

How availability of NSAIDs and public perception matters in Vulture conservation in the Nilgiri biosphere reserve, South India: An overt and covert survey approach

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ABSTRACT

The vulture population in South Asia is under extinction threat due to the unprecedented use of the toxic non steroidal anti-inflammatory drug diclofenac for livestock treatment over the last few decades. The subsequent ban in countries including India had stabilized the population at the declining level of some species of vultures, even though it was slightly significant. All the earlier assessments in India had excluded the viable breeding population of south India, including the Nilgiri Biosphere Reserve, which comprises three states. To overcome the gap in these findings, we conducted repeated covert surveys for two years in six districts of three states covering the vulture foraging areas from the nearest nesting population in a 100 km radius to check availability, brands, secondary ingredients in formulations, whether bolus and injectable or both formulations of NSAIDs, and then documented. Apart from this we also had an open questionnaire survey during the second year with the pharmacy owners about their perception and attitude toward vulture conservation. The results are mixed, with some areas showing positive trends and other areas showing negative trends in NSAIDs and vulture conservation. Hence, we suggest the need for more corrective and legislative measures, including enforcement, that have to be strengthened.

Key words: Covert survey, Non-steroidal anti-inflammatory drug, Nilgiri Biosphere Reserve, Vulture.

Introduction

In south Asia, the decline of vulture populations has been catastrophic, reaching near-extinction status in recent decades, and the most affected were the Gyps species (Chaudhary *et al.*, 2012). The unintentional poisoning of vultures due to the usage of the non-

steroidal anti-inflammatory drug (NSAID) diclofenac (Shultz *et al.*, 2004; Green *et al.*, 2004) in cattle treatment is considered the main reason for the drastic decline of the population. The extensive usage of diclofenac to treat cattle in South Asia during the 1990s and 2000s is well understood now (Schultz *et al.*, 2004; Prakash *et al.*, 2007). In India, the

population of White-rumped Vulture *Gyps bengalensis* had declined by 99.9% since the early 1990s, and that of Indian Vulture *Gyps indicus* and Slender-billed Vulture *Gyps tenuirostris* had declined by 96.8% (Prakash *et al.*, 2007). Vultures that scavenge on the carcasses of livestock and pets treated with diclofenac died within a few days due to kidney failure, as evidenced by macroscopic signs of extensive visceral gout at post-mortem examination (Oaks *et al.*, 2004; Swan *et al.*, 2006).

The drug diclofenac was banned in India for veterinary purposes in 2006 (Prakash *et al.*, 2007). This had a positive impact on the vulture population (Cuthbert *et al.*, 2014 a), as the proportion of vultures in the wild with diclofenac residues in animal carcasses sampled showed a small but significant decline after the ban (Cuthbert *et al.*, 2016). Cuthbert *et al.*, (2011) evaluated the provision of NSAIDs for livestock in pharmacies selling veterinary drugs in India and discovered that many were stuffing and selling human dosage forms of diclofenac for unauthorised use in cattle. Due to the illegal availability of these banned drugs and their use in livestock treatment, the carcasses of many cattle were still found with diclofenac residues (Cuthbert *et al.*, 2014 a), dead vultures were still found with diclofenac residues and visceral arthritis (Cuthbert *et al.*, 2015), and vulture populations had not recovered strongly (Prakash *et al.*, 2017). However, a census of the vulture population in Nepal and Pakistan shows a decline after the ban on veterinary diclofenac (Chaudhry *et al.*, 2012; Galligan *et al.*, 2019).

Several NSAIDs are commonly used in livestock in India and are toxic to *Gyps* vultures. Other NSAIDs that kill vultures include aceclofenac, which metabolizes to diclofenac in cattle (Galligan *et al.*, 2016), ketoprofen and carprofen (Naidoo *et al.*, 2018), and nimesulide and flunixin (Zorrilla *et al.*, 2014). Meloxicam is currently the only drug that is safe for vultures (Swan *et al.*, 2006; Prakash *et al.*, 2012). The incidence of diclofenac in animal carcasses in India has been greatly reduced, whereas the incidence of meloxicam has increased significantly (Cuthbert *et al.*, 2014 b). Furthermore, Tolfenamic acid has recently been identified as another safe drug for vultures (save-vultures.org).

