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Analysis of Epidemiological Indicators and Sanitation Information from the Brazilian Regions Through Information and Communication Technologies

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Abstract: The management of water resources is intrinsically related to the management of sanitation services, since drinking water supply services depend on the availability of water supplies with quantity and quality, and the absence or deficiency of sewage services negatively impacts the availability of water resources . Observing the health conditions of a population from indicators related to waterborne diseases allows inferring about the environmental and sanitary state of water resources, as well as defining strategies for conservation and mitigation of the impacts arising from the absence or deficiency of sanitation services in a region. This work aimed to evaluate the use of Brazilian Information and Communication Technologies, Tabnet DATASUS, of the Ministry of Health, and the National Information System on Sanitation, from the Ministry of Cities available for the management of sanitation, based on the variation of health indicators, infant mortality rate and the specific mortality coefficient for intestinal infectious diseases aged 0 to 4 years, in the Brazilian states, from 2000 to 2014, regarding the evolution of coverage and access to sanitation services (Water and Sewage). The results obtained allowed to verify the interrelationship of sanitation conditions and health indicators in this study. In general, the regression of the infant mortality index and the specific mortality coefficient were observed as sanitation coverage was expanded. Some results of the epidemiological indicators did not follow this tendency, and this fact may be related to the underreporting, or even, the non inclusion of the data in the systems. Therefore, considering the interaction between sanitation, health and water resources, it was possible to infer that the expansion of the coverage of sanitation services observed during the study period provided better conditions for protection of human and environmental health, especially considering the protection, recovery and conservation of the environment, in particular water resources.

Key words: sanitation, water resources, information and communication technologies, epidemiological indicators

1. Introduction

1.1 Contextualization: Water Resources and Basic Sanitation

According to Seifert (2014) [1], who noted United Nations studies compiled in 2013, at least 780 million people live without access to safe water, while 2.5 billion do not have adequate basic sanitation. Freshwater is one of the priceless environmental assets and we have already used it on a level above what nature can restore. Although 97% of the planet Earth consists of water, only 2.5% is potable. Of these, 2/3 are in glaciers, another part in very remote and inaccessible places. The end result is that only 0.2% of the world's water resources are effectively in use and distributed very unequally.

According to Seifert (2014) [1], the water crisis of the 21st century is related to poor management. To others, the crisis is related to environmental problems aggravated by others of economic origin and social

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development, and there are still those who defend the thesis of the real scarcity and increase of demand.

According to Tundisi (2008) [2] the following issues contribute to the water crisis:

• Intense urbanization that increases the demand for water and expands the discharge of effluents that contaminate the springs.

• Stress and water scarcity due to changes in availability and mainly in the increase of demand

• Precarious infrastructure in many urban areas, which favor network losses after water treatment.

• Problems of water scarcity and stress due to climate change, extreme hydrological events, increased population vulnerability and reduced food security, such as in heavy rains and prolonged periods of drought.

• Poor governance of water resources and environmental sustainability.

According to Nascimento and Heller (2005) [3], among the various water users, the sanitation sector is probably the one with the greatest interaction with water resources, and this relationship arises in the duality of sanitation as a water user and as an instrument of pollution control and, consequently, the preservation of water resources.

According to the National Sanitation Policy [4], the following comprise basic sanitation: Water Supply Systems (WSS), Sewage Systems (SS), Solid Waste Management (SWM) and Rainwater Management (RM). The interaction of these components with water resources is evident, making management of both sectors necessary as well as establishing and implementing water conservation, preservation and protection processes, so that sanitation becomes a mechanism for disease prevention and environmental protection [3].

1.2 Epidemiological Indicators

There are many indicators used in the health area and, according to Bonita et al. (2010) [5], are determinants for the behavior of social indicators, economic indicators, cultural and environmental factors, which are not always directly related to health, can be responsible for the maintenance of health in the individual. The Human Development Index (HDI) is based on levels of economic, social, literary, educational and life expectancy at birth, there is the risk factor, which refers to aspects of personal or of environmental exposure, which is associated with an increased likelihood of occurrence of some diseases and others.

