =	97	96	60	253	250,609,611
Overall	4054 (27.55)	1059 (07.20)	9603 (65.26)*	14716		4146 (53.91)**	2843 (36.97)	701 (09.12)	7690	

* $\chi^2 = 79.048$ Significant at ($p < 0.0001$)

** $\chi^2 = 46.470$ Significant at ($p < 0.0001$)

1 = 296, 310, 608, 609, 614	2 = 605, 608, 612, 619, 620	3 = 250, 609, 611, 624
4 = 605,608, 610,611,612, 620, 627	5 = 236, 250, 609, 610, 635, 636	6 = 250, 605, 608, 609, 611, 612
7 = 608, 620, 612, 623, 624	8 = 250, 605, 608-611, 620, 612, 636	9 = 612, 620, 624, 627
10 = 605, 609, 610, 611	11 = 250, 574, 619, 627	12 = 611,620,612,627
13 = 250, 440, 608, 609, 611	14 = 351, 605, 609-612, 620, 627	15 = 250, 350, 608, 609, 611
16 = 250, 348, 457, 458, 463, 466, 609- 611, 620, 623, 627, 642	17 = 183, 250, 348, 457, 463, 464, 609, 611, 648, 650	18 = 609, 611,620, 623,624
20 = 608,611,619, 621	21 = 250, 609, 611, 620	19 = 605, 610, 611, 642

Case fatality and mortality

Table 15 shows that 22 diseases and disorders are associated with case fatality in goats, whereas only three diseases (rabies 3.27%, FMD 1.11% and PPR 4.1%) are associated with case fatality in sheep. The PPR (73.56%), pneumonia (13.47%), rabies (12.15%), diarrhea (7.67%) and malnutrition (4.80%) have been reported as the major causes of case fatality in goats in Bangladesh (Table 15). The mortality caused by different diseases and disorders in goats have been reported^{605,618,633} but similar such mortality reports in sheep are very limited in Bangladesh (Table 15). These observations contradict the report in which five diseases (anthrax, rabies FMD, HS and PPR) have been reported to be associated with case fatality in both the goats and sheep based on analysis of clinical case records maintained at the different Veterinary hospitals of 64 districts in Bangladesh.⁶²⁸ However, the management system of the

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Government Veterinary Hospitals in Bangladesh has not yet been developed up to feedback system from hospital to smallholder farmers and farmers to hospital services and vice-versa to get the death information of animals in the hospital records. Moreover, the reported 4.9% case fatality rate in goats caused by PPR⁶²⁸ which widely differs with the 73.56% case fatality rate recorded in this review (Table 15) caused by the high epidemic PPR of goats in Bangladesh.^{182,327,450}

Table 15. Comparison on the case fatality between goats and sheep caused by different clinical diseases and disorders in Bangladesh during the last six decades in Bangladesh

S/ N	Diseases / disorders	Goat			Reference No.	Sheep			Ref No
		No. of reports	No. of cases	Case fatality No. (%)		No. of reports	No. of cases	Case fatality No. (%)	
01	Abscess	01	0380	001 (00.26)	618	-	-	-	-
02	Accident	01	0302	006 (01.99)	636	-	-	-	-
03	Anthrax	01	602	019 (03.16)*	628	01	45	0	628
04	Bloat	02	0630	003 (00.48)	618,633	-	-	-	-
05	Coccidiosis	02	1388	049 (03.53)	610,636	-	-	-	-
06	Diarrhea	03	1788	137 (07.67)	605,610,636	-	-	-	-
07	Dog bite/ Rabies	01	4504	547 (12.15)*	628	01	398	13 (03.27)*	628
08	Dystocia	03	1788	009 (00.50)	605,610,636	-	-	-	-
09	Eczema	01	0380	001 (00.26)	618	-	-	-	-
10	Enterotoxaemia	02	1486	042 (02.83)	605,610	-	-	-	-
11	FMD	01	24393	399 (01.64)*	628	01	1980	22 (01.11)*	628
12	GI parasites	01	0250	003 (01.2)	633	-	-	-	-
13	Got pox	01	0250	002 (00.80)	633	-	-	-	-
14	HS	01	0069	0*	628	01	05	0*	628
		01	0250	001 (00.40)	633	-	-	-	-
15	Malnutrition	01	0250	012 (04.80)	633	-	-	-	-
16	Mechanical	01	0400	001 (00.25)	605	-	-	-	-
17	Others	02	1486	005 (00.34)	605,610	-	-	-	-
18	Pneumonia	02	1388	187 (13.47)	610,636	-	-	-	-
19	Poisoning	01	0302	008 (02.65)	636	-	-	-	-
20	PPR	01	234879	11505 (04.9)*	628	01	12904	529 (4.1)*	628
		10	1908	1404 (73.56)	A**	-	-	-	-
21	Predators	02	1486	0006 (00.40)	605,610	-	-	-	-
22	Skin diseases	01	0380	0013 (03.42)	618	-	-	-	-
23	UGD	01	0302	0009 (02.98)	636	-	-	-	-
Overall		44	281241	14369 (05.11)	-	05	15332	564 (03.68)	

