ORIGINAL ARTICLE

IMPLEMENTATION OF SANITARY SEWAGE, IMPACT ON CHILD MORTALITY RATE*
IMPLANTAÇÃO DO ESGOTAMENTO SANITÁRIO, IMPACTO NA TAXA DE MORTALIDADE INFANTIL
IMPLEMENTACIÓN DE ALCANTARILLADO SANITARIO, IMPACTO EN LA TASA DE MORTALIDAD INFANTIL

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ABSTRACT
Objective: to evaluate the impact of the implementation of sewage service on the infant mortality rate. *Method:* this is a quantitative, analytical, exploratory, longitudinal study. The sample included children aged zero to one year old. The research instrument used was the survey of data available at the Municipal Health Secretariat (MHS) and the Primary Care Information Service (PCIS), DATASUS, the Brazilian Institute of Geography and Statistics (IBGE) and the Bahia Company of Water and Sanitation (EMBASA). The scope was restricted to a period ranging from 2006 to 2017. BioEstat 5.0 was used for data analysis. *Results:* it is revealed that there was a reduction in the infant mortality rate (IMR), from 2006 to 2017, after the implementation of the sewage service. It is noted that there was a significant inverse linear association ($p < 0.01$) and high magnitude ($r = -0.92$) between infant mortality rate and year. *Conclusion:* it is concluded that investment in basic sanitation is an important factor in reducing infant mortality. *Descriptors*: Basic Sanitation; Infant Mortality; Water; CMR; Contamination; Nursing.

RESUMO
Objetivo: avaliar o impacto da implantação do serviço de esgotamento sanitário na taxa de mortalidade infantil. *Método*: trata-se de um estudo quantitativo, analítico, exploratório, de corte longitudinal. Elencaram-se, como amostra crianças na faixa etária de 0-1 ano de idade. Utilizou-se, como instrumento da pesquisa, o levantamento de dados disponíveis na Secretaria Municipal de Saúde (SMS) e Serviço de Informação da Atenção Básica (SIAB), no DATASUS, no Instituto Brasileiro de Geografia e Estatística (IBGE) e na Empresa Baiana de Água e Saneamento (EMBASA). Restringiu-se a abrangência a um período variando entre 2006 a 2017. Utilizou-se o programa BioEstat 5.0., para análise dos dados. *Resultados*: revela-se que ocorreu uma redução na taxa de mortalidade infantil (TMI), entre os anos de 2006 a 2017, após a implantação do serviço de esgotamento sanitário. Detalha-se que houve uma associação linear inversa, significativa ($p<0,01$) e de alta magnitude ($r= -0,92$) entre a taxa de mortalidade infantil e ano. *Conclusão*: conclui-se que o investimento em saneamento básico é fator importante na redução da mortalidade infantil. *Descritores*: Saneamento Básico; Mortalidade Infantil; Água; TMI; Contaminação; Enfermagem.

RESUMEN
Objetivo: evaluar el impacto de la implementación del servicio de alcantarillado sanitario en la tasa de mortalidad infantil. *Método:* este es un estudio cuantitativo, analítico, exploratorio, de cohorte longitudinal. La muestra incluyó niños de 0 a 1 años. El instrumento de investigación utilizado fue la encuesta de datos disponibles en la Secretaría Municipal de Salud (SMS) y el Servicio de Información de Atención Primaria (SIAB), en DATASUS, el Instituto Brasileño de Geografía y Estadística (IBGE) y la Compañía de Bahía. Agua y Saneamiento (EMBASA). El alcance se restringió a un período comprendido entre 2006 y 2017. Se utilizó el programa BioEstat 5.0, para el análisis de datos. *Resultados:* se revela que hubo una reducción en la tasa de mortalidad infantil (IMR), de 2006 a 2017, después de la implementación del servicio de alcantarillado. Se observa que hubo una asociación lineal inversa significativa ($p <0.01$) y una alta magnitud ($r = -0.92$) entre la tasa de mortalidad infantil y el año. *Conclusión:* se concluye que la inversión en saneamiento básico es un factor importante para reducir la mortalidad infantil. *Descriptores*: Saneamiento Básico; Mortalidad Infantil; Agua; TMI; La Contaminación; Enfermería.

