Diseases related to inadequate environmental sanitation in the Metropolitan Region of Goiânia, Brazil, between 2008 and 2018

Doenças relacionadas ao saneamento ambiental inadequado na Região Metropolitana de Goiânia, Brasil, entre 2008 e 2018

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ABSTRACT

The main objectives of this study were to describe the occurrence of diseases related to inadequate environmental sanitation (DRIES) in the metropolitan region of Goiânia (RMG), between 2008 and 2018, through the number of hospitalizations, deaths, and the total amount spent on them in the National Health Service; to detail the occurrence of the most significant DRIES in the RMG and to compare two sources of SUS data. The study was descriptive based on secondary data from TabNet and Autorizações de Informações Hospitalares (AIH), from the Hospital Information System (SIH), considering 15 DRIES in 20 municipalities of the RMG over 11 years. DRIES caused 58,105 hospitalizations, 384 deaths and the total amount of R$ 20.5 million to the public health system. The most frequent DRIES were dengue, diarrhoea and other intestinal infectious diseases, whereas faecal-oral transmission diseases was the most significant group, with 57.3% of the cases. Elderly people aged 80 years and older were the most affected by dengue (4,972 cases); however, 11,355 hospitalizations were of adults between the ages of 20 and 59 years. Children and the elderly were the most affected by diarrhoea, with 40% of hospitalizations of children between the ages of 1 and 4 years. Large discrepancies were observed between the values obtained from TabNet and those obtained from AIH, indicating, in general, underreporting of the latter. DRIES hospitalizations still represent a significant impact on the public health system and are an important indication of the sanitation situation in the RMG municipalities.

Keywords: Hospitalizations, Public Health, Sanitation.

RESUMO

Os principais objetivos deste estudo foram descrever a ocorrência de doenças relacionadas ao saneamento ambiental inadequado (DRSAI) na região metropolitana de Goiânia (RMG), entre 2008 e 2018, por meio do número de internações, óbitos e do valor total gasto no Sistema Único de Saúde (SUS); detalhar a ocorrência dos DRSAI mais significativas na RMG e comparar duas fontes de dados do SUS. O estudo foi descritivo com base em dados secundários do TabNet e Autorizações de Informações Hospitalares (AIH), do Sistema de Informação Hospitalar (SIH), considerando 15 DRSAI em 20 municípios da RMG em 11 anos. As DRSAI causaram 58.105 internações, 384 mortes e o valor total de R$ 20,5 milhões ao SUS. As DRSAI mais frequentes foram dengue, diarreia e outras doenças infecciosas intestinais, sendo as doenças de transmissão fecal-oral o grupo mais significativo, com 57,3% dos casos. Idosos com 80 anos ou mais foram os mais acometidos pela dengue (4.972 casos); no entanto, 11.355 hospitalizações foram de adultos com idades entre 20 e 59 anos. Crianças e idosos foram os mais acometidos pela diarreia, com 40% das internações de crianças entre 1 e 4 anos. Foram observadas grandes discrepâncias entre os valores obtidos no TabNet e os obtidos nas AIH, indicando, em geral, subnotificação desta última. As internações por DRSAI ainda representam um impacto significativo no sistema público de saúde e são um importante indicativo da situação do saneamento nos municípios da RMG.

Palavras-Chave: Hospitalizações, Saúde Pública, Saneamento.

1 INTRODUCTION

The relationship between health and sanitation is well known throughout the world and has been studied since the 17th century. In 1983, the authors Sandy Cairncross and Richard Feachem classified the main infectious diseases related to environmental aspects (Cairncross and Feachem, 2019) paving the way for numerous studies on the relationship between these diseases and sanitation. The importance of this subject has made it recurrent in institutions such as the United Nations (UN), the World Health Organization (WHO), and other cooperation blocks and government bodies. However, developing countries, especially tropical countries, are the most affected by this problem. In fact, the coverage rates of sanitation services in countries such as Brazil are far from reaching universal access. On the other hand, Brazil has a database with great potential to support decision making regarding health and sanitation - the Hospital Information System (SIH). This study sought to investigate the occurrence of diseases and illnesses related to the precariousness of sanitation in an important Brazilian metropolitan region, so that the results obtained here may guide future policies and public actions that may

bring Brazil closer to the goals established by the UN, an organization of which Brazil is a member country.

Environmental sanitation is defined as the set of socioeconomic actions whose purpose is environmental health, such as potable water supply, adequate waste management, promotion of sanitary land use, urban drainage and control of transmissible diseases (FUNASA, 2015). Environmental health, in turn, is the state of hygiene of the population, which is linked to its capacity to combat the occurrence of endemics and epidemics conveyed by the environment. The concept of basic sanitation, which is more widespread among the population in Brazil, is more specific. According to Federal Law 11.445/2007, basic sanitation includes four main components: i) potable water supply; ii) sewage collection, transport and treatment; iii) urban cleaning and solid waste management; iv) drainage and urban rainwater management (Brasil, 2007). Both definitions make clear the intrinsic relationship between humans and the environment, such that the improvement of sanitary conditions is directly reflected to the quality of human life.

John Snow was one of the first scientists to expose the cause-and-effect relationship between sanitation and epidemics in 1854, by correlating a cholera epidemic to a contaminated water pump on a public road in London (Cameron and Jones, 1983). Since then, knowledge about public health and environmental health has advanced dramatically. In the book "Environmental Health Engineering in the Tropics", originally published in 1983, Cairncross and Feachem (Cairncross and Feachem, 2019) establish a new classification of infectious diseases that are of interest to environmental health. Instead of the traditional classification, which groups diseases according to the nature of their pathogens, the authors classified infectious diseases into categories which relate to the various aspects of the environment which can be altered. Since they are related to inadequate sanitary conditions, these diseases are, by definition, avoidable through sanitation measures. The new classification represented a great advance and has been widely adopted across the world. However, some diseases classified by Cairncross and Feachem (Cairncross and Feachem, 2019) do not apply to Brazil, since they have been eradicated or occur sporadically. From the Cairncross and Feachem classification, the National Health Foundation (FUNASA) then defined the Diseases Related to Inadequate Environmental Sanitation (DRIES) which are relevant in Brazil (FUNASA, 2010).

As a UN member country and signatory of UN's 17 Sustainable Development Goals (SDG), Brazil still has a long way to go. For example, only 43% of the Brazilian

population has its sewage collected and treated (ANA, 2017). According to the National Water Agency (ANA) Sewage Atlas (ANA, 2017), the situation in the Midwest region is better than the Brazilian average, with 63% of the population served by adequate sanitary sewage. The document points out that the attendance index reaches 95.4% in the capital of Goiás, Goiânia. However, the situation is very different in nearby municipalities: in Aparecida de Goiânia, whose boundaries are often confused with those of Goiânia, only 36.1% of the population is served (ANA, 2017).

