

Spatial study of the canine and feline anti-rabies vaccination coverage in Brazil

Estudo espacial da cobertura de vacinação anti-rábica de cães e gatos no Brasil

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ABSTRACT

The vaccinal prophylaxis of dogs and cats is one of the measures contemplated by the National Immunization Program (PNI) from the Brazilian Ministry of Health as a strategy of rabies control. Despite the efforts for the control of rabies in Brazil, there are still cases of this disease in either animals and humans. This study presents the longitudinal analysis based on the secondary data regarding the coverage of the canine and feline anti-rabies vaccination campaigns that occurred in Brazil from 2012 to 2017. While in 2017 anti-rabies vaccination coverage was higher in the period of study, the worst vaccinal coverage rates were registered in 2012 and 2016. The region North was highlighted since it presented the best vaccine coverage rates during the period, specially the states of Acre, Amazonas and Rondônia, while the regions Northeast, Midwest and Southeast presented the worst rates. It was possible to observe that some municipalities significantly exceeded the recommended rates, which could indicate problems in the animal population estimative or in data consolidation of the vaccination coverage rates. Animal population estimative and data consolidation in a systematic way, will guarantee the health information system reliability and the evaluation of public policies aimed at rabies control.

Keywords: Rabies, Vaccination Coverage, Health Information System.

RESUMO

A profilaxia vacinal de cães e gatos é uma das medidas contempladas pelo Programa Nacional de Imunização (PNI) do Ministério da Saúde como estratégia de controle da raiva. Apesar dos esforços para o controle da raiva no Brasil, ainda existem casos da

doença em animais e humanos. Este estudo apresenta a análise longitudinal com base nos dados secundários relativos à cobertura das campanhas de vacinação antirrábica canina e felina ocorridas no Brasil de 2012 a 2017. O ano de 2017 foi o que apresentou maior cobertura vacinal na série observada enquanto as menores taxas foram registradas em 2012 e 2016. A região Norte se destacou por apresentar as melhores taxas de cobertura vacinal no período, principalmente os estados do Acre, Amazonas e Rondônia, enquanto as regiões Nordeste, Centro-Oeste e Sudeste apresentaram as piores taxas. Foi possível observar que alguns municípios superaram significativamente as taxas recomendadas pelo Ministério da Saúde, o que permite pensar que, provavelmente, a estimativa da população animal está sendo subestimada ou a importância da consolidação dos dados referentes às campanhas de vacinação não está sendo devidamente realizada. A consolidação dos dados deve ser feita de forma sistemática para garantir a confiabilidade do sistema de informações em saúde e a avaliação das políticas públicas voltadas para o controle da raiva.

Palavras-Chave: Raiva, Cobertura Vacinal, Sistema de Informação em Saúde.

1 INTRODUCTION

Each year, rabies causes approximately 59,000 deaths worldwide, which generates cost of 8.6 billion US dollars/year (Hampson et al., 2015). Human rabies and accidents - such as scratches and bites - caused by animals potentially transmitters of rabies are subject of immediate compulsory notification in Brazil (Brasil, 2017). From 2015 to 2019, there were 676.000 annual average rate of antirabies post-exposure consultations and from 2010 to 2020, 38 human cases of rabies were reported in Brazil (Brasil, 2020).

Currently, vaccinal prophylaxis is one of the actions contemplated by the National Immunization Program (PNI) from the Ministry of Health as a public health strategy of SUS (Brasil, 2019a) and it aims to vaccinate dogs and cats in the country, as well as the human groups of risk for the disease, such as health professionals and animal keepers. This measure was responsible for the reduction in the frequency of human rabies cases with the canine viral variant in the country (the last registration being made in 2015, in the state of Mato Grosso).

Despite the efforts made in order to control the rabies in the country, cases of the disease still occur in both animals and humans (Brasil, 2020). From 2012 to 2017, twenty cases of human rabies were reported on the Notifiable Diseases Information System (SINAN) (Brasil, 2019b). During the same period, 79.079.596 prophylactic doses of vaccine were performed in dogs and 20.566.330 doses in cats (Brasil, 2019c).

This study aimed to conduct a temporal and spatial analysis of the rabies vaccination coverage in Brazilian dogs and cats and its spatial relation rabies cases reported in Brazil from 2012 to 2017.

2 MATERIAL AND METHODS

Area of Study

Brazil is a country located in South America with 8,515,692.27 km², distributed in a heterogeneous territory, often difficult to access, composed of 27 Federation Units and 5,570 municipalities and population of 211 million inhabitants. Brazil has the second largest population of dogs and cats according to data from The Brazilian Institute of Geography and Statistics (IBGE). At least one dog or one cat lives in 18,8 million Brazilian households. These data are freely available on <https://sidra.ibge.gov.br/tabela/4932>. The last national census conducted in 2015 demonstrated a population of 52,2 million dogs and 22,1 million cats, with the average of 1,8 dogs and 1,9 cats for each household (IBGE, 2015).

Type of Study and Data Source

A retrospective longitudinal study was carried out using secondary data collected from three different Brazilian Official system of information.