*This report published based on hospital clinical case records of 64 districts UGD = Uro-genital disorders

A** = 182,327,450, 460,461,463,467,610,633,636

Decade-wise published research reports

To analyze the advancement of research progress on small ruminants in Bangladesh, the research publication periods were divided into six decades starting from the first published report on goat diseases in the then East Pakistan in 1966.¹⁹¹ A total of 663 research articles on

Table 16. Decade-wise status of published articles on small ruminants in Bangladesh			
Decade	Years	Reference numbers	Total (%)
First	1966 - 1970	55, 68, 93, 112, 192, 193, 194, 200, 201, 478, 490, 505, 570	013 (01.96)
Second	1971- 1980	17, 24, 25, 46, 59, 70, 82, 84, 85, 87, 90, 91, 94-96, 98, 103, 105, 111, 138, 142, 144, 145, 151, 152, 210, 211, 222, 225, 235, 236, 240, 243, 249, 259, 280, 312, 318, 319, 321, 340, 341, 372, 379, 382, 400, 501, 504, 513, 552, 554, 557, 566, 569, 573, 576, 577, 578, 658, 658	060 (09.05)
Third	1981- 1990	18, 21, 26, 28, 32, 34, 35, 36, 40, 45, 47, 48, 50, 56, 57, 58, 64, 65, 67, 69, 75, 86, 92, 99, 101, 102, 104, 110, 136, 137, 153, 154, 155, 157, 171, 212, 226, 230, 234, 241, 242, 246, 248, 267, 281, 287, 307, 313-316, 322334, 336, 337, 352, 353, 358-360, 362, 363, 365, 367, 371, 374, 376, 378, 408, 434, 439, 443, 445, 487, 498, 499, 527, 539, 540, 543-545, 555, 564, 565, 568, 653	087 (13.12)
Fourth	1991- 2000	14, 19, 20, 22, 23, 49, 51, 71, 73, 83, 88, 117, 156,190, 191, 202, 207, 209, 220, 221, 223, 228, 244, 260, 261, 266, 274-276, 288, 290, 296, 303, 306, 310, 323, 332, 333, 354, 361, 364, 375, 377, 388, 389, 393, 395, 396, 397, 399, 401, 402, 424, 428, 444, 472, 483, 486, 503, 531-534, 541, 559, 574, 575, 579, 583-586, 590, 591, 600, 601, 618, 637, 638, 661	080 (12.07)
Fifth	2001 – 2010	9, 13, 16, 27, 29-31, 33, 37, 39, 42, 44, 52-54, 60-62, 66, 72, 74, 78, 79, 81, 89, 100, 106, 114, 115, 119, 121, 123, 128, 130, 135, 139, 150, 158, 159, 161, 169, 176-178, 189, 196, 204, 208, 215, 216, 218, 227, 238, 239, 251-257, 263, 264, 268, 269, 271, 272, 277, 282-284, 292-294, 297-299, 305, 308, 311, 317, 320, 328, 331, 349, 356, 357, 373, 394, 409, 414, 415, 420- 423, 425-427, 446, 447, 451, 453, 454, 459, 461, 462, 466, 469, 473, 476, 477, 479, 488, 489, 494, 595, 500, 509, 517, 518, 520, 523, 530, 535, 537, 542, 546-551, 556, 562, 581, 589, 592, 595, 598, 605, 613, 620, 624, 629, 633- 635, 641, 642, 654, 655, 662, 663	154 (23.23)
Sixth	2011 - 2019	1-8, 10-12, 15, 38, 41, 43, 63, 76, 77, 80, 97, 107-109, 113, 116, 118, 120, 122, 124-127, 129, 131-134, 140, 141, 143,146-149, 160, 162-168, 170, 172-175, 179-188, 195, 197-199, 203, 205, 206, 213, 214, 217, 219, 224,229, 231-233, 237, 245, 247, 250, 258, 262, 265, 270, 278, 279, 285, 286, 289, 291, 295, 300, 301, 302, 304, 309, 324-327, 329,330,335, 338, 339, 342-348, 350, 351, 355, 366, 368, 369, 370, 380, 381, 383, 384-387, 390-392, 398, 403-407, 410-413, 416-419, 429-433, 435-438, 440-442, 448-450, 452, 455458, 460, 463-465, 467, 468, 470, 471, 474, 475, 480-482, 484,485, 491-493, 496, 497, 502, 506-508, 510-512, 514-516, 519, 521, 522, 524-526, 528, 529, 536, 538, 553, 558, 560, 561, 563, 567, 571, 572, 580, 582, 587, 588, 593, 594, 596, 597, 599, 602-604, 606-612, 614-617, 619, 621-623, 625-628, 630-632, 636, 639-641, 643-652, 656, 657, 660	269 (40.57)
Overall			663 (100)