In a more general perspective, epidemiological indicators express the relationship between the subset of patients (or deaths from a disease, or subjects with a health-related condition) and the set of members of the population [6].

The epidemiological indicators approach aims to demonstrate the definitions and characteristics of the indicators used in the study: the infant mortality rate (per 1,000 live births) and the specific mortality rate for a given cause and age group (per 100,000 inhabitants).

Eqs. (1) and (2) are used to calculate Infant Mortality Index (IMI) and Specific Mortality Coefficient (SMC) respectively.

Infant Mortality Index – IMI

$$IMI = \left(\frac{ND}{NL}\right) \times 1000 \quad (1)$$

- IMI: Infant Mortality Index;
- ND: Number of deaths;
- NL: Number of live births.

Specific Mortality Coefficient – SMC

$$SMC = \left(\frac{DCAx}{NP}\right) \times 100.000 \quad (2)$$

- SMC: Specific Coefficient of Mortality referring to: Diseases classified as Cid 10 - Category A00 through A09, in the age group less than 1 year and from 1 to 4 years (0 to 4 years);
- DCAx: Number of deaths related to the cause and age group of interest;
- NP: Population of the age group of interest.

1.3 Infant Mortality

According to IBGE (1999) [7], until a few decades ago, Brazil had difficulty producing mortality estimates, making it difficult to conclude trends and possible future projections. Due to new technical procedures developed and also the availability of census, sample or administrative information, this task has become somewhat easier. Estimates of infant mortality rate in Brazil were obtained from the demographic census in the 1940s. It is also emphasized that the development model that prevails in the country is exclusive and concentrates income, resources and services in certain regions and social strata. Since the mid-1970s, the Brazilian state has sponsored compensatory measures such as basic sanitation, maternal and child health programs, and immunization in expanding the supply of decentralized medical and hospital services. This period coincides with strong declines in average levels of fertility, reflecting positive impacts on the survival of children's groups and also on the living and health conditions of the population.

1.4 Intestinal Infectious Diseases

Intestinal infectious diseases are listed in Chapter I of the International Code of Diseases (CID) under the heading "Some infectious and parasitic diseases", Group "Intestinal infectious diseases" Category A00 to A09, namely: A00-Cholera; A01-Typhoid and paratyphoid fever; A02-Other Salmonella infections; A03-Shiguelose; A04-Other bacterial infections; A05-Other bacterial food poisoning NCOP; A06-Amebiasis; A07-Other protozoal intestinal diseases; A08- Other viral intestinal infections and NE; A09- Diarrhea and presumed infectious gastroenteritis [4].

Intestinal parasites are one of the main debilitating factors in the population. It is often associated with chronic diarrhea and malnutrition, thus compromising physical and intellectual development, particularly among the younger age groups [8, 9].

Some of the intestinal parasites have their biological cycle closely related to the supply of water in adequate quantity and quality, while that of others with sanitary sewage and disposal of solid waste in the environment [10].

1.5 Information and Communication Technologies — ICT

1.5.1 TabNet

The TabNet DATASUS application is a generic public domain tab that allows you to organize data quickly. It was developed by the Ministry of Health to generate information from the databases of the Unified Health System (SUS). The data are fed by the various actors in the health area, the states and municipalities, as well as the interface with other systems, such as the Brazilian Institute of Geography and Statistics (IBGE), bringing demographic data onto its platform.

1.5.2 National Sanitation Information System — SNIS

The SNIS has had a sanitation database for WSS and SS since 1995. The formats of data presentation, as well as their quality, have changed over time and the data must be supplied by the sanitation service providers: private and public companies, municipalities and municipalities departments.

The SNIS was created under the Program for Modernization of the Sanitation Sector, linked to the Special Secretariat for Urban Development of the Presidency of the Republic and developed by the Institute of Applied Economic Research [11]. The collection, systematization and publication of data on basic sanitation, entitled Diagnosis of Water and Sewage Services, from 1999 to 2003, was developed by IPEA. From 2004 the responsibility of the SNIS data passed to of the National Secretariat of Environmental Sanitation, of the Ministry of Cities.

