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Prevalence and Associated Risk Factors of Genital Abnormalities in Bulls Slaughtered at the SODEPA Industrial Abattoir, Douala, Cameroon

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Abstract

The objective of this study was to investigate the presence of genital tract abnormalities in slaughtered bulls at the SODEPA Industrial Abattoir, Littoral Region. A total of 503 healthy bulls were randomly selected and examined from July 2020 to January 2021. Before slaughter, the animals were characterized by their species, breed, age, weight, and Body Condition Score (BCS) during ante mortem inspection. Following slaughter, visual inspection, palpation, and dissection of the entire genital tract of each male were inspected for gross pathological abnormalities via post mortem examination. Out of 503 bulls, 380 (75.5%) were affected by one or more gross genital abnormalities of unidentified causes. Means age (years), weight (kg) and BCS were 6.7± 1.93; 186.83 ± 17.08 and 2.77 ± 0.42 respectively. Balanoposthitis was the most frequent disorder with an overall prevalence rate of 30% (n=151/503) followed by postithis (21.5%; n=108/503), hematoma (14.9%; n=75/503), unilateral testicular hypoplasia (8.9%; n=45/503), hydrocele (2.4%; n=12/503), white buttons (2.2%; n=11/503) and epididymitis (2%; n=10/503). The study shows that a high rate of gross reproductive disorders was on adult bulls (244/380). Age and body condition did not affect the prevalence of any abnormality (P>0.05) except in balanoposthitis which was significantly varied among age group (P=0.003). There was a strong correlation between scrotal cellulitis and seminoma (r=0.706) and a moderate correlation between hydrocele and epididymitis (r=0.44). The high prevalence obtained in this study indicates that attention should be given to the reproductive management of bulls in Cameroon.

Keywords: Male, Reproduction, Pathology, Littoral Region, Cameroon

Introduction

Sub-Saharan Africa has one of the world's fastest-growing human populations, with a rate of increase of 2.6 percent per annum. This is coupled with the lowest average annual per capita consumption of livestock products: 11.0 kg of meat and 27.2 kg of milk, compared with the developing world average of 26.4 kg for meat and 48.6 kg for milk (1). Cameroon's livestock is mostly constituted of cattle, sheep, goats, pigs, and poultry. Despite its importance, this herd remains insufficient to meet the demand of the Cameroonian population for animal protein (2). Livestock productivity is dependent on reproductive performance (3). However, reproductive diseases have serious consequents on livestock production.

In Cameroon, there are about 7 million cattle (4), comprising indigenous (zebu), cross, and exotic breeds which are mainly kept under smallholder subsistence that represents 16% of the national agricultural production and supplies 61% of the national meat demands (5). The major cattle breeds are characterized by low productivity. In Cameroon, beef has an important role in the diet of about 60% of the population, constituting an increase of 29% in the last 10 years (6). This trend is expected to increase again by 107% when the projected population of 48 million people is attained by the year 2050. On the contrary, the number of cattle reared has been stable in the course of the last 10 years (7).

Reproductive performance is one of the major determinants of cattle productivity and a basic prerequisite to efficient livestock production in any production system. The reproductive performance depends upon the normal structure and functions of genital organs. Bulls represent half of the genetic composition of their progeny and many cows can be inseminated with the semen of a single bull. Failure of many bulls to breed consistently and efficiently has been reported to be associated with the production of poor-quality semen due to the pathology of testes and accessory glands (8).

The male reproductive system is essential for domestic animals' species propagation and survival. In cattle production, productivity depends on reproductive performance which depends on the fertility of both cows and bulls in the herd (9). Fertility in herds is influenced by factors related to cows and bulls as well as managerial and environmental conditions (10). However, the fertility of the bull is more important than that of any individual cow in the herd because a bull can mate and breed many cows in natural breeding or through artificial insemination (11). Thus, the fertility or reproductive capacity of the individual bull determines the reproductive performance of a herd (11) and is essential for sustainable cattle production (12). Regardless of these facts, fertility in bulls receives inadequate attention (11) and it is assumed that infertility is a female problem (13). Moreover, scientific and practical or management aspects of cattle production usually focused on the cows (10, 14). As a result, several aspects of male livestock reproduction are comparatively ignored (10). Particularly, bulls used for natural breeding fertility are rarely investigated as compared to bulls used for artificial insemination.