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INTRODUCTION

The relationship between poverty and child mortality has been known and recognized for many decades and has been the subject of several studies.[1-3] It can be seen that the causes of poverty are multiple, social, cultural, climatic, historical, anthropological, being the most important of all economic, translated by the concentration of income in the hands of few people scattered in some countries of the world. especially in North America, Europe, Japan and emerging countries such as Russia, India, China and Brazil.

In addition, at the World Economic Forum in Davos, Switzerland, in 2018, the Oxford Committee for Famine Relief (OXFAM) stated that of all the world's wealth produced in 2017, 82% went to 2,043 billionaires, while the poorest 3.7 billion were left with nothing.

According to the organization, one billion people are starving and sixty million live in unacceptable conditions in refugee camps. It is noted that between 1980 and 2016, only 1% of the world's richest people absorbed 27% of all global growth, while the poorest half only 13% of that total. This would require 175 times economic growth in the global economy for the entire world population to earn at least $ 5 a day, but that would be catastrophic on the environment.[4]

Despite having the ninth world economy, according to the World Bank, with GDP (Gross Domestic Product) in 2016 of US $ 1.798 trillion, far above the Nordic countries (Sweden - US $ 579.7 billion; Norway - US $ Denmark - $ 294.96 billion, Finland - $ 267.2 billion), social indicators such as the Gini Index, which measures inequality in income distribution and ranges from zero (total equality) to one (total inequality), and the Human Development Index (HDI), health (overall mortality rate, child mortality rate, specific disease mortality rate), educational indicators and basic sanitation coverage, fall well short of displayed by those countries.

The wealth of a country is expressed by its GDP, which is the sum of all wealth. On the other hand, the poverty of a nation translates into many existing social indicators, and one of these indicators is the lack of access to sanitation and one of the consequences of this situation is the high infant mortality rate (IMR) and high infant mortality rates, which differ in their concepts. The infant mortality rate (IMR) means the number of deaths of children under one year old per thousand live births (lb) in a given place over a period of one year. This rate is expressed by the equation $X / 1000$ nv, where X represents the number of deaths in this age group; The mortality rate in childhood, in turn, is the number of deaths of children under five per thousand live births, in a given place, over a period of one year.

Therefore, the preschool phase is where the child is more subject to other risk situations, such as accidents and urban violence, and the prevalence of Diseases Related to Inadequate Basic Sanitation (DRSBI), such as diarrhea, cholera, hepatitis A, dengue, Acute Chagas Disease, schistosomiasis, in this specific age group.[5]

It is observed in economically and socially developed countries, according to UNICEF-UN, that IMR is less than 3/1000 live births, as in Japan, Iceland, Finland, Sweden, Norway and Singapore, while African and Asian nations have very high rates, such as: Afghanistan (110/1000); Somalia (95/1000); Central African Republic (86.3 / 1000); Nigeria (81/1000); Sierra Leone (68/1000) and Angola (67/1000) (UN, 2017).

At this rate, the so-called BRICS (Brazil, Russia, China, India and South Africa) have been showing in this rate in emerging countries, with a downward trend in recent decades, with significant internal variations within them, depending on the largest or smallest development of their provinces or states. This was due to the increase in GDP of these nations, with better income distribution, as well as the implementation of public sanitation policies, income transfer programs and popular housing.

The unhealthy, unsanitary environment is warned to be a facilitating factor for health problems, including the emergence of DRSBI and currently nearly two billion people worldwide use water sources contaminated with faecal coliforms.[6] In countries with high IM rates, diarrhea continues as an important factor in morbidity and mortality. About 1.5 million children under the age of five are expected to die each year from poor sanitation and contaminated water, and diarrhea deaths reach 2195 children each day, representing more than malaria, AIDS and measles together.[7]

This study was justified by assessing the impact of the implementation of the sewage service, including adequate collection and treatment on the infant mortality rate in a defined population, in this case, the city of Guanambi-BA. It is located in the southwestern Bahia city of Guanambi (Center-South Baiano Mesorregion), microregion of Serra Geral, being considered the largest and most important city of this microregion, about 690 km from Salvador, with an estimated population of 86,802 inhabitants, having an area of 1,296,654 km², with semiarid climate and caatinga as predominant vegetation. The municipality is bathed by the Carnaíba de Dentro and Carnaíba de Fora rivers, tributaries of the Rio das Rãs, which, in turn, is a tributary of the right bank of São Francisco. It is added that the city is, therefore, in the Northeast of Brazil, a region that historically

has a higher infant mortality rate than that of the South, Southeast and Midwest, being below the North region only.[8] It may be, by the result of the study, support in the search for more financial resources aiming at the universalization of sanitation coverage in the city under study. It is noteworthy that this was also an applied research study, with educational character, for students of various courses in the area of Health and Environmental Engineering, and may have consequences and stimulate other research. Systematized knowledge was used in previous studies, although in different realities. It is the practice of public managers to say that each dollar spent on basic sanitation means a saving of five dollars on health spending. It is believed that this data is difficult to measure and to prove, as it would be necessary to evaluate the full impact of sanitation in a whole context in which the city is located, but the demonstration of a direct relationship between basic sanitation conditions and reduced mortality already justifies its elaboration.