The Metropolitan Region of Goiânia (RMG) comprises 21 municipalities: Abadia de Goiás, Aparecida de Goiânia, Aragoiânia, Bela Vista de Goiás, Bonfinópolis, Brazabrantes, Caldazinha, Caturaí, Goianápolis, Goianira, Guapó, Hidrolândia, Inhumas, Nerópolis, Nova Veneza, Santa Bárbara de Goiás, Santo Antônio de Goiás, Senador Canedo, Terezópolis de Goiás and Trindade (Goiás, 2018). Despite the precariousness of some sanitation services, the Atlas of Human Development in Brazil reports that the RMG scored a Municipal Human Development Index (IDHM) of 0.769 in 2010 (PNUD et al., 2013). In 2017, the Integrated Master Plan of the Metropolitan Region of Goiânia (PDIRMG) was launched, which gathered important information about municipalities that made up the RMG at the time, as well as established guidelines for urban development in the metropolitan region, in order to improve the quality of life and well-being of its population and restore the balance between social, urban and environmental concerns in the metropolitan territory (Goiás, 2017). The PDIRMG, as well as other regional management plans, is of extreme importance for the elaboration of sanitation and public health policies in the metropolitan region of Goiânia.

Moreover, the Hospital Information System (SIH) of the National Health Service (SUS) is a powerful source of public health information. Through its IT Department (DATASUS), SUS provides detailed information regarding all hospitalizations registered in public health units throughout Brazil. This data is freely accessible and supports numerous health and medical researches. SUS funding is provided as follows: federal resources destined to health services are deposited in the National Health Fund and then transferred to state and municipal funds, according to the mechanism established in 1994 by Decree No. 1,232 (Brasil, 1994). Its financing mechanism takes place in such a way that SUS also receives contributions from state and municipal resources (MS, 2002). Consequently, financial impacts on any of its units may be reflected at the municipal, state and federal level.

Sanitation is essential to guaranteeing a healthy and ecologically balanced environment which, according to Brazil's Federal Constitution, are both rights that all Brazilians are entitled to (Brasil, 1988). In Brazil, several DRIES still threaten the guarantee of these rights and have financial impact on SUS and other public bodies, especially in the context of preventable diseases and illnesses. In Brazil's current political and economic climate of instability, investment in basic sanitation is necessary and urgent, and must focus on protecting human health, preserving the environment, reducing avoidable expenses and maintaining national and international agreements that support the country's economic development.

This study sought to describe, through data from the Hospital Information System (SIH/SUS), the occurrence of Diseases Related to Inadequate Environmental Sanitation (DRIES) in the Metropolitan Region of Goiânia (RMG) between 2008 and 2018. Specifically, it was intended:

i) to survey the number of hospitalizations, deaths and the total amount spent on DRIES occurring in the RMG, through data obtained from TabNet (DATASUS, 2008a).

ii) to analyse the data from Hospitalization Authorizations (AIH) regarding the DRIES occurring in the RMG;

iii) to verify the compatibility between data obtained from TabNet and AIH;

iv) to analyse the DRIES occurrence profile that stood out in the RMG between 2008 and 2018.

2 MATERIALS AND METHODS

2.1 SPATIAL CUTOUT

The hospital data analysed represents individuals residing in the 20 municipalities that made up the Metropolitan Region of Goiânia at the time of the data collection. Those were: Abadia de Goiás, Aparecida de Goiânia, Aragoiânia, Bela Vista de Goiás, Bonfinópolis, Brazabrantes, Caldazinha, Caturaí, Goianápolis, Goianira, Guapó, Hidrolândia, Nerópolis, Nova Veneza, Santa Bárbara de Goiás, Santo Antônio de Goiás, Senador Canedo, Terezópolis de Goiás and Trindade (Goiás, 2018). The displacement of individuals and the location of the health unit where the care was provided were not considered.

2.2 DISEASES AND ILLNESSES ANALYSED

It was observed the selection of DRIES described in the "Final Report of Impacts on Health and in the National Health System Resulting from illnesses Related to Inadequate Environmental Sanitation"(FUNASA, 2010). This selection considers the Cairncross and Feachem (2019) and Heller (1995) classifications, excluding diseases not present in Brazil, or those present only in sporadic cases. Then, the availability of records of these DRIES in SUS was verified. Since cases of amebiasis and cholera were not insignificant in the RMG, those were added to the list of DRIES. Finally, we reached the 15 diseases and illnesses listed in Table 1.

Table 1. List of diseases related to inadequate environmental sanitation observed in the Metropolitan Region of Goiânia between 2008 and 2018.

DRIES [a]	**ICD-10** [b]
Amebiasis	A06, A06.0, A06.1, A06.4, A06.7, A06.9
Cholera	A00, A000, A001, A009
Conjunctivitis and other conjunctival disorders	B30, H10, H13.1, H13.2, H11, H11.8, H13.8
Dengue [c]	A90, A91
Diarrhoea and gastroenteritis presumably infectious origin	A09
Other intestinal infectious diseases [d]	-
Schistosomiasis	B65, B65.9
Yellow fever	A95, A95.9
Typhoid and parathyroid fevers [e]	A01
Filariasis	B74, B74.9
Other Helminthiasis	B83
Viral Hepatitis [f]	B19
Icterhemorrhagic [g]	A27, A27.0, A27.8, A27.9
Malaria [h]	B50, B51, B52, B53.8, B54
Mycoses	B49

(a) Diseases Related to Inadequate Environmental Sanitation.
(b) International Classification of Diseases, WHO's 1996 Review (WHO, 1989)
(c) Dengue [classic dengue], Hemorrhagic fever due to the dengue virus
(d) Has no direct equivalence with any ICD-10 code.
(e) Enteric fevers.
(f) According to Cairncross and Feachem (2019), only Hepatitis A is considered a DRIES. However, SUS online platform makes no distinction between types of hepatitis.
(g) Icterohemorrhagic leptospirosis, other forms of leptospirosis, leptospirosis unspecified
(h) Malaria by plasmodium falciparum, malaria by plasmodium vivax, malaria by plasmodium malaria, other forms of malaria according to parasitological examinations, malaria unspecified.
Source: The authors, 2019.