Data on the reproductive capacity of bulls enables to realize breeding success through examination and timely detection of the reproductive problems and developing appropriate reproductive management strategies (15, 16). Abnormalities of the

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reproductive tracts in domestic animals are efficiently studied using abattoir surveys (17). In Cameroon, the predominant breeding management system is natural mating. Regardless of the above-stated effects of the bull reproductive tracts abnormalities on the fertility and productivity of cattle production; there is a paucity of information on reproductive abnormalities of the bulls in Cameroon since very few studies have been conducted on sub-fertility or infertility due to testicular abnormalities of the bulls. The main aim of this study is to investigate the prevalence of reproductive tract abnormalities of bulls destined for slaughter at the SODEPA Industrial abattoir, Douala Cameroon. Specifically, we will have to characterize the animals available for this study, to identify the different types of genital disorders of the bull and to evaluate the influence of risk factors on the occurrence of the reproductive disorders.

Materials and Methods

Ethical statement

The study was approved by the Ethical Committee of the School of Veterinary Medicine and Sciences of the University of Ngaoundere as well as the ministry of livestock, fisheries, and animal industries.

Study area

The survey was carried out at the Douala industrial abattoir situated in Bonendale, a village in the littoral region of Cameroon at Latitude 4º4'40N and Longitude 9º40'33''E, in the Equatorial Mangrove ecological zone.

Animals

The study subjects comprised of intact bulls destined for slaughter at the Douala industrial abattoir. Most of the slaughter animals were purchased from the Bonendale Cattle Market. Several 503 Local breeds of bulls of different age and body condition scores that were brought from different parts of Cameroon for slaughter at the SODEPA abattoir were included in this study. These bulls had been kept under a traditional extensive management system and were used for natural breeding and as a source of meat, fertilizer, and draught power for agriculture production. The age was calculated as described by Pace and Wakeman (18). Body Condition Score (BCS) is estimated as described by Nicholson and Butterworth (19). The bodyweight of the bull was estimated using a spring balance with a precision of ± 0.3 %.

Genital abnormalities diagnosis

After slaughter, the whole genitalia consisting of the penis, prepuce, testes, epididymis, and scrotal sac were examined for evidence of gross pathological abnormalities. Testicular conditions such as bilateral testicular hypoplasia and atrophy were identified through gross changes in size, texture, and consistency of the testes. The spermatic cord was palpated up to the level of the inguinal ring for the presence of abdominal contents (scrotal hernia) or abnormalities of spermatic vasculature. After palpation of the preputial part of the penis, exteriorization of its free part where possible, palpation of the sigmoid flexures, and palpation of the prepuce and preputial orifice.

Data analysis

Data generated from antemortem and post-mortem inspection were recorded in the Microsoft Excel 2013; risk factors analyzed with Chi-square and those significant (P<0.05) a chi-square and fisher's exact test analysis were further analyzed using logistic regression model analysis to assess associations between incidences of the gross genital disorders and analyzed using SPSS version 23.0. Finally, a multivariate analysis was conducted to see whether, and to what extent all the risk factors and each genital tract abnormality were interrelated.

Results

Characteristic of slaughtered animals

The main breeds encountered was the white Fulani (46.7% n = 235), Red Fulani (29.2% n = 147), Gudali (21.5% n = 108) and Bokolo (2.6% n=13). The mean body condition score (BCS) of the animals was 2.7±0.4. A good number of bulls had a BSC of 3. The average body weight and age of the animal sampled were 186.63 ± 17.08kg and 6.7±1.93 years, respectively.