OBJECTIVE

• To evaluate the impact of sewage service implementation on infant mortality rate.

METHOD

This is a quantitative, analytical, exploratory study of longitudinal section. The study population included the residents of the city of Guanambi-BA and the sample was from zero to one year old. It is located in the southwestern Bahia city of Guanambi (Center-South Baiano Mesorregion), microregion of Serra Geral, being considered the largest and most important city of this microregion, about 690 km from Salvador, with an estimated population of 86,802 inhabitants and an area of 1,296,654 km², semi-arid and caatinga climate as predominant vegetation. The municipality is bathed by the Carnaíba de Dentro and Carnaíba de Fora rivers, tributaries of the Rio das Rãs, which, in turn, is a tributary of the right bank of São Francisco. It is emphasized that it was once a major producer of cotton and beans, but currently has its economy based on the production of energy from clean sources, wind and solar, as well as providing services in the commercial, health and education areas.[9]

The research instrument used was the survey of data available at the Municipal Health Secretariat (SMS) and the Primary Care Information Service (PCIS), at DATASUS, the Brazilian Institute of Geography and Statistics (IBGE) and the Bahia Company of Water and Sanitation (EMBASA). Data was collected from August 2017 to March 2018 through visits to SMS headquarters, Department of Primary Care and the headquarters of EMBASA Regional Engineering Center, as well as consultations with the pages of federal public agencies, being the same in the public domain. The scope was restricted to a period ranging from 2006 to 2017, thus comprising a period before and after the implementation of the sewage service.

The following data were collected: Infant Mortality Rate in Brazil, Bahia and Guanambi-BA; population growth in Guanambi; number of sanitary sewerage connections in Guanambi; reports of diarrheal diseases and hospitalizations for diarrhea in Guanambi.

Data on infant mortality in Brazil, Bahia and Guanambi-BA, population growth rate, number of sewage connections and diarrhea reports in Guanambi were submitted to Descriptive Statistics analysis. For the comparison of independent variables such as IM and year, IM and sanitary sewage connections, diarrhea cases and sanitary sewage connections, hospitalizations for diarrhea and year, the Analytical Statistics by Pearson's Linear Correlation was used, with significance ≤ 0.05 (p≤ 0.05). The BioEstat 5.0 program was used at all stages.[10]

Ethical and legal aspects, which did not apply to this study, were evaluated, as they did not involve people or animals, therefore, the referral to the Research Ethics Council was waived.