Diclofenac is still legally available for human usage in large Vials (>3ml). These drugs, with sufficient dosages, are misused for veterinary purposes by many local pharmacies. A study was conducted

in India to assess the availability of various NSAIDs, mostly restricted to a few regions of west, north, central, and east India (Cuthbert *et al.*, 2014 b). There is no scientific evidence that NSAIDs are available in South Indian pharmacy stores which is a huge gap for vulture conservation efforts in the region. We conducted covert vulture surveys in six districts in the Nilgiris Biosphere Reserve (NBR) region, primarily in the foraging area. In the NBR, this area has a viable breeding population of vulture species. An overt survey was also employed to assess the awareness and perceptions about vulture conservation among veterinary pharmacists. The survey was conducted with the following objectives: 1. to assess the availability of common NSAIDs (Diclofenac, Meloxicam, Aceclofenac, Nimesulide, and Flunixin). 2. to investigate the availability of lesser-known NSAIDs. 3. NSAID ingredients in addition to the primary ones 4. Pharmacists' perceptions of NSAIDs

Materials and Methods

The Study area

The Nilgiri Biosphere Reserve (NBR) is the first and foremost biosphere reserve in India established in the year 1986. It is located in the western Ghats and includes 2 of the 10 biogeographical provinces of India. Wide ranges of ecosystems and species diversity are found in this region. The total area of the NBR is 5,520 sq.Km (Puyravaud and Davidar, 2013). It is located 76°- 77°15'E and 11°15' - 12°15'N. The NBR encompasses parts of the states of Tamilnadu, Kerala, and Karnataka. Seven vulture species were found in the NBR. Out of seven vulture species, four are resident: the Egyptian Vulture *Neophron percnopterus*, The Red-headed Vulture *Sarcogyps calvus*, the White-rumped Vulture *Gyps bengalensis*, and the Long-billed Vulture *Gyps indicus*, and three are migrants, the Cinereous Vulture *Aegypius monachus*, the Himalayan Griffon Vulture *Gyps himalayensis*, and the Eurasian Griffon Vulture *Gyps Fulvus*.

Repeated covert surveys were done in pharmacies of vulture safe zones (VSZ) in south India, covering six districts for two years. The survey was conducted from October to December 2019 and November to December 2020. VSZ are defined as areas with a radius of 100 km from the vulture nesting colony (over 30,000 km²), with the first 50 km as the core

zone and the next 50 km as the buffer zone (SAVE 2014). The VSZ is centered on at least one of the four critically endangered vulture colonies in the area. The covert surveys were done in the core zone, which consists of five districts (Nilgiris, Erode, Tiruppur, and Coimbatore in Tamil Nadu, and Chamraj Nagar in Karnataka). The Waynad district in Kerala, which is in the buffer zone, was the second survey area (Figure 1).

In 2019, a covert survey of 280 pharmacies was done in core zones, cities, towns, and villages. During this, each pharmacy's name, address, and geographical coordinates were documented from the vehicle, and a repeated survey was done the following year. (Cuthbert *et al.*, 2011). In the first year of the survey, 54 veterinary pharmacies were located. In NBR, drugs intended for animals and humans are often sold in the same shops. Local men and livestock owners were employed covertly with already used old medicine boxes (diclofenac, ketoprofen, aceclofenac, and nimesulide) to approach pharmacy shops under the pretext of treatment for sick cattle to check the availability of NSAIDs in the market. The type of compound (the active NSAIDs within the compound) and brand names, as well as whether the drug is injectable or bolus, were all gathered. Manufacturing dates and prices of every available NSAID were collected in the process. Some of the volunteers even worked in pharmacies for a short time to gather reliable information about the toxic drugs being sold. This covert survey was repeated in 2020. An open questionnaire

survey to understand pharmacists' awareness was carried out in the second year (Table 3).