The National Secretariat of Environmental Sanitation of the Ministry of Cities annually discloses the "Diagnosis of Water and Sewage Services", based on data from the National Sanitation Information

System. The importance of the NHIS data as the main source of information on the sanitation sector has been demonstrated each year by its usage from different agents involved in the provision of water and sewage services and their corporate organizations, in addition to the organs government agencies, financial agents and educational and research institutions [12].

Based on this context, this study evaluated the use of ICT available in Brazil for sanitation management based on the variation of epidemiological indicators in relation to the evolution of sanitation coverage.

2. Material and Methods

Searches were carried out on the data platforms of TabNet (Datasus-Ministry of Health) and SNIS (Ministry of Cities) to collect information on health and sanitation, respectively.

To calculate the Infant Mortality Index, information was selected on TabNet on Live Births and Infant Deaths. With these data, Eq. (1) was used to obtain the Infant Mortality Index. The calculated values refer to the number of infant deaths per 1,000 live births.

To calculate the Specific Mortality Coefficient, information was selected from TabNet on deaths in the age group of less than 1 year and from 1 to 4 years, as a result of diseases of category A00 to A09 in the group of intestinal infectious diseases of ICD-10. The calculated values, according to Eq. (2), refer to the number of deaths per 100,000 individuals in the age group of interest.

Data on coverage of sanitation services were obtained from SNIS in the following groups:

- AG001: Total population served with water supply (inhabitants); and
- ES001: Total population served with sanitary sewage (inhabitants).

Since the SNIS does not provide the information grouped by Federation Unit (States), the values by municipality were grouped by State and then by Administrative Region, tabulated and summed in specific software for calculations and spreadsheets.

The results were expressed in graphs by Administrative Region, making it possible to observe the evolution in the coverage of sanitation services and the data on infant mortality and specific mortality coefficient for intestinal infectious diseases, according to ICD-10 category, in the lower age range of 1 year and 1 to 4 years.

3. Results and Discussion

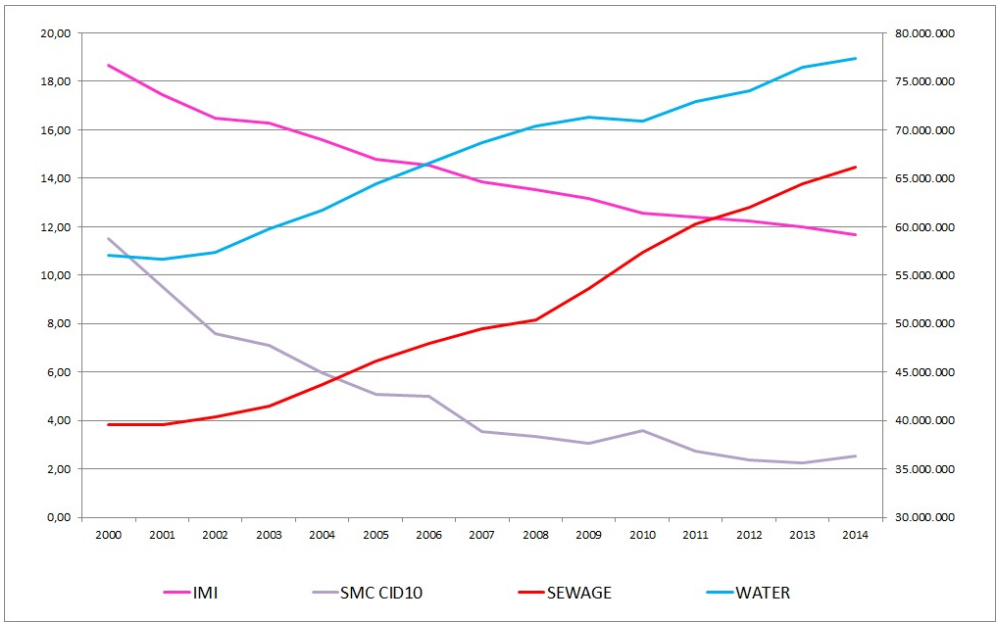

Fig. 1 Water supply and sewage coverage/Infant Mortality Index (IMI)/Specific coefficient of mortality from intestinal infectious diseases in the 0-year-old population and children under 1 year to 4 years old (SMC-CID10) in the Southeast Region.