RESULTS

The IM rate was shown to decrease over the study period, from 2006 to 2017 (r = -0.87, p = 0.0002), in which the sewage service was implemented in the city of Guanambi-BA (Figure 1). For comparison purposes, the IMR in Bahia and Brazil was surveyed in the same period, which showed a sustained reduction from 2000 to 2015 and an increase in 2016 using IBGE data.[8]
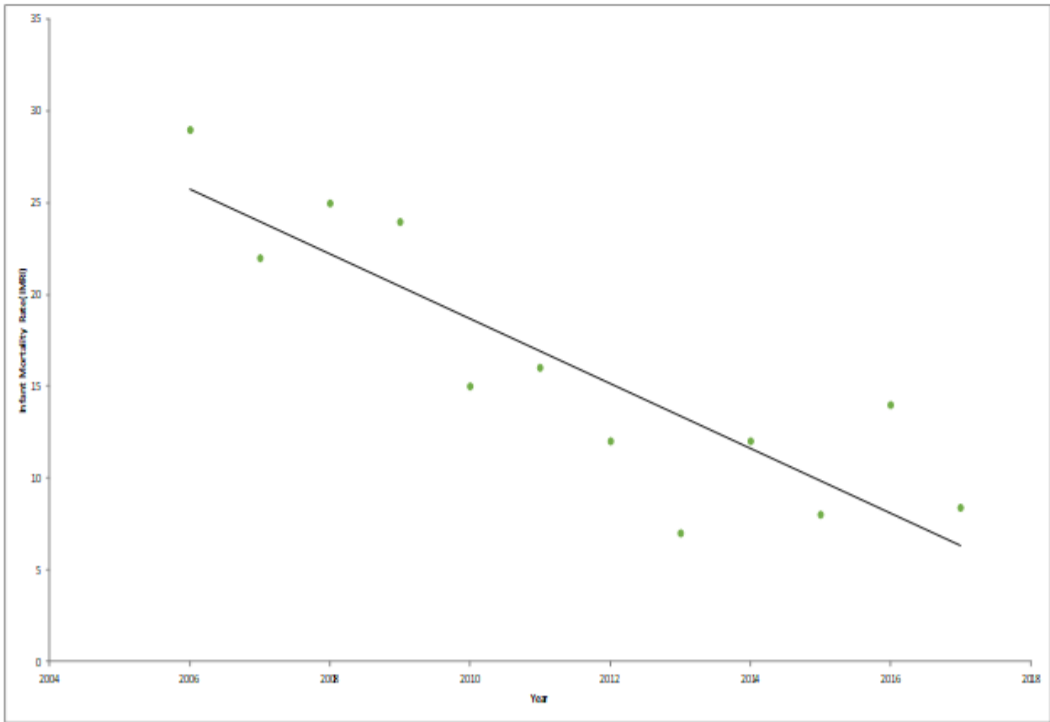
r= -0.87 - *p* =0.0002 – IMR= 3572.02 – 1,77year
Figure 1. Correlation between infant mortality rate and year, in the municipality of Guanambi-Bahia, from 2006 to 2017. Source: IBGE (2017).
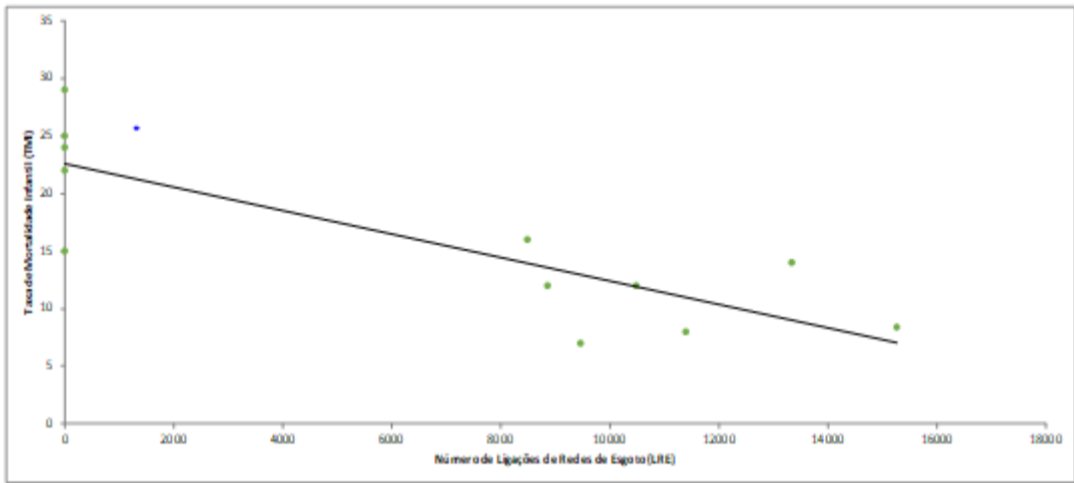
r= -0.83 - *p* =0.0008 – IMR= 22,57 – 0.001 SC
Figure 2. Correlation between infant mortality rate and number of sewage connections in the municipality of Guanambi, Bahia, between 2010 and 2017. Source:[9-11]
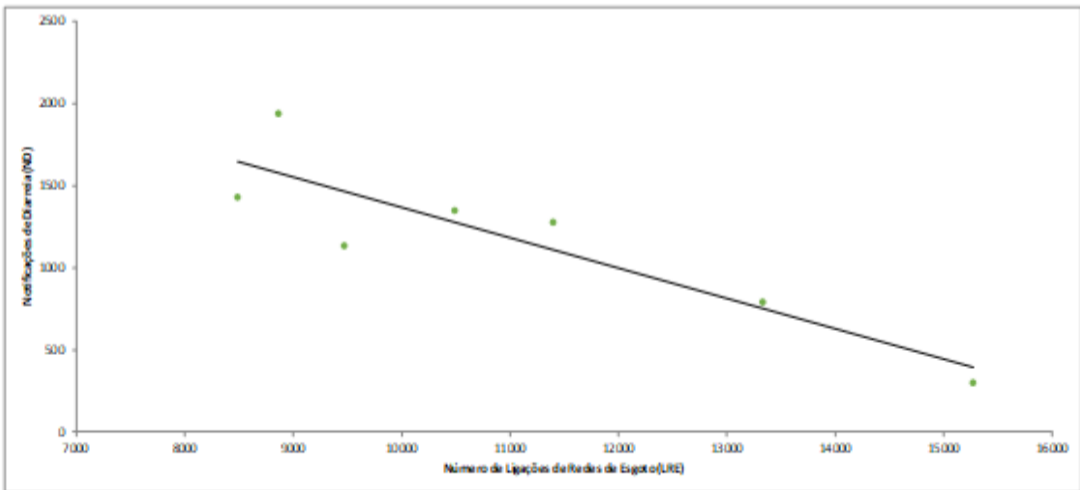
r= -0.89 - *p* =0.0072 – IMR= 3212.43 – 0,185 SC
Figure 3. Correlation between case reports of diarrhea and sewage connections in the municipality of Guanambi, Bahia, from 2009 to 2017. Source:[9-11]

