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The functional traits and threats to the Borgou cattle breed as perceived by farmers in Benin

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Abstract

Benin has been facing the loss of its animal genetic heritage over the years. The aim of this study was to explore the reasons related to the progressive abandonment of the Borgou cattle breed. The assessment of threat level and functional traits related to the Borgou breed was therefore collected through semi-structured interviews from 105 cattle farmers using the Likert scale (1 to 5), and the scores recorded were compared within each group of farmers using the Kruskal–Wallis and the Mann–Whitney *U* tests. The results showed that depending on the types of farmers surveyed, the Borgou breed is much more threatened by the Zebu Goudali ($p > 0.05$), Yakana ($p > 0.05$) and Azawak ($p < 0.05$) with their medians ranging from 3.5 to 5. The lack of good breeding bulls and uncontrolled cross-breeding were considered to be the socio-environmental factors having more influence on the conservation of the Borgou breed (medians ranging from 3 to 4) according to the types of farmers ($p > 0.05$). Farmers appreciated its qualities such as adaptability, resistance to diseases, fertility, manure production, conformation, aptitude for draught and valorization of food resources (median: 3 to 5). However, scores recorded (medians 2 to 3) for the growth ($p > 0.05$), milk production ($p > 0.05$) and selling price ($p < 0.01$) of Borgou cattle indicated that these traits were unsatisfactory for farmers and reveal that the Borgou breed is mainly discarded in view of its low capacity to swiftly produce meat and its low milk productivity. This leads farmers to resort to cross-breeding through the use of other more productive breeds. This study will therefore allow to take into account farmers' perceptions in the development of programmes and sustainable in situ conservation strategies of the Borgou cattle breed in Benin.

Keywords: Abandonment, Conservation, Cradle, Borgou, Benin

Introduction

Around the world and especially in Africa, cattle farming is of great importance for people who make it their main activity and the diversity of cattle breeds is essential for food security and the guarantee of livelihoods and resilience to climate change (FAO 2019; Cao et al. 2021). Recently, it has become evident that many indigenous cattle breeds in developing countries have disappeared and the proportion of animals threatened with extinction is gradually increasing. In these countries, many indigenous animal genetic resources are progressively declining due to several factors such as indiscriminate cross-breeding and the promotion of the use of high-yielding exotic breeds by national policies (ILRI 2009; Tesfa et al. 2017). In addition, due to their slow growth and low carcass yields, indigenous animal breeds are poorly represented in the commercial sector (Felius et al. 2011; Chingala et al. 2017). In Benin, the national herd is made up mainly of ruminants, with around 2,503,836 heads of cattle in the country in 2019 (Faostat 2021). Almost 85% of these animals are concentrated in the north of the country with 63% in the departments of Borgou and Alibori. The cattle

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population is comprised of a genetic diversity of Zebu and taurine breeds. Among these, the Borgou breed formerly represented 88% of the national cattle population (Sènou et al. 2008). This breed is thought to originate from a stabilized cross between the West African shorthorn cattle (Somba or Lagunaire) and the Zebu White Fulani (Domingo 1976). In addition to its hardiness and resistance to trypanosomiasis (Doko 1991), this breed is used to produce milk, labour and provides more than half of the meat consumed in Benin (Gbangboché and Alkoiret 2011; Youssao et al. 2013). For ex situ conservation purposes of this breed, the Benin government decided to install a nucleus herd of this breed at the Okpara Breeding Farm where the breed had been undergoing several studies (Alkoiret et al. 2016; Worogo et al. 2018; Adambi Boukari et al. 2018; Worogo et al. 2021) to promote its genetic improvement. However, crosses with exotic breeds such as Girolando or Gir were made but without success because these imported breeds failed to adapt to the living conditions of the Borgou breed. This gives rise to resorting to and re-assessing the farming and management of this breed in its natural biotope where it belongs to rural communities. Moreover, in Benin, intervention policies in the field of livestock farming in rural areas are limited to annual vaccination and deworming campaigns. The Borgou cattle breed is one of the indigenous cattle breeds of Benin, and many authors (Dehoux and Verhulst 1994; Alkoiret et al. 2009; Chabi Toko et al. 2016) mention that the breed undergoes extensive cross-breeding while it is well documented that this phenomenon is one of the main causes of genetic erosion in animals (FAO 2019). The abandonment of the Borgou breed in favour of cross-breeds makes its in situ conservation more and more complex and leads to the progressive loss of the breed even in in situ farms. This situation is much more accentuated due to the fact that in Benin, cross-breeding between cattle of different breeds in communities is free and not subject to any government regulation. Our hypothesis is that the local communities involved in the use and management of the Borgou cattle breed can play a vital role in its in situ conservation in the face of different threats. Numerous studies demonstrate the usefulness of communities in conservation processes in different domains (Brooks et al. 2013; Murray and Agyare 2018; Engen et al. 2019). This study therefore aimed to explore among cattle farmers the deep-seated reasons for the abandonment of the Borgou breed in favour of cross-breeds via their perceptions of the different forms of threats and the functional traits of this breed in its cradle of origin.

Material and methods

Data collection

Data collection for this study was carried out in the communities of Kalalé, Nikki, Pèrèrè, Parakou and Tchaourou, all located in the department of Borgou known as the cradle of the Borgou cattle breed (Fig. 1). Surveys were conducted with 105 cattle farmers from February to April 2020 using a semi-structured questionnaire. The cattle farmers who participated in this study were those who had at least one phenotype of the Borgou cattle breed and who participated in the previous study initiated by Worogo et al. (2019). The previous study identified four types of farmers: "Semi-intensive purebred Borgou cattle farming", "Sedentary purebred Borgou cattle farming", "Large transhumant of Zebu and Borgou crossbred cattle farming" and "Small transhumant of Zebu and Borgou crossbred cattle farming" referred to as "SIntPur" (n = 20), "SedPur" (n = 25) "LargeZB" (n = 30) and "SmallZB" (n = 55) respectively in the current study.

