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# *PRIMATES' RECEPTION AND DESTINATION BY THE WILD ANIMAL SCREENING CENTER IN BELO HORIZONTE, MINAS GERAIS: MANAGEMENT AND CONSERVATION CONSEQUENCES*

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## Abstract

Wildlife is threatened primarily by habitat loss and trafficking. The Wild Animal Screening Centers emerged in this context for animal rehabilitation victims of anthropic actions. This research aimed at describing temporal, spatial, and taxonomic patterns of primates' reception and destination by the Wild Animal Screening Center in Belo Horizonte-MG to assist their management process and mitigate the effects of illegal trafficking. From 1992 to 2021, 1,895 primates of ten genera and twenty two species arrived at the Wild Animal Screening and Rehabilitation Center. *Callithrix* was the most frequent genus (n=1,586). Primates came from 92 cities (Belo Horizonte city concentrated 44.9% of this total) in Minas Gerais as well as from Goiás, Amazonas, Ceará, Bahia, and Rio de Janeiro states. The main way animals were received was by collection (n=1,135), followed by voluntary delivery (n=500) and apprehension (n=210). Death (n=100) and release (n=98) destinations were higher when compared to the animals sent to another captivity (n=26). The highest number of primates received (n=127) at this center was in 2008, while the lowest number of them (n=6) was recorded in 2001. Most primates arrived in good body condition (n=108). Individuals with better body conditions spent less time at the Wild Animal Screening and Rehabilitation Center ($X^2$ = 21.684, p=0.00001956). There was also an association between body condition and schemes of destination ($X^2$ = 37.095, p= 0.0000001722). On the other hand, variables such as body condition, sex, origin, and distance from where they came did not influence on the length of stay of individuals at the Wild Animal Screening and Rehabilitation Center (rho=0.1281706; p= 0.07644). The results reinforce the importance of these Centers for wildlife, including primates. They also point out the importance of several actions on different fronts to reduce the trafficking pressure, such as investments in environmental education and science, creation of new wildlife projects, changes in legislation, and more inspection activities.

**Keywords:** Conservation. Ex-situ management. Illegal trade. Wildlife.

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# 1 Introduction

There is a great demand worldwide regarding the illegal trade of wild animals. Thus, it has been recorded as the second highest threat to populations of different species (SAS-ROLFES et al., 2019). The introduction of exotic species, spread of zoonoses, economic losses and ecological damage take part as the main consequences of wildlife trafficking (CHARITY; FERREIRA, 2020).

It is estimated that around 40 million animals are sold illegally per year in Brazil (CHARITY; FERREIRA, 2020; RENCTAS, 2001), and one of the most affected groups are non-human primates (ESTRADA et al., 2018). They are illegally traded, especially, for meat consumption and to keep them as pets in the domestic market (FILHO et al., 2021; OLIVEIRA; DE FREITAS TORRES; DA NÓBREGA ALVES, 2020). People wish having primates at home due to their culture, economic issues and because they want to expose those animals in social media (FUENTES; CORTEZ; PETERSON, 2016; RIDDLE; MACKAY, 2020).

Primates apprehended by inspection agencies are sent to the Wildlife Reception, Screening and Rehabilitation Centers (CETAS) (IBAMA, 2015). Although CETAS have been working since the 1970s, they were standardized only in 2008. The same year when the Wild Animal Rehabilitation Centers (CRAS) were created (IBAMA, 2008). Such places are regulated by two Normative Instructions (April 7, 2015 and May 13, 2021) of the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) (IBAMA, 2015, 2021). There is also the Resolution of the National Council for the Environment (CONAMA) that conceptualizes CETAS and CRAS as "places that are capable of receiving, identifying, marking, sorting, evaluating, recovering, rehabilitating and disposing of specimens from both wild fauna and exotic fauna" (CONAMA, 2018a).

In addition to assisting victims of trafficking, CETAS/CRAS are equally important to help synanthropic fauna, such as primates. They still exist in urban parks and rural areas and come into conflict with humans for food resources and space (KÖNIG et al., 2020; SANTINI et al., 2019). There are 65 CETAS in Brazil, in all states, except Rondônia (NEWS, 2021; RENCTAS, 2016). Minas Gerais has five of these Centers, and the oldest and most important was created in Belo Horizonte city in 1992.

There has been information recorded by receiving animals and their destination to CETAS-BH for 30 years. However, the research that analyze such data over this long term are scarce, especially if they are focused on a particular group, such as primates.

Currently, people's interest in having primates as pets has increased, so, CETAS can provide important information to help combatting wildlife trafficking (OLIVEIRA; DE FREITAS TORRES; DA NÓBREGA ALVES, 2020). The analysis of a large number of data also allows assessing the most used routes for trafficking and people's profile, involved in this crime (RENCTAS, 2016). This diagnosis is fundamental to get acquainted with the most trafficked and collected species. This is also important to make decisions that can positively influence animal welfare management and promotion (BROWNING; VEIT, 2021).

This research can be also useful in animal preservation programs and to improve that different primate species can be released (OKLANDER et al., 2020). Ultimately, primates have the potential to be ambassadors of environmental education actions against the effects of trafficking (CHAPMAN et al., 2020). Since they are considered charismatic and are a great group to be inserted in activities of sensitization and awareness, sponsored by environmental agencies (BOWEN-JONES; ENTWISTLE, 2002). Thus, this research aims at describing temporal, spatial and taxonomic patterns of receiving and destination of primates sent to CETAS of Belo Horizonte (MG) to assist animals' rehabilitation and mitigate illegal trafficking.

It aims specifically at identifying primates' genera and species that are received, as well as record how they are received, their destination, and when primates were most received concerning the years. It also aims at drawing a map to inform primates' origin, as well as verifying how long it takes to arrive at their destination and their body conditions, when they arrive.

For such purposes, the following hypotheses are: (i) *Callithrix* and *Sapajus* genera will be the most received ones; (ii) primates will arrive at CETAS, predominantly, by collection; (iii) and primates' main scheme of destination will be by releasing; (iv) there will be some changes in the number of primates received by the Center over the years; (v) more primates will arrive from Belo Horizonte and nearby cities than from other places; (vi) individuals with better body condition will spend less time at the Center; (vii) Release will be the main scheme of destination of primates, with good body condition.