the pre-clinical and clinical aspects in small ruminants published during the last six decades have been reviewed (Table 16). Table 16 shows that only 13 research articles on small ruminants were published during the East Pakistan period from 1966 to 1970 which has considered as the first decade in this article (Table 16). A total of 60 (9.05%) articles were published during the second decades (1971 to 1980) and then increased the trend of publication rates but somewhat similar rates maintained during the third (1981-1990; n = 87; 13.12%) and fourth (1991-2000; n = 80; 12.07%) decades (Table 16). Then increased the rate of publications during the fifth (2001-2010; n = 154; 23.23%) and sixth (2011-2019; n = 269; 40.57%) decades in comparison to earlier decades. This increased rate of research publications might be due to establishment of a dozen of veterinary medical educational institutions that probably influenced the veterinary academicians and research scientists to publish their research findings in journals which are usually required to get selection for their employment and promotion in professional services.

Small ruminants especially goats are multifunctional versatile animal providing meat and milk for human consumption, skin for foreign currency earning, income and poverty reduction for smallholders, employment generation in rural areas and cash income for women in Bangladesh. It gains much importance among farmers due to its higher prolificacy and short generation interval. Lactating goat has been described as a 'poor man's cow' (mini-cow) because the goat eats little, occupies a small area and produces enough nutritious and easily digestible milk for the average unitary family, feeding, milking and care of goats does not require much facilities, equipment and hard work, easily managed by women and children, capital investment and feeding costs are low, whereas maintaining a cow at home cannot be afforded by the homeowner, hence, the growing popularity of goat as the 'poor man's cow.' The importance of this valuable genetic resource is underestimated and its extent of contribution to the livelihood of the poor is inadequately understood in Bangladesh. They are often neglected in comparison with large ruminants. Part of this attitude towards them can probably be due to recognition of their capability, rather any prejudices against them it is believed that goats are intelligent, independent, agile, resistance to many diseases and parasites and can look after themselves much better than other livestock species.⁹

Currently, a dozen of veterinary academic institutions offer veterinary science and animal husbandry (BSc) and veterinary medicine (DVM) degrees without considering the international standard, uniform curriculum, future fate and requirement of the different types of veterinary graduates without any course on small ruminant medicine in the curriculum in Bangladesh.^{12,664} However, these public institutions involve in pre-clinical and clinical education and research but their activities and outcome are not coordinated and unified. Moreover, research and development investments to improve the relatively low level of goat's productivity do not match their potential importance, resulting in the only available Black Bengal goat breed in Bangladesh that remains genetically unexplored.

Veterinary medical clinical practices and research relies on knowledge of pre-clinical sciences. The pre-clinical studies are performed to establish the rationale for the planned clinical education and research in both the human medical and veterinary medical profession. The importance of veterinary medical professional review articles is increasing day by day,

because concerned students, academicians, research scientists and clinicians frequently benefit from review articles to update their knowledge in their field of specialization and use these articles as a starting point for formulation guidelines. The institutions and organizations which provide financial support for further research resort to these reviews to reveal the need for these researches. The value of review article is related to what is achieved, what is found and the way of communicating this information.

The clinical research especially the diseases and disorders which are associated with morbidity and mortality of small ruminants, cause direct loss of animals due to mortality and indirectly productivity loss, cost of disease management (treatment and vaccination), low quality products, disruption of market, uncertain food security, income loss and negative impacts on human health. The disease surveillance, monitoring, preparedness and response services are required to protect and improves the health, quality and marketability of live animals and their products are very limited in Bangladesh. Therefore, only the scattered published clinical reports based on clinical case records from different veterinary hospitals could be utilized to provide comprehensive small ruminant health services in Bangladesh. However, the four categories of diseases are usually occur in small ruminants that require for assessing their impact on animal and human health which include (a) Epidemic diseases- PPR, FMD, (b) Zoonotic diseases- brucellosis, hydatid disease, rabies, (c) Food borne infections- *Escherichia coli* and *Salmonella* and (d) Endemic diseases- mastitis, pneumonia and diarrhea required much more attention for future review for their prevention and control.