Data related to National Immunization Program (PNI) of the Ministry of Health were freely available in: http://pni.datasus.gov.br/consulta_antirabica_16_selecao.asp?naofechar=N&enviar=ok&grupo=todos&faixa=todos&sel=doses01#). This database refers to the anti-rabies vaccination coverage target for dogs and the number of doses of anti-rabies vaccine performed on dogs and on cats in all Brazilian municipalities, during the rabies vaccination campaigns, from 2012 to 2017.

Data on the cases of canine and feline rabies that occurred in the period from 2015 to 2017 and the human cases notified from 2012 to 2017 were obtained on the SINAN online portal (Freely available in: <http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sinannet/cnv/raivabr.def>). and no data were freely available on rabies in dogs and cats from 2012 to 2014.

Data on human population estimates by municipality as well municipalities codes were obtained from IBGE website, freely available in: <https://www.ibge.gov.br/en/statistics/social/population/18448-estimates-of-resident-population-for-municipalities-and-federation-units.html?=&t=downloads> .

Data organization

All data were downloaded and organized in electronic tables.

For the study “vaccine coverage target” was defined as the relative frequency of doses applied in dogs and cats according to the target established for the respective year for each of the Brazilian municipalities. This vaccine coverage targets were defined in Brazil as 80%, more than the 70% of coverage recommended by World Organization for Animal Health (OIE).

The Table 1 includes the names and description of variables in all databases considered.

Table 1 – Variables’ names, variables’ description and period considered in each database included in the spatial study of the canine and feline anti-rabies vaccination coverage and its relation with the cases of human rabies in Brazil, from 2012 to 2017.

Database	Variables’ name	Variables’ description	Period considered
National Immunization Program (PNI)	Year	The year of occurrence of anti-rabies vaccination campaign.	2012 to 2017 (all data available)
	Municipality	Name that identify the municipality in Brazil.	
	IBGE code	Code of municipality that was applied as a column link in spatial analysis.	
	Vaccination coverage target for dogs	Number of dogs expected to be vaccinated in each municipality representing 80% of dogs’ population informed in each municipality.	
	Vaccination coverage target for cats	Number of cats planned to be vaccinated in each municipality representing 80% of cats’ population. Author (consideraram ou estimaram??) as a quart of dogs’ population estimated the cats’ population. Achei essa frase estranha.	
	Dogs Vaccinated	Number of doses of anti-rabies vaccine performed on dogs informed in database.	
Cases of canine and feline rabies	Year	The year of the case occurred.	2015 to 2017 (All data available)
	Municipality	Municipality where the case occurred.	
	IBGE code	Code of municipality that was applied as a column link in spatial analysis.	
	Specie	Animal species affected (only dogs and cats were considered)	
Human population	Year	Year of the population census (2013, the last census realized in Brazil were considered).	2013
	Municipality	Name of each municipality in Brazil (5,570 in total)	
	IBGE code	Code of each municipality that was applied as a column link in spatial analysis.	
	Population	Number of people in each municipality	

As there was no target established for cats anti-rabies vaccination, it was estimated from data obtained in the work of Alves et al. (2005), who demonstrated that, for a population of four canine specimens, there is a feline specimen. After obtaining the feline vaccination coverage target, the information was treated using dynamic tables for the individualization of each year of vaccination by Federative Unit.

Afterwards, the frequencies of the anti-rabies vaccine coverage were calculated according to each species in order to verify if there was the compliance or not of the pre-established goal.

Statistical e Spatial analysis

At first, descriptive analysis including the absolute and relative frequencies of municipalities where the vaccination coverage targets were achieved and of the numbers of vaccinated animals by municipality were performed.

The information was georeferenced using the software QGIS - version 3.10 - with which qualitative thematic maps of the Brazilian territory were elaborated using the variable vaccination coverage, considering the municipal geocodes used by the Brazilian Institute of Geography and Statistics (IBGE).

For the division of vaccine coverage rates by region, the following intervals were considered - which refer to the relative frequencies obtained in each municipality: - below 50%; - between 50 and 80%; - between 80 and 120%; - above 120%.

This division was established in observance of the large number of municipalities that had vaccine coverages far above (120%) than that recommended by WHO (80%) and which results influenced the natural break of 25 intervals in the georeferencing program described above, which would be only two extremely disparate intervals between them.

The range between 50 and 80% of vaccine coverage refers to those municipalities that did not meet the established goal, but that did not have results as less than expected as those whose vaccination coverage represented rates below 50%.

Municipalities with good vaccine coverage were considered those with results between 80 and 120%, considering the fulfillment of the initial vaccination target for both species and the expected annual growth of the canine and feline populations.

The interval corresponding to vaccine coverage above 120% referred to those places where there was a large discrepancy between the initial goal and the inference of the occurrence of errors in the population estimate or in the consolidation of data about the rabies vaccination campaigns.