SIntPur is characterized by individuals from the Fulani ethnic group who have received formal education and training in animal production techniques. They own many animals (≥ 85 heads) and their objective is the improvement and conservation of the Borgou cattle breed. These farmers use natural pastures, artificial grasslands and agro-industrial by-products for feeding their animals, and health monitoring is provided by veterinary agents. SedPur is characterized by the Bariba ethnic group with small numbers of cattle (≤ 22 heads). The farmers are mostly illiterate and use the Borgou breed for draught purposes. Individuals of LargeZB are from Fulani and Gando ethnic groups owning a large number of cattle (around 75 heads) made up of Zebu breeds (Azawak and Yakana), taurine breed (Borgou) and their cross-breeds. They refer to veterinarians or endogenous practices to treat sick animals. Cattle are fed with natural pasture crop residues. Individuals of SmallZB are from the Gando ethnic group. They own medium-sized herds (around 30 heads). They use natural pastures for feeding animals while supplementing them with crop residues and salt (Worogo et al. 2019).

The interview questions were grouped into three categories:

- Questions related to the threat levels exerted by other breeds on the Borgou breed in terms of farmers' preference: these are essentially breeds that share the same farming area with the Borgou breed. These breeds are mainly Zebu (Azawak, Goudali, Mbororo, Yakana), taurine (Ndama, Somba) and exotic breeds (Gir, Girolando). The levels of influence of these breeds were assessed using the Likert scale (1 = very low, 2 = low, 3 = medium, 4 = strong, 5 = very strong).
- Questions related to the threat levels of socio-environmental factors influencing the survival of Borgou cattle: these socio-environmental factors are

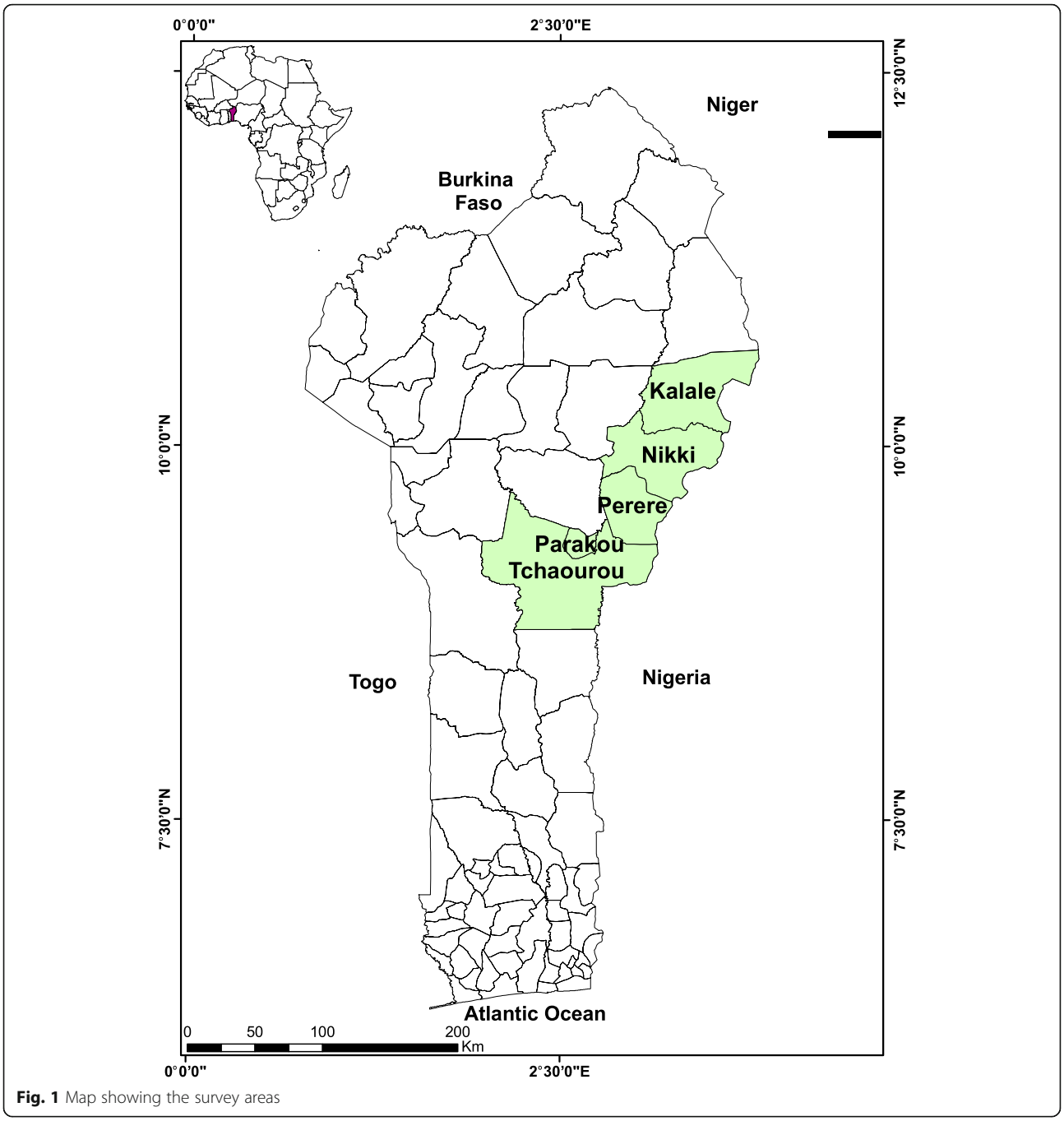

Fig. 1 Map showing the survey areas

the lack of good breeding bulls (LGBB), the lack of veterinary follow-up (LVF), climate change (CC), labour shortage (LbShort), poor management (PMgm) of the herds, reduction of pasture lands (RedPL), conflicts between farmers and herders and uncontrolled cross-breeding (UCB). These factors were also rated using the Likert 1 to 5 (1 = very low, 2 = low, 3 = medium, 4 = strong, 5 = very strong).

