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EXPENSES WITH EPIDEMIOLOGICAL SURVEILLANCE IN THE MUNICIPALITIES OF SANTA CATARINA

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ABSTRACT

Limitation of resources and social prioritization have led public health care to be guided by several debates. However, governments' choices can often follow individual priorities, as advocated by the public choice theory, especially in the epidemic area, which is strongly influenced by panic and the media. Therefore, the objective here is to analyze the efficiency of public resources applied in epidemiological surveillance in the mitigation of diseases such as AIDS, Dengue fever and Influenza. By means of descriptive statistics, correlation and panel data regression, 240 observations are analyzed in 60 municipalities in the Brazilian state of Santa Catarina for four years. The results indicate that the expenditures explain the occurrences of AIDS and Influenza in the opposite direction to that suggested by the literature (the more expenditures, the more cases of these diseases). On the other hand, cases of the three diseases increase epidemiological costs. Therefore, public administrators' choices seem to be directed more towards treatment than towards disease prevention, which goes against the Brazilian Unified Health Care System's precepts, increases the risks of epidemics and can aggravate the crisis in public health care. The discussions demonstrate possible occasional factors such as the lack of temporality in feeding the system and distortions regarding the place of incidence of the

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cases, which can also lead public administrators to make wrong decisions or diverge from those expected by their voters.

Keywords: Public Health. Epidemics. Cost Control. Efficiency. Theory of Public Choice.

1 INTRODUCTION

Public health involves a large area of activity, and the diversity and complexity of its activities require high investments. Zhu and Wang (2011) claim that most developed countries spend more than 10% of their government budget on health care while spending by developing countries is around 6%. In Brazil, according to the 2017 consolidated annual survey, the percentage applied to health care was 8.6% in relation to total public spending [Secretaria do Tesouro Nacional (STN), 2017].

The need for public investments in health care is intensified by the fact that it is a social right established by the Constitution of the Federative Republic of Brazil [Constituição da República Federativa do Brasil (CRFB), 1988], which establishes that it is the jurisdiction of the governments (municipal, state and federal) to ensure, protect and defend the population’s health care. Liu and Mills (2002) corroborate this idea by arguing that the government should not deviate from health care as a financing and supervisory agent for preventive public actions and emphasize that this also depends on political choices, while Holmes and Sunstein (2000) state that the right to health care cannot be protected or applied without public resources. Therefore, rights generate expenditures. Also, according to Dih-Ling, Cheng-Chieh, Yun-Ru and Szu-Chieh (2018), knowledge of expenditures, together with determination and characterization of diseases, are essential to support decisions that promote financial stability of hospitals and health care systems, in addition to supporting the different forms of resource allocation.

In this sense, studies from Malaysia and China show that, in addition to knowing general public health care expenditures, it is necessary to understand their efficiency in specific activities (Worrall, Rietveld & Delacollete, 2004; Liu & Mills, 2002). These authors report the difficulty in collecting health care information by area of activity and claim that their knowledge supports decisions that need to be disassociated due to the specific characteristics of each area. Also, Lapsley and Wright (2004) highlight the difficulties of researchers in identifying each government’s accounting functioning since accounting structures are not internationally standardized, which compromises the comparability and generalization of studies in the area.

According to Morais, Vicente and Souza (2016), the abridged classification used by the Organization for Economic Cooperation and Development (OECD) based on International Public Sector Accounting Standards (IPSAS 22) is the most used in accounting worldwide. In Brazil, the classification is determined by Administrative Regulation n. 42 of April 14, 1999 (STN, 2017) which establishes as subfunctions of health care: primary care; hospital and outpatient assistance; prophylactic and therapeutic support; health surveillance; epidemiological surveillance; and food and nutrition. According to Barbosa (2013), the field of surveillance refers to activities necessary to promote and inspect citizens’ health care and deserves prominence in collective health care due to the high externality and the need for quick and comprehensive actions, which demands high coordination. In this sense, public spending on surveillance is classified as epidemiological or sanitary (STN, 2017), the public actions of which are considered as prevention and mitigation, mainly those related to epidemiological surveillance.

Law no. 8,080 of September 19, 1990, known as the SUS Law, defines the “epidemiological surveillance” subfunction as a set of actions that provide knowledge, detection and prevention of any change that may affect individual or collective health care with the purpose of indicating and adopting measures for prevention and control of diseases or damage (Law No. 8080, 1990). For Worrall et al. (2004) public health care lacks multidisciplinary research on efficient spending, especially in the epidemic area, in which public choices are often driven by panic and strongly influenced by the media. This statement is corroborated by Lins, Ciríaco and Anjos (2019), who have analyzed the impact of federal funding on Dengue control in Brazil and say that there are still few studies seeking a causal relationship between the allocation of public funds and the notified cases of the disease, which makes inferences to support decisions by public administrators impossible.

In addition to this limitation, there are several factors that can hinder decision-making in the area of public health care. According to the public choice theory (PCT) by Buchanan and Tullock (1962), public administrators often make choices that follow individual or group priorities to the detriment of choices directed by the collective that elected them. In general, these decisions are inconsistent with the search for efficiency of public health care resources or with the eradication of diseases and thus can reduce collective well-being (Preaud et al., 2014).