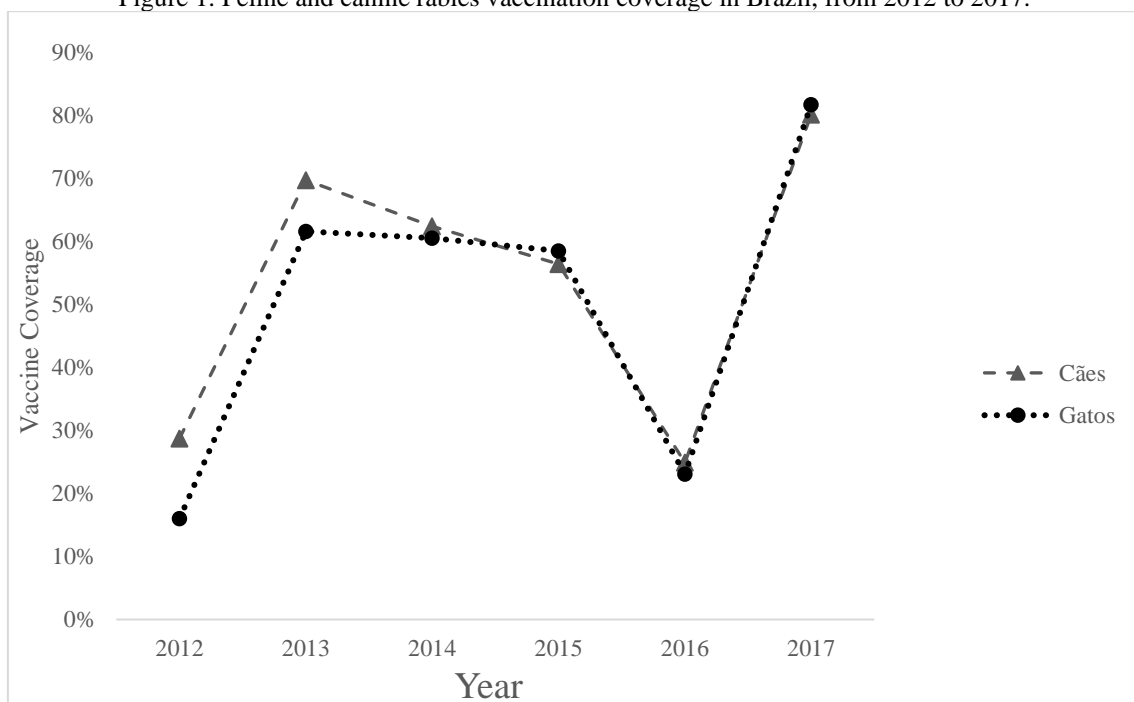
Then, a comparison of the targets made available by the PNI and the estimated targets for each municipality was conducted according to the method of dog and cat populations estimates proposed by the Pasteur Institute (Matos et al., 2002) and that with the indication of the PNPR - which sets as a goal the vaccination of 80% of the animals in a certain locality. In order to estimate the population of dogs and cats, it was considered that for every six humans in a population there is one canine specimen. Information regarding the human population for the year 2013 is available on the IBGE website.

The Mann-Whitney-Wilcoxon test was used to assess whether there was a significant difference between the presented and the estimated goals. For all statistical analysis, it was considered the statistical significance of 5%.

3 RESULTS

Figure 1 represents the vaccine coverage of the historical series considered.

Figure 1. Feline and canine rabies vaccination coverage in Brazil, from 2012 to 2017.



It was observed that in the period from 2012 to 2017, only in 2017 the vaccination coverage rate of 80% of the population of dogs and cats in Brazil was achieved. In the period from 2012 to 2016, the vaccine coverage of both species fell short of what was initially established as a goal. The canine and feline anti-rabies vaccination coverage by Brazilian State in the study period are presented in Table 2.

Table 2. Canine and feline anti-rabies vaccination coverage (%) by Brazilian State, from 2012 to 2017.

Brazilian State	2012		2013		2014		2015		2016		2017		Mean
	Dogs (%)	Cats (%)	Dogs (%)	Cats (%)	Dogs (%)	Cats (%)	Dogs (%)	Cats (%)	Dogs (%)	Cats (%)	Dogs (%)	Cats (%)	
Acre	72	97	77	91	68	55	92	98	68	41	94	63	76
Alagoas	138	214	126	153	133	196	93	95	89	123	22	17	117
Amapá	0	0	11	13	61	70	76	95	50	65	68	72	48
Amazonas	45	104	85	61	88	61	89	117	80	63	85	121	83
Bahia	16	15	55	49	63	50	58	55	3	2	66	64	41
Ceará	130	215	167	241	103	161	91	155	76	171	102	156	147
Distrito Federal	0	0	43	0	26.07	14.5	0	0	0	0	0	0	3.38
Espírito Santo	10	9	9	6	0	0	11	10	36	32	44	42	17
Goiás	91	35	86	34	102	39	0	0	83	37	77	44	52
Maranhão	1.657	3.631	2.525	4.479	510	917	1.600	2.903	440	638	457	761	1.710
Mato Grosso	15	16	82	71	101	80	107	75	114	97	169	133	88
Mato Grosso do Sul	63	50	68	54	75	66	73	83	1	1	70	56	55
Minas Gerais	12	7	83	51	3	3	88	51	69	43	76	50	45
Pará	41	52	93	108	104	94	99	87	5	5	94	106	74
Paraíba	48	63	86	101	87	112	78	89	84	89	91	104	86
Paraná	0	0	72	67	76	43	42.86	15.3	0	0	92	69	4.88
Pernambuco	7	14	34	52	77	102	64	90	19	20	50	65	50
Piauí	21	32	35	60	103	141	83	136	85	131	94	109	86
Rio Grande do Sul	0	0	0	0	0	0	0	0	0	0	92	69	13
Rio de Janeiro	11	7	12	11	44	28	28	15	44	25	65	85	31
Rio Grande do Norte	19	26	85	112	75	122	78	120	70	107	76	100	82
Rondônia	26	14	73	77	90	83	120	107	91	94	118	102	83
Roraima	0	0	49	71	458	280	376	266	486	582	631	541	312
Santa Catarina	0	0	0	0	0	0	0	0	0	0	92	69	13
São Paulo	21	14	64	39	53	37	6	6	71	46	81	80	43
Sergipe	65	79	91	85	79	93	88	112	57	62	82	95	82
Tocantins	0	0	95	93	101	114	0	0	101	110	137	150	75
Total	29	16	70	62	62	60	56	59	25	23	80	82	52