Overall prevalence of genital tract abnormalities of bulls

Of 503 slaughtered bulls examined at the Douala Industrial abattoir, 380 were affected with at least one genital disorder giving an overall prevalence of 75.5%. Out of the 380 bulls affected, 36.57% (n=139) of animals came from the North, 36.84% (n=140) from Adamawa, 14.21% (n=54) from the Northwest 10.7% (n=42) from the Far North and 1.3% (n=5) from the East. Based on breeds, White Fulani, Red Fulani, Gudali, and Bokolo breeds were affected with a prevalence of 35.2%, 22.3%, 16.5%, and 1.8% respectively.

Types of genital tract abnormalities encountered at the Douala industrial abattoir

Overall, 380 (75.5%) of the 503 examined bulls were affected by one or more gross reproductive abnormalities of unidentified causes. Balanoposthitis was the most common disorder with an overall prevalence rate of 30% (n=151/503) followed by posthitis (21.5%; n=108/503), hematoma (14.9%; n=75/503), unilateral testicular hypoplasia (8.9%; n=45/503), hydrocele (2.4%; n=12/503), white buttons (2.2%; n=11/503), epididymitis (2%; n=10/503), balanitis (1.8%; n=9/503), scrotal ecto-parasitism (1.8%; n=9/503), herpes posthitis (1.6%; n=8/503) and testicular atrophy (1.4%; n=7/503) (Table 1).

Type and prevalence of gross reproductive abnormalities in bulls present at the slaughterhouse

Unilateral testicular hypoplasia had a general prevalence of 8.9% and CI of [6.41-11.39]. Out of all factors examined, the only origin was seen to be significant (P= 0.001). Bilateral testicular hypoplasia had an overall prevalence of 1% and CI of [0.13-1.87]. Amongst all the factors evaluated only origin happened to vary with this disorder (P=0.028.). Orchitis had an overall prevalence of 1.4% and CI of [0.37 – 2.43]. In all the factors evaluated only origin happened to vary with the disease (P=0.000). Testicular atrophy had an overall prevalence of 1.4% and CI of [0.37 – 2.43]. Amongst all the factors evaluated, no factor was significant. Balanoposthitis had the greatest prevalence being 30% and CI of [26.0-34.0]. All the factors examined except BCS showed a significant association with the genital disorder; we have an origin (P=0.036), age (P=0.003), breed (P=0.030), weight (P=0.000). Hematoma had an absolute prevalence of 14.5% and CI of [11.79-18.01]. All the factors evaluated, no factor varied significantly with hematoma. Herpes posthitis had an overall prevalence of 1.6% and CI of [0.50-2.70]. Amongst all the factors considered, only carcass weight was significant with (P=0.004). Funiculitis had a total prevalence of 0.2% and CI of [0-0.59] and none of the factors were significant. The penile frenulum had an overall prevalence of 0.4% and CI of [0-0.95] and all variables were insignificant. Penile laceration had an overall prevalence of 0.8% and CI of [0.02-1.58] and there was no significant association with all the risk factors. Scrotal adhesion had a global prevalence of 1.8% and CI of [0.64-2.96].

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Table 1. Prevalence of pathologies in different parts of the genital tract