In view of the above and considering the need to avoid waste and maximize results – mainly for disease prevention but also so that treatments are not denied due to lack of resources (Dermindo, 2019) –, this study shall analyze the efficiency of public resources applied in epidemiological surveillance in the mitigation of diseases such as AIDS, Dengue and Influenza. Thus, using multivariate statistics, in which public spending in the area is related to the actual records of these diseases, in addition to population and territorial variables, data from municipalities in the Brazilian state of Santa Catarina are analyzed.

In general, the research identified on epidemiological surveillance addresses epidemic control, drug development and the means of spreading diseases. Therefore, this research brings a different view when addressing the financial bias by means of analysis of public spending efficiency. It also differs from studies such as that by Lins et al. (2019) insofar as it deals with epidemic expenditures related to several diseases while the latter is limited to the analysis of resources destined to a single program with actions to control only Dengue. Although little explored, the relationship between expenditures and epidemic diseases has gained more prominence in 2020 with the COVID-19 pandemic, since, in situations like this, despite the high cost to governments, this may be lower than the social and macroeconomic costs (McKibbin & Roshen, 2020).

The link between population's health care and economic aspects, without being restricted to epidemic issues, has been the subject of previous studies in several countries (Bousmaha, Ventelou & Abu-Zaineh, 2016; Araújo, Bezerra, Amâncio, Passos & Carneiro, 2017; Ensor, Chhun, Kimsun, McPake & Edoka, 2017) as well as government spending on health care (Liu & Mills, 2002; Zhu & Wang, 2011; Pan & Liu, 2012; Halici-Tülüce, Dogan & Dumrul, 2016; Mladenovi, Milevancevi, Mladenovi, Marjanovi & Petkovi, 2016; Younsi, Chakroun & Nafluma, 2016; Bein, Unlucan, Olowu & Kalifa, 2017; Costa & Gartner, 2017). However, there is no consensus on the best approach to assess health care systems performance as public choices and the characteristics of each sample lead to different results (Albuquerque et al., 2019). What is similar among these studies is the use of general health care expenditures since extracting specific data by area is not always possible. In this regard, Brazil has a potential still little explored, given that public accounting is more detailed, which allows analysis by subfunction.

It should be noted that most studies identified as the basis for this research use the OECD standard accounting classification, which inserts in an abridged account all public health care expenditures. However, understanding the reflexes of spending allocated in specific areas can bring important insights in the search for greater efficiency. Thus, one of the contributions of the present study is to direct analyses to spending only on epidemiological surveillance, an important area within collective health care, in order to produce knowledge to guide decision-making, including in the formulation of policies, organization of services and government programs (Barreto & Souza, 2015).

2 THEORETICAL FRAMEWORK

PCT has emerged based on the classic study by Buchanan and Tullock (1962), whose theoretical lens focuses on uncertain choices as to the future outcome of social welfare as decision makers have direct self-interest and leave aside ordinary political issues. For Fabre, Scheeffer, Dallabona and Kroetz (2018), PCT explains public administrators' private interests in overlapping society's interests when it comes to government public policies.

However, to understand the real motivations behind public administrators' decisions and choices, it is first necessary to know specific behaviors, especially those related to applying resources. In the area of health care, recent international research on public spending (Bousmaha et al., 2016, Ensor et al., 2017) relates populations' health care to economic development while seeking to characterize such expenditures.

Bousmaha *et al.* (2016) have studied public spending in countries in the Middle East and North Africa and found that public institutions with better structures can reduce spending. However, the decrease in spending does not always benefit everyone. The Cambodia experience, described by Ensor et al. (2017), reveals different benefits for different social classes. In the country there is a government policy that offers access to health care for all and, in some cases, a co-participation voucher is provided, that is, part of which is paid by the government and the other by the citizens. For the authors, this policy benefits the wealthiest socioeconomic classes which occupy most of the public services and disadvantages the poorest as it increases the commitment of their remuneration to individual health care expenditures.

Still, regarding public spending on health care, Zhu and Wang (2011) claim that there is no pattern of these resources or an association with the countries' economic performance. This is because, when analyzing the percentage allocated to health care actions, of the total resources available in each country, the authors have identified considerably different results, among which are mentioned: United States 21%; Australia 18.2%; Czech Republic 14.5%; Germany 13.6%; Russia 12.7%; Swaziland 11.4%; Romania 10.7%; Poland 10.3%; Bolivia 9.6%; Iran 6%; Singapore 5.8% and China 4%. Despite these differences, according to Younsi et al. (2016), who have that analyzed 167 low, middle and high income countries, something common to all of them is that the total expenditure on health care has increased in the last decades.

Despite this increase, and regardless of economic development, the World Health Organization (WHO) suggests that countries or regions should take measures to increase health care services efficiency in order to maximize results obtained with a given level of resources or minimize the resources necessary to obtain certain results (Dermindo, 2019). In this direction, according to Mladenovi et al. (2016), most studies confirm the positive relationship between public spending and improvements in health care. For the authors, who have analyzed European Union countries, the addition of resources for medical care and public health care (equivalent to the Brazilian primary health care) implies an improvement in the population's health care status and provides the best combination for forecasting the GDP growth rate.