# 2 Methods

## Study Area

This research was carried out at the Wildlife Reception, Screening and Rehabilitation Center of Belo Horizonte (CETAS-BH), Minas Gerais, Brazil. The CETAS has been working since 1992 under IBAMA's management. In 2006, it underwent a renovation to expand the structure in order to offer better conditions to the animals.

In 2013, due to the Complementary Law no 140, the management was shared with the State Forestry Institute (IEF) (BRASIL, 2011).

Regarding the physical structure, the CETAS-BH is composed of a room to receive puppies, a ward, a necropsy room, a veterinary clinic and a room for mammals. There is also a sector for birds of prey, a kitchen, a quarantine area, a pond for reptiles, eight collective enclosures and an administrative room. There are two biologists, six veterinarians, six attendants, two scholarship interns and volunteers in this team, but this number changes seasonally. There are some activities being carried out: environmental enrichment, physical and chemical containment, reception, marking of animals, their release, feeding management, neonatal care, veterinary care, environmental education and laboratory routine. There is a partnership and support from the Wild Animal Rehabilitation Center (CRAS) in Nova Lima city, which has its own team of keepers and 14 enclosures. They are usually used for large mammals, chelonians and parrots.

## Data collection

The records and spreadsheets of reception in which some genus or species of primate were included were analyzed to carry out this research. From 1992 to 2012, there were only records from IBAMA. From 2013 to 2021, the records and spreadsheets from IEF were also analyzed. Records from 2013 to 2021 were accessed using the Minas Gerais Electronic Information System platform. For 2020 and 2021, information was only available in data from the IEF. Data were consulted from December 2021 to February 2022 (authorization n° 38945434- IEF). Information about sex, city of origin, arrival date, reason for such collection or delivery and primates' identification were obtained in the records of IEF and IBAMA. On the other hand, departure dates, body condition in which primates arrived, and destination were only available on the IEF's records spreadsheets from 2016 to 2021.

Three schemes were considered for the variable species reception: apprehension, collection and voluntary delivery. Seizure (S) is an inspection action by a competent agency that seizes animals after denunciation and sends them to the CETAS. Collection (C) consists of rescuing animals that come into conflict with humans or are injured and abandoned. Voluntary delivery (VD) is when someone gives back an animal, that is kept legally or illegally, and he decides to hand it over spontaneously, without suffering any penalty. There are also three possibilities for the variable destination: death (D), release (R) or sent to another captivity (CA). Civil society and/or competent institutions can carry out both collection and voluntary delivery, except seizure.

The length of stay at CETAS was recorded in days. Distance from places where primates came from was standardized in kilometers. The difference between Belo Horizonte city and other cities where primates came from was adopted using Google Maps. Geographic coordinates of CETAS (-19° 93' 43" S, -43° 95' 17" W) and Belo Horizonte city (-19° 48' 57' 'S,-43º 57'15"W) were applied for primates that came from this capital to calculate the distance. Only twenty five (25) records contained the exact geographic information.

According to the records, body condition was classified as good (G), fair (F) or poor (P), but criteria for such classification were not explicit at primates' reception records. For sex, the records were: male (M), female (F) or undetermined (U). Finally, files to draw the source maps were obtained from websites of the Brazilian Institute of Geography and Statistics (IBGE), and from the Spatial Data Infrastructure of Minas Gerais (IDE) (IBGE, 2022; IDE, 2022).

## Data Analysis

Primates' identification records were considered at the species level for data analysis. The Software R Studio 4.0 (R Team Core, 2022) was used for all the tests. Kruskal-Wallis test was applied to check: if there is a predominance of certain genera (hypothesis 1); if there is a greater reception of primates by collection than by voluntary delivery and seizure (hypothesis 2); if release in a natural environment predominates in destination (hypothesis 3); if the number of received primates is related to the place (hypothesis 5); and if body condition at reception influences the length of stay at CETAS (hypothesis 6).

Chi-square test was used to evaluate if primates' body condition, when they arrived, interferes in the destination scheme (hypothesis 7). While Pearson correlation was applied to evaluate if the year influenced on how primates were received (hypothesis 4). Spearman's correlation was applied to evaluate if the distance from where the primates came from influences on the length of stay at CETAS. Permanova was also applied to evaluate if and which variables (body condition, gender, origin and distance from where the primates came to the Center) influenced on time (days) for destination. For hypotheses 1 to 5, information was obtained of records from 1992 to 2021, but for hypotheses 6 and 7, information was obtained of records from 2016 to 2021.

Many records showed incomplete information, so that the relevant variables in this research had different sized samples. Finally, QGis software was applied to draw a map with the places (origin) where primates came from and received at the Center. A 5%-significance level was adopted for all analyses.

# 3 Results and Discussion

## Primates' identification

CETAS-BH received 1,895 primates from 1992 to 2021. 1574 records were from IBAMA and 321 from IEF. 1,586 individuals belonged to genus *Callithrix*, followed by genus *Sapajus* (184 primates). These data corroborate hypothesis 1 that these are the predominant primate genera. However, there was no significant relation ($X^2$ = 9, p=0.4373) between gender and the number of primates received.

Ten genera and twenty two species were identified, all from the Brazilian territory and sixteen species are native from Minas Gerais (Table 1). This number represents 88% of species that occur in Minas Gerais (REIS et al., 2010). 152 individuals were females, 225 were males of the total, and sex was not identified in 1,517 of them (n=1,894). Among the species, the conservation status ranged from "the least concerned" to "critically endangered" (Table 1). The only column which summed values will always add up to the total is the 'origin'. The others may vary depending on how the terms are filled out. The status of body condition was obtained from the International Union for Conservation of Nature (IUCN, 2021) website (Table 1).