2.3 DATA COLLECTION

All hospital information used in this study comes from the National Health System (SUS). Data was collected from the Hospital Information System (SIH/SUS), whose access is provided by SUS IT Department (DATASUS) in two different ways:

i) TabNet: through the page http://tabnet.datasus.gov.br, under the domain of the Ministry of Health, where it is possible to select variables and generate tables with most of the hospital information (DATASUS, 2008a).

ii) Reduced AIH: through the download of "RD*" type reduced files, containing hospitalization authorizations (AIH), available at http://www2.datasus.gov.br/SIHD/reduzida, under the domain of the Ministry of Health, consisting of 114 fields of information for each hospitalization record (DATASUS, 2008b).

First, TabNet was used to collect information on hospital morbidity, aggregated by patient's place of residence and the 15 diseases and illnesses contained in Table II. The records of all hospitalizations of individuals residing in 20 municipalities were observed. The hospitalizations considered were those recorded between January 2008 and December 2018. The following data was used: total amount spent, number of hospitalizations and number of deaths. The information was downloaded in ".csv" format, tabulated and analyzed with the help of TabWin32 (version 4.1.5) and Microsoft Excel (2016) softwares. In each file, the municipality of Inhumas was removed and the municipality of Santa Bárbara de Goiás was added.

At the same time, AIH was downloaded for the state of Goiás every month between January 2008 and December 2018. The files, in ".dbf" format, were unified and organized in a MySQL database (version 8.0). Of the 114 fields available in the records, only eight (8) were selected: hospitalization year (ANO_CMPT), hospitalization month (MES_CMPT), patient's municipality of residence (MUNIC_RES), patient's gender (SEXO), hospitalization total amount spent (VAL_TOT), main diagnosis (DIAG_PRINC), patient's age (IDADE), indication of death (MORTE). Regarding financial information, no updates or monetary corrections were made. In this database, only ten (10) of the fifteen (15) DRIES of interest were recorded.

Based on demographic data from the 2000 and 2010 census (IBGE, 2010), 2013 RMG's population was estimated, from which the hospitalization and mortality rates were calculated (per 100,000 inhabitants/year and per 10,000 inhabitants/year, respectively). The population for 2013 was chosen because it was the midpoint between 2008 and 2018, following the method described by Nugem (2015). The amount spent per capita with these hospitalizations was also calculated, dividing the total amount spent on hospitalizations in the period by the population of 2013 in each municipality. With these rates, three (3)

maps were generated, showing: hospitalization rate, death rate, and amount spent per capita with DRIES hospitalizations in the RMG.

After calculating the total values and rates obtained from the TabNet and the AIH files, comparative tables were made, by DRIES and by municipality. These tables showed the incompatibilities between the two data sources.

Finally, dengue and diarrhoea were selected, since they had the highest number of records according to AIH files and were among the 3 most frequent in the RMG according to TabNet. Then, their occurrences between 2008 and 2018 were counted and aggregated by month, year, age and gender.

3 RESULTS AND DISCUSSION

In this section, all the results and discussions obtained in the research are presented. Item 1.1 contains only the results obtained from the TabNet information, organised by municipality (3.1.1) and by disease (3.1.2). Then, in subsection 3.2, more detailed analyzes of hospitalizations for dengue (3.2.1) and diarrhoea (3.2.2), made from the Hospitalization Authorizations (AIH), were presented. Finally, section 3.3 presents a comparison between the results produced with each data source (TabNet and AIH), considering only the 10 diseases or illnesses that coincided in both.

3.1 RESULTS OBTAINED FROM TABNET

3.1.1 By municipality

According to TabNet data, diseases related to inadequate environmental sanitation were the main diagnosis of 58,105 hospitalizations in the public health system of the metropolitan region of Goiânia between 2008 and 2018. These occurrences generated a total amount spent of R$ 20,468,097.41 and caused 384 deaths. The results equate to a rate of 22.9 hospitalizations per 10,000 inhabitants/year and 1.5 deaths per 100,000 inhabitants/year in the RMG, in addition to a total per capita expenditure of R$ 8.89 during the entire period.

If compared with the morbidity rate found by Siqueira et al. (2017) for the Metropolitan Region of Porto Alegre, of 6.8 hospitalizations per 10,000 inhabitants/year, the RMG hospitalization rate is quite high. However, Fonseca and Vasconcelos (2011) show that the rate obtained for the State of Goiás between 2000 and 2010 was about 21.7 hospitalizations per 10,000 inhabitants/year, approaching the rate found here (22.9). The

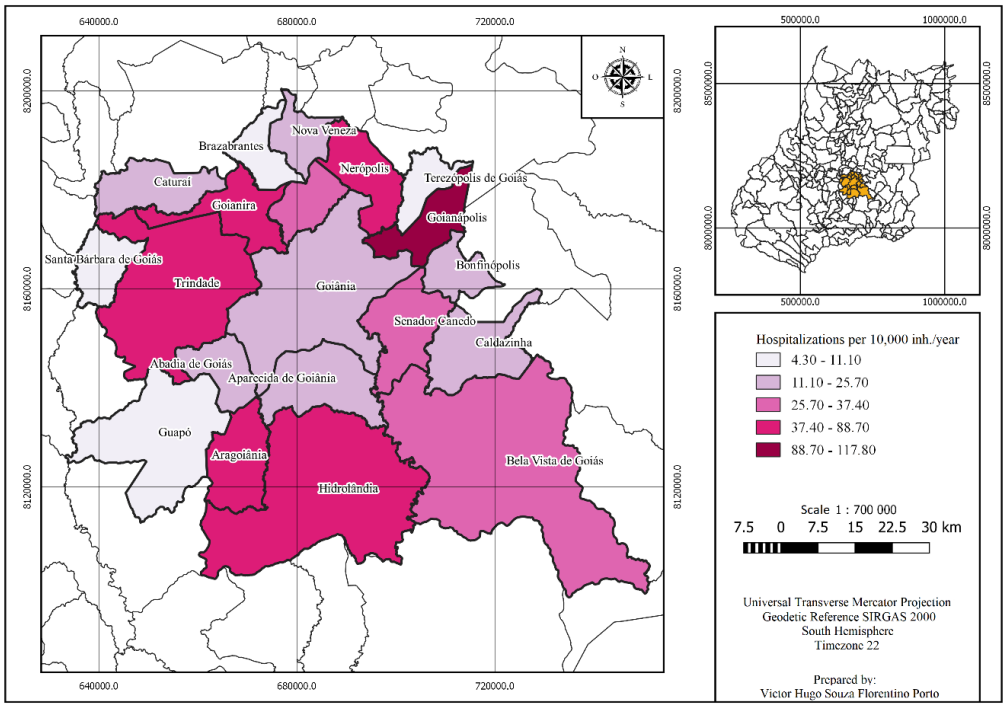
death rate (1.5 per 100,000 inhabitants/year) was the same rate found for the Metropolitan Region of Porto Alegre (Siqueira et al., 2017).