In Brazil, the effect of allocating resources on health care and education has been analyzed by Costa and Gartner (2017) who have concluded that higher expenditures in some subfunctions of health care (primary care, hospital care, prophylactic and outpatient supports) and in child education produce improvements in workers' well-being and positive effects on the increase in income in the country's states surveyed. When analyzing the efficiency of resources applied in specific health care actions, Lins et al. (2019) have found that federal public spending for the Dengue reduction program has had a positive effect, with a reduction in cases of the disease. The authors have analyzed 4,956 Brazilian municipalities with less than 50 thousand inhabitants from 2002 to 2015 and, despite the improvement identified, given that since 2002 efforts have been made to decrease the number of cases by means of prevention and reduction in mosquito proliferation, there is still strong heterogeneity in the response among the country's regions. This is mainly due to differences in levels of economic and social development.

Albuquerque *et al.* (2019) also deal with the differences between the levels of development when evaluating the performance of the health surveillance regionalization in Brazil. The authors establish three aspects of evaluation: policy, structure and organization, for which there are different attributes. The adopted methodology does not aim to draw a direct relationship between these aspects and financial data, despite being intrinsically linked. Even so, the findings gain relevance because they reveal, from the point of view of the key surveillance actors who answered the questionnaire, that there is insufficient availability of physical, human and financial resources, which makes it difficult to advance the regionalization policy and reach of macro objectives. In addition, these authors conclude that the higher the level of economic development and the provision of services, the better the performance of the health surveillance regionalization.

Likewise, the spending impacts on the population's health care do not follow a worldwide pattern. When analyzing 44 (high and low income) countries over a period of 17 years, Halici-Tülüce et al. (2016) have concluded that public and private health care spending has no return on economic growth in the short term. However, in the long run, public health care has a strong positive impact on the population's economic growth and the well-being while private health care has a negative impact. Contradicting these results by means of a study on the effects of public and private health care policies in Africa, Bein et al. (2017) state that there is a strong association between the increase in public spending and the immediate increase in the population's health care while private institutions' expenditure has results for the population in the medium term.

In China, Pan and Liu (2012) have related the public health care quality to GDP and concluded that government spending does not influence that indicator or the population's health care, which makes spending inefficient. However, for Liu and Mills (2002) public health care spending has positive effects in combating certain diseases when analyzing the health care reform in China characterized by a reduction in the public budget and the introduction of charges for the provision of services. The authors have concluded that, despite bringing economic incentives to private institutions and improving public institutions' productivity, preventive services have been drastically reduced by charging fees, which has generated a considerable increase in epidemiological diseases. However, in a study on the cost of COVID-19, McKibbin and Roshen (2020) claim that preventing epidemics seems to be the most efficient way to avoid greater proportions, which result in damage to life and the macroeconomics.

Also, regarding epidemic diseases, Dih-Ling et al. (2018) bring a different conception when inverting the analysis logic of the aforementioned studies. This is because the authors have analyzed the economic effects of Dengue in Taiwan in the period from 1998 to 2014. That is, instead of checking how the application of resources impacts the cases of this disease (efficiency), they have verified how the cases of Dengue impact spending behaviors when comparing epidemic and non-epidemic years (consequences). To characterize such expenditures, the authors have divided them into direct (medical costs) and indirect (decreased productivity and caregiver remuneration) ones, the results of which have indicated that expenditures were 12.3 times higher in epidemic years. In addition, they have found that from the total direct expenditures during this period, 86.9% are linked to hospitalization, 7.77% with an emergency, 6.1% with an outpatient clinic and 0.03% with medication. As for indirect spending, productivity loss due to death (70.76%) stands out.

Araújo *et al.* (2017) also recognize the broad effects of epidemic diseases. According to the authors, epidemics need to be controlled as they cause temporary or permanent loss of health care, weaken jobs and harm not only health but also the economy of the affected region. According to Preaud et al. (2014), if countries would follow the guidance from WHO and the European Center for Disease Control (ECDC) and expand vaccination and preventive actions, they could reduce cases of these diseases worldwide, increase public health care resources efficiency, preserve people's health, prevent loss of productivity and stimulate economic growth.

In this sense, Naseem, Rashid and Kureshic (2014) emphasize that information plays a crucial role for effective surveillance, especially in combating epidemics, by observing the effects of electronic health care information systems (e-health care) on the doctor-patient relationship and the capacity of health care professionals in relation to using information technology in Pakistan. For the authors, although technology and e-health care are important to control epidemiological diseases, there is currently a shortage of qualified professionals and technological tools in the country's public health care system.

Given the above, it appears that governments' role in promoting public health care by the power of disseminating information (Naseem et al., 2014), training personnel, provision of infrastructure, policies aimed at surveillance and preventive campaigns to combat epidemic diseases (Liu & Mills, 2002) result in greater efficiency of services in the short and medium terms (Bein et al., 2017), improving the population's health care. The consequence of this is the positive relationship between public health care spending and the nations' economic development (Mladenovi et al., 2016, Costa & Gartner, 2017, Bein et al., 2017).

3 METHODOLOGICAL PROCEDURES

The present study is characterized as empirical, with a predominantly quantitative approach, a descriptive objective and with data collection procedures since it analyzes the efficiency of spending on epidemiological surveillance in the mitigation of specific diseases. It is worth mentioning that in Brazil several epidemics affect the population annually. However, as it is a country of continental dimensions with different climates and different characteristics among regions, choice has been towards analyzing only four variables of epidemic diseases, namely: Influenza, Dengue cases, Dengue outbreaks and AIDS in adults. This delimitation occurs because it deals with the most incident diseases in the state of Santa Catarina, the region selected for this research, as the necessary data are made available by the Directorate of Epidemiological Surveillance in the Brazilian state of Santa Catarina (Diretoria de Vigilância Epidemiológica [Dive], 2017).