Location/portion	Reproductive tract abnormality	Frequency	Prevalence (%)	Confidence interval
Testicular conditions	Unilateral hypoplasia	45	8.9	[6.41 – 11.39]
	Bilateral hypoplasia	5	1	[0.13 – 1.87]
	Orchitis	7	1.4	[0.37 – 2.43]
	Testicular atrophy	7	1.4	[0.37 – 2.43]
	Testicular degeneration	5	1	[0.13 – 1.87]
	Testicular caseation	2	0.4	[0-0.95]
	Seminoma	1	0.2	[0 – 0.59]
	Testicular abscess	4	0.8	[0.02 – 1.58]
Total	**08**	**76**	**15.1**	
Penile conditions	Balanoposthitis	151	30	[26.00 – 34.00]
	Hematoma	75	14.9	[11.79 – 18.01]
	Herpes posthitis	8	1.6	[0.50 – 2.70]
	Persistent frenulum	2	0.4	[0 – 0.95]
	Penile laceration	4	0.8	[0.02 – 1.58]
	Habronemiasis	1	0.2	[0 – 0.59]
	Hypospadias	2	0.4	[0 – 0.59]
	White buttons	11	2.2	[0.92 – 3.48]
	Balanitis	9	1.8	[0.64 – 2.96]
	Postithis	108	21.5	[17.91 – 25.09]
Total	**10**	**371**	**73.8**	
Scrotal condition	Scrotal ectoparasitism	9	1.8	**[0.64 – 2.96]**
	Scrotal cellulitis	2	0.4	[0 – 0.95]
	Hydrocele	12	2.4	[1.06 – 3.74]
Total	**03**	**23**	**4.6**	
Ducts	Epididymitis	10	2	[0.78 – 3.22]
	Funiculitis	1	0.2	[0 – 0.59]
	Varicocele	1	0.2	[0 – 0.59]
	Sperm granuloma	2	0.4	[0 – 0.95]
Total	**04**	**14**	**2.8**	
Grand Total	**25**	**484**	**96.3**	

No factor was seen to vary with the disorder. Testicular degeneration had a total prevalence of 1% and CI of [0.13-1.87] and there was no significant difference with any of the factors. Sperm granuloma presented a global prevalence of 0.4% and CI of [0-0.95] which varied significantly with origin with (P=0.000). Amongst all the factors evaluated, carcass weight was significant with (P=0.004). Varicocele had an overall prevalence of 0.2% and CI of [0-0.59] and showed no significant difference between risk factors. Scrotal cellulitis had an overall prevalence of 0.4% and CI of [0-0.95]. There was no significant difference amongst factors. Habronemiasis had an absolute prevalence of 0.2% and CI of [0-0.59] and showed no significant difference amongst factors. Seminoma had an overall prevalence of 0.2% and CI of [0-0.59] and showed no significant difference amongst factors. Hypospadias had an overall prevalence of 0.2% and CI of [0-0.59] and showed no significant difference amongst factors. White buttons had an overall prevalence of 2.2% and CI of [0.92-3.48] and showed no significant difference amongst factors. Epididymitis had an overall prevalence of 2% and CI of [0.78-3.22] and showed no significant difference amongst factors. Balanitis had an overall prevalence of 1.8% and CI of [64-2.96] and showed no significant difference amongst factors. Posthitis had a total prevalence of 21.5% and CI of [17.91-25.09]. There was a significant difference between this genital abnormality with the breed (P=0.021), weight (P=0.002), and origin (P=0.0029). The testicular abscess had a global prevalence of 0.8% and CI of [0.02-1.58] and was observed to vary greatly with origin (P=0.000). Testicular caseation had an overall prevalence of 0.4% and CI of [0-0.95] and showed no significant difference amongst factors. Hydrocele had an overall prevalence of 2.4% and CI of [1.06-3.74]. Amongst all factors examined, the only breed had a significant difference (P=0.033).

Influence of breed, age, BCS, origin and weight, and genital tract abnormalities of bulls

