THE EFFECTS OF THE NEW FISCAL REGIME ON THE EFFICIENCY AND PRODUCTIVITY OF HEALTH SERVICES IN MUNICIPALITIES IN CEARÁ

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ABSTRACT

From the approval of Constitutional Amendment nº 95/2016, the New Fiscal Regime (NRF) was instituted in Brazil, establishing the freezing of primary government spending for 20 years, limiting its growth above inflation. As a result of the decentralization of Public Health Actions and Services and the processes of agreement between federal entities, municipalities are seriously affected. This study analyzes the efficiency and productivity of health services in the municipalities of Ceará before and after Amendment 95/2016. The sample comprises 137 municipalities. The data analysis for the period 2014–2019 was performed using the combined use of Data Envelopment Analysis (DEA), the Malmquist Productivity Index (MPI), tests of differences between means and correlation analysis. The main results indicate that before the Amendment came into force, the average efficiency was 3.4% higher than that of the subsequent period and that productivity increased by 3.5% after the Amendment, pointing to

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divergent findings from those of efficiency. In Addition, it was observed that the municipalities that increased per capita expenditure on health did not increase total productivity. The analysis results contribute to the advancement of knowledge, improving the understanding of the fiscal austerity effects actions implemented by the federal government since the effectiveness of Amendment 95 /2016. It is suggested that there is an indication that the most significant impacts will occur over the coming years of its effectiveness.

Keywords: Fiscal regime. Public spending. Efficiency. Productivity. Public municipal management.

OS EFEITOS DO NOVO REGIME FISCAL NA EFICIÊNCIA E NA PRODUTIVIDADE DOS SERVIÇOS DE SAÚDE EM MUNICÍPIOS CEARENSES

RESUMO

Desde a aprovação da Emenda Constitucional nº 95/2016, foi instituído, no Brasil, o Novo Regime Fiscal (NRF), que estabeleceu o congelamento dos gastos primários do governo durante 20 anos, limitando-se o seu crescimento acima da inflação. Em decorrência da descentralização das Ações e Serviços Públicos de Saúde e dos processos de pactuação entre os entes federados, os munícipios são seriamente afetados. Este estudo objetiva analisar a eficiência e a produtividade dos serviços de saúde nos municípios do Ceará antes e depois da EC 95/2016. A amostra reúne 137 municípios e a análise do período 2014–2019 foi realizada com o uso combinado da Análise Envoltória de Dados (DEA), do Índice de Produtividade de Malmquist (IPM), e de testes de diferenças entre médias e análise de correlação. Os principais resultados indicam que antes da vigência da EC a média de eficiência foi 3,4% maior que a do período posterior e que a produtividade aumentou em 3,5% depois da EC, apontando para achados divergentes dos da eficiência. Adicionalmente, observou-se que os municípios que aumentaram os gastos per capita com saúde, não aumentaram a produtividade total. Os resultados da análise da eficiência e da produtividade dos serviços de saúde nos municípios cearenses antes e depois do NRF, contribuem para o avanço neste conhecimento e podem melhorar a compreensão dos efeitos das ações de austeridade fiscal implementadas pelo governo federal desde a vigência da EC 95/2016. No entanto, há indicação de que os maiores impactos ocorrerão ao longo dos próximos anos de sua vigência.

Palavras-Chave: Regime fiscal. Gastos públicos. Eficiência. Produtividade. Gestão pública municipal.

1 INTRODUCTION

Brazil has one of the most decentralized healthcare systems in the world, in which municipalities take on the fundamental role of implementing policies and providing services. However, in addition to regional and local differences between

the availability of resources for healthcare needs and the capacity to provide services, the country also needs more funding for the sector. This results in territorial imbalances and significant challenges for the management of the system (Menicucci, Costa, & Machado, 2018).

As of the implementation of the decentralization process, there have been expectations that public services would be more efficient, thus raising the level of well-being of the population. It was believed that the executive bodies closest to the population would have better mechanisms to instrumentalize social participation and would, therefore, offer goods and services more suited to the needs of citizens (Bandeira & Reyes, 2021). In the meantime, concerning the financing of the public health system, the paradox that Brazil spends little but spends badly remains (Araújo, Lobo, & Medici, 2022).