The strategies for dogs and cats population estimative could be inadequate in some Brazilian States, which generates vaccination rates above 100%, as in Distrito Federal, Maranhão, Paraná and Roraima. The most of rabies cases in dogs, cats and humans, from

2015 to 2017, were reported in Brazilian regions where the vaccination coverage where lower than 80% or higher than 100% (Table 3).

Table 3. Number of rabies cases in dogs, cats and humans by Brazilian State from 2015 to 2017

Brazilian State	2015			2016			2017			Total
	Dog	Cat	Human	Dog	Cat	Human	Dog	Cat	Human	
Alagoas	0	0	0	0	1	0	0	0	0	1
Amapá	0	0	0	1	0	0	0	0	0	1
Amazonas	0	0	0	0	0	0	0	0	3	3
Bahia	0	0	0	2	1	0	0	1	1	5
Ceará	3	1	0	0	0	1	2	1	0	8
Maranhão	2	1	0	1	0	0	4	0	0	8
Mato Grosso do Sul	71	0	1	1	0	0	1	0	0	74
Paraíba	0	1	0	0	0	0	1	0	0	2
Pernambuco	0	0	0	5	0	0	0	1	1	7
Rio Grande do Norte	6	0	1	1	0	0	0	0	0	8
Rio Grande do Sul	0	1	0	0	0	0	0	0	0	1
Roraima	0	0	0	0	1	1	0	0	0	2
São Paulo	1	4	0	1	4	0	1	0	0	11
Sergipe	0	0	0	1	1	0	0	1	0	3
Tocantins	0	0	0	0	0	0	1	0	1	2
Total	83	8	2	13	8	2	10	4	6	136

A total of 7 to 10 human cases of rabies from 2015 to 2017 occurred where dogs and cats' cases of rabies where also reported. From 2012 to 2017 were registered 40 rabies cases in human, and one of these were transmitted by dogs. At the same time three cases transmitted by cats. and no data were freely available on rabies in dogs and cats from 2012 to 2014.

Figures 2 and 3 show the canine and feline rabies vaccination coverage in Brazil during the studied time series.

Figure 2. Coverage of the canine rabies vaccination campaign in Brazil, 2012-2017.