Nine species were received at CETAS-BH and take part of the fourteen chosen ones at the National Action Plan for the Conservation of Primates of the Atlantic Forest and White-collared Sloth (PANPPMA) (ICMBIO, 2018). They are: *Alouatta guariba* (Humboldt, 1812), *Brachyteles arachnoides* (Saint-Hilaire, 1806), *Brachyteles hypoxanthus* (Kuhl, 1820), *Callicebus personatus* (Saint-Hilaire, 1812), *Callithrix aurita* (Saint-Hilaire, 1812), *Callithrix flaviceps* (Thomas, 1903), *Leontopithecus chrysomelas* (Kuhl, 1820) and *Sapajus robustus* (Kuhl, 1820).

Twenty-three species of primates are present in one of the biomes in Minas Gerais, the Atlantic Forest. And seventeen of them are on the Official National List of Endangered Fauna Species (ICMBIO, 2018). Habitat loss, its fragmentation, the introduction of invasive primate species, hunting and apprehension, and yellow fever are the main threats identified for the taxon in this biome (ESTRADA et al., 2018; ICMBIO, 2018).

1,773 primates have been identified to the species level, although 122 were identified to the genus level. Species identification is a very important stage as it has direct consequences on how to handle with primates and their destination, especially for those ones that can return to their natural environment. An incorrect identification can result in releasing an individual outside its range, for example (OKLANDER et al., 2020).

There was no distinction between male and female in 80% of individuals concerning their sex. This differentiation is named as sexual dimorphism, which can be primary (differences related to sex and mating) or secondary (differences in body size, canines and coat color).

In platyrrhines, secondary differences are more subtle or absent (PLAVCAN, 2001). *Alouatta caraya* (Humboldt, 1812) is an exception as it presents evident dimorphism in which females have yellow brown coat and males have black coat (FLORES; CASINOS, 2011). Males also have a protruding hyoid bone and are slightly larger (FLORES; CASINOS, 2011). Usually, at the moment primates are received, there is no time to check their primary characteristics and their secondary characteristics are difficult to evaluate quickly or they do not exist.

## Genera *Sapajus* and *Callithrix*

Species of the genus *Sapajus* deserves to be carefully identified. Amongst the five species received, *Sapajus apella* (Linnaeus, 1758) was the most representative (Table 1). However, it is the only one that does not have a natural distribution in Minas Gerais (LYNCH ALFARO et al., 2012; REIS et al., 2010). This fact as well as the absence of legalized breeding grounds to commercialize primates as pets reinforce that it is a trafficking process. It is also possible their incorrect identification, because it is difficult to identify *Sapajus* spp. since hybridization is common in nature, especially in ecotones (LIMA et al., 2018). For example, in Minas Gerais, there is a transition between Cerrado, Caatinga and Atlantic Forest (COUTINHO, 2016).

*Callithrix* was the most received genus and *Callithrix penicillata* (Saint-Hilaire, 1812) was the most representative species. When it comes to the national sphere, representatives of this genus are also the most received at CETAS followed by genus *Sapajus* (IBAMA, 2016). The highest reception of such genera is justified because they are the most legally traded and trafficked genera among neotropical primates (FILHO et al., 2021). In addition, species of genus *Sapajus* are still hunted to be consumed. Furthermore, behavioral plasticity of these genera have allowed them to thrive in urban environments (BACK; SUZIN; AGUIAR, 2019).

There are about 500 individuals of species *C. penicillata* living in parks of Belo Horizonte (TEIXEIRA et al., 2015). They manage to survive only by consuming plant exudate, and supplement their diet with fruits, insects and anthropic food sources (SILVA et al., 2013). When foraging, they are able to move easily, even at risk, among the green spots of cities. The main threats they go through are the presence of domestic animals, some possibility of collisions and being run over, as well as exposure to new pathogens (DE ANDRADE, 2022; DUARTE; YOUNG, 2011).

**Table 1.** Reception and destination data of species and genera of primates that arrived at the Wild Animal Screening Center of Belo Horizonte from 1992 to 2021. It contains information about sex, body condition, conservation status (SC) and geographical distribution (weather the primates occur in Minas Gerais (MG) or not). M = Male, F = Female, I = Indeterminate, G = Good, P = Poor, F = Fair, C = Collection, VD = Voluntary Delivery, S = Seizure, U = No Information, CA = Captivity, D = Death, R = Release.