In absolute numbers, Goiânia, Aparecida de Goiânia and Trindade were, in this order, the municipalities with the highest number of DRIES cases. Goiânia was responsible for 49.9% of the hospitalizations, 58.3% of the deaths and 51.6% of the total amount spent. Aparecida de Goiânia had 13.2% of the hospitalizations, 17.8% of the deaths and 14.1% of the total amount spent, and Trindade had 12.7% of the hospitalizations, 10% of the deaths and 11.7% of the total amount spent. These numbers were to be expected, since Goiânia, Aparecida de Goiânia and Trindade are the most populated cities in the region, totaling 2,186,990 inhabitants in 2018, or 86.8% of the population living in the Metropolitan Region of Goiânia (IBGE, 2010).

It is notable that Goianápolis and Nerópolis had hospitalizations (117.8 and 88.7 per 10,000 inhabitants/year, respectively) and amount spent per capita (R$ 42.26 and R$ 26.82, respectively) far above from the average of the RMG. Though Goianápolis has 84.59% of its population uncovered by sewage collection and treatment services, this percentage is much lower in Nerópolis (26.59%). However, 71.97% of Nerópolis wastewater is treated on site. Nerópolis's high rate of hospitalizations for DRIES, combined with its high percentage of individual sewage solutions, might indicate the inefficiency of such solutions (ANA, 2017). Nonetheless, the other three components of basic sanitation should also be considered when analyzing the causes of DRIES. It is also important to analyze the daily displacement of individuals between the municipalities of the RMG and the coverage rate of private health plans, which can take significant portions of hospitalizations.

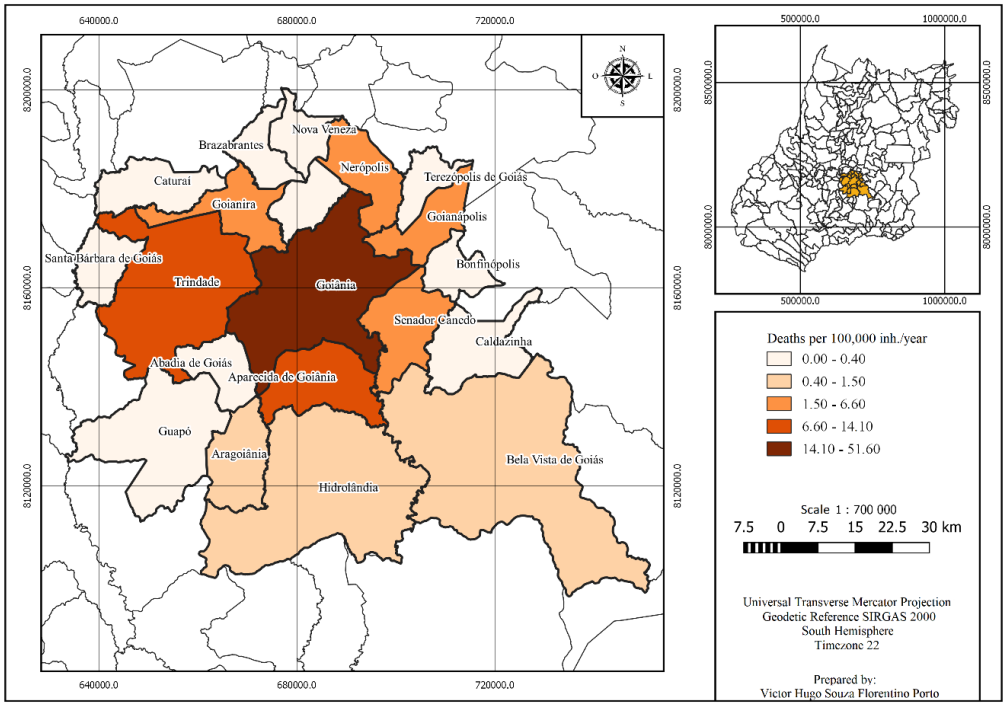
The maps in Figures 1, 2 and 3 show, per municipality, the hospitalization rate (per 10,000 inhabitants/year), the death rate (per 100,000 inhabitants/year) and the total amount spent per capita (in R$), referring to cases of DRIES in the public health system between 2008 and 2018.

Figure 1. Map of hospitalization rates for diseases related to inadequate environmental sanitation (DRIES) in the public health system, per 10,000 inhabitants per year, per municipality, of individuals residing in the metropolitan region of Goiânia, between 2008 and 2018.



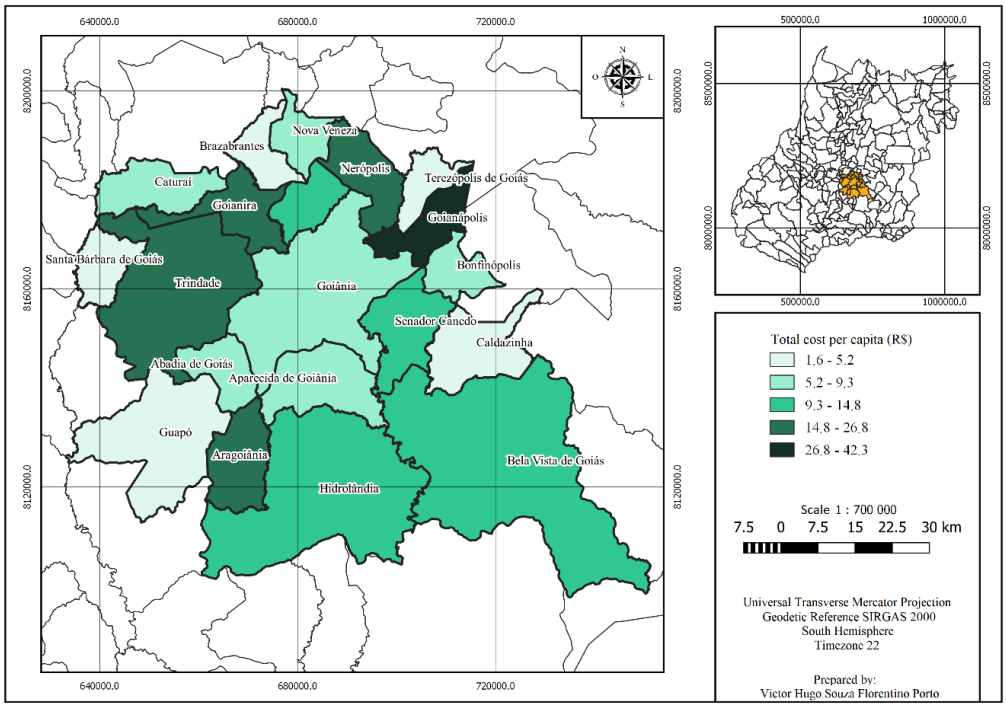
Source: The authors, 2019. Prepared by: Victor Hugo Souza Florentino Porto.