Since the creation of the Unified Health System (SUS), the commitment to consolidate it has been made repeatedly by different governments. Nonetheless, there are many challenges to ensuring its proper functioning (Vieira & Benevides, 2016), considering that some constitutional amendments altered the rules governing its financing. The Amendment 29/2000, which established resource distribution, was in force until 2015. As of this year, the Amendment 86/2015 established that the amount destined to Actions and Public Health Services (ASPS) would have to correspond to at least 15% of public revenues (RCL) within the Union. This proportion must gradually be modified, from 13.2% in 2016 to 15% in 2020 (Vieira & Benevides, 2016).

With the advent of the New Fiscal Regime (NFR), instituted by the Amendment 95/2016, the rules were altered through the provisions of article 110 of the Transitional Constitutional Provisions Act (ADCT), which established the anticipation of the calculation of the ASPS minimum at the rate corresponding to 15% of the RCL for 2017 (Constitutional Amendment nº 95, 2016). Due to that fact, since 2018, the federal government spending ceiling has been calculated by updating the previous year's minimum by the Broad National Consumer Price Index (IPCA). The ceiling establishes the correction of federal government expenditure by inflation over the last 12 months up to June of the previous year (Constitutional Amendment nº 95, 2016).

On the one hand, this NFR implementation scenario contains the urgency of correcting public spending in a clear imbalance, which may lead to a framework of rising interest rates and further fall in investment and economic activity, flirting with the possibility of an inflationary framework. On the other hand, the solution proposed by this correction – the NFR – faces the challenge of compensating constant growth of public primary expenditures, which are shielded by the Constitution, flattening discretionary spending and its essential items for society (Bronzim, 2019).

This way, the fiscal austerity actions implemented by the federal government since Amendment 95/2016 came into force may contribute to slowing down the decline in infant mortality rates in Brazil by 2030 (Rasella et al., 2019). Implementing this measure could affect the Family Health Strategy (ESF) program and other indicators (Rasella et al., 2018).

Based on the "myth of expansionary fiscal contraction", Alesina et al. (2017) assure that the NFR will stimulate private investment and the return of economic activities by adjusting public expenditure. Others consider that the efficiency and productivity of public health services are not only related to the amount of resources spent (Duarte & Diniz, 2018). However, it is understood that the application of the fiscal austerity policy implemented by the Amendment 95/2016 threatens health as a universal, integral, and fair right once it can impact the efficiency and productivity of the services in this area (Rasella et al., 2018, 2019; Vieira & Benevides, 2016).

Specifically, Machado, Irffi, and Benegas (2011) found low technical efficiency in the application of public spending on health in the municipalities of Ceará. Nunes and Souza (2019) claim that Ceará has faced numerous problems related to infrastructure in the health segment, even though it has contributed directly to other areas, such as education, economic and social development. Furthermore, considering efficiency indicators of the dimensions of education, health, and income, Silva e Crisóstomo (2019) analyzed the effects of fiscal management and efficiency of public management in the socioeconomic development of municipalities of Ceará. It concluded that fiscal management and the efficiency of public management positively influence municipal socioeconomic development, signaling that public managers must improve the efficiency of their management and observe the rules of fiscal control. Nevertheless, this research is justified by focusing on the municipalities of Ceará.

As exposed, some studies point to disagreements relating to the impacts of fiscal austerity policy on health indicators. The Amendment 95/2016 was approved recently, yet the effects of this regulation on the efficiency level and municipal productivity were not assessed from a health perspective. In this sense, the study aims to analyze the efficiency and productivity of Ceará municipalities in healthcare services before and after Amendment 95/2016 came into force. Additionally, it is sought to verify if Ceará municipalities that increased productivity in public health services differ significantly in terms of the amount of spending in the area considering the two periods.

Some recent research dedicated to analyzing the performance of municipalities has demonstrated that due to the varying levels of service provision in this sphere, in most cases, municipalities showed low efficiency and productivity in implementing public policies (Nunes & Sousa, 2019; Oliveira, Mota, & Vasconcelos, 2022; Teles, 2018).

Thus, Oliveira, Mota, and Vasconcelos's research (2022) is the closest to this study. This one innovates by evaluating 137 municipalities in Ceará, not only the 36 largest ones, but by meeting the recommendation to expand the time series, using a reference to the span between 2014 and 2019, in addition to evaluating if the municipalities which increased productivity in health services differ significantly concerning the number of spendings in the two periods, with the latter not explored in correlated studies. It also contributes to improving public health policies by comparing the effects of the variables before and after Amendment 95/2016 came into force.