Statistical Analysis

Statistical analyses were performed using a Windows based statistical package, *viz.* Microsoft Excel and SPSS (Statistical Package for Social Science: Nie *et al.*, 1975). The NSAIDs' available data were converted into percentages, and a logistic regression model analysis was done. For hypothesis testing, $P < 0.05$ and $P < 0.01$ were considered, and these levels of significance are indicated as appropriate. The non-parametric test used was the Chi-square test for testing the association between variables in human perception.

Results and Discussion

Repeated covert surveys for NSAIDs in the vulture safe zone area documented 280 pharmacy shops, of which 56 were veterinary stores and the rest human drug stores. When an NSAID was available, it varied slightly between 2019 (49%) and 2020 (51%). The availability of the banned drug diclofenac was found in the pharmacy shops of Erode (Tamil Nadu) and Chamraj Nagar (Karnataka) districts in 2019 at 2% each ($n = 1$). During 2020, the drug was available only in Chamraj Nagar district at 2% ($n = 1$) (Figure 2). Six districts revealed a significant difference ($b = -3.277$, S. E = 0. 509, $df = 1$, $p < 0.0001$) (Table 2).

During the surveys, we found that another mostly available NSAID was Meloxicam. In 2020,

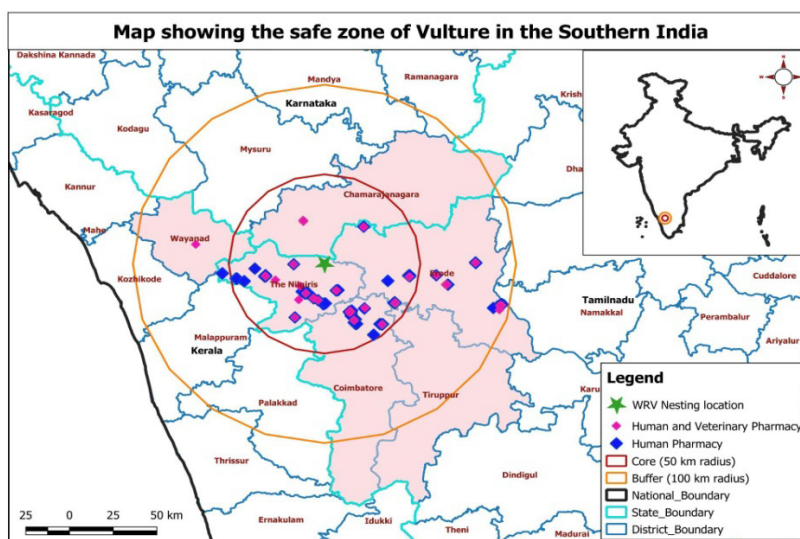


Fig. 1. Map of the study area.

Table 1. The number of brands of NSAIDs in oral and injectable formulations from six districts (2019 and 2020); Paracetamol was a second active ingredient in the brands in parentheses.

Active ingredient	Bolus	Injectable	Total
Tolfenamic acid		1(1)	1(1)
Meloxicam	4(2)	6(2)	10(4)
Diclofenac	3(1)	2(1)	5(2)
Ketoprofen	2	2	4
Aceclofenac	1(1)	1	2(1)
Flunixin		1	1
Ibuprofen	3(2)		3(2)
Nimesulide	6(1)	1	7(1)
Paracetamol		1	1
Analgin	2(1)	1(1)	3(2)
Total with paracetamol as secondary compound	21(8)	16(6)	37(14)

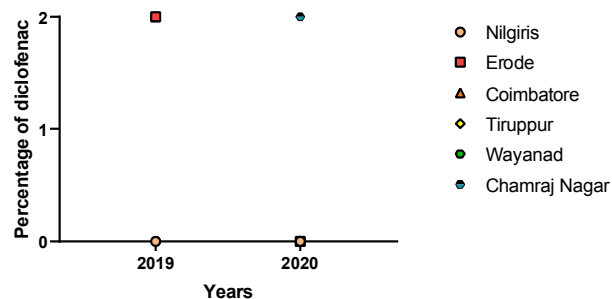


Fig. 2. Availability of diclofenac in the pharmacies in the Vulture habitat

Erode district had the highest availability of Meloxicam (29.63%, $n = 16$), followed by Coimbatore (22.22%, $n = 12$) and Nilgiris (18.52%, $n = 10$). Tiruppur (16.67%, $n = 9$) had the highest percentage in 2019, followed by Chamraj Nagar (9.26%, $n = 5$) in both years and Wayanad (7.341, $n = 4$) in both years. There is a significant difference in six districts ($b = 1.7771$, $S.E = 0.270$, $df = 1$, $p < 0.0001$) (Table 2) (Figure 3).