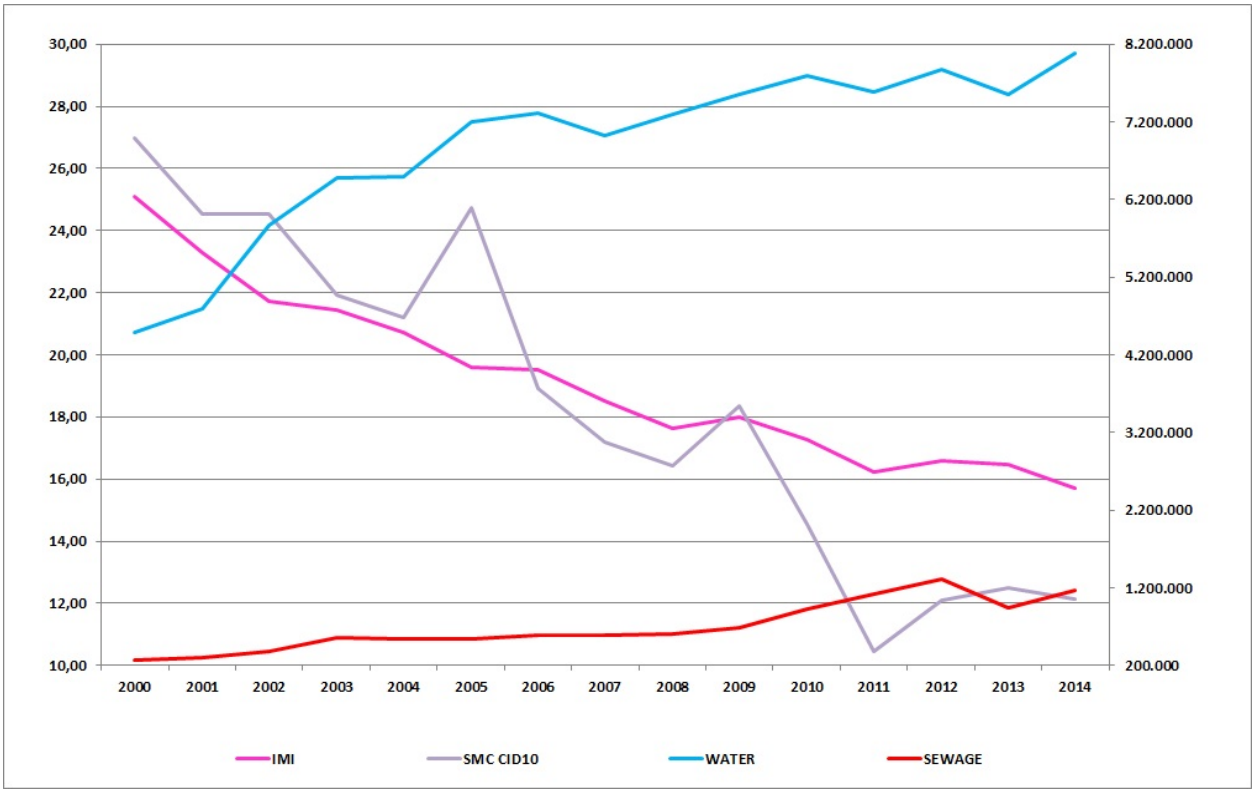

Fig. 2 Water supply and sewage coverage/Infant Mortality Index (IMI)/Specific mortality coefficient for intestinal infectious diseases in the 0-year-old population and children under 1 year old up to 4 years old (SMC-CID10) in the Northern Region.