Figure 2. Map of death rates due to diseases related to inadequate environmental sanitation (DRIES) in the public health system, per 100,000 inhabitants per year, per municipality, of individuals residing in the metropolitan region of Goiânia, between 2008 and 2018.



Source: The authors, 2019. Prepared by: Victor Hugo Souza Florentino Porto.

Figure 3. Map of total amount spent capita expenses, in reais (R$), per municipality, for hospitalizations caused by diseases related to inadequate environmental sanitation (DRIES) in the public health system, of individuals residing in the metropolitan region of Goiânia, between 2008 and 2018.



Source: The authors, 2019. Prepared by: Victor Hugo Souza Florentino Porto.

In TabNet, no records were found for the municipality of Santa Bárbara de Goiás for any category between January 2008 and August 2018; however, the municipality presented records from September to December 2018 for more than one DRIES.

3.1.2 By DRIES

Diarrhoea and dengue were the most commonly occurring DRIES, diarrhoea being reported in 18 and dengue in 19 municipalities, out of the 20 considered.

The DRIES that stood out the most in the RMG was dengue, with 37.0% of the total amount spent, 40.2% of hospitalizations and 38.1% of deaths. In second place, the category of "other intestinal infectious diseases" registered 29.9% of the total amount spent, 29.0% of hospitalizations and 19.7% of deaths. Hospitalizations due to diarrhoea, in turn, accounted for 23.6% of the total amount spent, 24.8% of hospitalizations and 16.0% of deaths in the period analyzed.

Although dengue alone was the most prominent disease, insect vector transmitted diseases were not the most significant group. Faecal-oral transmissitted diseases ranked first in total amount spent (R$ 11.8 million - 57.6% of all DRIES), number of hospitalizations (33,316 cases - 57.3% of all DRIES), and number of deaths (189 cases -

49.2% of all DRIES). These numbers illustrate the peculiarity of the Goiás municipalities in relation to those in the South of the country, where faecal-oral transmitted diseases account for over 90% of DRIES cases (Siqueira et al., 2017). In the case of RMG, it appears that diseases transmitted by insect vectors stand out more due to the strong relationship between the proliferation of vectors and higher temperatures, among other factors.

Table 2 shows the results, by DRIES, obtained from TabNet data. Dengue, diarrhoea and other intestinal infectious diseases were the most significant diseases for all parameters analyzed.

Table 2. Total amount spent (in R$), hospitalizations and deaths from diseases related to inadequate environmental sanitation in the public health system, in the Metropolitan Region of Goiânia, between 2008 and 2018.

DRIES [a]	Total Amount	Hospitalizations	Deaths
Dengue [b]	7.574.369,64	23.375	147
Other intestinal infectious diseases	6.125.547,59	16.856	75
Diarrhoea and gastroenteritis presumably infectious origin	4.835.867,80	14.451	62
Mycoses	769.644,06	927	40
Viral Hepatitis	284.115,34	582	37
Cholera	279.627,24	698	10
Amebiasis	216.866,29	598	5
Other Helminthiasis	160.076,47	66	1
Malaria [c]	57.825,45	122	4
Conjunctivitis and other conjunctival disorders	51.023,35	210	0
Typhoid and parathyroid fevers	44.827,43	132	0
Leptospirosis [d]	35.197,48	26	2
Filariasis	29.215,86	53	0
Yellow fever	2.212,10	5	1
Schistosomiasis	1.681,31	4	0
TOTAL	20.468.097,41	58.105	384

(a) Diseases Related to Inadequate Environmental Sanitation.
(b) Dengue [classic dengue], Hemorrhagic fever due to the dengue virus.
(c) Malaria by plasmodium falciparum, malaria by plasmodium vivax, malaria by plasmodium malaria, other forms of malaria according to parasitological examinations, malaria unspecified.
(d) Icterohemorrhagic leptospirosis, other forms of leptospirosis, leptospirosis unspecified.
Source: The authors, 2019.

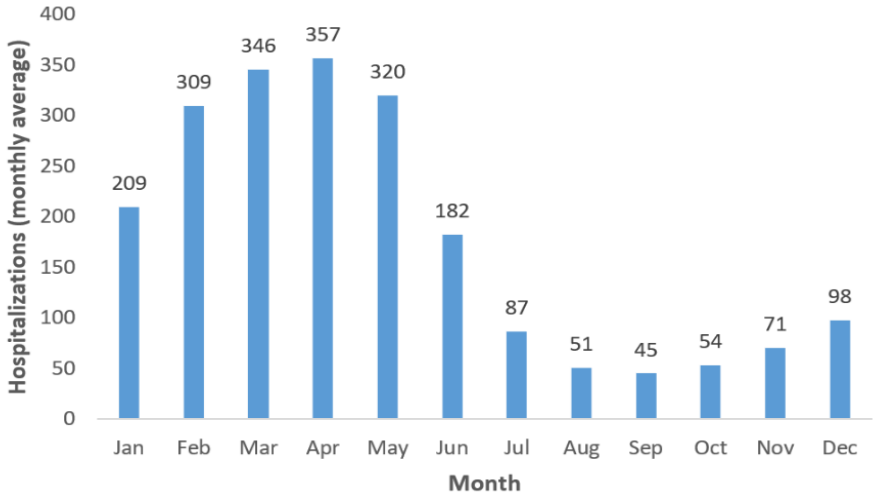
3.2 RESULTS OBTAINED FROM HOSPITALIZATIONS AUTHORIZATIONS (AIH)

The information gathered through the AIH allowed for detailed analyzes of the occurrence of 10 DRIES. In this section, analyzes of the occurrences of the two most frequent and costly DRIES are presented: dengue (3.2.1) and diarrhoea (3.2.2).

3.2.1 Dengue

Figure 4 shows the monthly occurrence pattern of dengue cases, drawn by calculating the average number of hospitalizations each month over the 11 years analyzed. It is notable that periods of drought and lower temperatures, which occur between July and November in Goiás, showed lower average number of hospitalizations.This is likely because precipitation and temperature have a direct influence on the life cycle of the dengue-transmitting mosquito, as evidenced by Souza et al. (2010) for the municipalities of Goiás.

