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Prevalence of single and multiple reproductive disorders in Jersey crossbred cows of sub-tropical North-Western Himalayas

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Propensity of crossbred cows to a variety of diseases, including infertility, has been the major economical impediment (Dhindsa 2014), probably posing a huge threat to the existence of cattle husbandry as evinced from a 14.95% decadal reduction in cattle population (20th Livestock census of H.P. 2019). Investigation on the prevalence of different reproductive disorders is required in strategic designing of appropriate policies and measures to control reproductive disorders. Importantly, presence of one reproductive disorder may accentuate a simultaneous occurrence of another disorder in the same animal (multiple disorders). For instance, a large percentage of cows with urovagina are concomitantly affected with prolonged estrus/ delayed ovulation (Sood and Vatsayan 2017). Apart from the latter findings, the presence of multiple reproductive disorders has not been elaborated in cows in India. Hence, the objectives of the present study were to document the prevalence of single and multiple disorders along with the effect of age and season per se in the crossbred cows of North-Western Himalayan region.

The study included 1612 Jersey crossbred cows presented in 118 infertility camps (October 2013 to February 2021) in different rural North-Western Himalayan areas experiencing a monsoon influenced sub-tropical climate. On presentation, the past and present reproductive history was ascertained and was followed by a detailed reproductive examination to confirm and categorize pattern of congenital and acquired reproductive disorders (Arthur *et al*. 2001). Of the 1612 cows, 352 were excluded from statistical analysis as these were either reproductively normal, had gestational abnormalities or displayed a reduced detectable frequency. The noticeable infertility situations (single or multiple) were true anestrus (TA), silent estrus (SE), infantile genitalia (IG), metestral bleeding (MEB), prolonged estrous (PE), endometritis (ENDO), repeat breeding (RB) and kinked cervix (KC). In terms of age, the animals (n=1260) were categorized into Group 1 (≤2.5 years; n=198), Group 2 (2.5-7 years; n=812) and Group 3 (≥7 years; n=250), respectively (Schuster *et al*. 2020). The seasons were categorized as spring (March to April), summer (May to June), monsoon (July to August) and prewinter- winter (September to February) (Jaswal *et al*. 2015).

The data was analysed using descriptive statistics and Pearson's chi-square test. Individual binomial logistic regression was also designed to predict the relative risk of occurrence of disorders for different age groups. For this, the reproductive disorder under deliberation was considered as predictor variable and Group 1 was taken as reference category with an odds ratio of 1.000. A difference of $p<0.05$ (at least) was considered as significant. The analysis was done on SPSS version 24.0 (SPSSInc. Chicago, IL, USA).

Our findings of TA, ENDO, IG, RB and SE being most prevalent (Table 1) resembled to the presence of TA (40.5%) in H.P (Sood *et al*. 2012) and anestrus (31.8%) and RB (24.6%) in North-East (Khan *et al*. 2016) cows. In a subsequent study from Maharashtra, ENDO, anestrus and RB were prevalent in 36.6%, 22.3% and 21.3% cows, respectively (Ambore *et al*. 2009). In terms of multiple disorders [Fig. 1.(b)], there was a major co-existence of ENDO with PE and RB with MEB. The pattern of single reproductive disorders cited *vide supra*, suggested undernourishment and/or unscientific feeding as common etiologic denominator (Dutta *et al*. 2019). Moreover, the average cultivable land under fodder in H.P (< 0.5%) is considerably less than the national average (4.4%) (DOA 2009), thereby resulting in green fodder deficit of 57.4% (Radotra *et al*. 2015). Fodder based feeding regimens are important for a profitability dairy entrepreneurship (Policy Paper 59, 2013).

Although considered as different clinical entities (Arthur*et al*. 2001), ENDO can result into PE, as absorption of bacterial endotoxins from uterus into circulation disturbs neuro-endocrine functions (Sheldon *et al*. 2009) to cause ovulatory disorders (Williams *et al*. 2007). We recorded an ENDO-PE nexus in urovagina related infection in cows