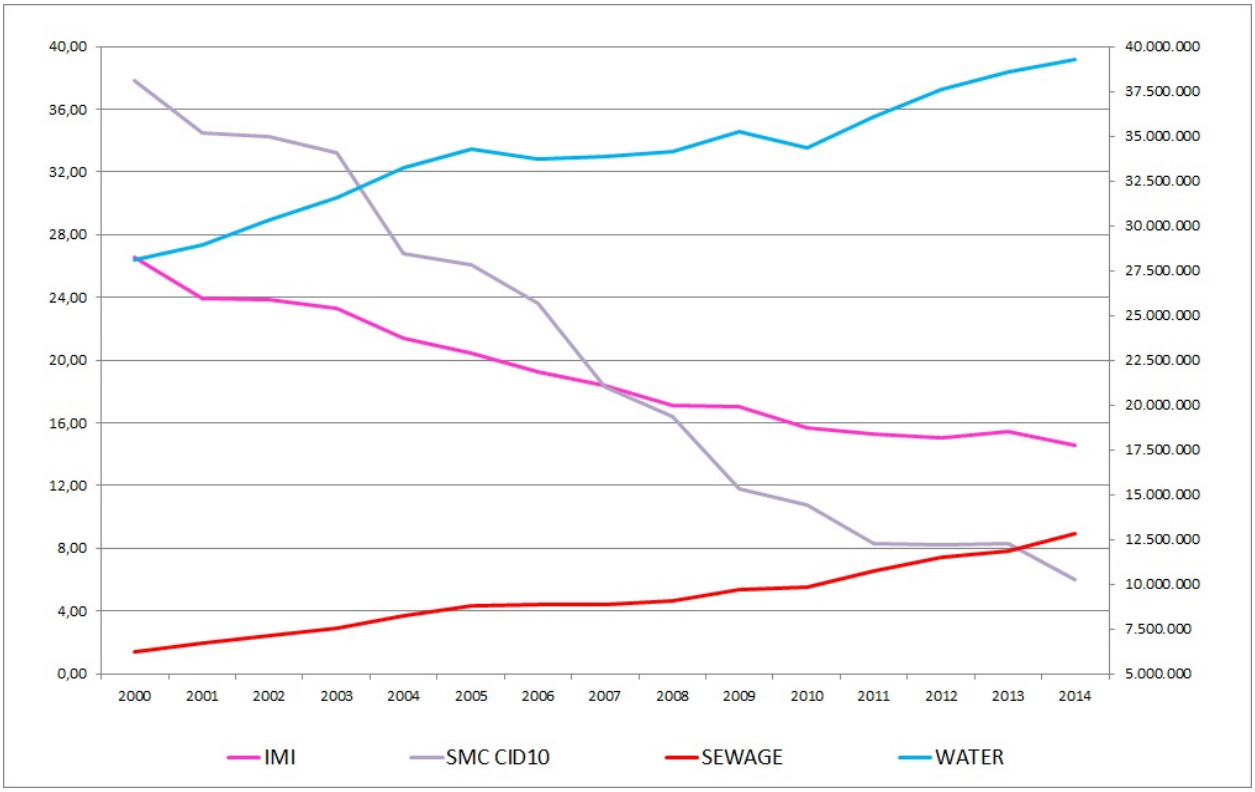

Fig. 3 Water supply and sewage coverage/Infant Mortality Index (IMI)/Specific mortality coefficient for intestinal infectious diseases in the 0-year-old population and children under 1 year old up to 4 years old (SMC-CID10) in the Northeast Region.