– Questions related to the assessment of the functional traits of the Borgou breed within farmer communities: the functional traits taken into account were the "Adaptability" of the Borgou cattle to the environmental conditions, its "Conformation", its "Growth", its "Fertility", its production of "Manure", its "Milk Production" (MilkProd), its "Selling price", its "Resistance to diseases" (DisRes),

its "draught" ability and its "Valorization of Feed Resources" (ValFR). These criteria were assessed on the Likert scale (1 to 5) with the following levels: 1 = very bad, 2 = bad, 3 = acceptable, 4 = good and 5 = very good.

One to 2 h was needed to complete individual interviews.

Statistical analysis

The survey data were entered in an Excel 2013 spreadsheet, which allowed us to graphically display the frequencies obtained for each score of the Likert scale with regard to each variable on the threat levels of the other cattle breeds, the threat levels of socio-environmental factors on the in situ conservation of the Borgou breed and the assessment of the functional traits of Borgou cattle. The non-parametric Kruskal–Wallis H test and the Mann–Whitney U test were used for the comparison of medians of the threats and traits between farmers' groups. In the tables, descriptive statistics are presented as median (*interquartile range*) and mean ± SD. The analyses were performed using software R.3.4.0 (R Core Team 2020).

Results

Overall threat level from the other cattle breeds on the Borgou cattle breed

The perceptions of the farmers on the threats from other cattle breeds sharing the same distribution area with the Borgou cattle are presented in Fig. 2. The respondents perceive that the highest levels of threats are attributable to Goudali, Azawak and Yakana breeds (43.81%, 36.19% and 31.43%). The levels of threats of these breeds rated as strong (Likert scale 4) by farmers were 31.43%, 25.71% and 31.43% respectively for these same breeds. Very few farmers mentioned that these three breeds influence weakly (6.67%, 10.48% and 13.33% for Goudali, Azawak and Yakana respectively) or very weakly (3.81%, 6.67% and 6.67% for Goudali, Azawak and Yakana respectively) the existence of the Borgou breed in the study area. On the other hand, the greatest proportions of threat level "Very low" (score 1) were attributed to the Somba and Ndama breeds by 44.76% and 42.86% of farmers respectively. The same trends were observed for score 2 (39.05% and 46.67% for Somba and Ndama breeds respectively). In addition, approximately 50% of the farmers asserted that the exotic breeds influence the Borgou breed "lowly" (score 2) and around 20% of these farmers gave the score 1. As for the Mbororo breed, farmers gave relatively scores 3 and 4 (30.48% and 20.95% of farmers respectively). In addition, similar percentages of appreciation (18.1%) were obtained for scores 1 and 2.

Between-farmers' perceptions on threat levels from the other cattle breeds

The variations in threat levels from the different breeds between groups of farmers with regard to each breed are presented in Table 1. The Kruskal–Wallis test did not reveal any significant difference between the levels of threat recorded between farmers' groups for each breed ($p > 0.05$) except the level of perceived threats for Azawak and Ndama ($p < 0.05$) and exotic breeds ($p < 0.01$). The scores for the Azawak breed were higher in LargeZB than the other groups of farmers. For exotic breeds, the scores were lower in SedPur farmers (median: 2 (1); mean: 1.72 ± 0.75) but higher in LargeZB farmers (median: 2 (1); mean: 2.52 ± 0.59). SedPur and