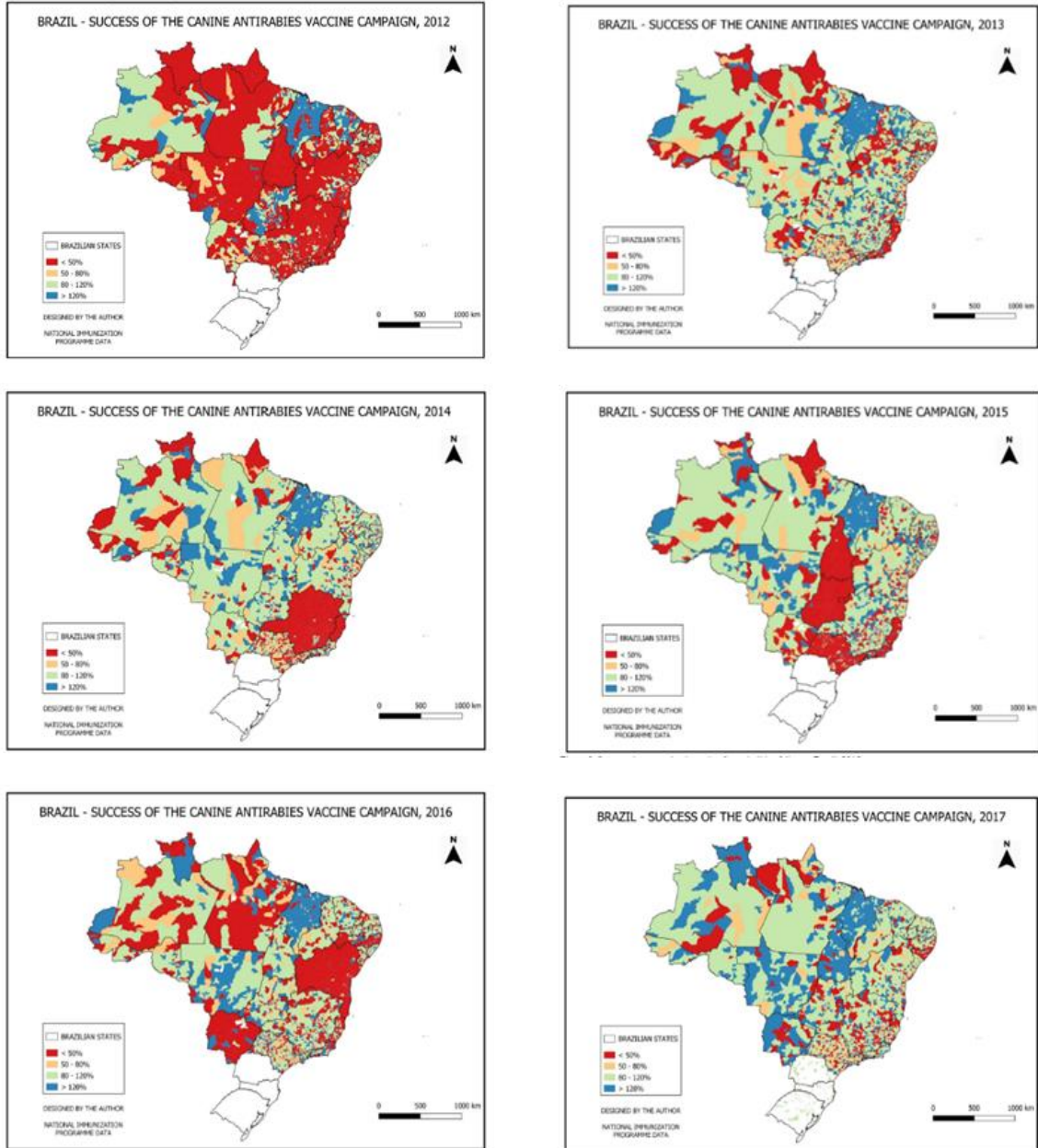
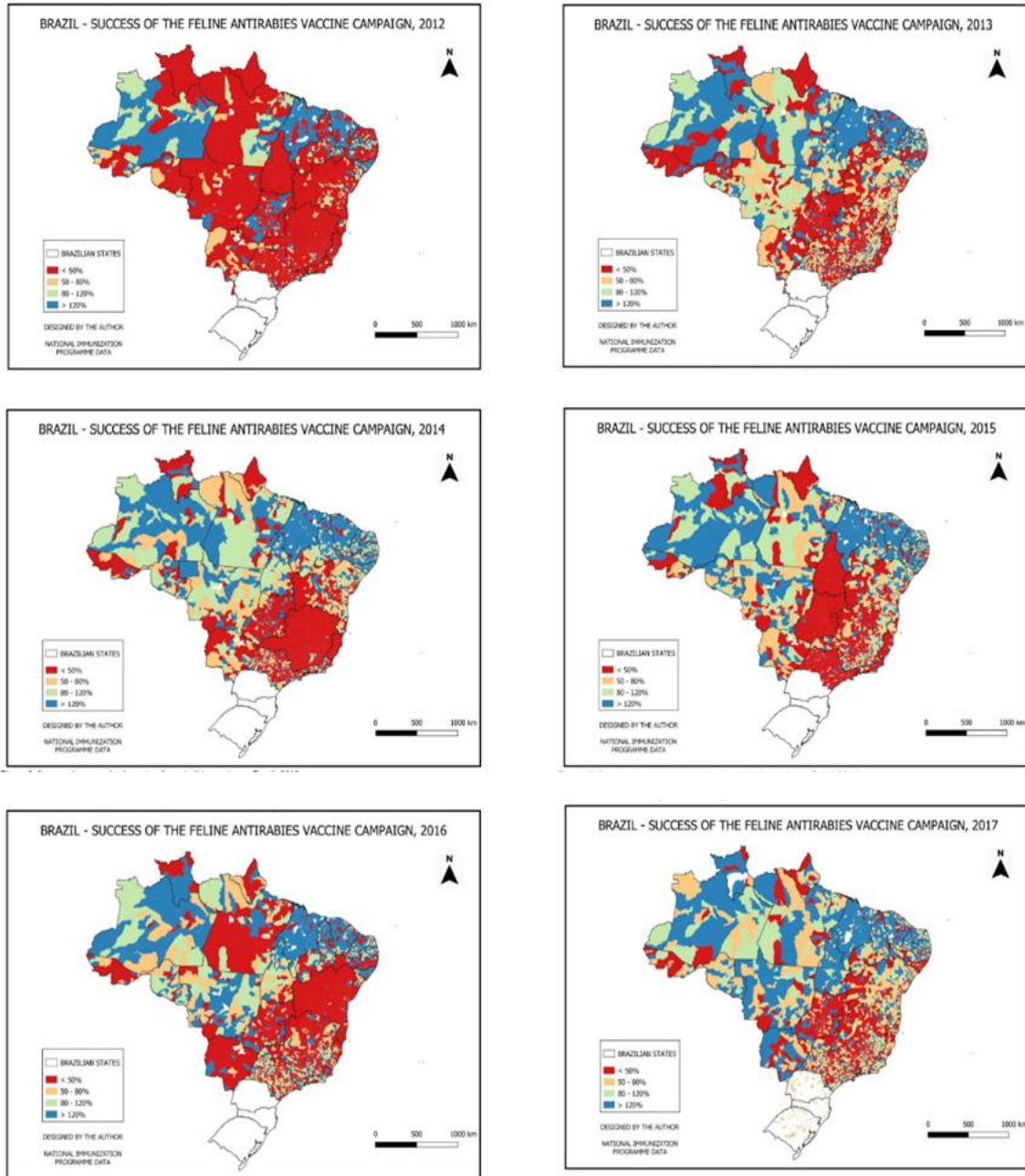


Figure 3. Coverage of the feline rabies vaccination campaign in Brazil, 2012-2017.