Correlations between the study variables:

Figure 1-Infant mortality rate and year (Guanambi, Bahia, 2006 to 2017); Figure 2- Infant mortality rate and number of sewage connections (Guanambi, Bahia, 2010 to 2017); Figure 3- Case reports of diarrhea and sewage connections (Guanambi, Bahia, 2009 to 2017). [9-11]

The growth rate of the population of the municipality of Guanambi, Bahia from 2006 to 2017 showed a rate of 15%, which means 1.36% per year (r = 0.9730, p <0.0001), according to the tests performed in the BioEstat 5.0 program, using data from Guanambi-BA.[9-10]

The number of connections from the sewage system in the municipality of Guanambi-BA over the years (r = 0.9659, p <0.0004) increased from zero connection in 2010 to 8,466 in 2010, 2011, and 15,277 calls, in the year 2017.

It is evident that, before 2010, the number of sanitary sewage connections was considered non-existent (zero), as the system was inadequate and comprised of insufficient collection, without any kind of treatment and poor maintenance. It is noted that these characteristics did not allow the accounting of the existing service within the state or national system, as well as any type of collection by the managing concessionaire company.
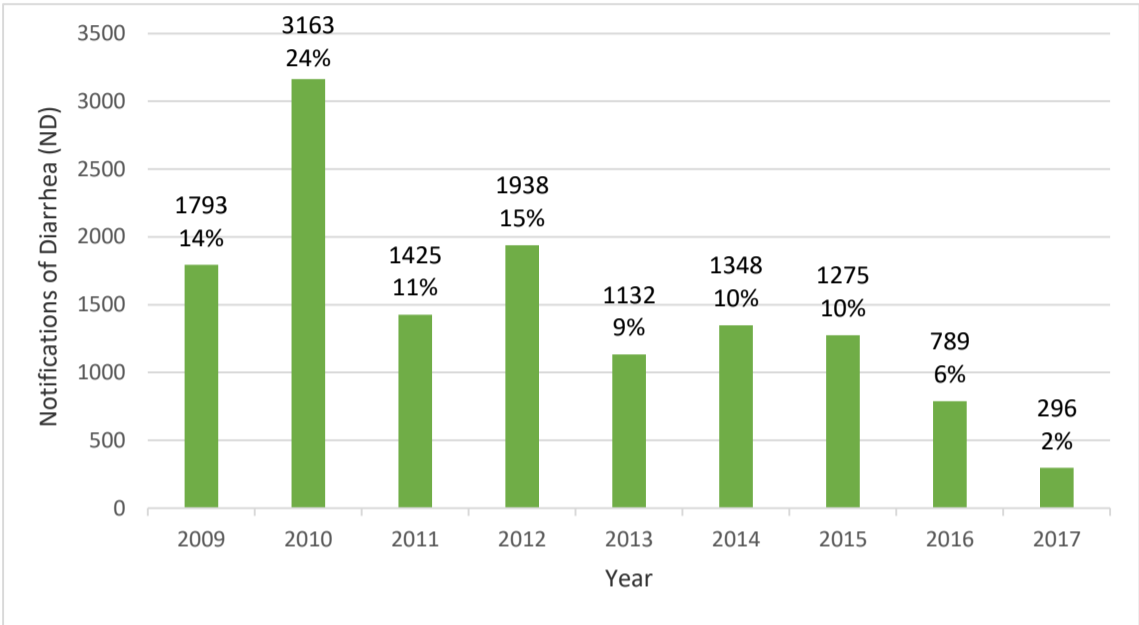