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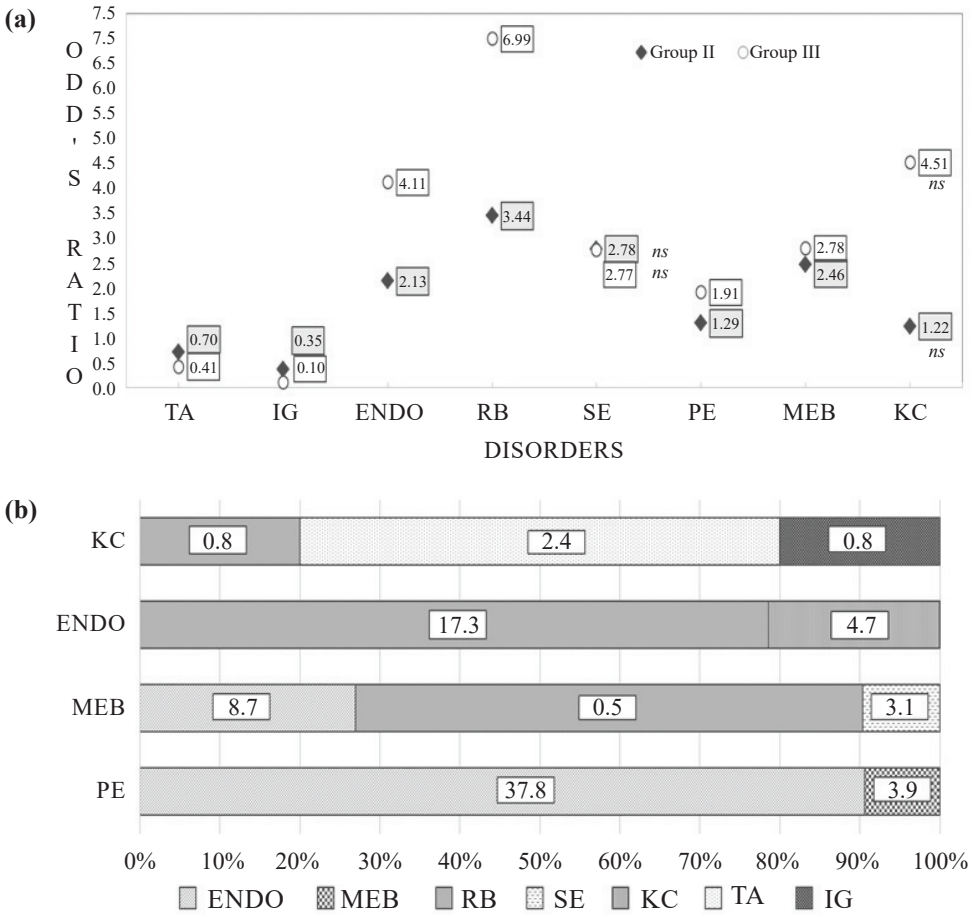

Fig. 1. **(a)** Forest scatter plots depicting Odd's ratio for infertility disorders in differet age groups. Numbers in text box indicates Odd's ratio where shaded text box corresponds to Group II and white text box corresponds to Group III ($p<0.05$; ns-non significant). **(b)** Side-bar depicting inter-relationship of infertility disorders. **[**KC, ENDO, MEB, PE depicts major infertility disorders simultaneously having other infertility disorders and numbers in text box indicates percentage of respective cases. ENDO-Endometritis, RB-Repeat breeding, KC-Kinked cervix, PE-Prolonged estrus, SE-Silent estrus, MEB- Metestrus bleeding, TA-True anestrus and IG-Infantile genitalia]

(Sood and Vatsayan 2017). From a clinical perspective, it would be intriguing to know if endometritis treatment restores normalcy of estrus duration; if so, the findings will be clinically vital as the need for PE treatment can be avoided in cows treated for ENDO. Another important association between MEB and RB also needs a mention (Fig. 1); MEB in cows is considered physiological (Roberts 1986). To the contrary, our extensive clinical experience on cattle infertility shows that nearly 67% of the RB cows exhibiting MEB conceived following an exogenous administration of progesterone 72 h after AI (Sood P; unpublished data). Hence, a progesterone deficiency or disturbed progesterone: estrogen ratio in the RB cows with MEB could be speculated, which although needs a scientific validation.

In terms of age, Group 2 cows were highly susceptible for presence of different single as well as multiple disorders; RB was, however, most common in Group 3. Interestingly, PE with ENDO and RB with MEB were more prevalent as multiple than single disorders in Group 2 and 3, which also had a higher likelihood of their presence [Table 1 and Fig. 1.(b)]. Likewise, the relative risk of presence of TA and IG was higher in Group 1 [Fig. 1.(a)]. Presence of ENDO (Kim and Kang 2003), PE (Fonesca *et al*. 1983) and RB (Asaduzzaman *et al*. 2016) is known to increase with aging of cows. More infertility evidence during pre-winter to winter season, considered as a lean period in terms of fodder production, justifies the findings per se (Table 1).