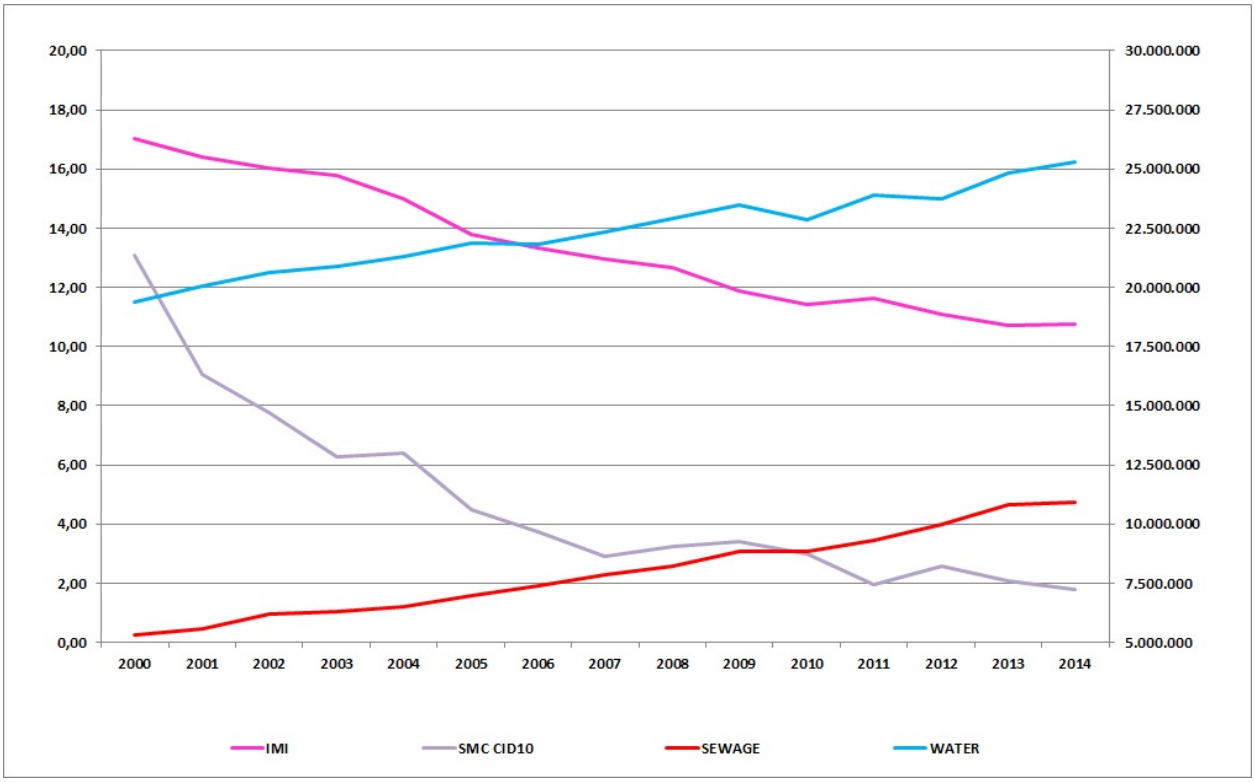

Fig. 4 Water supply and sewage coverage/Infant Mortality Index (IMI)/Specific mortality coefficient for intestinal infectious diseases in the 0-year-old population and children under 1 year old up to 4 years old (SMC-CID10) in the Southern Region.