The Northern region of Brazil was highlighted for presenting the vaccination coverage closer to the vaccination coverage target during the period studied, especially the states of Acre, Amazonas and Rondônia, while the Northeast, Midwest and Southeast regions had the worst rates, with emphasis on Maranhão, Federal District, Rio de Janeiro and São Paulo.

Table 4 contains the analysis to assess the difference between vaccination coverage target and registered vaccine coverage and the 1:6 proportion of the target with the goal stated in the data provided by the PNI.

Table 4 – Comparison of vaccination coverage target and registered vaccine coverage in Brazil, 2012-2017.

Time series evaluated	Comparison result	p-value
Goal 80% of 1:10 and declared vaccination	Equal	P>0,05
Goal 80% of 1:6 and declared vaccination	Different	P<0,01*
Goal 80% of the proportion Human:Animal (IBGE,2015) and declared vaccination	Different	P<0,01*
Declared goal and declared vaccination	Different	P<0,01*
Declared goal and goal 80% for 1:6	Equal	P>0,05

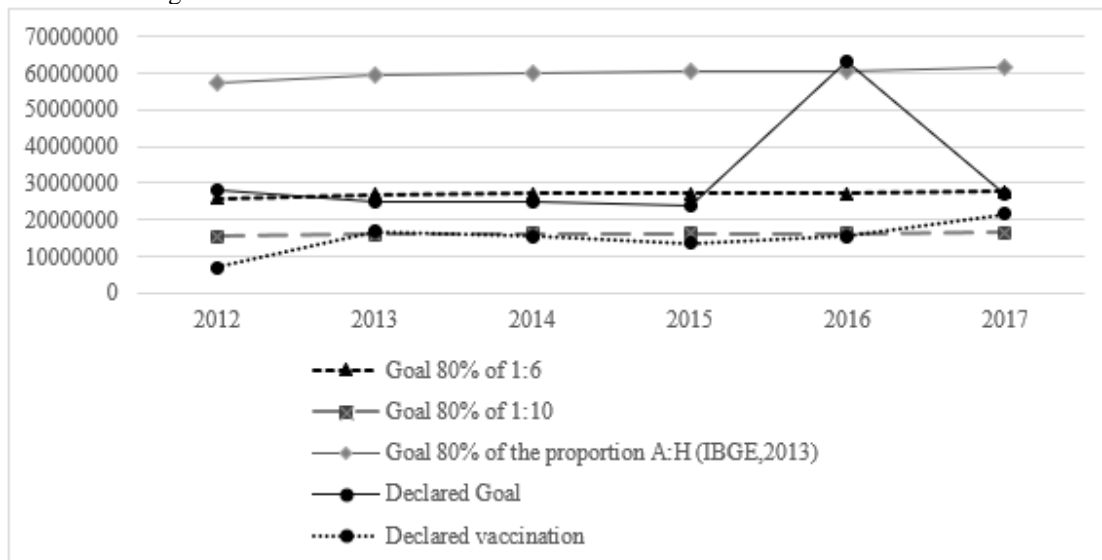
* Statically significant in Mann-Whitney-Wilcoxon test considering 5% of significance.

From 2012 to 2017, Brazil maintained an animal rabies vaccination at the proportion of eight vaccinated animals for every 100 humans (80% of 1:10), a significantly different value ($p < 0.05$) of vaccinations in relation to the goal declared by the System and the estimated goal, considering the population of dogs and cats estimated by IBGE in 2015.

It was also observed that the stated goal is similar to a proportion of eight vaccinated animals for every 60 humans (80% 1: 6) and a Pearson correlation of 0.88 ($p = 0.01$) between the estimated 80% target of 1:10.

Figure 4 shows the results of the trend analysis related to the vaccine coverage of dogs and cats according to the animal population estimates recommended by both Pasteur Institute and IBGE from 2012 to 2017.

Figure 4. Time series of animal rabies vaccination in Brazil from 2012 to 2017.



Caption: Vaccination declared, vaccination goal reported and goals estimated at 80% of the animal:human ratio in Brazil, considering the proportions of 1:10, 1:6 (Pasteur, 1999) and proportion in relation to the estimate of dogs and cats by the National Health Survey of IBGE in 2015.

Independently of the stated goal and of the estimated goals through the application of different methodologies, the vaccine coverage of the annual campaigns focused on canine and feline anti-rabies prophylaxis was below of that recommended by WHO in all scenarios and an annual decrease of the coverage is occurring.