| Species | Total | % | Sex | | | Body condition | | | MG | SC | Origin | | | | Destination | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M | F | U | G | P | F | | | C | VD | S | U | CA | D | R |
| *Alouatta caraya* (Humboldt, 1812) | 23 | 1,2137 | 6 | 6 | 11 | 5 | 1 | 0 | Yes | Least concern | 7 | 16 | 0 | 0 | 2 | 1 | 3 |
| *Alouatta fusca* (Saint-Hilaire, 1812) | 9 | 0,4749 | 2 | 0 | 7 | - | - | - | Yes | Least concern | 5 | 3 | 1 | 0 | - | - | - |
| *Alouatta guariba* (Humboldt, 1812) | 19 | 1,0026 | 1 | 9 | 9 | 3 | 0 | 0 | Yes | Least concern | 7 | 12 | 0 | 0 | 1 | 0 | 2 |
| *Alouatta sp.* | 14 | 0,7378 | 3 | 4 | 7 | - | - | - | - | - | 4 | 9 | 0 | 1 | - | - | - |
| *Brachyteles arachonoides* (Saint-Hilaire, 1806) | 1 | 0,0527 | 0 | 1 | 0 | - | - | - | Yes | Endangered | 1 | 0 | 0 | 0 | - | - | - |
| *Brachyteles hypoxanthus* (Kuhl, 1820) | 2 | 0,1055 | 2 | 0 | 0 | 0 | 1 | 1 | Yes | Critically endangered | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| *Callicebus nigrifrons* (Spix, 1823) | 27 | 1,4248 | 3 | 3 | 21 | 8 | 3 | 0 | Yes | Near threatened | 23 | 3 | 2 | 0 | 2 | 7 | 2 |
| *Callicebus personatus* (Saint-Hilaire, 1812) | 15 | 0,7915 | 1 | 1 | 13 | - | - | - | Yes | Vulnerable | 13 | 1 | 0 | 1 | - | - | - |
| *Callicebus sp.* | 5 | 0,2638 | 1 | 0 | 4 | - | - | - | | - | 4 | 1 | 0 | 0 | - | - | - |
| *Callithrix aurita* (Saint-Hilaire, 1812) | 4 | 0,211 | 1 | 0 | 3 | 2 | 0 | 0 | Yes | Vulnerable | 3 | 1 | 0 | 0 | 1 | 1 | 0 |
| *Callithrix flaviceps* (Thomas, 1903) | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | Yes | Endangered | 0 | 1 | 0 | 0 | - | - | - |
| *Callithrix geoffroyi* (Humboldt, 1812) | 36 | 1,8997 | 3 | 4 | 29 | 2 | 0 | 0 | Yes | Least concern | 16 | 13 | 7 | 0 | 0 | 0 | 2 |
| *Callithrix jacchus* (Linnaeus, 1758) | 17 | 0,8970 | 3 | 1 | 13 | - | - | - | No | Least concern | 9 | 3 | 3 | 2 | - | - | - |
| *Callithrix penicillata* (Saint-Hilaire, 1812) | 1483 | 78,2585 | 144 | 89 | 1249 | 71 | 60 | 46 | Yes | Least concern | 958 | 340 | 156 | 29 | 7 | 88 | 81 |
| *Callithrix* sp. | 44 | 2,3818 | 5 | 5 | 34 | - | - | - | - | - | 20 | 7 | 7 | 10 | - | - | - |
| *Callithrix kuhlii* Coimbra-Filho, 1985 | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | Yes | Near threatened | 0 | 1 | 0 | 0 | - | - | - |
| *Chiropotes albinasus* (Saint-Hilaire & Deville, 1848) | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | No | Endangered | 1 | 0 | 0 | 0 | - | - | - |
| *Lagothrix lagothricha* (Humboldt, 1812) | 3 | 0,1583 | 0 | 1 | 2 | - | - | - | No | Vulnerable | 0 | 3 | 0 | 0 | - | - | - |
| *Lagothrix sp.* | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | - | - | 1 | 0 | 0 | 0 | - | - | - |
| *Leontopithecus chrysomelas* (Kuhl, 1820) | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | No | Endangered | 1 | 0 | 0 | 0 | - | - | - |
| *Saguinus* sp. | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | - | - | 1 | 0 | 0 | 0 | - | - | - |
| *Saimiri sciureus* (Linnaeus, 1758) | 2 | 0,1055 | 0 | 0 | 2 | - | - | - | No | Least concern | 0 | 1 | 1 | 0 | - | - | - |
| *Saimiri* sp. | 1 | 0,0527 | 0 | 0 | 1 | - | - | - | - | - | 1 | 0 | 0 | 0 | - | - | - |
| *Sapajus apela* (Linnaeus, 1758) | 100 | 5,2770 | 27 | 7 | 66 | 2 | 2 | 0 | No | Least concern | 41 | 42 | 15 | 2 | 1 | 0 | 1 |
| *Sapajus libidinosus* (Spix, 1823) | 16 | 0,8443 | 4 | 3 | 9 | - | - | - | Yes | Least concern | 2 | 8 | 6 | 0 | - | - | - |
| *Sapajus nigritus* (Goldfuss, 1809) | 6 | 0,3166 | 4 | 1 | 1 | 3 | 1 | 0 | Yes | Near threatened | 2 | 1 | 3 | 0 | 1 | 1 | 2 |
| *Sapajus robustus* (Kuhl, 1820) | 4 | 0,211 | 2 | 1 | 1 | - | - | - | Yes | Endangered | 1 | 3 | 0 | 0 | - | - | - |
| *Sapajus* sp. | 56 | 2,955 | 13 | 14 | 29 | 12 | 6 | 1 | - | - | 13 | 29 | 9 | 5 | 10 | 2 | 5 |
| *Sapajus xanthosternos* (Wied-Neuwied, 1826) | 2 | 0,1055 | 0 | 2 | 0 | 0 | 1 | 0 | Yes | Critically endangered | 0 | 2 | 0 | 0 | 1 | 0 | 0 |

There is only one group of *Sapajus* at the Museum of Natural History and Botanical Garden of the Federal University of Minas Gerais in Belo Horizonte (RIGHI; FARIA, 2019). *Alouatta* and *Callicebus*, the third and fourth most representative genera, do not occur in Belo Horizonte or in the metropolitan area. They are more common in rural areas of the state and in protected areas (BATISTA et al., 2021; CARNEIRO et al., 2016).

CETAS receive, in greater numbers, not endangered individuals of urban and peri-urban species. Furthermore, the most frequently received genera have a high zoonotic risk (HAN; KRAMER; DRAKE, 2016; NICOLELIS et al., 2021). The expressive number of *C. penicillata*, for example, must be carefully analyzed. On the one hand, care is needed not to blame the species for anthropogenic environmental situations that led to its population increase and predominance in urban areas.

Studies on epidemiological, ecological and evolutionary impacts of CETA's current operating standards must be developed more accurately. For example, marmosets' destination on a large scale and in different areas can act as a propagator of zoonoses. It is also necessary to consider the severe ecological impacts that may be imposed by marmosets in releasing areas, mostly due to egg predation and their demographic impacts on birds (ALEXANDRINO et al., 2012; VALE; PREZOTO, 2015).

## Primates' reception and destination

According to data obtained by samples, CETAS-BH has received nearly 63.3 primates for 30 years along this research. IBAMA has received 83% of primates from 1992 to 2013, and it was the only agency responsible for CETAS management. Another information comes with the Complementary Law n°140 of 2011, which transfers responsibility of the fauna management raised in captivity to the states, although IEF has also managed CETAS since 2013 (BRASIL, 2011).

It is worth mentioning that with regard on how the animals are received, 1,135 primates were collected, 500 of them by voluntary delivery, 208 were given away by civil society, 210 animals were captive and 50 of them had an undetermined origin. The main reasons that led to their collection were the request (n=646), injured primates (n=400) and vulnerable puppies (n=89). Primates' collection represented 80% the way they were collected, and this corroborated hypothesis 2. The number of primates (n=1,845) was influenced by their origin ($X^2$=6.6053, p=0.03679), although the post-hoc of "Bonferroni" did not show significant difference on how primates were received at CETAS-BH (collection, voluntary delivery and apprehension).