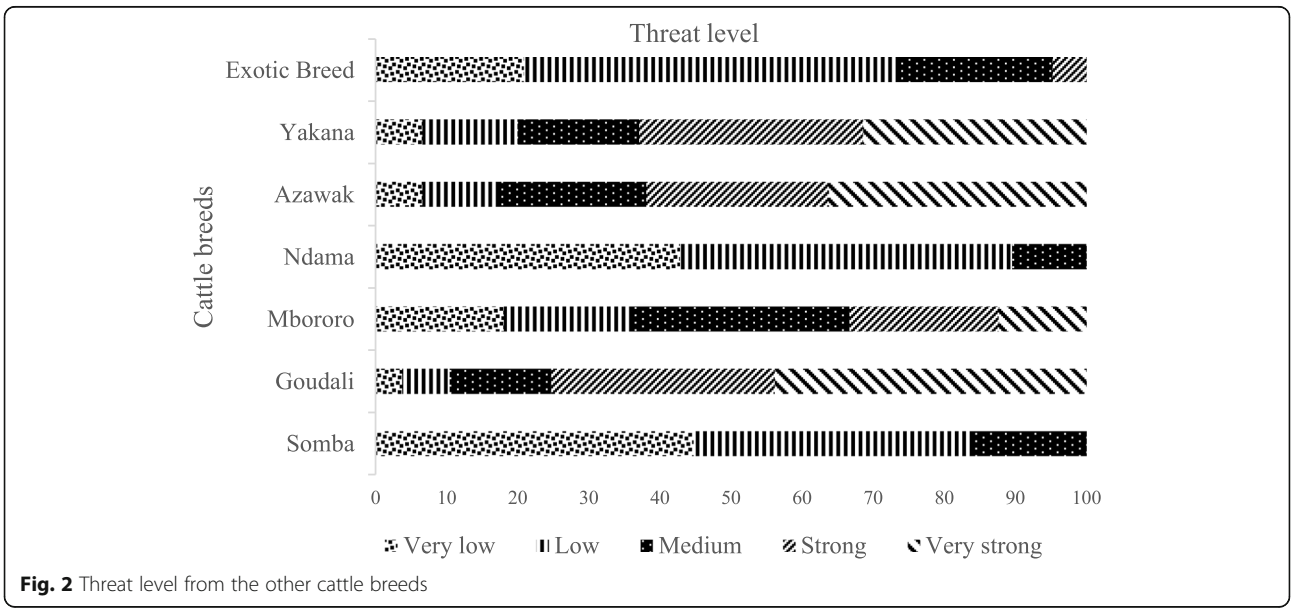

Fig. 2 Threat level from the other cattle breeds

Table 1 Threat level from the other cattle breeds according to groups of farmers

Breed	LargeZB (*n* = 23)	SedPur (*n* = 35)	SIntPur (*n* = 18)	SmallZB (*n* = 29)	Kruskal–Wallis test	*p*-value and S
Azawak	4 (2)[a] 4.10 ± 1.37	4 (2)[b] 3.63 ± 1.24	4 (1)[b] 3.28 ± 0.99	4 (2)[b] 3.72 ± 1.17	5.185	0.0211*
Goudali	4 (0.5)[a] 3.96 ± 1.31	4 (1)[a] 4.36 ± 0.85	3.5 (2)[a] 3.50 ± 1.16	5 (1)[a] 4.06 ± 0.99	5.8831	0.1174 NS
Mbororo	3 (1.5)[a] 2.50 ± 1.34	2 (2.5)[a] 2.96 ± 1.29	3.5 (1)[a] 3.35 ± 1.00	3 (2)[a] 3.03 ± 1.23	4.1881	0.2419 NS
Ndama	2 (1)[a] 2.00 ± 0.81	2 (1)[b] 1.53 ± 0.62	2 (0)[ab] 1.71 ± 0.46	1 (1)[b] 1.51 ± 0.50	5.273	0.0147*
Somba	2 (1)[a] 1.67 ± 0.77	2 (1)[a] 1.83 ± 0.69	2 (1)[a] 1.50 ± 0.65	2 (1)[a] 1.72 ± 0.76	0.37008	0.9464 NS
Yakana	4 (2)[a] 4.00 ± 0.95	4 (2)[a] 3.71 ± 1.27	4 (2)[a] 3.27 ± 1.36	4 (2)[a] 3.62 ± 1.29	2.8065	0.4224 NS
Exotic breeds	2 (1)[a] 2.52 ± 0.59	2 (1)[b] 1.72 ± 0.75	2 (1)[ab] 2.00 ± 0.87	2 (0)[ab] 2.13 ± 0.69	13.358	0.003923**

Values in brackets are interquartile range (IQR)
SIntPur semi-intensive purebred Borgou cattle farming, *SedPur* sedentary purebred Borgou cattle farming, *LargeZB* large transhumant of Zebu and Borgou cross-bred cattle farming, *SmallZB* small transhumant of Zebu and Borgou cross-bred cattle farming, *p-value* value of the probability, *S* significance, *NS* non-significant
[a,b,c]The values on the same row with different letters are significantly different
*$p < 0.05$, **$p < 0.01$

the SmallZB farmers perceived less the risk that the Ndama breed could participate in the genetic erosion of the Borgou breed (median: 2 (1); mean: 1.53 ± 0.62 and median: 1 (1); mean: 1.51 ± 0.50 respectively) comparatively to the farmers of other groups.

Overall threat level from the socio-environmental factors on the Borgou cattle breed

The farmers' perceptions on the threats exerted by the various socio-environmental factors on the rearing and in situ conservation of the Borgou breed are presented in Fig. 3. The uncontrolled cross-breeding was cited by the respondents as a factor influencing the in situ conservation of the Borgou breed at scales 4 and 5 (34.5% and 34.29% respectively). The lack of good breeding bulls in Borgou cattle herds was also mentioned as a cause linked to the abandonment of the Borgou breed (24.76% and 30.48% respectively for scores 4 and 5). Conflicts with farmers only slightly or very weakly threaten the in situ conservation of the Borgou breed according to the farmers (42.86% and 25.71% respectively for scores 2 and 1). Only a few farmers (15.24%, 10.48%

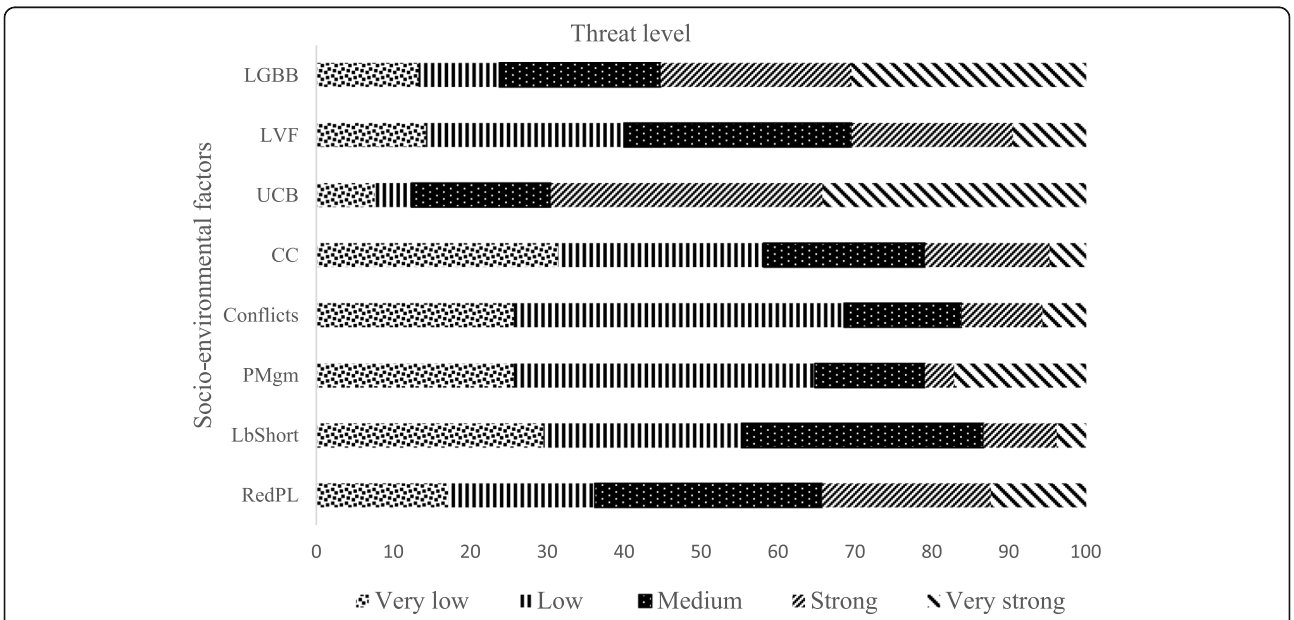

Fig. 3 Perceived threat level from the socio-environmental factors. LGBB lack of good breeding bulls, LVF lack of veterinary follow-up, UCB uncontrolled cross-breeding, PMgm poor management, RedPL reduction of pasture lands, LbShort labour shortage, CC climate change