A random sample of 60 municipalities was selected from 295 in Santa Catarina. Initially, stratification by housing ranges was carried out: large, medium and small municipalities. Then, using Microsoft Excel® software, 20 municipalities belonging to each group (range) were selected, the list of which is shown in Table 1.

Table 1
Research Sample

Housing Range	Selected Cities
Large municipalities (50,001-600,000 inhabitants)	Joinville, Caçador, Blumenau, São José, Criciúma, Chapecó, Itajaí, Lages, Jaraguá do Sul, Palhoça, Balneário Camboriú, São Bento do Sul, Concórdia, Camboriú, Navegantes, Rio do Sul, Araranguá, Indaial, Canoinhas and Itapema.
Medium-sized municipalities (10,001-50,000 inhabitants)	Videira, Xanxerê, São Francisco do Sul, Rodeio, Seara, Siderópolis, Cocal do Sul, Schroeder, Taió, Jaguaruna, Garopaba, Guabiruba, São Joaquim, Urussanga, Xaxim, São João Batista, Braço do Norte, Timbó, Rio Negrinho and Ibirama.
Small municipalities (0-10,000 inhabitants)	Tigrinhos, Bom Jesus do Oeste, São Bernardinho, Marema, Ouro Verde, Abdon Batista, Zortea, Mirim Doce, Belmonte, Paraíso, Nova Erechim, Riqueza, Timbé do Sul, Luzerna, Caibi, Petrolândia, Água Doce, Ouro, Agrolândia and São José do Cerrito.

Source: Prepared by the authors (2019).

In view of the sample, analysis was carried out on how total municipal expenditures, that is, public resources from own sources or not, applied in epidemiological surveillance, affect the number of occurrences of each disease during the years 2013 to 2016. The definition of the time lapse occurred due to the PCT, which establishes that public resources are allocated to actions chosen by the elected public administrators. Therefore, the period corresponding to the mayors' last full term was selected. As for the number of occurrences, although health surveillance performance evaluations use different methodological approaches in Brazil (Albuquerque et al., 2019), the decision was towards analyzing epidemiological performance by means of the effective registration of cases, as in the studies by Liu and Mills (2002) and Lins et al. (2019). Table 2 presents the definition of all study variables and the respective data collection sources.

Table 2
Variables and sources researched

Variables used	Research source
Municipal public health care expenditures allocated to the epidemiological surveillance subfunction.	Public surveys made available in the Brazilian government agencies Accounting Data Collection System (SISTN) or Brazilian Public Sector Accounting and Tax Information System (Siconfi): Summary Report on Budget Execution (RREO), Annex 2, subfunction 305 – epidemiological surveillance.
Influenza Cases; Dengue cases and outbreaks; AIDS cases in adults.	Directorate of Epidemiological Surveillance of the Brazilian state of Santa Catarina (DIVE)
Number of inhabitants; territorial area (Km²).	Instituto Brasileiro de Geografia e Estatística (IBGE).

Source: Prepared by the authors (2019).

After collection, data were tabulated and organized using Microsoft Excel® software. In all, the database resulted in 240 observations covering 60 municipalities over four years. For data analysis, the descriptive statistics technique was first used for a better understanding of the variables, for, as suggested by Dih-Ling et al. (2018), characterization of the disease and its costs is important to identify possibilities for resource allocation. Pearson's multivariate statistical methods and panel data regression were also used, similarly to the work by Younsi et al. (2016), under the justification that they consider both the cross-section characteristics, that is, the differences among individuals, and the differences in time series.

To achieve the proposed objective, four equational models have been established with differences only in terms of the dependent variable, that is, the cases of diseases: Influenza, Dengue and AIDS in adults, with emphasis on Dengue, which is segregated in cases and outbreaks. This segregation occurs because epidemiological surveillance develops actions that provide knowledge, detection and prevention of diseases (DIVE, 2017). And in this case the outbreak control is considered a preventive action (Lins et al., 2019). Thus, the Dengue case model includes the number of outbreaks as an explanatory variable, as it is understood that the higher this number, the greater the risk of contracting the disease (Araújo et al., 2017). Another particularity to be highlighted is about AIDS: because it is a disease that still has no cure and, therefore, the number of cases is cumulative (DIVE, 2017), in the present study only new cases detected in each period are considered, which allows us to visualize the evolution in the spread of the disease.

The explanatory variable of the models is the amount of expenditures allocated to the epidemiological surveillance subfunction, while the population and the territorial area are control variables, which aim to isolate the differences in size among the municipalities so that the indexes are parameters for all models. As it is a panel data regression, the analysis of the best estimation model has been performed, with verification of the basic assumptions: normality, homoscedasticity and lack of self-correction and multicollinearity (Gujarati, 2006).

As limitations, the fact that it is not possible to separate public spending by type of disease is highlighted. The source of data related to Brazilian expenditures presents the standard normative classification, which is more analytical than the international one. Despite this, some epidemiological expenditures can be accounted for in other subfunctions when related to other health care procedures. In addition, the analyzed period was not evaluated as to the possibility of containing epidemic problems remaining from previous years.