The study brings theoretical, practical, and methodological contributions. The quality of the use of public resources and the efficient use with high

productivity are concepts that the public administration has been incorporating over the years, which are necessary to be related to the austerity of fiscal policy (Grin, 2014). Different from previous studies, this research contributes to the literature by analyzing the effect of the Amendment 95/2016 on the efficiency and productivity of public management in municipalities of Ceará since future dynamics in health expenditure, in a context of limited growth in public spending, imposed by the norm, leads the public municipal administration to seek efficiency and productivity gains. With the new economic situation implemented in the country, uncertainties have been raised about its benefits, which can affect health rights once investments in this sector are reduced throughout the 20 years that Amendment 95/2016 has been in force.

From a social perspective, the study proves relevant by investigating municipalities of a state in the northeast of Brazil, a region characterized historically by poor income distribution and low levels of life quality, as well as minimum capacity of tax collection, which enables an increase in the relevance of efficient management, especially in times of tax adjustment.

These themes are commonly studied through non-parametric methods based on the Data Envelopment Analysis (DEA) and the Malmquist Productivity Index (MPI) (Duarte & Diniz, 2018). Therefore, there is the combined use of DEA and MPI techniques as a methodological contribution. Most empirical research that used DEA in combination with the MPI up to this point was implemented in developed countries (Peña, Albuquerque, & Daher, 2012). From a practical viewpoint, they propose advancements for evaluating public health policies by applying techniques that seek to estimate relative efficiency levels and productivity dynamics in the context of the norm implementation.

The results indicate that the 137 municipalities showed in the period before the Amendment an average efficiency 3.4% higher than the period of its existence. Regarding productivity levels, results reveal that, on average, during none of the two periods (before and after Amendment 95/2016 has been in force), municipalities neither increased their productivity in health services nor presented an index superior to 1. It was found that there was a 3.5% increase in the productivity of municipalities, comparing the periods before and after the implementation of Amendment 95/2016. In addition, it was found that the increase in per capita public spending on health is not related to the positive variation in the productivity of health services in the municipalities of Ceará.

2 THEORETICAL FRAMEWORK

This section covers the impacts of NFR on healthcare financing, efficiency, and productivity in the sector, emphasizing the DEA and MPI techniques and presenting related studies.

2.1 Impact of the NRF on Health Financing

Since the creation of SUS, guaranteeing more significant equity in meeting society's needs through improving public health services was sought in a context in which, beyond the reduction of available resources, there was a change in the

epidemiological and demographic profile of the Brazilian population (Carvalho, 2013; Ferreira & Pitta, 2008). With the enactment of Law No. 8.080/1990, which organized the SUS, the attributions and competencies of each level of government were established: the states were responsible for promoting the decentralization of health services and actions, while the municipalities were responsible for the management and execution of local services (Noronha *et al*., 2018).

This law assigned the planning and the execution of public health services locally, which would demand higher spending once actions are specialized, with high operational, personal, and technological costs (Pescuma & Mendes, 2015).

In virtue of that fact, municipalities faced some challenges enabling the execution of these services, which can lead to inefficiency. According to Rodrigues, Sallum, and Raupp (2020), the inefficiency of health public expenditure in Brazil constitutes one of the main problems of the system alongside a shortage of resources, considering that, grounded on the World Health Organization (WHO) study around 40% of resources available in the health sector in Latin America are wasted. In agreement with Mota, Oliveira, and Vasconcelos (2021), one of the significant challenges for public managers, especially in the health sector, is achieving efficiency gains since these resources are scarce.

Specifically in the context of SUS, these matters related to the lack of resources can be intensified with the Amendment 95/2016, which has established the spending ceiling and has frozen the Union minimum investments. This has made it impossible to sustain federal funding for health. The NRF removed, in practice, the federal government from the SUS funding pact made by municipalities, states, and the Union (three-way) and weakened its role in the national coordination of the public sector (Costa & Lago, 2020).

This way, underfunding will reduce spending on health and education for the following 20 years (Rossi & Dweck, 2016). Due to the decrease in public investments in the health sector, private arrangements are being encouraged daily, particularly with the revision of the methodology for transfers from the federal government to the municipalities, implemented by Ministério da Saúde (MS) in 2017. This marked fragmentation of SUS is similar to what occurred in the 1990s (Noronha et al., 2018).

Additionally, Rossi and Dweck (2016) also informed that the federal primary cut in spending is not a guarantee of improved tax indicators. On the contrary, the authors mention that tax revenue plummeted and the deficit grew, highlighting the counterproductive nature of this adjustment, which generates interruption of public investments and budget restrictions for health and education.