Regarding primates' destination, there were 98 releases, 100 of them died and 26 were sent to another captivity. Four primates were sent to other CETAS in Brazil, three of them were sent to zoos, fifteen were sent to fauna keepers, three were sent to scientific breeding grounds and one animal was sent to a conservationist breeding grounds. These results did not confirm hypothesis 4 that releasing is the main decision for primates' destination. The number of primates (n= 231) was not influenced by their destination scheme ($X^2$ = 2.5901; p = 0.2739).

Many primates already arrive at CETAS-BH extremely weakened. This factor plus the stress of management and new environment contribute to their deaths (McPHERSON, 2013; SILVA et al., 2021). In order to record their causes of death, necropsy is carried out at the Center in partnership with Public Universities and private laboratories. However, the veterinary clinical records were poorly filled out and did not specify the reason of their deaths.

Collection was the main way to better receive those primates, and this confirmed hypothesis 2 (IBAMA, 2016). As previously highlighted, their presence in urban centers and in agricultural areas have exposed them to dangers and conflicts with human beings (KÖNIG et al., 2020). Agricultural activity and urbanization are not usually planned considering the survival needs and displacement of wild fauna (KÖNIG et al., 2020). The challenges posed by anthropic activities put even more pressure on primates who end up being sent to CETAS. Furthermore, trafficking has persisted as a threat.

In general, primates are seen as charismatic beings whose behavior often resembles humans (LEIGHTY et al., 2015). Such perception, combined with cultural issues, is the main reason why people want to have them as pets (BOCKHAUS, 2018). This attractiveness is influenced, among other aspects, by how they are portrayed in media, by the lack of knowledge regarding risks in keeping primates at home, and by inefficient legislation and inspection (RENCTAS, 2016).

Collections, apprehensions, and voluntary deliveries can also indicate animals' trafficking or their species introduction in a new environment. This happens when individuals are collected in places that do not correspond to their original place. This is the case of species *Callithrix jacchus* (Linnaeus, 1758), *S. apella*, *Chiropotes albinasus* (Saint-Hilaire & Deville, 1848) and genera *Saimiri* and *Lagothrix* that do not originally occur in Minas Gerais (LINERO; CUERVO-ROBAYO; ETTER, 2020; MALUKIEWICZ et al., 2020; PINHEIRO; FERRARI; LOPES, 2013; REIS et al., 2010). So, CETAS decided that the first step that must be done is receiving them and filling out their formularies (CONAMA, 2018b). Records must contain as much detailed information as possible. However, many formularies were incomplete, and there was no standardization to differ collection from voluntary delivery.

Release, on the other hand, consists of primates' return to nature, but only those ones that have been rehabilitated and are able to go back 'home'. In addition to physical and behavioral features, it is also necessary to pay attention to the natural area where the species occurs (RESENDE et al., 2021; TETZLAFF; SPERRY; DEGREGORIO, 2019). In Minas Gerais, the release is carried out taking into account the guidelines of the Wild Animal Release Area project. This initiative was created due to decree No. 182 publication, on December 9th, 2013, and, currently, there are 62 registered areas (IEF, 2021).

Individuals of genus *Callithrix* are rehabilitated at CETAS-BH, then, when in groups, they are sent to the Wild Animal Release Areas (ASAS in Portuguese). The other genera should conclude their rehabilitation at CETAS-BH, before returning to nature. Thus, they can undergo a hard or soft release (RESENDE et al., 2021).

Secondly, the procedure includes adaptation with subsequent nursery opening, so that the individuals leave definitively when they feel comfortable. It would be better if the IEF decree No. 182 of 2013 had included a mandatory post-release monitoring to assess its effectiveness and impacts on ecosystems. It would also be pertinent to request genetic studies to find out where the individuals came from and if they are hybrids, as well as up-to-date veterinary exams to prevent diseases spread.

Due to these shortcomings, the integration of *ex-situ* and *in-situ* conservation continues to be ineffective in Brazil. For primates, there is the golden lion tamarin — *Leontopithecus rosalia* (Linnaeus, 1766) — conservation program as a successful example of this integration (ASSOCIAÇÃO MICO LEÃO DOURADO, 2022). This conservation work started in the 60s by the Brazilian primatologist Prof. Adelmar Faria Coimbra-Filho (http://www.abc.org.br/membro/adelmar-faria-coimbra-filho/), and today has the support of national and international institutions (ASSOCIAÇÃO MICO LEÃO DOURADO, 2022).

Finally, forwarding to captivity for those primates who are unable to return to the natural environment has demanded them to remain for a long time at the Center. The demand is greater than availability of other categories of use and management of fauna in captivity, such as zoos and keepers. Such places are usually at the limit with their squad, thus, they are not able to receive new individuals quickly (RENCTAS, 2016).

Data concerning primates' destination must also be compiled by IBAMA and IEF with information about their final destination and location, in case of release. So, it is necessary that CETAS have a field team to evaluate the effectiveness of this procedure. Thus, individuals that arrive may be part of the reintroduction programs of population for species that are somehow under threat.

## Variation on primates' number

The lowest number of primates' reception (n=6) was in 2001 and the highest number (n=127) was in 2008 (Figure 1). It should be reinforced that the lowest number of primates that has been received occurred in the same year in which the lowest number of them has arrived at the CETAS-BH (n=1,056).

The highest number of primates arrived in 2008, although, the highest number of them (n=16,327) was recorded at CETAS-BH in 2009. Thus, it can be concluded that the year did not influence on the number of primates received, as evidenced by the Pearson correlation (t=1.4905, p=0.1473).