4 RESULTS

In order to verify the data temporal evolution, in Figure 1 the average of the variables "expenditures" and "cases of diseases" of all municipalities for each year is graphically demonstrated.

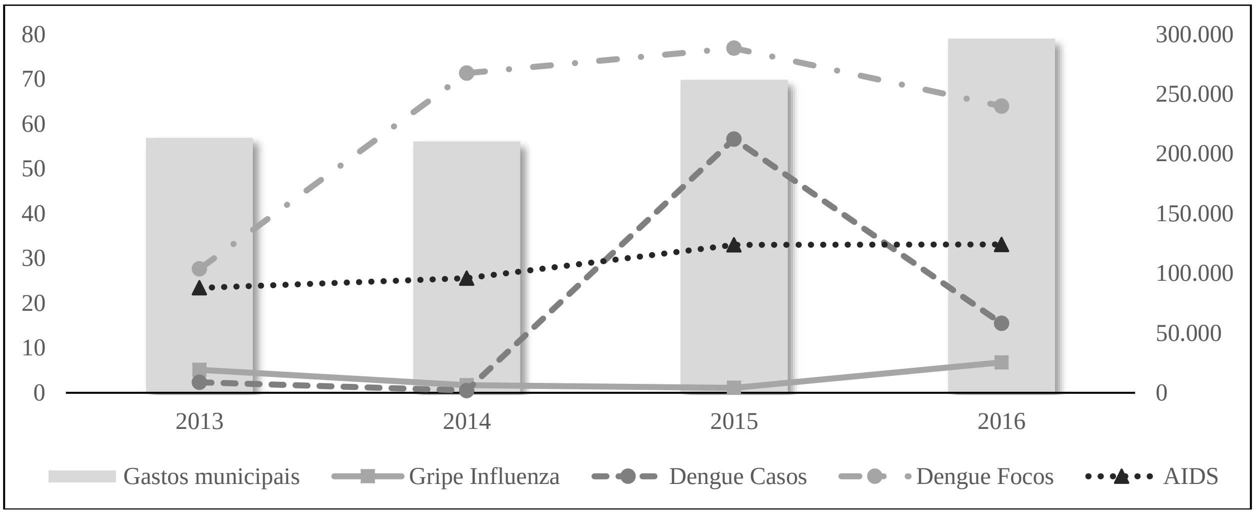

Figure 1. Temporal evolution of expenditures and cases of diseases.
Source: Prepared by the authors based on the survey data (2019).

As for municipal spending, it can be seen that after a small reduction between the years 2013 and 2014, corresponding to 1.35% (from BRL 213,156.22 to BRL 210,287.36), until 2016 there is an increase in the average of resources for epidemiological surveillance in the 60 municipalities analyzed (BRL 261,91626 in 2015 and BRL 296,336.96 in 2016). In other words, in relation to the immediately preceding year, spending in this area grew by 24.55% in 2015 and in 2016, 13.14%. This fact corroborates the research by Younsi et al. (2016) that the total expenditures with health care have increased with the time.

However, even with these investments, cases of diseases have also increased during this period. In 2014 there was an expressive growth in the outbreaks of the mosquito-borne Dengue: in 2013 there were a total of 1,658 outbreaks in the 60 municipalities analyzed (average of 27.63 per municipality) while in 2014 it increased to 4,280 outbreaks (average of 71.33 per municipality), remaining practically stable in the following years. This has caused Dengue cases to increase considerably, from a total of 31 in 2014 (average of 2.37 per municipality) to 3,397 cases in 2015 (average of 56.61 per municipality), which characterized an epidemic of this disease in the country (Araújo et al., 2017). The increase in Dengue cases in this period is not exclusive to the municipalities of the state of Santa Catarina. The studies by Araújo et al. (2017) and of Lins *et al.* (2019), even with different samples, show that all Brazilian regions and states had an increase in cases of the disease. Lins *et al.* (2019) also highlight that, according to the Ministry of Health of Brazil in 2015, from cities with an epidemic situation (over 300 cases reported for each group of 100 thousand inhabitants), 87% are small municipalities with less than 50 thousand inhabitants. As for Influenza, it remained stable over the four years analyzed, with a higher incidence in 2016, when 407 cases occurred (average of 6.78 per municipality). For AIDS in adults, the variations are also smaller but increasing over the four years. In 2013, for example, 1,404 cases were detected while in 2016 there were 1,986 cases.

In order to complete these analyses, Table 3 presents the descriptive statistics for the variables of all municipalities in all years.

Table 3
Descriptive Statistics

	Expenditure	Influenza	Cases of Dengue	Outbreaks of Dengue	AIDS	Population	Area
Average	245,424.20	3.68	18.75	59.94	28.78	62,000.08	407.75
Standard error	29,432.09	0.58	13.42	14.99	3.61	6,267.64	29.48
Minimum	0	0	0	0	0	1,254	46.24
Lower quartile	0	0	0	0	0	5,964	160.9
Medium	28,289.05	0	0	1	1	21,873.50	251.11
Upper quartile	275,346.59	4	1	13	28.5	69,464.25	447.76
Maximum	2,330,115.86	70	3,128	2,686	278	569,645	2,631.5
Standard deviation	455,959.91	8.98	207.92	232.27	55.89	97,097.94	456.78
Kurtosis	6.61	25.88	212.31	72.21	6.02	11.57	9.19
Asymmetry	2.56	4.64	14.32	7.47	2.51	3.07	2.79
Coefficient of variation (CV)	1.86	2.44	11.09	3.87	1.94	1.57	1.12

Source: Prepared by the authors based on the survey data (2019).