Thus, strengthening the decentralization could reduce pressure on the Health Ministry in a scenario of federal government minimum investments freezing and produce more significant impacts on municipalities' health spending (Jaccoud & Vieira, 2018). In this context, Rasella et al. (2018) emphasize that municipal administrations face political and economic challenges to improve services; it is added to the impacts of fiscal austerity, which will reduce investments in social and health assistance programs substantially in the next 20 years.

Rasella et al. (2019) conducted simulations and projections of the NFR impact in 5.507 Brazilian cities for the next ten years in the light of four scenarios.

The author verified that the ESF primary service would be more affected in the poorest centers. In the worst scenario, the child mortality taxes due to complications resulting from infectious diseases and nutritional deficiencies would be 11.7% higher compared to the current coverage situation in municipalities.

Vieira et al. (2020) believe that the barriers to accessing health services in cities must be treated comprehensively, besides being a starting point for formulating interventions destined to amplify coverage, reducing disparities in the use of services to improve population health, and being more efficient. Implementation of fiscal austerity policies in Brazil, which was based on the myth of expansionist hiring, when reducing public investment ends up compromising the system's essential indicators and actions, requiring public entities to increase efficiency and productivity of health system levels (Schenkman & Bousquat, 2019).

On the other hand, Barbosa (2017) believes that the Amendment 95/2016 would help overcome the recession and unemployment from that time through the return to the Union fiscal balance, which went through rigid control of primary expenditure.

2.2 Efficiency and Productivity in the Health Sector

The Malmquist evaluation of efficiency and productivity (MPI) on health services, in an international context, was carried out in research by Färe *et al*. (1997), Asandului, Roman, and Fatulescu (2014), Stefko, Gavurova and Korony (2016), Zhang *et al*. (2018) and Witte *et al.* (2020).

Hadad, Hadad, and Simon-Tuval (2013) compared health system efficiency via DEA in the Organisation for Economic Cooperation and Development (OECD) countries, considering life expectancy and tax of children's survival as a result of two models. The first incorporated the system's discretionary inputs, density of doctors and hospital beds, and those inputs out of the health system control: Gross Domestic Product (GDP), fruit and vegetable consumption, and health expenditure. The second model observed that institutional arrangements, population behavior, and socioeconomic or environmental determinants are associated with countries' health systems. The findings indicate: i) nine stable, large-economy countries were considered efficient by the model I but were inefficient in model II, and ii) the association between socioeconomic and environmental indicators was ambiguous.

From Debreu's analysis of productivity (1951) – which initiated the studies on the Economic Theory of Efficiency – and by deepening introductory research developed by Koopmans, the scholar Farrell (1957), through the study The Measurement of Productive Efficiency proposed a method to measure the economic efficiency of a production unit. Farrell (1957) affirmed that a company's most obvious measure of efficiency is its costs. Cost comparisons should be limited to the situations in which all the compared companies confront the same pricing factors, but in these cases, they constitute a much better criterion than productivity and are equivalent to the best "efficiency index."

Specifically regarding the Economic Theory of Efficiency, Mattos and Terra (2015) consider that the central problem is the shortage of resources, regardless of their nature. Thus, according to the authors, in a context with several restrictions, the Economic Theory of Efficiency tries to develop itself to attain public policies that can obtain more profit from available resources (Mattos & Terra, 2015). In conclusion, it is observed that achieving the most significant possible benefit with a determined amount of resources is precisely the primary goal of efficiency.

The assessment of efficiency and productivity allows for the observation that the operation of the Decision Making Unit (DMU) may vary over time. Measuring changes can be relevant for understanding how much public entities' performance is impacted by the technological shift or their initiatives (Duarte & Diniz, 2018; Witte *et al.,* 2020).

According to Rodrigues (2017), efficiency and productivity analysis can be a strategy for increasing the quality of public services; providing measurement, comparisons of different periods, impacts of regulatory changes, and ascertaining how the organization has been working to similar ones.

Notably, in times of crisis, healthcare public managers search for an increase in resource efficiency and productivity gain in the management of SUS (Cruz, 2016). This occurs especially in municipalities since resources are limited and composed, in majority, by federal and state government transfers.

Benchmarking efficiency can be carried out by using parametric and non-parametric methods. To do so, they are outlined by considering production, such as inputs and outputs, and grounded on the conception of efficiency frontiers (Peña, 2012). Non-parametric methods are most used to measure efficiency levels of determined DMUs. Among these methodologies, DEA is highlighted (Monte & Leolpodino, 2020).