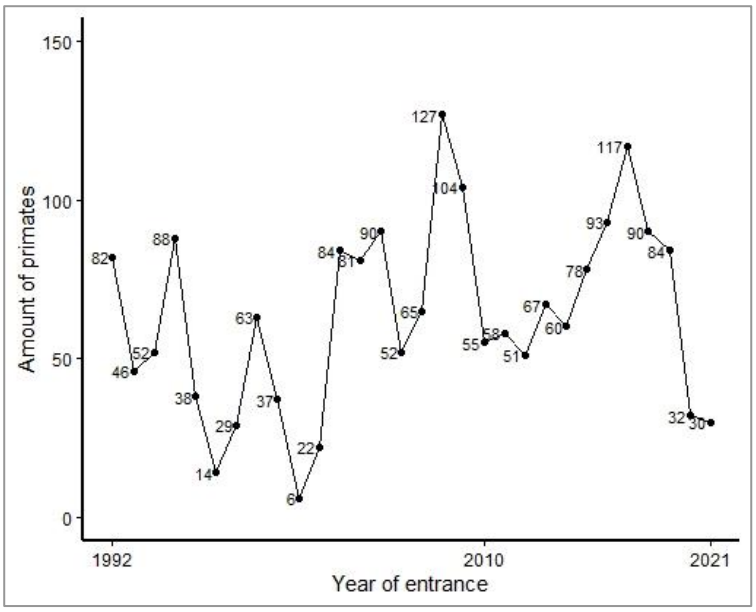


**Figure 1.** Variation in the number of entrances of primates in the period from 1992 to 2021. Each point means one year.

In Minas Gerais, the Secretary of Environment and Development (SEMAD) and the Military Police of Minas Gerais (MP-MG) are the agencies responsible for prevention, inspection and repression of environmental crimes. Until 2008, there was an agreement between the MP-MG and IBAMA regarding wild animals destination, as they were received by the CETAS-BH (FREITAS, 2014). From 2009 to nowadays, the agreement with the Government of Minas Gerais State was official to act out on environmental demands, and the Military Police became part of the State Environmental System (MINAS GERAIS; SOCIAL, 2008).

Currently, the MP-MG comprises eighteen units in the state that carry out policing in 853 cities (MINAS GEIRAIS, 2016). For each headquarter of Military Police in its countryside, there is an Operational Execution Unit called the Independent Company for the Environment and Traffic. In turn, there is the Independent Military Police Company for the Environment in the capital and its metropolitan region (CIA PM Ind. MAMB) (MINAS GERAIS, 2016).

This agency takes part in the prevention and inspection of crimes against wildlife, fishing, flora and polluting activities (GERAIS, 2016). According to the Integrated Information Center of the Social Defense, there were 3,544 complaints (almost 40% total) regarding wild fauna from 2012 to 2015 (SOUZA, 2017). The emphasis is explained by the strong presence of wild animal trafficking and threats imposed on them by urban environment (ESTRADA et al., 2018; GEDEF, 2016).

The number of animals that arrive at the Center, including primates, varies mainly due to the effort and demand of such environmental inspection agencies (BASTOS et al., 2008; FREITAS, 2014). In particular, the CIA MP Ind. MAMB is responsible for about 70% of all wild animals sent to CETAS (FREITAS, 2014).

Furthermore, variation occurs due to anonymous complaints and environmental education campaigns. In 2008, there was a National Wildlife Protection Campaign that encouraged people to hand over their illegal wild animals to IBAMA (BASTOS et al., 2008; FREITAS, 2014; MENDES, 2008). At the CETAS-BH, there was an environmental education project in which people who delivered animals were interviewed and had their doubts clarified by an expertise team in this area (CARNEIRO, 2019). However, this project was interrupted after the analyst, who was responsible for it, left the team. This number may still vary due to overcrowding at CETAS-BH or problems on food bidding process that temporarily obstructed its reception. In 2020 and 2021, fewer primates arrived due to the COVID-19 pandemic, which allowed the delivery only from civil society.

## Spatial analysis

Primates were received from 92 cities in Minas Gerais from 1992 to 2021. 851 primates came from Belo Horizonte, 261 of them came from countryside cities of the state and 475 from the metropolitan region (Figure 2). This result corroborated hypothesis 5 that more primates would arrive from Belo Horizonte and the nearby cities.

In addition, primates were received from the states of Ceará, Bahia, Goiás, Rio de Janeiro and Amazonas (Table 2). There was no significant difference in the number of primates received by CETAS-BH, considering those who came from Belo Horizonte, from countryside cities or from the metropolitan region ($X^2$=4.0538; p=0.1317). So, 1,404 records of reception were considered to be analyzed. They had information about where the primates came from, regarding their species. 812 primates came from Belo Horizonte, 160 came from countryside cities and 432 of them came from the metropolitan region.

The spatial analysis revealed that 83.5% of primates came from the metropolitan region and the capital (Figure 2). A total of 65 countryside cities correspond to 313 individuals. And 103 of them came from one of the other four cities that also have CETAS, whose primates are received by exchange among institutions. Therefore, 210 primates remain from 61 cities (Figure 2). These data corroborate the spatial analysis that was carried out in 2011 at the CETAS-BH. Considering all 7,426 animals received in that year, 75% (5,589) came from the capital or metropolitan region (PARREIRAS et al., 2015).

The CETAS is more restricted to the city where it is located in or to the cities near it. This fact justifies the creation of new units in the state and more active inspection by CIA MP Ind. MAMB in the countryside. The spatial analysis also confirmed the presence of primate trafficking on a national scale with twelve primates (7 Callithrix spp. and 5 Sapajus spp.) from other Brazilian states.

Although minor, trafficking on a national scale can lead to the introduction of species outside their natural range (GARCÍA-DÍAZ et al., 2017). *C. jacchus* is a species that came from the Northeast, but now, it can be found in Rio de Janeiro and Minas Gerais (SILVA et al., 2018). The species *C. penicillata* is from Cerrado and was introduced into the Atlantic Forest (VALE; PREZOTO, 2015). Competition for resources and hybridization are consequences of its introduction that threatens native species such as the golden lion tamarin, *L. rosalia* (MALUKIEWICZ et al., 2020; MORAES et al., 2019).

## Time of primates' destination and implications in their management

The average length concerning primates' stay (n=224) at CETAS-BH was 101.7 days. For Alouatta genus, the average length of stay was 284.3 days, for genus *Brachyteles*, it was 16 days, for *Callicebus*, this answer was 172.2 days, for *Callithrix*, 75.2 days and for *Sapajus*, 198.6 days. Nevertheless, only primates of one of these five genera arrived along these last six years.