Figure 4. Number of connection of the sanitary sewerage network of the municipality of Guanambi-Bahia, from 2010 to 2017. Source:[11]
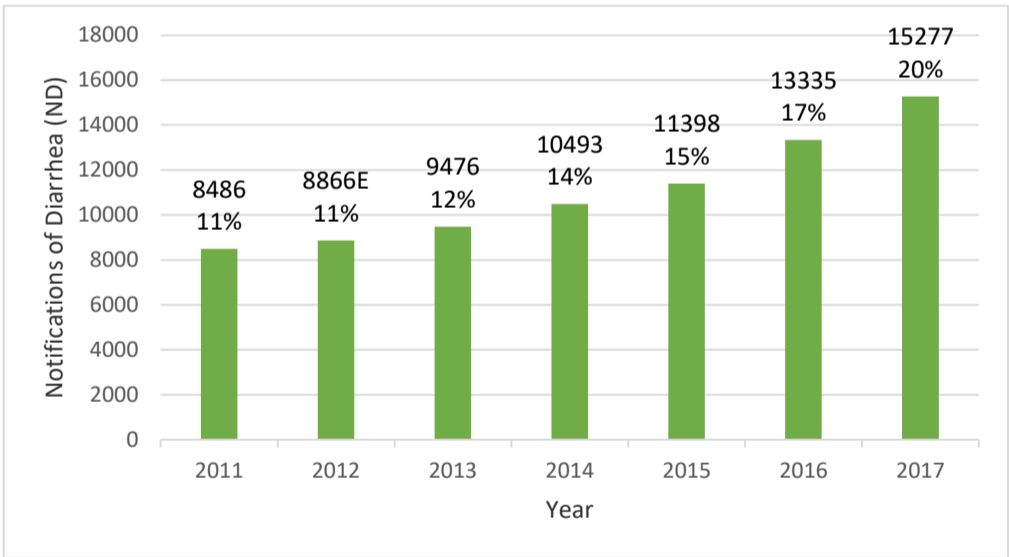

Figure 5. Notification of diarrhea cases in the municipality of Guanambi, Bahia, from 2009 to 2017. Source:[9]

IM decreased as the number of sewage connections increased from 2006 to 2017 (r = -0.83, p = 0.0008) (Figure 2). By reporting diarrhea cases, a borderline downward trend (r = -0.7049, p = 0.0508) has been shown between 2009 and 2017 in Guanambi, Bahia, especially in the last three years. (Figure 5). The number of diarrhea case reports decreased with the increase in the number of sewage network connections (r = -0.89; p = 0.0072) (Figure 3), corroborating the results of similar studies.

It was observed that hospitalizations for diarrhea decreased from a total of 523 hospitalizations in 2006 to a total of four

hospitalizations in 2016 (r = -0.90, p = 0.0002), according to tests performed in the BioEstat 5.0 program, using data from the City Hall of Guanambi-BA.[9-10]

DISCUSSION

It was positively impacted by the implementation of the sewage service, the reduction in child mortality in the city of Guanambi-BA (Figure 1), because the reduction of the IM rate after the implementation of the sewage service in the city of Guanambi -BA, happened because of the reduction in cases of diarrhea, the main infectious disease that causes

child death.[14] It is believed that other factors associated with this reduction may have contributed to this finding, such as the increase in the number of FHP teams from six to 19, during the study period, in addition to the installation of the Neonatal Intensive Care Unit in a regional referral public hospital.[15] It was also pointed out the increase in job offer and the improvement in the general living conditions of the local population as important factors.[9]

Regarding the behavior of the IM rate in Bahia and Brazil, factors related to higher investment in health and sanitation and better general living conditions were fundamental in sustained reduction over 16 years. On the other hand, the Zika Virus epidemic, which mainly hit the states of Bahia and Pernambuco, and the economic crisis, which began in 2014 and deepened from 2016, explain the increase in the rate of IM in 2016. Including, among other consequences of this crisis, for example, the lowest rate of vaccination in children in the last 15 years, because instead of spending money on transportation to go to the clinic, people choose to buy food or job search.[8]