It was observed that the age and body condition score of the study bulls had not caused the significant discrepancy in the prevalence of all gross genital abnormalities (P>0.05) except in the case of balanoposthitis where animals between 3-7 years were more affected (P<0.05). The age-specific incidence of all pathological conditions encountered was 48.5% in bulls aged 3–7years, 27.0% in bulls aged 7-12years. These incidences did not vary significantly (*P*> 0.05) between bulls aged 7-12 years. The odds of bulls aged between 3-7 years were 1.803 times more than the prevalence of bulls between 7-12 years. Also, the prevalence of balanitis, Balanoposthitis, posthitis, and hydrocele significantly varied with the breed (P<0.05). The breed-specific incidence of all pathological conditions gotten in the present study for Bokolo, Gudali, red Fulani, White Fulani were 1.6%, 16.5%, 22.3%, 35.2% respectively. White Fulani was seen to have a significantly high prevalence (P <0.05) compared to other breeds. The odds of breed and Balanoposthitis reveal that Gudali and Bokolo breeds were 1.692 and 1.442 times more likely at risk respectively. The breed was observed to vary greatly with balanitis, posthitis, and hydrocele. The Red Fulani breed was 1.5 times more likely to be affected with posthitis and 1.25 times to get infected with balanitis. The Gudali breed was 0.455 times less susceptible to having hydroceles. To proceed, weight had a significant effect on Balanoposthitis and herpes posthitis.

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Table 2. Odds Ratio (OR) for the different significant risk factors of Reproductive abnormalities in bulls destined for slaughter at the SODEPA abattoir

Factors	Variables	Pathology	N	N*	Pr. (%)	OR	P-value (X^2)
Age (year)	Adult (3-7)	Balanoposthitis	151	87	17.3	1.803	0.003 (8.590)
Breed	Gudali	Balanoposthitis	151	22	4.4	1.692	0.030 (8.916)
	Red Fulani	Balanitis	9	1	0.2	1.253	0.021 (9.742)
	Red Fulani	Posthitis	108	22	4.4	1.575	0.002 (14.912)
	Gudali	Hydrocele	12	2	0.4	0.455	0.033 (8.723)
Weight (Kg)	<200	Balanoposthitis	151	102	20.3	2.486	0.000 (16.791)
	<200	Herpes Posthitis	8	3	0.6	6.502	0.004 (8.388)
Origin	Dumbu	UTB	45	4	0.5	1.233	0.001 (38.85)
	Garoua/guider/ Maroua	Balanoposthitis	151	1	0.2	1.222	0.036 (26.208)
	Ngaoundere	Posthitis	108	15	3.0	$7.7x10^6$	0.029 (27.008)
	Guider/Maroua	Abscess	4	1	0.2	0.91	

N=number of animals examined, N*=number affected, Pr. = Prevalence, OR= odd ratio, CI= Confidence Interval, UTH= Unilateral testicular hypoplasia, BTH= bilateral testicular hypoplasia

Table 3. Overall prevalence of genital diseases of bulls based on age, BCS, origin, weight, and breed

Characteristics of bulls		N	N*	Prevalence	P value
Age in year	3-7	337	244	48.5	0.019
	7.1-12	166	136	27.0	
BCS	Poor (1)	1	1	0.2	0.018
	Average (2)	110	72	14.3	
	Normal (3)	392	307	61.0	
Weight (Kg)	<200 (1)	397	282	56.1	0.00
	>200 (2)	106	98	19.5	
Breed	Bokolo	13	8	1.6	0.033
	Gudali	108	83	16.5	
	Red Fulani	147	112	22.3	
	White Fulani	235	177	35.2	
Origin	Adoumri	65	56		
	Banyo	81	72		
	Bertoua	2	2		
	Dumbu	5	4		
	Foumban	74	50		
	Garoua	6	4		
	Guider	6	5		
	Guidiguis	33	24		
	Kalfou	15	13		
	Maroua	6	5		
	Mbaiboum	48	35		
	Meiganga	19	13		
	Ndokayo	5	3		
	Ngaoundal	3	0		
	Ngaoundere	79	55		
	Touboro	56	39		

N=number of animals examined, N*=number affected.

The weight-specific incidence of all pathological conditions observed in our study was 56.1% and 19.5% for bulls weighing <200 and >200 kg carcass weight respectively. These incidences did not vary significantly (P> 0.05) between bulls weighing > 200kg. Bulls weighing <200 kg were 2.486 and 6.502 times more likely to be affected with balanoposthitis and herpes posthitis respectively than bulls weighing > 200kg (Tables 2 and 3).