The Nilgiris and Erode districts had the highest availability of the drug ketoprofen (20.83%, $n = 5$) in

Table 2. Availability of various NSAIDs in veterinary pharmacies in the NBR (2019 and 2020)

NSAIDs	B	S. E	Df	Sign
Diclofenac	-3.277	.509	1	.000
Meloxicam	1.771	.270	1	.000
Aceclofenac	-.368	.194	1	.058
Nimesulide	-.223	.194	1	.249
Flunixin	-.521	.197	1	.008

B- (Beta), S.E - Standard Error, Df- Different

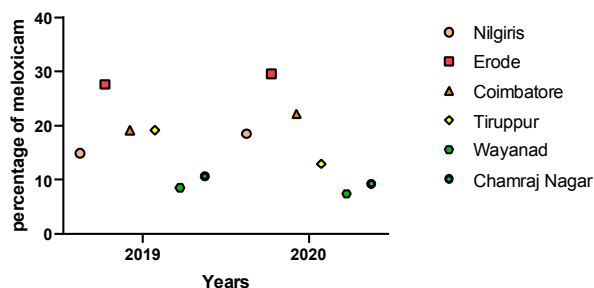


Fig. 3. Availability of Meloxicam in the pharmacies in the Vulture habitat

the 2020 survey, followed by Coimbatore, Tiruppur, Chamraj Nagar, and Wayanad districts, each with $n = (4)$ (Figure 4). Statistics show that there is no statistically significant difference between the six districts ($b = -3.68$ S.E. = 194, $df = 1$, $p > .058$) (Table 2).

In 2019, Coimbatore (226.67%, $n = 8$) had the

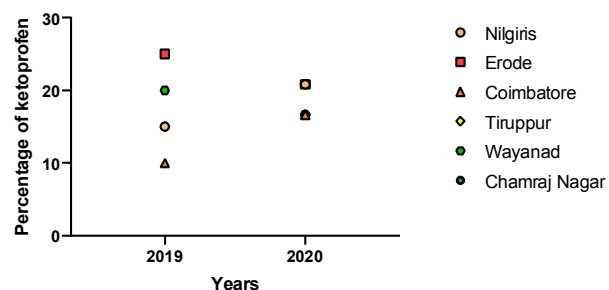


Fig. 4. Availability of Ketoprofen in the pharmacies in the Vulture habitat

highest availability of the medication nimesulide, followed by Erode (20%, $n = 6$), Tiruppur (16.67%, $n = 5$), Chamraj Nagar (16.67%, $n = 4$), and Wayanad (6.67%, $n = 2$). (Figure 5). The differences between the six districts are not statistically significant ($b = -223$, $S.E = 0.194$, $df = 1$, $p > .249$) (Table 2).

Aceclofenac, another NSAID, was commonly

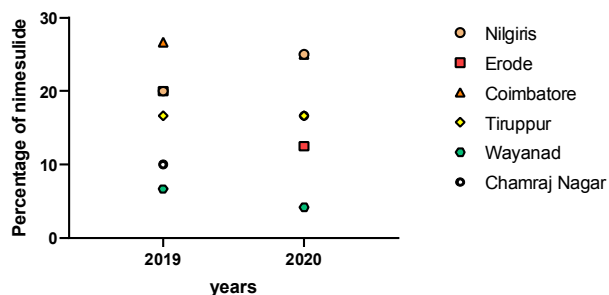


Fig. 5. Availability of Nimesulide in the Pharmacies in the Vulture Habitat

available in the shops. Aceclofenac was found in the highest concentrations in Erode (50%, $n = 11$) and Coimbatore (22.73%, $n = 5$), both in 2020. In 2019, Tiruppur, Nilgiris (16.67%, $n = 4$) and Chamraj Nagar (8.33%, $n = 2$) had the highest availability of aceclofenac. But this drug was not available in any pharmacy shop in the Wayanad district in the 2020 surveys (Figure 6). There are no statistically significant differences between the six districts ($b = -521$, $S.E = 0.197$, $df = 1$, $p > .008$) (Table 2).