A total of 108 primates were received in good body condition, 71 in fair body condition and 52 in poor body condition (n = 231). There was a significant difference (X2 = 21,684, p = 0.00001956,) for good body condition and primates' length of stay at the CETAS-BH, which corroborates hypothesis 6 - animals in better condition stayed less time at the Center. The Post hoc showed that the "good body condition" group is different from the "fair body condition" and "poor body condition" groups.

It is worrying the time primates remain at CETAS-BH, as they are overcrowded and receive more animals than they have conditions to guarantee satisfactory levels of welfare. There are two destination options for those who survive: release or send them to another captivity. Puppies of *B. hypoxanthus* stayed only 16 days at CETAS, after this term, they were sent to another place. As this species is classified as critically endangered, it was sent to the Muriqui Biodiversity Institute Project for rehabilitation.

At release, the waiting time is worsening by those few areas available in Wild Animal Release Areas that correspond to the area of natural occurrence for primates.

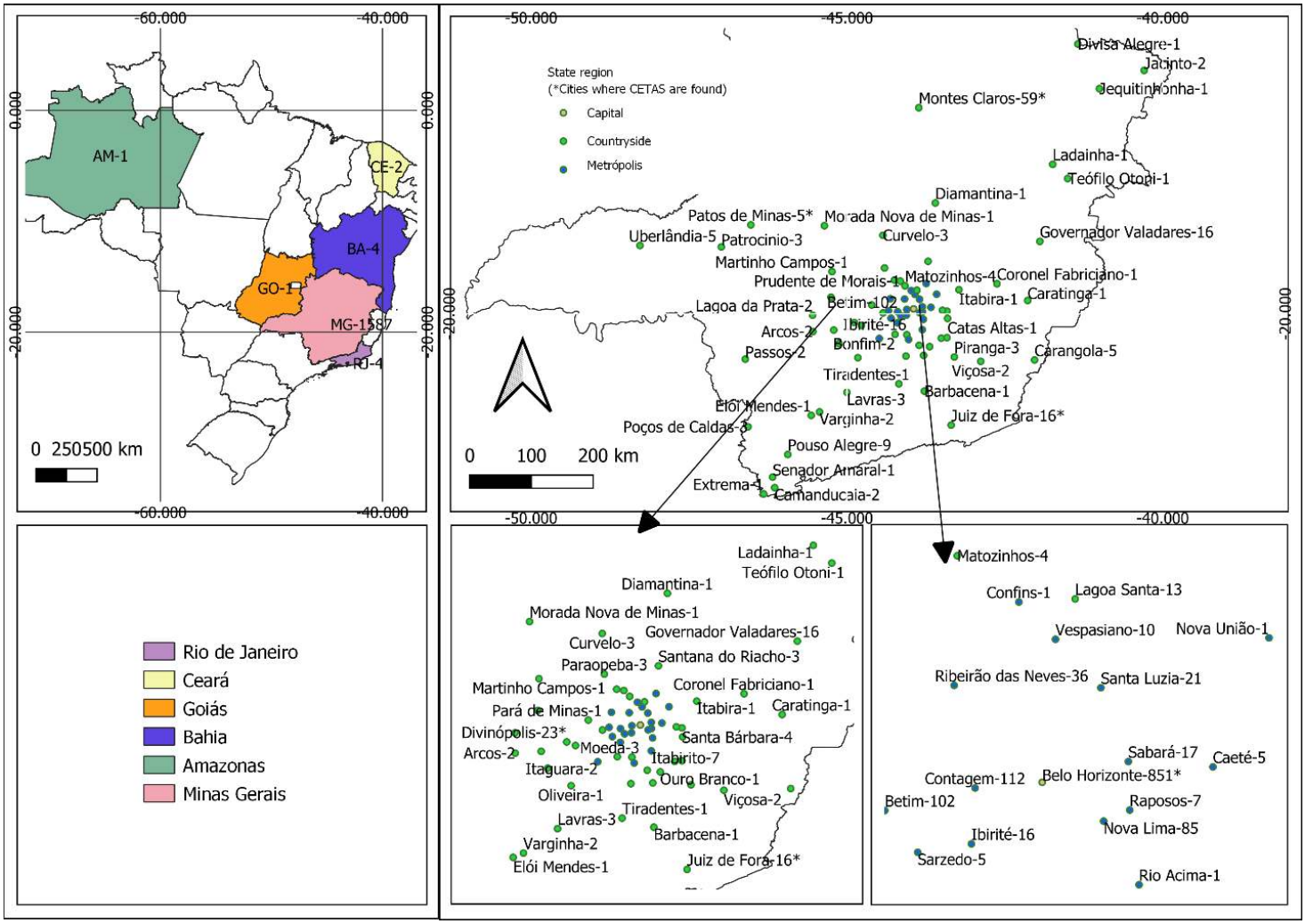


**Figure 2.** Number of primates received by location by the Wild Animal Screening Center of Belo Horizonte between 1992 and 2021. Reference system SIRGAS 200222. Projection system: UTM. Author: Matheus Mir Leite Ferreira.

Furthermore, as they are sociable animals, the best decision is to release them in groups to increase their chance of survival (GUY; CURNOE; BANKS, 2014). However, this process can be long since there is no way to predict when other individuals of the same species will arrive.

All this waiting interferes on the rehabilitation process due to the enclosures quality, and the stimuli they receive are not enough. Most primates live in 2 m2 enclosures at CETAS-BH, which has two suitable places for them, although they are not enough to serve all individuals. Environmental enrichment is also essential to promote welfare, and to prevent animals from getting fat, as well as to reduce stress and improve physical fitness that will be important for a successful return to nature (TETZLAFF; SPERRY; DEGREGORIO, 2019; YOUNG, 2003). CETAS-BH has a guidebook about environmental enrichment for animals that are most received there, including primates. It has information and measures, but they are not well adopted (FERREIRA, 2021). In addition to these aspects, feeding is another important factor in management (MAPLE; PERDUE, 2013). Primates are classified according to their diet as frugivores, folivores, omnivores and gomivores (STUDIES et al., 2003). The most common genera, which are frequently received at the Centre, are *Callithrix*, *Sapajus*, *Alouatta* and *Callicebus*.