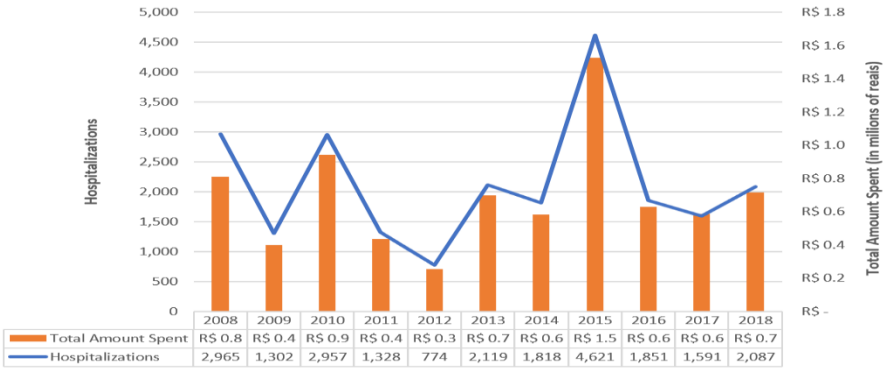
Figure 4. Graph of the average number of hospitalizations for dengue in the public health system per month, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.



Source: The authors, 2019.

The annual analyzes of dengue cases did not show any trend of continuous increase or decrease in hospitalizations over the period observed. Figure 5 shows that 2015 had a peak in dengue cases, while the remaining years showed no observable pattern.

Figure 5. Graph of hospitalizations and total amount spent on dengue cases in the public health system per year, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.



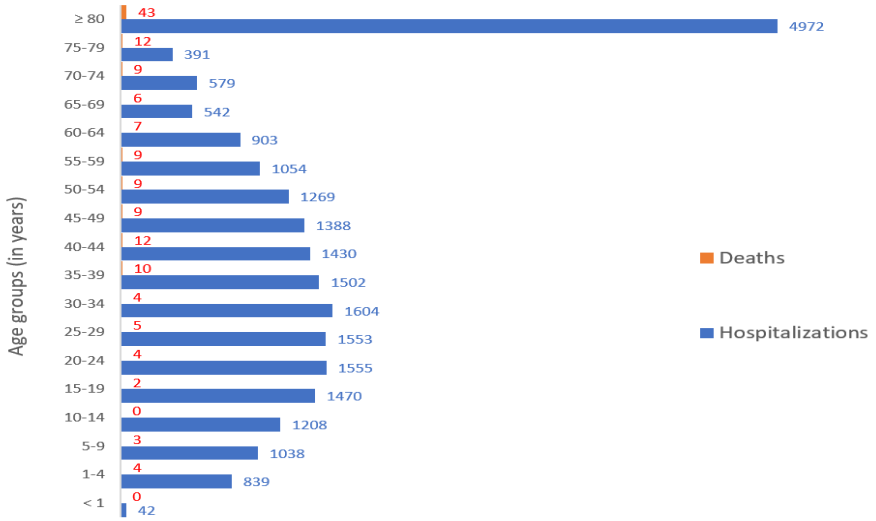
Source: The authors, 2019.

The distance between the hospitalizations curve and the total amount spent graph decreases over time, which may indicate an increase in the average cost of hospitalizations for dengue in the public system. However, the graph does not account for inflation or global economic variations. Therefore, these results should be analyzed in more detail in subsequent studies.

Regarding the gender of the patients, 55% of hospitalizations for dengue were female patients. Regarding the deaths, 53% were male patients. 100% of the AIH had the field "SEXO" filled with the number 1 (male) or 3 (female), and there were no records of individuals who did not wish to declare this information.

Figure 6 shows the hospitalizations and deaths by dengue recorded in each age group in the RMG. A significant portion of the hospitalizations were of individuals between 20 and 59 years old (11,355 hospitalizations - 48.5%), a range in which the population is expected to be actively engaged in the labor market. Individuals affected by dengue are unable to work while recovering and therefore generated another negative financial impact. Such indirect impacts were not accounted for in this study. Another alarming fact is the number of people 80 years old and over affected by dengue. It is necessary to investigate what conditions expose this age group to infection, or if there is underreporting in other age groups.

Figure 6. Hospitalizations and deaths due to dengue in the public health system, by age group, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.

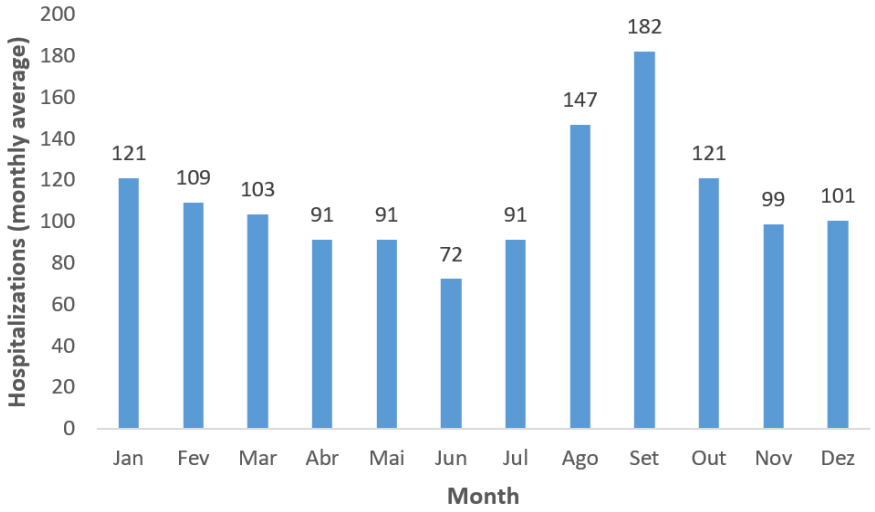


Source: The authors, 2019

3.2.2 Diarrhoea

Figure 7 shows the monthly occurrence pattern of diarrhoea cases, drawn by calculating the average number of hospitalizations in each month over the 11 years analyzed.

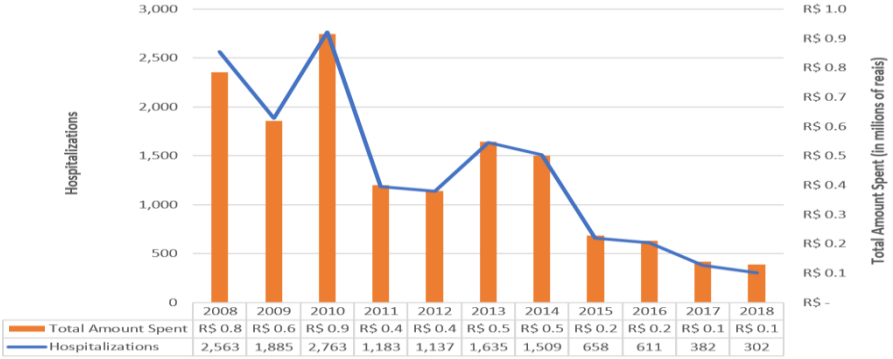
Figure 7. Graph of the average number of hospitalizations due to diarrhoea in the public health system, per month, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018. Source: The authors, 2019.