According to Table 3, the average annual expenditure by municipality for epidemiological surveillance is BRL 245,424.20. In certain years, there are municipalities that did not allocate funds for this subfunction. On the other hand, the municipality that invested the most was the city of Criciúma, in 2016, with a total of BRL 2,330,115.86. It should be noted that the population level is among the various risk factors that may influence the need for spending on epidemiological surveillance. In the case of Criciúma, a large municipality, in the year in which it presented the highest expenditure (2016), the population was 209,153 inhabitants, above the upper quartile.

Also regarding the population, the sample average is 62 thousand individuals per municipality, with a variation between 1,254 (Jaguaruna) and 569,645 (Joinville). Due to this disparity, there is a significant difference between the mean and the median, which is expected, since the sample is stratified by housing ranges. Likewise, there are larger and smaller municipalities in terms of area, that is, territorial extension. The territorial average of the sample is 407.75 km², with the municipality of Balneário Camboriú being the smallest, with only 46.24 km², and Lages is the largest, with 2,631.50 km². The stratification of the sample, when considering 20 municipalities in each housing range, also justifies the differences between the mean and the median of the other variables under study since in all cases the lower and upper extreme values are considerably dispersed.

As for diseases, the highest average occurrence is for AIDS (28.78 cases). This is because the outbreaks of the mosquito that transmits the Dengue fever virus, which have an average of 59.94, do not represent an effective disease. Although AIDS has the highest average, when considering all municipalities in all years, the disease with the highest occurrence is Dengue, because in 2015, when there was an epidemic in Brazil, the municipality of Itajaí registered 3,128 cases, the highest record of all diseases in all years and municipalities. However, due to the fact that several municipalities in different years do not register any case of Dengue, the average value of this disease is reduced. Although Itajaí has the largest number of cases of Dengue, it is not the one with the greatest number of outbreaks, because in 2014 the municipality of Chapecó found 2,686 outbreaks of the transmitting mosquito and in that same period there were only three cases of the disease in the municipality. However, in later years Chapecó has had a considerable increase in cases as in 2015 it notified 45 infected people and in 2016, 785. This demonstrates that there may be a delay between the period of proliferation of Aedes aegypti (the primary vector of transmission) and the actual contagion. Furthermore, the existence of the mosquito does not necessarily represent the occurrence of the disease as the virus is transmitted by the female's bite only when it is already infected (Araújo et al., 2017).

In view of these findings, it is also important to analyze the relationship among these variables, that is, of the outbreaks and cases of Dengue. To understand the relationship among all variables, the results of Pearson's correlation are shown in Table 4.

Table 4
Pearson's correlation coefficient test

	Expenditure	**Influenza**	**Cases of Dengue**	**Outbreaks of Dengue**	**AIDS**	**Population**	**Area**
Expenditure	1						
Influenza	0.4268*	1					
Cases of Dengue	-0.0331	0.0413	1				
Outbreaks of Dengue	0.0601	0.0895	0,273*	1			
AIDS	0.5607*	0,583*	0,201*	0.3386*	1		
Population	0.4887*	0,633*	0.1377**	0.2967*	0.8868*	1	
Area	0.0305	0.1681*	-0.0082	0.0069	0.1558**	0.2794*	1

Note. *Correlation is significant at 1%.
** Correlation is significant at 5%.
Source: Prepared by the authors based on the survey data (2019).

Based on Table 4, it is possible to infer that most variables are correlated to the 99% confidence level. Among the significant relationships, spending has a positive correlation with Influenza, AIDS and the population. However, it was expected that the relationship between expenditures and these diseases would be inverse (negative), that is, a greater allocation of resources could prevent diseases and reduce their occurrence, which has not been confirmed. This expectation has been created due to the preventive bias given to the subfunction of epidemiological surveillance (DIVE, 2017). In addition, the studies by Liu and Mills (2002), Bein et al. (2017) and Lins et al. (2019) have shown that higher public spending has positive effects in combating certain diseases, with a reduction in cases.

It is also noted that the variables of Dengue cases and outbreaks of the mosquito that transmits the virus are positively and significantly correlated, which confirms that more outbreaks may increase the risk of contamination, differently from what was observed in the municipality of Chapecó in 2014. It is also highlighted that AIDS is positively and significantly correlated with all diseases.

Finally, as already mentioned, it can be seen that the size of the population correlates positively and significantly with all variables, which indicates that more populous municipalities have higher expenditures with epidemiological surveillance, cases of diseases and outbreaks of the mosquito that transmits the Dengue fever virus. In a complementary analysis, using per capita spending instead of total spending, it appears that the coefficient starts to represent an inverse relationship between spending and population but it does not present statistical significance to allow any sustainable inference. It is worth noting that, in the case of epidemic diseases, the use of a per capita amount may skew the analyses, since there are different risk groups, which cause greater spending to be directed to a small portion of the population, while few resources are intended for a larger group of people. Thus, the use of an average among the entire population is not consistent with reality and, therefore, decision has been towards maintaining the analyses with the total expenditure and the number of inhabitants (population) and the total area were used as variables of control. In this way, in addition to size, demographic density can also be verified, since the population level and area are considered, which are the variables used in this indicator.