Correlations between factors of variation and genital abnormality

Global correlations

It can be seen from Figure 1 that:

- There is a fair correlation of 0.6 between scrotal cellulitis and seminoma
- Abscess and sperm granuloma is correlated to the origin
- There is an association between Hydrocele and epididymitis

Correlations between reproductive tract abnormality and all factors

There was a strong correlation of 0.706 between Scrotal Cellulitis and Seminoma and a moderate correlation of 0.444 between Hydrocele and Epididymitis.

Discussion

This study revealed an overall prevalence of gross reproductive abnormalities in bulls of local breeds slaughtered at Douala Industrial abattoir of 75.5% (n=380/503). This overall occurrence rate of gross genital abnormalities of unidentified causes in bulls was far higher than the reports of Eshetu *et al.* (20), Migbaru *et al.* (21) in central Ethiopia, Barth (22) in beef bulls in Canada, and Silva *et al.* (23) in Brahman, Nelore and Brown Swiss bulls in Mexico; where the prevalences were 52.5, 47.6, 30.4, 22.1, 8.37, 6.78 and 6.88%, respectively. These

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differences might be attributed to variations in animal management systems, breeds of bulls studied, and geographic and climatic conditions of areas. A study in Sulaimania showed that a high number of genital lesions in goats is probably due to many factors that include: poor housing, inadequate knowledge of the owners, bad management, insufficient nutritional level, and increased contamination (24).

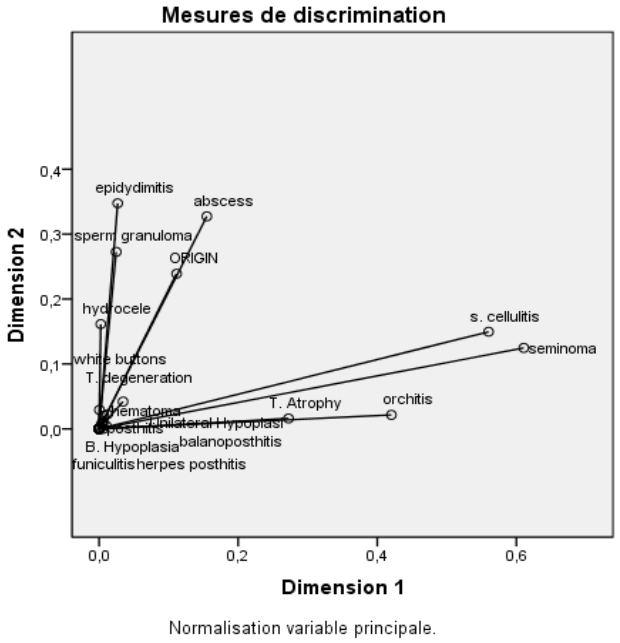

Figure 1. Global correlation between all variables

It had been documented that sex-related disorders in domestic animals varied depending upon the species and breed and the selection practice used by breeders (25).

The most common abnormality identified was balanoposthitis with a prevalence rate of 30% (n=151/380). This is in contrast with the fact that testicular hypoplasia is reported to be the most common reproductive abnormality of bull encountered by veterinary practitioners (13). This result was 30 times superior to that recorded in feral male goats by Tarigan *et al.* (26) in Australia (1.1%). This unusual high prevalence could be because there is inadequate examination/attention given to bulls in herds and untimely detection of reproductive problems hence, leading to infection. This study revealed that aged bulls were more likely to be affected with balanoposthitis than the younger animals, also the breed varied significantly with the disorder, the Gudali breed was seen to be more touched by the disease followed by Bokolo and red Fulani. There was a significant difference between weight and balanoposthitis, where the healthier the bull, the greater its chances of getting infected.