In natural environment, marmosets (*Callithrix* sp.) feed themselves mainly on exudate and supplement their diet with insects, eggs and fruits (FRANCISCO; SILVA, 2015). While capuchin monkeys (*Sapajus* sp.) have their diet based on fruits, which correspond to about 60% consumed by them (FRAGASZY; FEDIGAN; VISALBERGHI, 2004). They also ingest eggs, invertebrates and small vertebrates. Guigós (*Callicebus* sp.) are more frugivorous and supplement their diet with leaves and insects (FERNANDES, 2013; MOURA et al., 2019).

Howler monkeys (*Alouatta* sp.), in turn, are more folivorous and complement their diet with fruits (MIRANDA; PASSOS, 2004).

At the CETAS-BH, they are fed primate food, supplemented with fruits (bananas, apples, papayas) and eggs twice a day. However, the offered commercial fruits have high sugar content, that is harmful to wild animals (BRITT et al., 2015; KUHAR; FULLER; DENNIS, 2013). Its excessive intake can lead to obesity, dental problems and behavioral changes (BRITT et al., 2015; KUHAR; FULLER; DENNIS, 2013). One way to replace commercial fruits is to offer vegetables such as sweet potatoes and carrots. And, regarding exudate, a commercial version is already available and can be given to primates of Callithrix genus. Infants can be fed by whole cow's milk every two hours. Primates' weaning of Callithrix genus occurs close to the sixth month, while, the others are weaned after fifteen months (LEE; MAJLUF; GORDON, 1991; SMUCNY et al., 2004). Then, little by little, mashed foods and insects should be added to their diets until they are ready to consume the same diet adults' intake. It is essential to offer calcium to puppies four times a week to prevent osteodystrophies (STUDIES et al., 2003).

The daily energy requirement has already been estimated more precisely for some genera of primates. Callithrix, Alouatta and Sapajus need at least 50 kcal, 600 kcal and 340 kcal a day, respectively (EDWARDS; LONSDORF; PONTZER, 2017; PONTZER et al., 2014; STUDIES et al., 2003). Also, food calories must be considered, as well as their ratio and feeding frequency of each item to know how many grams of each food should be offered to them. Food calories can be found on the product label or on the Brazilian Food Composition Table, standardized to 100 grams (UNICAMP, 2011).

### Primate's body condition

There was an association between body condition and schemes of destination ($X^2$=37,095, p=0.0000001722). The analysis of adjusted standardized residual showed that primates with poor body condition die more often than those with good or fair body condition, corroborating hypothesis 7. Variables such as sex, body condition and distance, analyzed by Permanova, did not show influence on the individuals' length of stay at CETAS-BH. This result was reinforced by the weak correlation obtained (rho = 0.1281706; p = 0.07644) between the distance from where they came from (origin) and their length of stay at CETAS-BH.

When the animals arrive at CETAS-BH, their body condition influences their length of stay as well as their final destination, that is, if they will be released, die or be sent to another captivity. Therefore, it is essential to ensure an efficient veterinary care.

The principles of preventive medicine, which include food, adequate spaces and environmental enrichment, are also important (MAPLE; PERDUE, 2013).

Primates that arrived in poor body condition are more likely to die than those that arrived in fair or good condition. This can be explained by the fact that poor body condition, added to the stress of management, leads them to death. It is crucial to check the diagnosis described in their clinical records to know the cause of their weakened body condition and death. However, such forms were very poorly filled out, consequently, the analyses and information crossing were impossible.

It is also necessary to standardize what is considered good, poor or fair body condition. This can be done by adapting the protocol developed by Summers et al. (2012). The protocol proposes, among other aspects, a body condition scale that goes from very thin to obese, and the parameters adopted for each classification (SUMMERS; CLINGERMAN; YANG, 2012). The primates chosen as samples were individuals of *Macaca mulatta* (Zimmermann, 1780), but it is possible to adapt such protocol to other primates.

There was no factor (body condition, sex, origin and distance from the cities to the CETAS-BH) that made difference in the time of destination. And, although there was no significant relationship between the distance from the cities where they came from and the length of stay at CETAS-BH, it is important to move them as quickly as possible. Primates can be injured on their path and are commonly apprehended or collected by the police with other groups of vertebrates, which are more susceptible to stress such as birds.

# 4 Conclusions

There is a low representation of receiving records of the most endangered primate species. This reflects the low existence of these species in nature and the inability of the Wild Animal Screening and Rehabilitation Centers to monitor the environments in which they are found. The predominance of genera *Callithrix* and *Sapajus* shows that the Screening Centers mainly receive species adapted to the urban environment that occur in nearby cities or in the municipality where the Center is. It was not possible to access the places where primates were destined to.

However, these data are important to understand their reception and destination flows and to improve their release process. The presence of species that do not occur in the Minas Gerais state plus voluntary surrender by civil society and seizures indicate the presence of illegal trade of primates in Brazil.

Thus, as long as they remain at CETAS, there can be seen improvements on animals' welfare. This involves changes in the enclosure size and complexity, as well as on environmental enrichment offering, diet change and veterinary protocols. Captive fauna management in Brazil usually needs major changes.

Therefore, it is necessary to produce advances in legislation that will positively affect decision-making to raise, maintain and release wild animals. The production or not of a national pet list, the review of size and quality of the spaces for each species/kind of enterprise, and the release process are examples of practical applications with changes in regulations.

It is still urgent to develop new reception and destination protocols that incorporate molecular technologies to diagnose zoonoses. As well as it is essential in-depth studies on ecology and genetics to understand the impact of primate releases to the communities and ecosystem functions.

Combating primate trafficking also involves strengthening environmental control and surveillance agencies and classifying this activity as a crime. The inclusion of environmental education, in this context, remains essential, as it is necessary that animal trafficking ceases to be a socially accepted activity. It is worth highlighting that corruption and underdevelopment, present in Brazil, have negatively influenced the environment.

Thus, eradicating this illegal activity is totally related to the improvement in people's quality of life, which live with their basic rights (leisure, education, health, and housing) denied.

# CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Both authors participated in Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Writing, Review.

# DECLARATION OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could appear to influence the study reported in this manuscript.

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