That said, we start with the analysis of panel data regression. Firstly it is highlighted that all models have heteroscedasticity, autocorrelation and non-normality of the residues. Therefore, and considering the tests of the best estimation model, Table 5 presents the results of the regression by the Pooled Ordinary Least Square (pooled OLS) model with robust clustered standard errors, as it is shown as the most appropriate.

Table 5
Results of regressions by the pooled OLS model with robust clustered standard errors

	Influenza		**Cases of Dengue**		**Outbreaks of Dengue**		**AIDS**	
No. of observations		240		240		240		240
Prob > F		0		0.7848		0.0844		0
R-Squared		0.4189		0.088		0.106		0.8138
	P>t	**Coeff.**	**P>t**	**Coeff.**	**P>t**	**Coeff.**	**P>t.**	**Coeff.**
Expenditure	0.003	0.00000306	0.241	-0.0000507	0.462	-0.0000636	0.021	0.0000191
Outbreaks of Dengue	-	-	0.353	0.2153793	-	-	-	-
Population	0.000	0.0000513	0.326	0.0002872	0.123	0.0009204	0.000	0.0004797
Area	0.783	0.0001642	0.289	-0.0198338	0.015	-0.0492266	0.057	-0.0100149
_cons	0.191	-0.3185854	0.343	8.740591	0.021	38.56407	0.474	-1.568858

Source: Prepared by the authors based on the survey data (2019).

The results indicate that the Influenza and AIDS models are significant at the confidence level established in this study (90%) and the joint independent variables explain, respectively, 41.89% and 81.38% of the disease cases. For Influenza, the variables “expenditure” and “population” have statistical significance. As for AIDS in adults, all variables are significant, that is, expenditure, population and area. Given the positive coefficient of the variable “expenditure” in both models, as verified in Pearson’s correlation and contrary to what is expected by the literature in which health care investments prevent diseases and, consequently, reduce their occurrence (Liu & Mills, 2002, Bein et al., 2017, Lins et al., 2019), it appears that, statistically, the use of resources in epidemiological surveillance increases the number of cases of these diseases. Therefore, it can be said that the expenditures allocated to this subfunction impact the cases of Influenza and AIDS, even if they have a considerably low coefficient (for each BRL 1.00, there is an increase of 0.00000306 in cases of Influenza and 0.0000191 increase in AIDS cases).

The explanation for such behavior is based on several reasons. According to Santos, Tayra, Silva, Buchalla and Laurenti (2002), the main problem in the case of AIDS is the delay in the arrival of data for inclusion in the epidemic information system. This difficulty is due to the easy access to drugs and to the innumerable tools of medicine, which delay symptoms and often diagnoses, causing cases to enter the system later and later and make planning about their real situation unfeasible. Therefore, choices by municipal public administrators as to resources allocated to actions to prevent this disease can also be influenced by the informational limitation and not only by personal interests as foreseen in the PCT.

Another issue to be raised is that the diagnosis of AIDS is often registered in large centers and not in the municipalities where the case originated, which ends up distorting the information by municipality. One example is Itajaí, which in the 1990s was cited as the municipality with the most AIDS cases in the state of Santa Catarina. In 1998 it was also characterized as the municipality with the highest incidence rate in Brazil: 142.3 cases for every 100 thousand inhabitants (Diretoria de Vigilância Epidemiológica (DIVE), 2006). It turns out that the Regional Hospital, based in that city, was one of the few qualified to perform the exam at the time. Thus, people from several municipalities, and even foreigners (since it is a port city), were diagnosed as HIV-positive in Itajaí.

As for Influenza, it is noteworthy that in 2009 WHO communicated to all countries a public health emergency of international concern caused by the influenza A virus subtype H1N1

(A/H1N1) (Temporão, 2009). Since then, in view of increases in cases of this disease, the Brazilian government has started to make the vaccine available for free to some groups at higher risk, which has increased epidemiological spending but the disease control is gradual and still ongoing. Despite this fact having occurred four years before the initial period of analysis of this study, it must be considered that the actions and decisions taken in areas such as health care may take time to have an effect, especially when considering that the prevention policies for this disease have started after the outbreak began in the country.

Given the particularities about AIDS and Influenza, we proceed to analyze the cases of Dengue and the outbreaks of the transmitting mosquito. Also according to Table 5, it appears that these models are not significant and neither are their explanatory variables. Therefore, there is no statistical confidence, within the established parameters, to make any inference about the impact of spending on epidemiological surveillance in cases of Dengue and in the outbreaks of Aedes aegypti. Therefore, some tests have been carried out in the search for more suitable models and with the following changes: (i) use of the natural logarithm to reduce the scales and (ii) exclusion of outliers using the interquartile amplitude technique plus a constant. Results from the four regressions (cases and outbreaks with natural logarithm and cases and outbreaks without outliers) were significant but when the explanatory variables were analyzed in isolation, in none of the models did the expenditure on epidemiological surveillance show significance, which reiterates the limitation of inferences of this relationship.

Finally, it is worth noting that the population, in addition to correlating with all diseases (Table 4), has a proven impact on Influenza and AIDS (Table 5); that is, the larger the population, the greater the occurrence of these diseases. This corroborates the findings by Santos et al. (2002), Preaud et al. (2014) and Araújo et al. (2017) that epidemiological diseases spread more easily in population agglomerations.