From the findings of this study it can be concluded that TA still holds the top most position among the prevalent reproductive disorders in the state. This demands an urgent need to strategize different policies and measures ensuring nutritional security in cows. Additionally, the depiction of simultaneous occurrence of more than two reproductive disorders in same animal is interesting and paves way for more potential future studies.

SUMMARY

A total of 1612 cows during 118 rural infertility camps (October 2013 to February 2021) in Himachal Pradesh were examined for prevalence of single and multiple reproductive disorders. Subsequently, prevalence of reproductive disorder was analysed from a perspective of age (Group 1: ≤2.5 years; Group 2: 2.5-7 years; Group 3: ≥7

Table 1. Age-wise and season-wise prevalence of infertility disorders

Reproductive disorder	Single / Multiple	Age-wise prevalence			Overall	Season-wise prevalence			
		Group 1 (n=198)	Group 2 (n=812)	Group 3 (n=250)		Winter (n=492)	Summer (n=72)	Monsoon (n=222)	Post-monsoon (n=474)
True anestrus	Single	19.3 (105)	65.8 (357)	14.3 (78)	39.4 (543)*Ω	44.6 (242)	3.7 (20)	11.0 (60)	40.7 (221)
	Multiple	-	0.4 (2)	0.2 (1)					
Infantile genitalia	Single	33.8 (52)	59.7 (92)	5.8 (9)	11.1 (154)*Ω	47.4 (73)	5.2 (8)	9.1 (14)	38.3 (59)
	Multiple	0.7 (1)	-	-					
Endometritis	Single	3.9 (10)	42.2 (108)	19.9 (51)	18.4 (256)*Ω	27.7 (71)	9.8 (25)	25.0 (64)	37.5 (96)
	Multiple	3.9 (10)	19.2 (49)	10.9 (28)					
Repeat breeding	Single	3.5 (5)	40.8 (58)	21.1 (30)	10.2 (142)*Ω	31.7 (45)	7.7 (11)	24.6 (35)	35.9 (51)
	Multiple	1.5 (2)	8.5 (12)	24.6 (35)					
Silent estrus	Single	6.7 (7)	69.5 (73)	20.0 (21)	7.5 (105)*Ω	48.6 (51)	16.2 (17)	9.5 (10)	25.7 (27)
	Multiple	-	1.9 (2)	1.9 (2)					
Prolonged estrus	Single	1.3 (1)	24.7 (19)	5.2 (4)	5.5 (77)Ω	18.2 (14)	11.7 (9)	45.5 (35)	24.7 (19)
	Multiple	11.6 (9)	35.1 (27)	22.1 (17)					
Metestrus bleeding	Single	5.7 (5)	32.2 (28)	9.2 (8)	6.3 (87)Ω	27.6 (24)	9.2 (8)	29.9 (26)	33.3 (29)
	Multiple	1.2 (1)	35.6 (31)	16.1 (14)					
Kinked cervix	Single	4.4 (1)	21.7 (5)	26.1 (6)	1.6 (23)#	43.5 (10)	-	34.8 (8)	21.7 (5)
	Multiple	4.4 (1)	21.7 (5)	21.7 (5)					
Total		15.2 (210)	62.5 (868)	22.3 (309)	100 (1387)	38.2 (530)	7.07 (98)	18.1 (252)	36.6 (507)

*, significantly prevalent infertility disorders ($p<0.05$); #, significantly least prevalent infertility disorder ($p<0.05$); Ω, marks the infertility disorders significantly influenced by season ($p<0.05$).

years) and season (summer, monsoon, post-monsoon and winter). In descending order, true anestrus, endometritis, infantile genitalia, repeat breeding and silent estrus were most prevalent single disorders. However, prolonged estrus with endometritis (62.3%) and metestral bleeding with repeat breeding (29.8%), respectively were concomitantly present as multiple disorders (in the same set of cows). Group 2 cows were highly susceptible for the presence of single and multiple disorders; whereas the disorders were most prevalent during pre-winter-winter and minimum during summer season.

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