4 DISCUSSION

There are many challenges on coordinates an integrated public health program in a country same as Brazil given its spatial extension, social and climatic diversity and economics problems. Despite this, the country is controlling the rabies transmitted by dogs. From 2012 to 2017 were registered 40 rabies cases in human, and one of these were transmitted by dogs. At the same time three cases transmitted by cats are an alert for this specie importance on rabies transmission (Vargas et al., 2019). Given the difficulties of coordinating the Brazilian program for urban rabies control, problems must be verified to improve the efficacy on decision-making.

Some municipalities significantly exceeded the recommended vaccinated coverage targets. As an example, in 2012, 1.642 Brazilian municipalities presented the vaccine coverage rate above 120% of the recommended target. Mirador, a municipality in the State of Maranhão, presented a vaccination target of only three canine and one feline, but in that year, 3.041 and 1.223 individuals of both species received doses of vaccine. Probably it was due to the misconduction of the animal population estimate or to the typo.

A time series statistical analysis was carried out by comparing the estimated domiciled animal population recommended by the World Health Organization and the data made available on IBGE regarding the canine and feline census. The results showed that, despite a probable population underestimation in the national context, the rabies vaccination of dogs and cats has been undergoing an important decrease in the coverage. A Pearson correlation of 0.88 ($p = 0.01$) was observed between the estimated target of 80% of 1:10, suggesting that, in general, Brazilian municipalities are planning their canine and feline rabies vaccination activities based on such proportion. This decrease may indicate a problem on the PNPR data registration or in population estimation.

Therefore, it is desirable to carry out the animal census in each location or a probabilistic sample study in order to conduct an adequate prophylaxis that ensures the prevention of viral circulation and consequent human protection against the disease and fidelity to the actions and objectives contemplated by the National Program. The

underestimation of the animal population has the implication of a deficit in vaccination coverage, which may reach levels below 80%, leading to a damage to human health (Miranda et al., 2003; Canatto, 2010). Free-roaming animals represent a serious health problem, since they can maintain the rabies cycle and cause attacks (Reece and Chawla, 2006; Reece et al., 2013; Bandeira et al., 2018; Cavalcante & Alencar, 2018)

Bandeira et al. (2018) highlight that there was a rabies outbreak in wild animals in Rio Grande do Norte in the period from 2010 to 2016. It is observed that this fact coincides with the notification of the human case that occurred in 2015 and was caused by an aggression of a cat with the variant AgV3. In that year, 130 among its 167 municipalities obtained the canine anti-rabies vaccine coverage between 80 and 110%. These data can indicate which measures should be adopted to prevent human rabies that involves the wild viral variant.

There were two human cases in São Luís (MA), in 2012, and one case in Corumbá (MS), in 2015, which were related to dog rabies epizootics (Brasil, 2016). Only one case of the disease was reported in 2012, in the municipality of Rio Casca (MG), which viral variant involved was AgV3 (from chiropterans). According to the Ministry of Health, the patient in question either did not seek post-exposure prophylactic treatment or was subjected to an erroneous protocol in the health unit, progressing to death (Brasil, 2016). In these states, it was possible to observe that the vaccine coverage rates varied from far beyond or far below the target for the period, showing a precarious adoption of measures for rabies control and prevention, from the moment there is a super or an underestimation of the animal population.

The South and Southeast regions of Brazil are considered free from human rabies transmitted by dogs and cats. The last case in a dog was notified in Santa Catarina in 1981 (Cavalcante *et al.*, 2018). However, in February 2016, a beagle dog was diagnosed with rabies confirmed through laboratory tests. This animal was domiciled in Maringá (PR) - vaccination-free region for the disease - and had a history of travel to Macapá, capital of Amapá. At this location, it was probably infected through the chiropteran saliva, due to the variant identified in the samples collected, as disclosed by the Ministry of Health (Brasil, 2016). In addition, in a report released by the agency in 2016, there were campaigns vaccination in two municipalities in Paraná bordering Paraguay and these would cease in a short period of time (Brasil, 2016).

The maintenance of cases of rabies in animals, although there are intervention measures, such as vaccination, can be a consequence of inefficiency or the absence of

public policies. One can also think that it is a chronic problem (endemic or epidemic) related to the maintenance of the disease. In areas known to be endemic, capturing and driving free-roaming dogs to public shelters should be carried out in order to be observed for at least three working days. From this observation, those animals with neurological symptoms or those who died should be referred for laboratory rabies diagnosis. If viral circulation is detected, actions such as blocking the focus should be performed to prevent the occurrence of human infection and the new cases among animals (Brasil, 2009; Brasil, 2019c).

For the Ministry of Health, the continued occurrence of animal cases in a municipality, even if there are control actions, implies the lack of effective and quality of sanitary measures and can characterize a local chronic problem (endemic or epidemic) (Brasil, 2009).

The notification of suspected epizootic cases in the various existing information systems must be carried out in order to conduct passive surveillance of the disease in dogs, cats and wild animals and it is mandatory to notify suspected cases (Benavides et al., 2019; Brasil, 2019c). Wild rabies demands specific measures for its control due to the severity of the attacks of blood-sucking bats and the predatory behavior of cats that might favor the increased incidence of this disease in Brazil. Surveillance is essential, as well as the assessment of wild animals that are potential reservoirs and that contribute to maintaining the circulation of the viral variant involved, including the incidence among domestic animals (Brasil, 2009; Brasil, 2019c).