The reduction of the IM rate was chosen as the fourth of the eight UN Millennium Development Goals set in 2000, and this reduction was one of the most impacted by programs implemented by official agencies in most 192 governments that are document signatories.[14] Differences are observed in various parts of the world, mainly due to economic, social, health care, environmental and cultural issues. IM influences the factors related to care / health care, especially for issues ranging from prenatal and delivery care, with adequate support for at-risk newborns, to breastfeeding programs and vaccines, follow-up of infant growth and development, among others.[17]

Guanambi's growth rate was found to be above the national rate in the years 2001-2018, which was 21% or 1.16% per year. It is noteworthy that the main factors related to this population growth above the national average were: the implantation, in the municipality, of a large renewable and clean energy generator pole constituted by the Wind and Photovoltaic Energy Park (solar energy); the west-east railroad works; the expansion of educational services, with the implementation of new courses in the already installed colleges and openings of other higher education units; the installation of health services such as an emergency unit, specialized services in kidney, heart, orthopedic and other diseases, all of which would have led to increased employment and opportunities.[9]

It is reported that in 2011, when the current system was inaugurated, 8,486 calls had been made, with the progressive increase over the subsequent years, reaching a total of 15,277 calls in 2017.[11]

Due to the lack of sanitation, many negative impacts on the health of the population result in human waste, contaminating the soil and the waters used for the most varied needs of the population, such as: ingestion; domestic services; labor activities in agriculture, industry and commerce and related to leisure. Therefore, through this contamination, there is damage to individual and collective health, in addition to increasing public and private health expenditures for the treatment of diseases.

The reduction in diarrhea notifications from 2009 to 2017 can be attributed to the implementation of the sewage service, as this service prevents contamination of the soil and groundwater by human waste deposited on the surface or in septic tanks, making the cycle of contamination by the most varied pathogens more difficult, either directly or through the reuse of contaminated water. Sanitary sewage service is therefore considered efficient public policy as it reduces the incidence of diarrhea.[17-8,20] Contributing to the introduction of rotavirus vaccination coverage, one of the main causative agents of acute diarrhea, in the public health network, established since 2006, also contributes to this reduction of notifications of this disease.[19] The development of vaccines and coverage expansion, the proper management of oral (ORT) and venous (TRV) rehydration therapy, the use of zinc and the careful indication of antibiotics are important factors in reducing the lethality of this disease.[12]

The previous data on the reduction of diarrhea notifications due to the implementation of the sewage service, as well as demonstrating the best management of the disease, with only the most severe cases being reaffirmed, due to the reduction in hospital admissions for diarrhea.[12] It is understood that hospitalizations for diarrhea were, for many decades, an important cause of hospitalization in Brazil and continue to be in several poor countries of the world, but after the implementation of the Oral Rehydration Program worldwide, still in the decade of 1980, that started to change. This reality was considerably influenced by improvements in general sanitary conditions and the increase in health care by multidisciplinary teams.[21]

CONCLUSION

The IMR in Guanambi-BA increased from 29/1000 live births in 2006 to 8.4 / 1000 live births in 2017.

The IMR showed a significant reduction over the study period. This reduction can be related by the study carried out with the implementation of the sewage service in the city of Guanambi-BA from 2011.

It is noteworthy that the population of the municipality of Guanambi had a growth rate in the period studied, from 2006 to 2017, of 15%, which meant 1.36% per year, ranging in absolute numbers from 76,854 to 86,802 residents.

The number of sanitary sewage connections was varied from zero in 2006 to 15,277 connections in 2017.

In this study, there was a trend towards a reduction in the number of reports of cases of acute diarrhea, a disease linked to lack of access to basic sanitation, after the implementation of the sewage service in the city of Guanambi, BA.

There was also a marked reduction in hospitalizations for diarrhea.

It is understood that the study, finally, showed no relationship between hospitalizations for diarrhea and notifications of this disease. It is concluded that, although the municipality is, in 2016, in 27th position in the GDP of the Bahian municipalities and 28th in the population index, it is in 336th position in the IM rate, among the 417 Bahian municipalities, and in the 2,545th position at the Brazilian level, demonstrating that much still needs to be done to achieve compatibility between socioeconomic and health indicators.

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