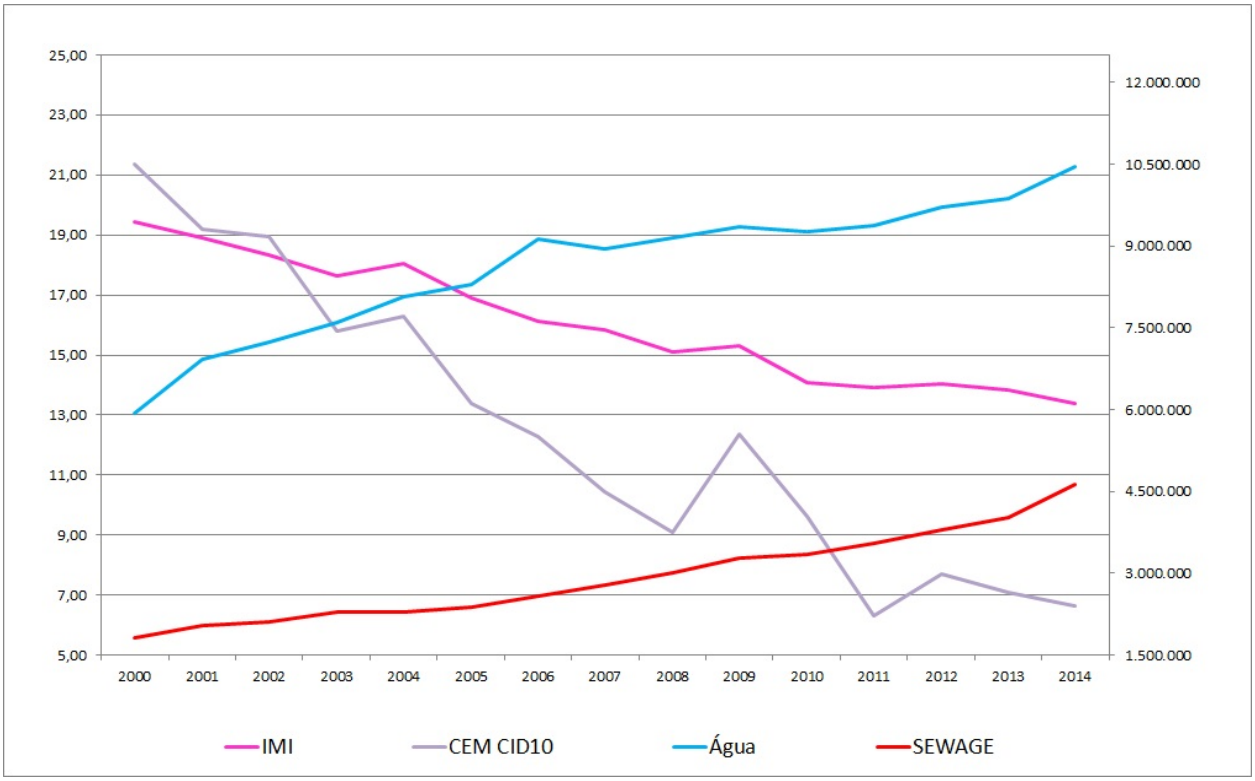

Fig. 5 Water supply and sewage coverage/Infant Mortality Index (IMI)/Specific mortality coefficient for intestinal infectious diseases in the 0-year-old population and children under 1 year old up to 4 years old (SMC-CID10) in the Midwest Region.