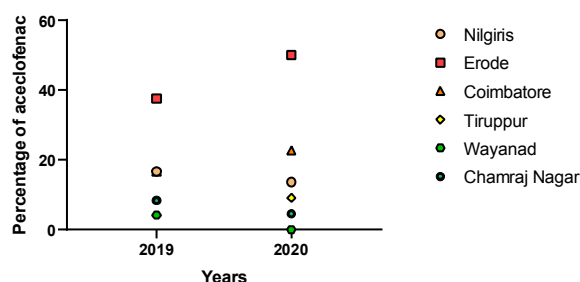


Fig. 6. Availability of aceclofenac in the pharmacies in the vulture habitat

Additionally, there are NSAIDs like Flunixin, Tolfenamic Acid, Ibuprofen, and Analgin. Pharmacies' accessibility to these drugs was also investigated in the study area. In 2019, the shops in the Erode district sold the most other NSAIDs (29%, $n = 14$). In 2020, the maximum number of available districts was Coimbatore (26%, $n = 133$), Nilgiris (18%, $n = 9$), and Tiruppur (14%, $n = 7$). Other NSAIDs were available in pharmacies in Wayand and Chamraj Nagar districts in both years (8.51%, $n = 4$). (Figure 7).

In the survey results across six districts, 21 bolus brands and 16 injectable brands of NSAIDs were recorded from pharmacies that made them available for sale to treat livestock. Meloxicam, diclofenac, nimesulide, and flunixin were the NSAIDs with the greatest number of manufacturer's brands. A total of ten types of NSAIDs were found on sale: aceclofenac, analgin (also known as metamizole),

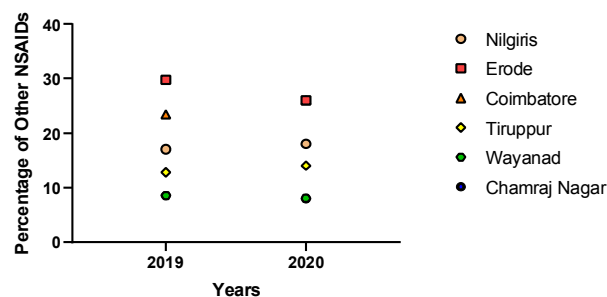


Fig. 7. Availability of Other NSAIDs in the pharmacies in the Vulture habitat

diclofenac, flunixin, ibuprofen, ketoprofen, olfenamic acid, meloxicam, nimesulide, paracetamol (also known as acetaminophen), and piroxicam. The majority of NSAIDs on the market contain more than one active ingredient. The most commonly used secondary ingredient was paracetamol. According to the surveys, it was found in 65% of boluses and 20% of injectable formulations. This includes drugs like Nimesulide, Diclofenac (in bolus forms), and Meloxicam (in bolus and injectable forms), which were the common ones available in shops with paracetamol combinations. Two brands of diclofenac alone or combined diclofenac and paracetamol were found in the survey, including 16 brands of boluses and 26 brands of injectables. Diclofenac, the most used drug, had two injectable brands available on the market that were meant for human use but sold for veterinary treatment (Table 1).