The prevalence of 8.9% of testicular hypoplasia in the present study is higher than 0.66% obtained by Bousmaha, and Khoudja in Algeria (27), 3.1% obtained by McGowan *et al.* in Brahman bulls (28), and 3.6% obtained by Eshetu *et al.* in Ethiopia (29). However, the prevalence obtained (8.9%) is lower than the 18.8% obtained in Eastern Ethiopia by Eshetu *et al.* (20) and 14.4% obtained in Addis Ababa by Migbaru *et al.* (21). These differences could be due to variations in the climatic condition of the study areas and the breed of animals studied. Also, testicular hypoplasia is a hereditary condition with breed predisposition and its incidence rises under tropical conditions (30). The prevalence of unilateral ($\chi2$=38.85; P<0.01) and bilateral ($\chi2$=27.07; P<0.01) testicular hypoplasia significantly varied with location Age and body condition of bulls did not significantly affect the occurrences of unilateral and bilateral testicular hypoplasia (P>0.05). Similar to this study, it has been reported that testicular hypoplasia had no significant association with the age of the bulls (21). Hypoplasia of the testes occurs in all farm animals but, certain breeds seem to be more prone to testicular hypoplasia, as in Swedish Highland bulls, with prevalence up to 25% (11), which is higher than the prevalence of testicular hypoplasia (8.9%) in this study. Hypoplasia of the testes was also reported by Gadisa and Amare (31) in sheep and by Igbokwe *et al.* (32) in goats.

Orchitis has an incidence of 7% in this study. It is slightly lower than the reports of Eshetu *et al.* (20) (8.3%) but higher than the reports of Migbaru *et al.* (21) (4.4%) in Ethiopia and 1.32% in Algeria (27); but, was in line with the 7.1% reported by Eshetu *et al.* (29). However, Hopkins (13) reported that orchitis was infrequently diagnosed in the bull. Hematoma had a prevalence of 14.9 % (penile and testicular). These results are greater than that obtained by Eshetu *et al.* (20) (9%), Eshetu *et al.* (29) (7%), and Migbaru *et al.* (21) (2.1%). These differences could be due to trauma, harsh conditions, and excessive physical torments leading to injury before bleeding which might cause rupture of superficial vessels of the prepuce. This study revealed that epididymitis had an overall prevalence of 2%. These results are inferior to the 3.4% recorded in Ethiopia (21), and 3% in Australia (28). However, there are comparable with the 2.5% in Central Ethiopia (20) and by results recorded (2%) by Eshetu *et al.* (29). Furthermore, it did not significantly vary with any risk factor (P>0.05).

The incidence of testicular degeneration in the present study happened to be 5%. These findings are slightly inferior to the 6.5% obtained by Eshetu *et al.* (20), 7% obtained by Amare *et al.* (2016), and 8.1% obtained by Migbaru *et al.* (21). This could be explained by the fact that a low number of young bulls came to the abattoir, environmental conditions as it was seen in a similar study that testicular degeneration varied with age (21).

The genital part with the greatest rate of occurrence of reproductive disorder was the penis (73.8%), followed by the testis (15.1%), then comes the scrotum (4.7%) before the ducts (2.8%). Pathological conditions of testicular disorders (15.1%) were greater than earlier reports of Igbokwe *et al.* (33) (7.82%) in Nigeria, but comparable to the 17.8% recorded by Regassa *et al.* (34) in Ethiopia in bucks. The breed was observed to vary greatly with balanitis, posthitis, and hydrocele. The Red Fulani breed was 1.5 times more likely to be affected with posthitis and 1.25 times to get infected with balanitis. The Gudali breed was 0.455 times less susceptible to having hydroceles.

Conclusion

The findings of this study tell that more attention should be given to the reproductive management of bulls as the fertility of the bull is more important than that of any individual cow which could cause subfertility, infertility, or sterility. We would recommend routinely checking on bull reproductive soundness at the farm level.

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Conflict of Interest

The authors declared that there is no conflict of interest.

Authors' contribution

All authors of this study have a complete contribution to data collection, data analyses, and manuscript writing.

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