The months of August and September presented considerably higher averages, compared to the other months. The cause of these peaks may be related to water availability, which decreases due to the draught and may affect water quality. The quality and the quantity of water for public supply are inversely correlated to the number of cases of diarrhoea in a population, since both determine the sanitary and hygienic conditions through which diarrhoea can be prevented (WHO, 2009).

Figure 8 shows a drop in the number of hospitalizations due to diarrhoea over the years. However, it is worth mentioning that this illness still represents a significant number of cases each year. Diarrhoea is considered one of the major DRIES in the literature, as it represents an important indication of the sanitation situation of a region.

Figure 8. Graph of hospitalizations and total amount spent on diarrhoea cases in the public health system, per year, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total Amount Spent	R$ 0.8	R$ 0.6	R$ 0.9	R$ 0.4	R$ 0.4	R$ 0.5	R$ 0.5	R$ 0.2	R$ 0.2	R$ 0.1	R$ 0.1
Hospitalizations	2,563	1,885	2,763	1,183	1,137	1,635	1,509	658	611	382	302

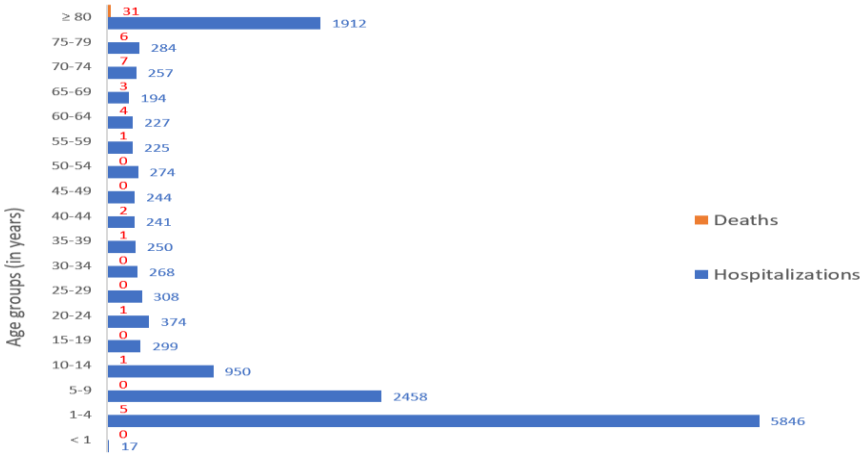
Source: The authors, 2019

In 2018, the bar corresponding to the total amount spent rises above the curve for hospitalizations, which may indicate a higher cost of hospitalizations, similarly to the case of dengue (Figure 5).

As for gender, 51.72% of hospitalizations and 51.61% of deaths were attributed to females.

Figure 9 shows hospitalizations and deaths due to diarrhoea registered in each age group in the RMG. Different from what was observed for dengue fever, the most significant portions of hospitalizations for diarrhoea were those of children and elderly. In fact, diarrhoea is more severe for these individuals, resulting in hospitalization and often the use of Intensive Care Units (ICU), as shown by Siqueira et al. (2017) while the age groups between 15 and 59 years had less significant numbers of hospitalizations and deaths.

Figure 9. Hospitalizations and deaths due to diarrhoea in the public health system, by age group, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.



Source: The authors, 2019

3.3 COMPARISON BETWEEN RESULTS

The comparison between the information obtained from the TabNet and the Hospitalization Authorizations showed that, in general, the former data source has more records than the latter, for the 10 diseases that were in both. Table 3 shows the values obtained through each data source and the difference between them, for the Metropolitan Region of Goiânia between 2008 and 2018.

Table 3. Comparison between TabNet and AIH[(a)] data sources for: total amount spent, hospitalizations, deaths and rates associated with diseases related to inadequate environmental sanitation[(b)], of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.

	TabNet	AIH[(a)]	Difference [(c)]
Total amount spent (R$)	13.851.849,27	12.971.281,12	+880.568,15
Amount spent per capita (R$)	6,02	5,63	+0,38
Hospitalizations	40.465	39.231	+1.234
Hospitalization rate (per 10 thousand inhab/year)	16,0	15,5	+0,5
Deaths	271	232	+39
Death rate (per 100 thousand inhab/year)	1,1	0,9	+0,2

(a)HospitalizationAuthorization.
(b) Amebiasis, cholera, conjunctivitis, dengue, diarrhoea and gastroenteritis of presumed infectious origin, yellow fever, filariasis, leptospirosis, malaria and mycoses.
(c) Calculated subtracting AIH numbers from TabNet numbers.
Source: The authors, 2019.

Santa Bárbara de Goiás was the only municipality in which the AIH values exceeded those collected in TabNet: a difference of R$ 167,302.12 spent, 531 hospitalizations and 1 death. As a result, hospitalization rate rose from 3.2 to 83.1 hospitalizations per 10,000 inhabitants per year, while per capita spending varied from R$ 1.54 to R$ 28.99, becoming the highest according to both data sources. It is possible that this discrepancy is related to the municipality's recent addition to the RMG, as well as several changes in its urban perimeter since the beginning of the decade (Santa Bárbara de Goiás, 2013).

Only three DRIES had higher values in AIH than in TabNet: Cholera, Dengue and Diarrhoea. Table 4 shows the differences observed in these cases.

Table 4. Total amount spent, hospitalizations and deaths related to cholera, dengue and diarrhoea, observed from each database, of individuals residing in the Metropolitan Region of Goiânia, between 2008 and 2018.

	Total amount spent (R$)			Hospitalizations			Deaths		
	TabNet	AIH[(a)]	Diff.[(b)]	TabNet	AIH[(a)]	Diff.[(b)]	Tabnet	AIH[(a)]	Diff.[(b)]
Cholera	279.627,24	279.701,75	-74,51	698	698	0	10	10	0
Dengue[(c)]	7.574.369,64	7.588.822,23	-14.452,59	23.375	23.413	-38	147	148	-1
Diarrhoea[(d)]	4.835.867,80	4.854.832,79	-18.964,99	14.451	14.628	-177	62	62	0

(a) Hospitalization Authorization.
(b) Dengue [classic dengue], Hemorrhagic fever due to the dengue virus.
(c) Calculated subtracting AIH numbers from TabNet numbers.
(d) Diarrhoea and gastroenteritis of presumed infectious origin.
Source: The authors, 2019.

Other DRIES have drawn attention for presenting very discrepant figures between the two data sources. In the case of mycoses, for example, there was a difference of R$ 741,163.63 (2,602% more) in total amount spent, 906 occurrences and 38 deaths, with TabNet being the source with the largest number of records.