The median number of brands per compound held by each pharmacy that sold NSAIDs was one, with only meloxicam and meloxicam plus paracetamol boluses being sold by more than one pharmacy. Among the pharmacies selling meloxicam, 72% sold both injectable and bolus forms, with 17% selling only bolus formulations and 1% only injectable formulations. This is followed by Nimesulide-selling pharmacies that sold 65% bolus formulation, 23% injectable formulation, and 12%

Table 3. The perception of vulture conservation among pharmacy shops keepers of all six districts

Questions related to vulture conservation	Yes		No		Not Reported	
	N	%	N	%	N	%
Do you know Toxic effect of Diclofenac in Vultures	110	39.29	105	37.50	65	23.21
Do you know about other harmful NSAID to vultures	86	30.71	139	49.64	55	19.64
Are vultures declining in your location	139	49.64	83	29.64	58	20.71
Are vultures beneficial to humans?	116	41.43	85	30.36	79	28.21

both injectable and bolus forms. Paracetamol sold in pharmacies comes in both injectable and bolus forms, with 63% in injectable and bolus and 37% in bolus-only form. Analgin was sold by pharmacies that sold 46% of the bolus formulation, 31% of the injectable formulation, and 23% of them sold both injectable and bolus forms. In pharmacies, ibuprofen was sold in 67% bolus formulations and 33% injectable and bolus forms. The pharmacies that sold Flunixin had 82% of both injectable and bolus forms and 18% of injectable formulations. Aceclofenac was sold in stores in 63% injectable and bolus forms and 3% bolus formulations alone. In addition, 67%, 57%, and 40% of pharmacies sell Diclofenac and Ketoprofen in injectable and bolus formulation respectively. Diclofenac (37%) was sold in injectable formulations, while tolfenamic acid was available at a few pharmacies in both injectable and bolus forms (Figure 8).

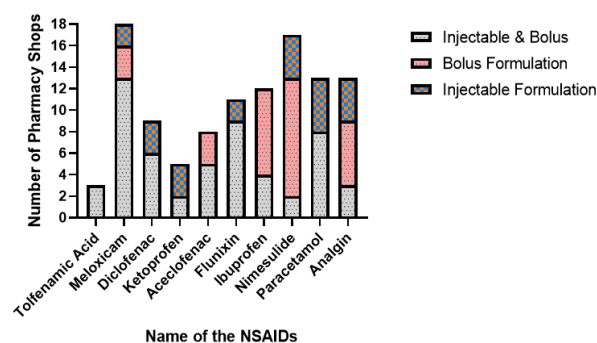


Fig. 8. Prevalence of NSAIDs in pharmacy shops in all districts surveyed, holding only injectable formulations, only bolus formulations, or both

A straightforward survey was done with pharmacy owners regarding vulture conservation, and the results are tabulated (Table 3). Most pharmacists (39.29% of them) are aware of diclofenac, a dangerous drug for vultures. A hundred and thirty-nine pharmacy keepers do not know about other harmful drugs such as Aceclofenac, Nimesulide, Flunixin, and Ketoprofen. Likewise, 49.64% are of the opinion that vulture numbers are declining in the NBR. Surprisingly, 30.36 percent of pharmacists believe vultures are harmful to humans.

A dichotomized scale survey was used to test the key predictors of respondents' perceptions of vulture conservation in the NBR. One of the key findings was that female respondents are more positive (58.04%) toward vulture conservation compared to

male respondents (41.06%) ($\chi^2 = 76.192$, $p < 0.001$). Among the districts that favoured vulture conservation, Nilgiris (33.1%) stood first. Statistically, a significant difference exists among districts. (Chi-Square 113.093, $df = 15$, $p < 0.000^{*b}$). On a demographic scale, the younger generation's positive attitude towards vulture conservation shows a significant difference among age groups. (Chi-Square - 158.569, $df = 6$, $p < 0.0001$). Educational degree wise, respondents with a B. Pharm (pharmacy-based) degree (74.6%) have a highly positive attitude toward vulture conservation, which is a significant (Chi-Square - 125.741, $df = 9$, $p < 0.0001$) difference between other education categories. Pharmacy owners with ten or more years of experience (42.1%) supported vulture conservation. Other experience categories varied significantly. (Chi-Square - 154.993, $df = 6$, $p < 0.0001$) (Table 4).