and 5.71% for scores 3, 4 and 5 respectively) reported that "Conflicts" constitute a significant threat to the conservation of the Borgou breed. The LbShort is represented only very little in scores 4 and 5 but at around 30% for the other scores (1, 2 and 3). As for CC, only 4.76% of farmers mentioned that this factor constitutes a real threat to the in situ conservation of Borgou cattle at a "Very strong" level. The other scores (1, 2, 3 and 4) were represented with 31.41%, 26.67%, 20.95% and 16.19% respectively. Among the respondents, 14.29% and 25.71% attributed scores 1 and 2 for LVF as a factor influencing the conservation of Borgou cattle and around 50% of the farmers shared their opinions for scores 2 and 3. A small proportion of respondents (9.52%) consider that this factor threatens the conservation of the Borgou cattle breed at a "Very strong" level in its natural biotope. As for RedPL in the areas where Borgou cattle are raised, few respondents (12.38% and 21.29%) consider that it constitutes an obstacle to the conservation of Borgou cattle at scores 5 and 4 respectively when considering the Likert scale. The farmers consider that PMgm practices can only threaten the protection of Borgou cattle lowly (39.05%) or very lowly (25.71%). Those who consider that this factor has a "medium" or "Very strong" influence are represented by 14.29% and 17.14% of farmers respectively.

Between-farmers' perceptions on threat levels from socio-environmental factors

The variations in threat levels from socio-environmental factors between groups of farmers are presented in Table 2. The Kruskal–Wallis test did not reveal any significant difference between the levels of threat recorded between farmers' groups for all the socio-environmental factors ($p > 0.05$) except for "Climate Change" ($p < 0.05$). All the scores were generally low for CC; however, the scores recorded were higher in LargeZB (median: 3 (1); mean: 2.82 ± 1.33) and lower ($p < 0.05$) in SIntPur (median: 2 (1.75); mean: 1.92 ± 1.14).

Overall functional traits in Borgou cattle within herding communities

The levels of appreciation of the functional traits of the Borgou breed according to the farmers are presented in Fig. 4. The most cited scores by farmers regarding draught aptitude in the Borgou breed were 5 (62.86%) and 4 (28.57%). Only a small minority of farmers gave small scores for this quality. This is the same for its resistance to disease and its adaptability to environmental conditions. Scores 5 and 4 were more represented for these two qualities. Around 50% of the farmers affirm that score 4 (49.52%) allows to better qualify the manure production in the Borgou breed while another group of farmers (45.71%) prefers the scale 5. On the other hand, scores 1 (very bad) and 2 (bad) were not cited in the assessment of manure in Borgou cattle. On the other hand, the selling price of Borgou cattle does not seem to be appreciated positively by farmers (only 1.9% for score 5 and 17.14% for score 4). The most represented score is 2 (bad) with 43.81%. Other farmers (23.81%) nevertheless considered that its selling price is acceptable (score 3). As for the ValFR, farmers estimated that this quality

Table 2 Threat level from socio-environmental factors according to groups of farmers

Threats	LargeZB (n = 23)	SedPur (n = 35)	SIntPur (n = 18)	SmallZB (n = 29)	Kruskal–Wallis test	p-value and S
LGBB	4 (2)[a] 3.42 ± 1.47	4 (1.5)[a] 3.50 ± 1.27	3 (3)[a] 3.35 ± 1.33	4 (3)[a] 3.57 ± 1.43	0.91529	0.8217 NS
LVF	3 (2)[a] 2.82 ± 1.12	3 (1.5)[a] 2.83 ± 1.26	3 (1.75)[a] 2.85 ± 1.09	3 (2)[a] 2.90 ± 1.25	1.2248	0.7471 NS
CC	3 (1)[a] 2.82 ± 1.33	2 (1)[a,b] 2.26 ± 1.17	2 (1.75)[b] 1.92 ± 1.14	2 (2)[a,b] 2.24 ± 1.11	5.2194	0.032*
Conflicts	2 (1)[a] 2.42 ± 1.25	2 (2)[a] 2.13 ± 1.07	2 (1.5)[a] 2.21 ± 0.89	2 (1)[a] 2.30 ± 1.18	1.9582	0.5811 NS
UCB	4 (2)[a] 3.64 ± 1.47	4 (1.5)[a] 3.86 ± 1.04	4 (1)[a] 3.85 ± 1.16	4 (2)[a] 3.96 ± 1.04	2.3018	0.5122 NS
LbShort	2 (3)[a] 2.46 ± 1.34	3 (1)[a] 2.53 ± 1.00	2 (2)[a] 2.07 ± 0.91	2 (1)[a] 2.12 ± 1.05	4.2287	0.2378 NS
PMgm	2 (2) 2.82 ± 1.51[a]	2 (1)[a] 2.10 ± 1.18	3 (2)[a] 2.42 ± 1.39	2 (2)[a] 2.54 ± 1.37	2.4218	0.4896 NS
RedPL	3 (2.5)[a] 2.78 ± 1.39	3 (2)[a] 3.00 ± 1.33	3 (1.75)[a] 2.64 ± 1.21	3 (2)[a] 3.12 ± 1.11	0.68523	0.8767 NS