4 CONCLUSIONS

The results draw attention, mainly, to hospitalizations for dengue, diarrhoea and other intestinal infectious diseases. The improvement of basic sanitary conditions is essential for the prevention of the three diseases. In addition, the total amount spent on hospitalizations for DRIES show great potential for financial savings if investments are made in basic sanitation.

This work fulfilled its objective by describing the occurrence of DRIES in the RMG, but it also paves the way for deeper investigations into the relationship between health and sanitation, including political and socioeconomic aspects, in the state of Goiás, and Brazil. On the other hand, the data sources that were used in the production of the results presented here can still be improved, in order to make future research more agile, accurate and efficient.

Dengue, diarrhoea, and other intestinal infectious diseases represent the most expressive groups of DRIES in the RMG. Together, these three diseases cost R$ 18.5 million (90.5% of the total) to the public system. It should be noted that the decrease in cases over the years may not represent a decrease, of the same proportion, in the expenses associated with them. For dengue, the lack of decrease in hospitalizations between one year and the next may also indicate low effectiveness of prevention and combat actions.

The high impact of the DRIES highlights the importance of taking direct actions to prevent them. Cairncross and Feachem (2019) cite simple strategies for the prevention of DRIES according to each transmission route. For diseases transmitted by insect vectors, such as dengue, it is recommended to improve surface water management, destroy insect proliferation spots, reduce the need for inspection of proliferation spots, and use nettings on doors and windows. In the case of faecal-oral transmitted diseases, the quality and quantity of drinking water should be improved, the collection and treatment of sanitary sewage should be increased, and hygiene habits should be promoted (Cairncross and Feachem, 2019).

The vector that transmits dengue benefits from the insufficient drainage of rainwater, open sewage and improperly disposed waste, especially during the rainy

season. The relationship between dengue cases and the climatological variables was highlighted by the graph of the average hospitalizations in each month (Figure 4), which shows decrease in the number of cases during the winter in the RMG. The pathogens related to diarrhoea and other intestinal infectious diseases, in turn, are usually transmitted due to inadequate systems of collection and treatment of sanitary sewage, in addition to the insufficient treatment of water for public supply. In fact a large part of the populations of Aparecida de Goiânia and Trindade lack collection and treatment of sanitary sewage: 63.9% and 49.5%, respectively (SNIS, 2017).

According to Instituto Trata Brasil, on average, 55% of Brazilian children do not have access to proper sewage systems, and perhaps that is why they are the most affected by diarrhoea (Trata Brasil, 2009). In fact, the distribution by age group (Figure 6) showed that 40% of the hospitalizations for diarrhoea in the RMG were of children between 1 and 4 years old. Like other studies, Trata Brasil links the decrease in infant mortality to the increase in coverage of sanitation services (Trata Brasil, 2009). Thus, sanitation has an important role in meeting the goal of reducing child mortality established by the UN (2015). Moreover, the monitoring of hospitalizations for diarrhoea in SUS in the coming years will be able to reveal the effects of the new regulatory frameworks of sanitation on public health (Senado Federal, 2019).

This study made it possible to visualize the spatial distribution of DRIES cases in the RMG, laying the foundation for future studies to investigate the correlation between DRIES and the public health situation of each municipality. The need to monitor and subsidize actions in smaller municipalities is also highlighted. Although the 4 largest municipalities concentrate 82% of hospitalizations, 12 out of the 20 municipalities of the RMG have less than 15 thousand inhabitants. The results obtained for Goianápolis and Santa Bárbara de Goiás show that these municipalities may be neglected. Investment in sanitation in these municipalities is crucial due to their potential for rapid growth, their proximity and dependence on Goiania's infrastructure, and their inadequate sanitation situation, which threatens human health and the environment. Moreover, challenges were posed by the various changes in the configuration of the RMG since its creation. It was clear that the constant changes made it difficult to monitor the situation of some municipalities over the years, especially Santa Bárbara de Goiás.

The discrepancy between the amounts spent per place of residence and per place of hospitalization, the former being significantly larger than the latter, corroborates the hypothesis that there are hospitalizations in the public health units of the RMG of

individuals who did not reside in the RMG. This indicates that other Goiás municipalities rely on the health units in the Metropolitan Region. This hypothesis should be investigated in further studies.

The total amounts spent presented here are the original values, in reais (R$), without adjustment. As the general trend of the Real currency was devaluation between 2008 and 2018, the corrected amount is expected to be even higher than R$ 22.5 million. This correction may be made in subsequent studies. However, the total amount spent is expressive, representing an average annual expense of R$ 1.8 million that could be invested in continuous and consistent sanitation actions. Considering the WHO's estimate that every $1 invested in water and sanitation generates a 4.3 dollar saving in health expenses (WHO, 2014) in a rough approximation, the RMG can save about R$ 7 million per year, once the necessary investments are made. These savings go beyond the financial aspect, as lives would also be saved.

Finally, it is crucial to make some considerations about the Health Information System (SIH/SUS). Despite being one of the largest health information database in the world, some obstacles were encountered during the survey: i) lack of clarity regarding the methodology used to obtain and tabulate health information; ii) difficulty in manipulating "RD*" type files; iii) difficulty in finding the meanings of some acronyms and codes; iv) server instability, causing file download failures; v) lack of direct equivalence or specificity between the International Classification of Diseases (ICD) codes and the selection options provided on the online platform (TabNet); vi) absence of a user service or instruction guide.

When comparing the databases (TabNet and AIH), their different purposes or uses were evident. TabNet is an accessible and intuitive online platform, aimed at the general public and therefore limited. AIH, on the other hand, is raw technical records, intended for health professionals, which are made available in formats that require specific software and some knowledge in computer programming for the optimal treatment of information. Due to their level of detail, AIH allows faster and more accurate analysis. However, the AIH database is outdated, presenting underutilized fields, incompatibility in records from one year to the other and deficit of records in relation to TabNet.

The discrepancies found between TabNet and AIH information are significant and should be investigated and corrected in order to improve the effectiveness of both. The probable cause of the discrepancies is human error when entering and managing the data of the Hospital Information System (SIH) and communication failures between units of

the National Health System (SUS), such as health centers, public hospitals, and municipal and state health departments, as well as the SUS IT Department itself (DATASUS). It is also important to remember the existence of a third source of SUS data that was not analysed in this study: the National Disease Notification System (SINAN). SINAN gathers, mainly, information on compulsory notification diseases (MS, 2017). Since dengue is classified as a compulsorily notifiable disease, it is recommended to consult SINAN in future studies.

Solving, even partially, some of the problems mentioned here, would deliver significant progress towards meeting the SIH's objectives of providing quality information to the population and subsidizing studies and researches in the health area.

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