In 2016, the Indian government imposed stricter regulations on diclofenac. The ban also affected the manufacture of human formulations in vials larger than one human dose (3 ml). Two Indian pharmaceutical corporations immediately challenged the restriction, but the Madras High Court upheld it in 2017 (Galligan *et al.*, 2020). The findings of the repeated covert survey are discussed based on the availability of drugs on the market—the most widely available, least-known, and safest drugs. The overt survey covering pharmacists' attitudes toward various NSAIDs and vulture conservation in the region is also done separately to understand the human side.

Commonly available NSAIDs

Several NSAIDs are commonly available from the pharmacy shops in all six districts. Most of them that are toxic to vultures include nimesulide, ketoprofen, flunixin, aceclofenac, and phenylbutazone, with nimesulide being the most prominent. These findings corroborate those of the earlier ones (Cuthbert *et al.*, 2015; Phuyal *et al.*, 2016). Ketoprofen was widely available in all six districts. This drug is toxic to vultures and has been reported in livestock carcasses in India (Naidoo *et al.*, 2018; Taggart *et al.*, 2006). They existed as two brands in the market: two boluses and two injections. Aceclofenac was available in both bolus and injection forms with separate brand names in all districts. This drug has a similar structure to diclofenac and is metabolized into it in cattle, making it toxic to vultures (Sharma 2012; Galligan *et al.*, 2016). Galligan *et al.* (2016) re-

ported evidence of high residues of diclofenac in cattle tissues shortly after aceclofenac injections. The vulture population in NBR could be negatively impacted if the sale of aceclofenac is increased. Flunixin was sold in pharmacies with only one injectable brand and may be toxic to scavenging birds (Cuthbert *et al.*, 2015). Residues of this drug were reported from dead Eurasian Griffon Vultures *Gyps fulvus* in Spain (Zorrilla *et al.*, 2014) and from two captive Ruppell's Vultures *Gyps rueppellii* and one captive African White-backed Vulture *Gyps africanus* (Eleni *et al.*, 2019).

Even though these NSAIDs are widely available in pharmacies, nothing is known about their safety or toxicity. The safety or toxicity of paracetamol (acetaminophen) to vultures and other scavenging birds is unknown, but this compound is frequently used in combination with other drugs, both injectable and bolus formulations of meloxicam, in veterinary pharmaceuticals. Aceclofenac, flunixin, and phenylbutazone are usually available at low prevalence, but several are known or suspected to be toxic to vultures. These drugs are available in both injectable and bolus forms. As several formulations are already available, it could become a major veterinary drug in the future (Galligan *et al.*, 2020).

Less commonly available NSAIDs

The banned drug diclofenac was available in the

districts of Chamraj Nagar and Erode, but only in the former in the follow-up, repeat survey. We recorded diclofenac on sale for veterinary use in 2% of pharmacies. The presence of these drugs, even if in fewer shops, is a cause for concern since diclofenac was banned nationally a long time ago. Cuthbert (2011) reported the wide availability of diclofenac despite national legislation to ban its veterinary use. According to Phuyal *et al.* (2016), veterinarians disclosed that local residents persist to prefer diclofenac because they believe it is less expensive and more efficient than most other NSAIDs. But our present study found that the sale of diclofenac has been on the decline in NBR. All the injectable formulations of diclofenac offered for sale in NBR were for human use, and therefore the manufacture was legal. However, they were being offered for sale for veterinary use (Cuthbert *et al.*, 2011), which is illegal, with two bolus brands and one injectable brand found manufactured after the 2006 ban. The illegal sale of diclofenac is a major concern, we found no evidence that any compounds were mislabelled by manufacturers, as would occur if manufacturers were trying to sell old stocks of diclofenac as another drug. The slow process of ban implementation and the availability of diclofenac in veterinary pharmacies is the probable cause of the decline in the prevalence and concentration of diclofenac in cattle carcasses since 2006 (Cuthbert *et al.*, 2014 a).