Limitations due to inappropriate data and plagiarism

Research articles that reported the morbidity, mortality and case fatality rates based on hospital clinical case records contradict the epidemiological definitions of these terms. The term morbidity refers the affected rate and mortality refers to the death rate in a specific population, whereas case fatality refers death rate among the affected cases. Therefore, the presented morbidity, mortality and case fatality rates based on hospital case records may not be reflected the actual results. Table 12 shows clinical prevalence (morbidity) of PPR 15.18% in goats and 9.11% in sheep, whereas case fatality rate 4.9% in goats and 4.1% in sheep (Table 15). However, no clinical cases of PPR have been reported in sheep from microbiology (Table 4), pathology (Table 7) and even clinical studies (Table 9). Moreover, PPR has been reported to cause 75% morbidity, 59% mortality and 74% case fatality rates in goats in Bangladesh.³²⁷

Abstracts of the inland research papers are sometimes poorly written often lack of important information. A standard abstract should include background, objectives, methods used, results and conclusions on the conducted research. However, the populations studied in some articles have not been mentioned either in their abstract,^{130,605,628} or in the materials and methods of the articles,¹¹⁶ and even different number of populations have also been mentioned in different parts the of the same article,⁶⁰⁵ inappropriate age length has been used to classify different age groups, some authors considered kids aged between 0 to 12 months,²⁵⁰ some considered < 3 months,^{130,605} and some considered < 6 months,²⁴⁵ whereas growing goats considered between 13 to 24 months,²⁵⁰ some considered 3 to 8 months,¹³⁰ and some considered >3 to 12 months,⁶⁰⁵ and some considered adult >24 months,²⁵⁰ some > 8 months,¹³⁰

and some >12 months⁶⁰⁵ and even age-wise classified goats into 0 to 2 years, 2 to 5 years and 5 to 8 years.⁶⁰⁴ These inappropriate age-wise classification of goats and the different length period of age used for classification found difficulty to analyze the findings of different articles. This also reflect the prevalence of anestrus, repeat breeding syndrome, mastitis, abortion and dystocia which have been reported in kids and growing stages due to use of inappropriate ages to classify goats.^{606,611}

Plagiarism is the research misconduct and an assault on integrity of scientific research. It can be self-plagiarism and plagiarism from others. Most important self-plagiarism practiced is the duplicate publication, when substantially similar data, idea and article published to different journals with or without editing, with or without changing of authorship orders.⁶⁶⁵ It appears from this review that multiple articles have been published in duplicate in different journals by using self-plagiarism and some of them are included as genetic and phenotypic parameters,^{148,149} prevalence of parasites,^{186,187} prevalence of ectoparasites,^{237,325} comparative efficacy of anthelmintics,^{384,385} evaluation of anthelmintic efficacy,^{386,387} incidence of gid^{573,574} and surgical treatment of coenurosis.^{578,579} Articles published with inadequate and inappropriate data and used plagiarism that reflect the analysis of reviewed data and interpretations of the analyzed findings. Authors, reviewers, editors, academicians, readers and science community need a more caution approach to deal these types of articles with inadequate and inappropriate data and self-plagiarism.

CONCLUSIONS

There are four key findings recorded in this review on the pre-clinical and clinical research in small ruminants in Bangladesh. Firstly, a significant gap of research reports between sheep and goats and more especially no research reports could be traced on histological studies in sheep. Secondly, some studies had lack of population, duration of study, age-wise classification of animals based on different length of age and even same data and articles published in two different journals. Thirdly, epidemiological methods not accurately followed for calculation of morbidity, mortality and case fatality rates. Finally, most of the clinical diseases and disorders diagnosed based on history and clinical findings. Therefore, there is a need for the development of disease diagnostic laboratories with necessary facilities and development of feedback mechanism for accurate surveillance studies to control the diseases. This report on pre-clinical and clinical research including disease profile in small ruminants might help the veterinary academicians, research scientists, farmers, veterinarians, government, research funding organizations, livestock planner, human health care providers and neighboring countries that may need to take action. To recommend the priority based disease status to draw notice for the Veterinary medical physicians, concerned organization and government to create accurate diagnostic and therapeutic facilities and provision for adequate effective vaccines for the preventive and control of these infectious diseases in Bangladesh. According to the economic impact, the small ruminants are going to be more important source of livelihood for many more rural people in coming years and thus, they deserve greater attention from government and veterinary medical academic and research institutions to upgrade and unified veterinary medical education with small ruminant courses in the veterinary medicine curriculum and

specific emphasis on pre-clinical and clinical research on small ruminants. Therefore, it is the high time to consider and pay attention to the value and capacity of small ruminants especially in goats for their optimum safe meat and milk for human consumption.

ETHICAL APPROVAL

This review article does not contain any studies with animals or human participants performed by the authors. Therefore, ethical approval is not required for this review article.

CONFLICT OF INTEREST

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