Values in brackets are interquartile range (IQR)

SIntPur semi-intensive purebred Borgou cattle farming, *SedPur* sedentary purebred Borgou cattle farming, *LargeZB* large transhumant of Zebu and Borgou cross-bred cattle farming, *SmallZB* small transhumant of Zebu and Borgou cross-bred cattle farming, *S* significance, *LGBB* lack of good breeding bulls, *LVF* lack of veterinary follow-up, *UCB* uncontrolled cross-breeding, *PMgm* poor management, *RedPL* reduction of pasture lands, *LbShort* labour shortage, *CC* climate change

[a,b,c]The values on the same row with different letters are significantly different at 5%

*$p < 0.05$

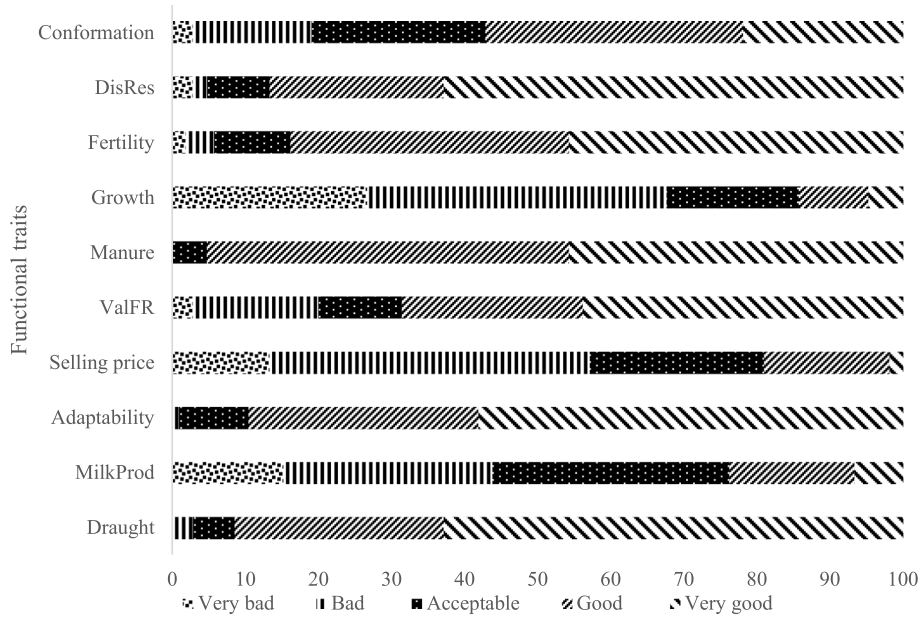

Fig. 4 Perceived functional traits in the Borgou cattle breed. DisRes disease resistance, MilkProd milk production, ValFR valorization of feed resources

can be rated as "Very good" (43.81%) and another group preferred to give a score of 4 (24.76%). The other scores were less represented. Almost two-thirds of the farmers shared their opinions in assigning scores 2 (40.95%) and 1 (26.67%) to denote that the Borgou cattle have a slow growth. Another proportion of farmers nevertheless considered that its growth is "acceptable" (18.1%). MilkProd was considered as "acceptable" for 32.38% of farmers and "bad" for 28.57% of respondents. Other farmers (15.24%) preferred to give score 1 to assess MilkProd in Borgou females. The fertility of Borgou females was rather well appreciated by farmers (45.71% for score 5 and 38.1% for score 4). Scores 1 and 2 were very poorly represented (1.9% and 3.81% respectively). The rest of the farmers (10.48%) thought that their fertility is "acceptable" (score 3). About one-fourth of farmers consider the "Conformation" of Borgou cattle is acceptable (score 3), while around one-third of farmers think that the conformation of these cattle deserves a score of 4. Another category of these farmers (21.9%) judge that the Borgou breed has a conformation that can be described as "Very good" and a small minority (2.86%) consider that it has a "Very bad" conformation.

Between-farmers' perceptions on functional traits in the Borgou cattle breed

The assessment of the functional traits of the Borgou breed according to the viewpoints of cattle farmers is presented in Table 3. Regarding the ten rated traits, only two (selling price and ValFR) showed a significant difference within the types of farmers according to the Kruskal–Wallis test. The scores obtained for selling price in SIntPur farmers (median: 2.5 (2); mean: 3.00 ± 0.96) and SedPur farmers (median: 2 (1); mean: 2.73 ± 0.86) were higher than those of the two other groups. These scores were lower in LargeZB farmers (median: 2 (1); mean: 2.03 ± 0.92). For ValFR, the scores were higher in LargeZB (median: 4 (1); mean: 4.28 ± 1.15) and SmallZB herders (median: 5 (2); mean: 4.03 ± 1.23) and lower in SIntPur farmers (median: 4 (3); mean: 3.28 ± 1.32).

Discussion

Cattle farmers' perceptions on threats from other cattle breeds

In this study, the results confirm the statements of Dehoux and Hounsou-Ve (1993) who already indicated that nearly 65% of cattle farmers in northeastern Benin introduced Zebu breeders into their herds. In addition, other authors (Alkoiret et al. 2009) spoke of the phenomenon of "zebunization" within farms to allude to the phenomenon of cross-breeding observed in cattle herds. This could be explained by the fact that these breeds are all Zebu and farmers prefer to use them for the improvement of conformation and growth performance of Borgou cattle. The high levels of influence of these Zebu breeds on the Borgou breed testify to the gradual replacement of the Borgou breed by cross-breeds within the cattle farms in the study area.