5 CONCLUSIONS

Human rabies is a controlled disease in Brazil given the success of canine and feline vaccination campaigns in Brazil in past years. However, there are problems in the vaccination coverage rate in some Brazilian states and in data registration and availability, mainly in Northeast and Southeast regions that require attention to achieve urban rabies eradication.

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REFERENCES

- Alves, M.C.G.P., Matos, M.R.De, Reichmann, M.deL.A.B., Dominguez, M.H.S., 2005. Dimensionamento da população de cães e gatos do interior do Estado de São Paulo. *Rev. Saúde Pública*. <http://dx.doi.org/10.1590/S0034-89102005000600004>.
- Bandeira, E.D., Filho, A.S.deB., Santos, E.G.deO., Barbosa, I.R., 2018. Circulação do vírus da raiva em animais no município de Natal-RN e profilaxia antirrábica humana de pós-exposição, no período de 2007 a 2016. *Journal of Health & Biological Sciences*. <http://dx.doi.org/10.12662/2317-3076jhbs.v6i3.1959.p258-264.2018>
- Benavides, J.A., Megid, J., Campos, A., Rocha, S., Vigilato, M.A.N., Hampson, K., 2019. An evaluation of Brazil's surveillance and prophylaxis of canine rabies between 2008 and 2017. *PLoS Neglected Tropical Diseases*. <https://doi.org/10.1371/journal.pntd.0007564>.
- Brasil, 2009. Guia de Vigilância Epidemiológica, sétima ed. Ministério da Saúde, Brasília.
- Brasil, 2016. Nota Informativa: Informações sobre raiva canina por variante 3 de Quiróptero, Ministério da Saúde, Brasília.
- Brasil, 2017. Portaria de Consolidação nº 4, de 28 de setembro de 2017, Ministério da Saúde, Brasília.
- Brasil, 2019a. Programa Nacional de Imunizações, Ministério da Saúde, Brasília.
- Brasil, 2019b. Raiva - casos confirmados notificados no Sistema de Informação de Agravos de Notificação, Ministério da Saúde, Brasília.
- Brasil, 2019c. Guia de Vigilância em Saúde. 3ª edição, Ministério da Saúde, Brasília.
- Brasil, 2020. Raiva, Ministério da Saúde, Brasília. Disponível em < <http://antigo.saude.gov.br/saude-de-a-z/raiva> >.
- Canatto, B.D., 2010. Caracterização das populações de cães e gatos domiciliadas no município de São Paulo. Dissertação (Mestrado em Epidemiologia Experimental e Aplicada às Zoonoses): Universidade de São Paulo. Disponível em: < https://www.teses.usp.br/teses/disponiveis/10/10134/tde03022011131309/publico/Bianca_Davico_Canatto.pdf >, último acesso em 29 jul 2020.
- Cavalcante, K.K.deS., Alencar, C.H., 2018. Human rabies: evaluation of post-exposure prophylaxis prevalence in Ceará, Brazil, 2007-2015. *Epidemiol. Serv. Saúde*. <https://doi.org/10.5123/s1679-49742018000400009>.
- INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). 2015. Pesquisa Nacional por Amostra de Domicílio: síntese de indicadores 2013. Coordenação de Trabalho e Rendimento. IBGE. 2. ed. 296p. Rio de Janeiro.

Hampson, K., Coudeville, L., Lembo, T., Sambo, M., Kieffer, A., Atflan, M., Barrat, J., Blanton, J.D., Briggs, D.J., Cleaveland, S., 2015. Estimating the global burden of endemic canine rabies. *PLoS Negl Trop Dis* 9, 1–20.

Matos, M.R.de, Alves, M.C.G.P, Reichmann, M.deL.A.B., Dominguez, M.H.S., 2002. Técnica Pasteur São Paulo para dimensionamento de população canina. *Cad. Saúde Pública*. <http://dx.doi.org/10.1590/S0102-311X2002000500035>.

Miranda, C.F.J.de, Silva, J.A.da, Moreira, E.C., 2003. Human rabies transmitted by dogs: risk areas in Minas Gerais, Brazil, 1991-1999. *Cad. Saúde Pública*. <https://doi.org/10.1590/S0102-311X2003000100010>

Reece, J.F., Chawla, S.K., 2006. Control of rabies in Jaipur, India, by the sterilisation and vaccination of neighbourhood dogs. *Vet Rec*, v. 159, n. 12, p. 379-83. ISSN 0042-4900 (Print) 0042-4900.

Reece, J.F., Chawla, S.K., Hiby, A.R., 2013. Decline in human dog-bite cases during a street dog sterilisation programme in Jaipur, India. *Veterinary Record*, v. 172, n. 18, p. 473. Disponível em: <<https://www.scopus.com/inward/record.uri?eid=2-s2.0-84877607326&doi=10.1136%2fvr.101079&partnerID=40&md5=0ac75c20edcbe57fb5233c40e61d3716>>.

Vargas, A., Romano, A.P.M., Merchán-Hamann, E., 2019. Human rabies in Brazil: a descriptive study, 2000-2017. *Epidemiologia e Serviços de Saúde*, v. 28, p. e2018275.