In view of the aforementioned results, in general it appears that expenditures on epidemiological surveillance explain the occurrence of two of the three diseases analyzed but in the opposite direction to that expected by the literature on the topic. Thus, as a complementary analysis, in order to better understand these relationships, a new regression model is estimated, in which expenditure becomes the dependent variable and cases of diseases become the explanatory variables, the results of which are shown in Table 6.

Table 6
Result of regression – determinants of spending on epidemiological surveillance

No. of observations	240	F(6.59)	2.16
R-Squared	0.3651	Prob > F	0.0595
	t	**P > t**	**Coefficient**
Influenza	2.27	0.027	7,388.494
Cases of Dengue	-3.34	0.001	-274.7933
Outbreaks of Dengue	-1.51	0.136	-203.1288
AIDS	2.08	0.042	5,190.191
Population	-0.26	0.797	-0.4762369
Area	-1.17	0.246	-64.88276
_cons	2.79	0.007	142,182.6

Source: Prepared by the authors based on the survey data (2019).

According to Table 6, the model is significant and the dependent variables together account for 36.51% of expenditures on epidemiological surveillance. When analyzing the variables individually, the three diseases (Influenza, Dengue and AIDS) have statistical significance, with Influenza and AIDS increasing the costs of this subfunction (each registered case increases the costs by BRL 7,388.49 and BRL 5,190.19 , respectively), while Dengue cases decrease their value (− BRL 274.79 per case). Outbreaks of the transmitting mosquito, as well as the two control variables, are not statistically significant, which limits inferences.

When analyzing the results of all regressions (Tables 5 and 6), in general there is a scenario in which greater expenditures with epidemiological surveillance also imply more cases of diseases. In turn, more cases of disease increase spending. This may mean that public resources destined to this subfunction have a connotation of treatment instead of prevention, which differs from the recommendations since, according to DIVE (2017), these resources should be directed towards actions for knowledge, detection and prevention of diseases. However, it must be taken into account that the economic burden of an epidemic, when it is established, is significant, as it requires emergency actions and has an impact on different sectors of the economy (Dih-Ling et al., 2018). Thus, even though the incidence of actions for treatment is lower, the monetary differences in relation to preventive actions can influence these results.

5 CONCLUSION

Of the three diseases analyzed in the present study, only Dengue (cases and outbreaks of the mosquito) does not allow inferences as to the impact of spending on epidemiological surveillance in mitigating their cases. For the others, contrary to what is expected by the literature (Liu & Mills, 2002, Bein et al., 2017, Lins et al., 2019) and by the population appeal, it can be verified that the higher the expenditures in this subfunction, the more cases of these diseases are evidenced.

However, it is not possible to verify that the expenditures on epidemiological surveillance are necessarily inefficient in mitigating these diseases since they can only present a direction contrary to what is expected; not acting preventively, but curatively, focusing on treatment. Therefore, in a complementary analysis, it can be seen that the more cases of influenza and AIDS, the greater the expenditures allocated to this subfunction, which reiterates that public choices may deviate from the central purpose of the Brazilian Unified Health System, which is prevention. The fact that the analysis of the Dengue outbreaks does not show significance in any model can contribute to this statement since, among the variables analyzed, this is the only one entirely destined to disease prevention. In addition, it must be considered that health care actions may not have immediate effects and the resources allocated in a given period become efficient for mitigation of diseases only in later periods.

As much as this study does not allow inferences about the real motivations for decision making by public administrators, in terms of verifying whether they act in their own interest – or not – according to the PCT precepts (Buchanan & Tullock, 1962), the discussions presented here demonstrate that there is a behavior that differs from the expected one and therefore needs a better understanding to guarantee the efficiency in the application of public resources. This study also points out other factors that hinder health care planning and that can influence public administrators' decisions such as those resulting from delays in feeding information in the system (Santos et al., 2002) and distortions as to where the incidence of cases occurs due to the demand for major health care reference centers. Also, McKibbin and Roshen (2020, p. 26) claim that many politicians "continue to ignore scientific evidence about the role of public health care in improving the quality of life and as a driver of economic growth." Therefore, it is suggested that future studies explore extensively and in more detail the causes of this behavior since the PCT precepts may not be sufficient to explain decision-making different from voters' expectations.

It should be noted that the data researched here referring to the period from 2013 to 2016, according to Liu and Mills (2002) and Bein et al. (2017), are sufficient to reflect the impact on the number of cases of AIDS, Dengue and Influenza since some public expenditures generate immediate improvements for the population's health care. But as the statistical results did not confirm such a relationship, it may be necessary to collect longer temporal data, as suggested by Halici-Tülüce et al. (2016), with more than one term of mayors, which can also allow an analysis with more specificity for different public choices, in addition to reducing the statistical problems of autocorrelation and non-normality of residues.

The need for more in-depth research focusing on specific areas of health care, such as that carried out in this study for epidemiological surveillance, is imminent. Most studies, especially international ones, tend to use the OECD standard accountancy classification, which inserts all health care expenditures in an abridged account. However, the use of data at the macro level and its generalization to the microlevel may be unrealistic, given that each government and each region have their specificities, in addition to health care being a highly specialized area with different characteristics. Therefore, it is necessary to redirect public accounts and the first step is to understand how spending behaves.

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