In this study, the highest frequencies for scores 1 and 2 are obtained for Somba, Ndama and exotic breeds (Gir or Girolando), and within each type of farmers, the

Table 3 Functional traits in the Borgou cattle breed according to groups of farmers

Traits	LargeZB (*n* = 23)	SedPur (*n* = 35)	SIntPur (*n* = 18)	SmallZB (*n* = 29)	Kruskal–Wallis test	*p*-value and S
Adaptability	5 (1)[a] 4.32 ± 0.90[a]	5 (1)[a] 4.53 ± 0.68[a]	5 (1)[a] 4.71 ± 0.46[a]	5 (1)[a] 4.42 ± 0.61	1.5799	0.6639 NS
Conf	4 (2)[a] 3.60 ± 1.28	4 (2)[a] 3.90 ± 0.95	3 (1.75)[a] 3.35 ± 1.21	3 (1)[a] 3.33 ± 0.92	6.8375	0.07726 NS
Growth	2 (1.5)[a] 2.32 ± 1.33	2 (1)[a] 2.33 ± 0.95	2 (1.75)[a] 2.14 ± 1.02	2 (2)[a] 2.15 ± 1.06	1.5784	0.6643 NS
Fertility	4 (2)[a] 4.07 ± 1.18	5 (1)[a] 4.40 ± 0.81	4 (1)[a] 4.35 ± 0.74	4 (1)[a] 4.12 ± 0.81	5.5863	0.1336 NS
Manure	5 (1)[a] 4.42 ± 0.69	4 (1)[a] 4.40 ± 0.49	4.5 (1)[a] 4.50 ± 0.51	4 (1)[a] 4.36 ± 0.60	3.4187	0.3315 NS
MilkProd	3 (1)[a] 2.42 ± 0.99	2 (1)[a] 2.83 ± 1.11	3 (2)[a] 2.92 ± 1.20	3 (2)[a] 2.75 ± 1.19	1.0597	0.7868 NS
Selling price	2 (1)[b] 2.03 ± 0.92	2 (1)[a] 2.73 ± 0.86	2.5 (2)[a] 3.00 ± 0.96	2 (1)[a,b] 2.48 ± 1.03	23.288	0.00831**
DisRes	5 (1) 4.78 ± 0.41[a]	5 (0.5) 4.36 ± 0.96[a]	4.5 (1)[a] 4.28 ± 0.82	5 (1)[a] 4.21 ± 1.19	1.8543	0.6032 NS
Draught	5 (1)[a] 4.39 ± 0.87	5 (1)[a] 4.60 ± 0.62	5 (1)[a] 4.21 ± 0.89	5 (1)[a] 4.66 ± 0.59	0.8221	0.8442 NS
ValFR	4 (1)[a] 4.28 ± 1.15	4 (2)[a,b] 3.66 ± 1.12	4 (3)[b] 3.28 ± 1.32	5 (2)[a] 4.03 ± 1.23	16.486	0.0486*

Values in brackets are interquartile range (IQR)

SIntPur semi-intensive purebred Borgou cattle farming, *SedPur* sedentary purebred Borgou cattle farming, *LargeZB* large transhumant of Zebu and Borgou cross-bred cattle farming, *SmallZB* small transhumant of Zebu and Borgou cross-bred cattle farming, *DisRes* disease resistance, *MilkProd* milk production, *ValFR* valorization of feed resources, *Conf* conformation

[a,b,c]The values on the same row with different letters are significantly different at 5%

*$p < 0.0$. **$p < 0.01$

scores recorded are all lower than the score 3 (median: 2). These results reveal that these breeds have very little influence on the Borgou breed and show that these breeds are very little exploited in cross-breeding with Borgou cattle on in situ farms. The farmers expressed that Somba and Ndama breeds are taurine breeds like the Borgou and even less productive. As a result, farmers find less interest in the use of these breeds for cross-breeding purposes given their low potential to improve the productivity of the Borgou breed. Comparative studies (Alkoiret et al. 2010) showed that abortion rates, perinatal mortality rates and overall pre-weaning mortality rates were higher in the Ndama breed compared to those in the Borgou breed. Other authors (Gbangboché and Alkoiret 2011; Alkoiret et al. 2016) also show that the Borgou breed has better milk and weight yields compared to Ndama. On the other hand, the reason is very different for the exotic breeds (Gir or Girolando). Farmers explained that exotic breeds had great potential to improve dairy and meat yields in Borgou cattle but are not viable in the natural environment of the Borgou breed. Such observations were made by Doko et al. (2010) who highlight the failure of the imported breeds to adapt to the environmental conditions of the Borgou breed. The Mbororo breed rather presents a moderate influence (higher frequency for score 3 and secondarily for score 4). This could mean that the influence of the Mbororo breed is less than that of Yakana, Goudali or Azawak breeds.

In this study, the medians obtained to compare the perceptions of farmers according to the types of farmers did not vary statistically for Goudali, Mbororo, Somba and Yakana breeds. In contrast, perceptions on threat levels were significantly different for Azawak, Ndama and exotic breeds depending on the type of farmers. The influence of the Azawak breed was much more marked among LargeZB farmers, less remarkable among SIntPur herders and intermediate in SedPur and SmallZB farmers. This could be linked to herd structures. A recent study on the four types studied (Worogo et al. 2019) showed that LargeZB farmers own the Azawak breed in their herds, unlike the other farmers. These farmers are thus likely to better perceive the influence of the Azawak breed in cross-breeding with the Borgou breed. As for the Ndama breed, although the scores were low (medians: 1 to 2), its threats were less perceived by SIntPur farmers. This could be explained by the fact that these farmers (belonging to the Okpara Breeding Farm) experienced the introduction of the Ndama breed (Youssao et al. 2000; Gbangboché and Alkoiret 2011) and that this breed is no longer present on that farm during the study period. The levels of threat from exotic breeds varied with the type of farmer. SedPur farmers perceive the influence of exotic breeds on the Borgou more weakly

compared to the other types of farmers. This could be explained by the production goals. In fact, SedPur farmers use the Borgou breed for draught purposes (Worogo et al. 2019) and this breed seems better suited for this type of production than imported breeds which are much more specialized for meat and milk productions.