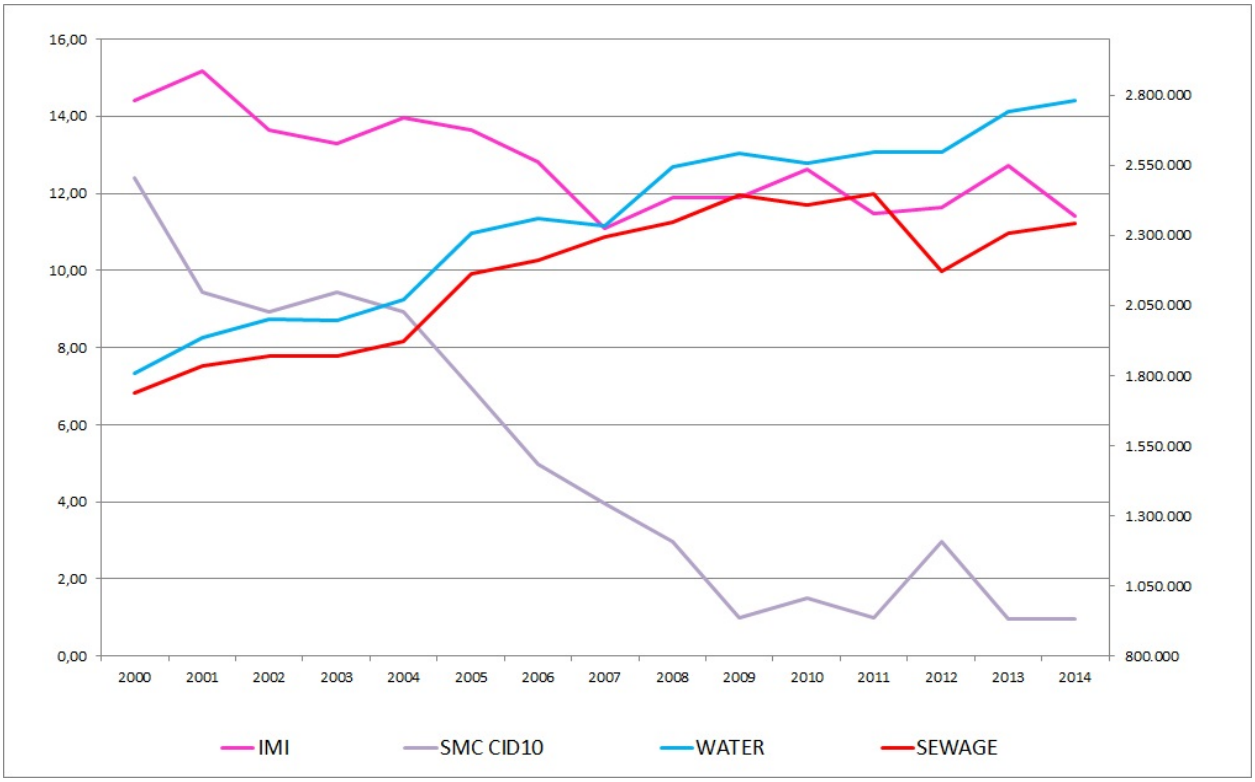

Fig. 6 Water supply and sewage coverage/Infant Mortality Index (IMI)/Specific mortality coefficient for intestinal infectious diseases in the 0-year-old population and children under 1 year old up to 4 years old (SMC-CID10), in the Federal District.

In general, the behavior and evolution of the data on the expansion of the coverage of sanitation services (Water and Sewage) over time and in the different regions was increasing and already in relation to the Infant Mortality Index (IMI) and Specific Mortality Coefficient (CEM), we observed the decline of these variables. This was already expected, since access to sanitation services allows better health conditions and, consequently, life.

Regarding epidemiological data, it was observed that in some cases (Figs. 2, 5 and 6), the behavior of the graph, specifically CEM CID10, did not follow the general trend, which may have been caused by climatic events, disease outbreaks, or sub or super reporting of cases of intestinal infectious disease mortality in the age range of interest, in Datasus' TabNet.

It should be emphasized that there are unexpected behaviors in the case of the curves related to sanitation coverage data. Again, underreporting by municipalities, in this case in the NHIS, may be one of the causes of this, especially since the expansion of access to sanitation services is increasing in the country, which seeks to universalize sanitation services throughout the national territory until 2033, according to the National Basic Sanitation Plan [4].

Finally, the expansion of coverage and access to sanitation services in the regions and in the period studied is also indicative of the preservation, protection and conservation of water resources, since sanitation actions influence the quality of water sources and water availability.

4. Conclusion

Information and Communication Technologies are important tools for managing public services. This includes sanitation services that, with the observation of specific indicators, it is possible to analyze and evaluate the expansion of coverage and access of Water Supply Systems and Sanitary Sewage Systems, including their direct impact on the improvement of population health from of health indicators, as evidenced in this study.

In addition to improving human health, the expansion of sanitation services promotes the improvement of environmental health as a whole, especially in the protection of water sources and the reduction of pollutants derived from domestic sewage in the water glasses.

Thus, the use of sanitation coverage data and health indicators present in ICT related to sanitation allows the integrated management of sanitation services and water resources, in order to obtain evaluation and planning parameters for protection, conservation and preservation the environment.

Finally, it is recommended to use ICT as a tool for planning and assisting in the elaboration of public policies, since they allow a broad observation on local and regional needs and specificities, seeking the integration of society, poverty reduction and social inclusion.

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