Table 4. The relation between socioeconomic factors and conservation attitudes of the local pharmacy keeper on vulture conservation

Factors	Categories	No	Not Reported	Yes	Chi-Square	df	Sig
Gender	Female	79.4%	89.8%	58.4%	94.759	3	.000*
	Male	20.6%	10.2%	41.6%			
District	Chamraj Nagar	5.2%	7.6%	5.6%	113.093	15	.000* ^b
	Coimbatore	35.6%	47.5%	23.6%			
	Erode	19.6%	9.3%	21.3%			
	Nilgiris	18.6%	10.2%	33.1%			
	Tiruppur	19.6%	22.9%	14.6%			
	Wayanad	1.5%	2.5%	1.7%			
Age	18-30 Years	66.0%	37.3%	78.1%	158.569	6	.000*
	30-50 Years	8.2%	29.7%	6.2%			
	Above 50 years	25.8%	33.1%	15.7%			
Education	B.Pharm	6.7%	9.3%	6.2%	125.741	9	.000*
	Post Graduate	55.2%	74.6%	39.3%			
	Secondary School	12.9%	0.0%	24.7%			
	Under Graduate	25.3%	16.1%	29.8%			
Experience	1-5 Years	13.4%	0.0%	25.3%	154.993	6	.000*
	6-10 years	35.1%	19.5%	42.1%			
	Above 10 years	51.5%	80.5%	32.6%			

Meloxicam and the safe drugs

Our findings revealed a positive trend towards the availability of the vulture safe drug meloxicam in the six districts. Sales of meloxicam increased in all areas, and it was the most common drug sold in pharmacies with four boluses and six injectable brands purchased in our covert survey. This is important since, during the ban period of 2006, only two companies were manufacturing veterinary meloxicam in India (Swan *et al.*, 2006b). Meloxicam is the only NSAID that has been proved through safety testing (Swan *et al.*, 2006b; Swarup *et al.*, 2007) to be non-toxic to Gyps vultures at doses they are likely to be exposed to in the wild. The role of conservationists in India in the promotion of meloxicam as the only safe NSAID for treating livestock that is harmless to vultures.

The recently identified one more safest and non-toxic drug for vulture tolafenamic acid which is used for livestock treatment particularly in the vulture foraging zone of NBR. This drug would provide an additional alternative alongside meloxicam.

How does human perception affect the use of NSAIDs?

The experienced pharmacy shop's owners in NBR who run shops for more than ten years were well aware of the ban of diclofenac and other banned drugs and their effect on the vulture population compared to less experienced ones. This is because only a few of those who are employed in medical shops are B. Pharm (pharmacy) educated. On the contrary, the ones with less awareness lack proper science based education there and had degrees like BBA (administration), BCom (commerce and finance), and 12th (high schools) graduates. Females in general were more empathetic to vultures than men, which is a general trend everywhere. Among the districts, Nilgiris pharmacists were keen on vulture conservation as other district shopkeepers were mostly not aware of other harmful drugs for vulture such as Aceclofenac, Nimesulide, Ketorolac and Flunixin. One of the major reasons for this could be the increased exposure of the Nilgiri region to Vulture conservation efforts both by the forest department and the non-governmental organisations. Some past studies had emphasized the need of environmental education involving people for conservation (Heinen 1998, Emtage 2004).

Conclusion

To conclude, this study has documented baseline data of the wide range of NSAIDs available in veterinary pharmacies in the study area. We recommend that continued monitoring and awareness for pharmacies, shop owners and labourers should be undertaken in the same areas to evaluate the future availability of NSAIDs across southern India. To prevent the misuse of these compounds, establishing the safety or toxicity of other NSAIDs is a priority, along with action against pharmaceutical companies, pharmacies that are breaking the law, and legal restrictions on the size of vials of diclofenac manufactured for human use. Green *et al.* (2004) stated that based on demographic modelling, it has been established that less than 1% of a lethal level of diclofenac can reason a hasty population crash to the vulture population. Therefore, educating livestock holders, farmers and veterinary personnel may help to secure healthy food for vultures. A long-term solution would be the incorporation of environmental education in schools and colleges and paying more compensation for livestock kills to secure the country's southernmost vulture population. In addition, adequate cattle tissue samples need to be tested both qualitatively and quantitatively in order to support the prevalence of NSAIDs in a 100 km radius of the vulture habitat.

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