Farmers' perceptions on the level of threats from socio-environmental factors

The lack of good breeding bulls and uncontrolled cross-breeding practices with other breeds presented high percentages for scores 4 (strong), 5 (very strong) and 3 (medium) unlike the other socio-environmental factors. This shows that these two factors have a determining role in the in situ conservation of Borgou cattle. Studies (Dehoux and Hounsou-Ve 1993; Dehoux and Verhulst 1994; Alkoiret et al. 2009) have also specified that it is often Borgou males that are the most replaced by the Zebu males in the herds. Farmers prefer to introduce Zebu males into Borgou herds to improve production and prefer to keep Borgou females in order to take advantage of the Borgou breed's good adaptation to environmental conditions, its better DisRes and its fertility. Thus, the practice of cross-breeding in Borgou herds is the consequence of the lack of good Borgou bulls among Borgou cattle populations. In this study, farmers perceive less the influence of factors such as LbShort, conflicts between crop farmers and cattle farmers, PMgm or even CC due to the higher frequencies for scores 1 (very low), 2 (low) and 3 (medium). The respondents mentioned that these factors are common to the farming of other cattle breeds sharing the same area with the Borgou breed and therefore less specifically linked to the Borgou breed. However, farmers asserted the need to take these factors into account in the in situ conservation processes of that breed. On the other hand, LVF and the RedPL seem to be more or less significant threats in the in situ conservation of Borgou cattle; scores 3, 4 and 5 are represented at approximately 60% for each of the two factors.

Threat levels did not show significant differences between types of farmers for factors such as LGBB, LVF, conflicts, UCB, LbShort, PMgm and RedPL. Only the scores obtained for CC showed significant differences between the types of herders. The medians were higher among LargeZB farmers and lower in SIntPur herders. This can be explained by the fact that LargeZB farmers are more inclined to adapt to CC due to their greater movements (longer distances and more frequent movements). This has become a recurring phenomenon since several authors (Ferner et al. 2018; Zampaligré and Fuchs 2019; Ouédraogo et al. 2021) mentioned that in several African countries, the fodder demand for cattle feeding is increasingly high and farmers are forced to practise more mobility to cope with the scarcity of fodder caused by climate change. As for SIntPur herders, they benefit more from the technical and financial support of State institutions and numerous studies aimed at describing or improving the zootechnical performances of the Borgou breed have been carried out in these herds (Youssao et al. 2000; Gbangboché and Alkoiret 2011; Worogo et al. 2018). In fact, through their works, we can notice that SIntPur farmers provide less effort to feed or care for their cattle compared to farmers of the other groups. This could therefore explain the fact that the influence of CC is less perceived by SIntPur farmers.

Functional characteristics of Borgou cattle within herding communities

In this study, ten functional characteristics of the Borgou breed were submitted to the cattle farmers for consideration. On these ten functional traits: draught ability, adaptability to environmental conditions, ValFR, manure production, fertility and DisRes each total between 65 and 95% of frequencies for the scores 4 (good) and 5 (very good). These high scores testify that these qualities are highly valued by farmers involved in Borgou cattle farming in its cradle. The other scores are hardly represented. However, MilkProd performance in Borgou cattle is not very appreciated by farmers. Indeed, scores 1 (very bad), 2 (bad) and 3 (acceptable) total nearly 75% of the percentages. Studies show that the milk production of Borgou females varies from 0.84 L (Dehoux and Hounsou-Ve 1993) to 2.4 ± 1.1 L per day (Sènou et al. 2008). These low productions could be one of the main reasons justifying the use of more productive breeds such as the Goudali breed, whose milk production is around 7 L according to Assani et al. (2015). As for the conformation of Borgou cattle, the perceptions of farmers seem to be divided between scores 3 (acceptable), 4 (good) and 5 (very good). In fact, the farmers surveyed expressed that the general conformation of the Borgou cattle does not present any major defects. In this study, statistical analyses showed significant differences only for scores related to the selling price and ValFR. The scores (selling price) were lower in LargeZB herders and higher in SedPur herders and those in semi-intensive systems. This could be explained by the fact that LargeZB farmers have heavier breeds (Zebu) in their herds and whose after-sale revenues are likely to be greater than those obtained from the sale of Borgou cattle. In addition, SedPur farmers mainly use the Borgou breed for animal traction (Worogo et al. 2019), and therefore, these farmers are likely to obtain animals that are well conformed and meet the specificities of animal traction when choosing animals. These animals can therefore be more prized and thus influence the

perceptions of farmers using the Borgou breed for draught purposes. In SIntPur, the animals benefit from food supplements and more adequate care, which is rather an advantageous factor in obtaining heavier Borgou animals.

Conclusion

This study reveals that the perceptions of cattle farmers vary with the type of threats and the functional traits considered. All types of farmers perceive the Zebu breeds to be more productive than the Borgou breed, and therefore, these are increasingly used to replace the Borgou breed by means of inter-breeding. However, all types of farmers recognize, in the Borgou breed, qualities such as good fertility, good adaptability to environmental conditions, resistance to disease, the valorization of food resources and its ability for draught. It would therefore be wise for farmers to benefit from technical support to improve the performance of Borgou cattle through selection and, in turn, to reduce genetic erosion in this breed. Given the diverse reasons that contribute to the abandonment and inter-breeding of the Borgou cattle breed and other breeds around the world, there would be interest to promote participatory situ conservation methods to maintain their integrity.

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Authors' contributions

HSSW contributed to the design, collection, analysis and interpretation of the data. He also wrote the manuscript. CCH, ASA, RI, CDAA and YI contributed to the design, collection, analysis and interpretation of the data. They read and approved the final manuscript. JSA, MA and BGCA contributed to the study design and read and approved the final manuscript. All authors read and approved the final version of the manuscript. ITA provided overall guidance on the data collection, analysis and drafting of the manuscript.

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Declarations

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This paper does not involve patient data or clinical studies, and the authors obtained informed consent from all the participants in the study.

Consent for publication

Yes

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The authors declare that they have no competing interests.

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