In the studies that evaluate efficiency, DEA is pointed out as one of the most employed techniques (Witte *et al.,* 2020). The methodology has been extensively used in national and foreign research on the efficiency of public expenditure (Peña, 2008). In research related to health and education, DEA supports the elaboration and monitoring of public policies through efficiency scores for the application of resources, services, and managed processes (Silva, Silva, Gonçalves, & Gonçalves, 2021).

The present study aims to analyze the effect of the Amendment 95/2016 on efficiency. For this purpose, it is necessary to consider the dynamics of efficiency over time. One methodology used for this goal is the MPI (Malmquist Index), which does not use prices to group distinctive entries and exits (Bogetoft & Otto, 2011). The DEA and the MPI help estimate levels of relative efficiency and productivity or efficiency dynamics, respectively (Peña, Albuquerque, & Daher, 2012).

The MPI seeks to measure two distinct effects: 1) the pairing (catch-up effect, which looks at the increase or decrease in efficiency over time; and 2) the displacement of the productivity efficiency frontier (frontier-shift effect), which demonstrates the upward or downward advances in productivity as a result of technological, managerial, administrative and legal innovations, as is the case here (Cooper, Seiford, & Tone, 2007). The MPI was utilized in line with DEA in studies

that analyzed productivity and efficiency alterations in allocating health inputs (Duarte & Diniz, 2018; Zhang *et al*., 2018).

Concerning health-destined resources, Funcia and Ocké-Reis (2018) show that federal contributions to SUS will be reduced from 1,7% to 1,2% of GDP until 2036. Hence, the MH expenses transferred to states, Federal District, and municipalities will be reduced by two-thirds (2/3), affecting funding of actions and health services developed by federal entities, according to simulations conducted by Funcia and Ocké-Reis (2018). The investment cut in the ESF and Bolsa Família program would result in 19.732 more deaths of up-to-5-year-old children by 2030 (Rasella *et al*., 2018). Reduction in financial sources can influence the level of system efficiency, leading to the necessity of improving the cost-benefit-return ratio of public input dedicated to this area (Macedo *et al.,* 2019; Nunes & Sousa, 2019), above all after Amendment 95/2016 came into force.

As for the variables used, those are considered preventive and curative health once they constitute fundamental references for measuring efficiency in healthcare (Fonseca & Ferreira, 2009). Public spending per capita on health indicates the average amount of public resources available per resident in each Federation Unit, in addition to measuring the dimension of total public spending on health per resident and absolute participation of each government sphere in the financing of SUS (Ripsa, 2008).

The percentage of application in Public Health Actions and Services (ASPS) establishes minimum spending on priority areas such as health, besides highlighting that these segments are fundamental, basic rights for human dignity (Silva *et al*., 2019).

SUS Basic Attention Services are provided by a multiprofessional team and offered to the population in a given territory. Vaccination coverage is characterized by the percentage of children immunized with specific vaccines in a given geographical site in a reference year (Ripsa, 2008).

Infant mortality is a severe world public health matter. Though its indexes have decreased globally, it is still a current reality in developing countries, like Brazil (Sanders *et al.,* 2017). The critical indicator is outpatient production, constituted by numerous forms of outpatient output provided by SUS. The COVID-19 pandemic made evident the discrepancy between the number of hospital beds provided by SUS and the private sector. SUS offers almost five times fewer ICU beds than the private network for each 100 thousand inhabitants (Costa & Lago, 2020).

Based on the assumptions of the Economic Theory of Efficiency and the literature recommendations presented on the relationship between efficiency and productivity and health funding, the three following hypotheses are proposed:

H1: The relative efficiency level of health services in the municipalities of Ceará in the period before the Amendment 95/2016 came into force is lower than the period in which the norm has been in force.

H2: The level of productivity of health services in the municipalities of Ceará was not affected by the implementation of the Amendment 95/2016.

H3: There is no significant difference in the volume of health spending among the municipalities of Ceará, which increased productivity in health services as Amendment 95/2016 is in force compared to the others.

3 PROCEDIMENTOS METODOLÓGICOS

Concerning the methodological framework, the present study is qualitative. Regarding objectives, it is classified as descriptive, for which documental analysis is used in order to proceed to secondary data collection.

To carry out this research, data from official reports available on DATASUS/Health Ministry, in the Brazilian Institute of Geography and Statistics (IBGE) and the Health Secretariats of the Ceará state was collected (Oliveira, Mota, & Vasconcelos, 2022; Teles, 2018). Data on the municipalities in Ceará from 2014 to 2019 was also used. Of the 184 municipalities, 47 did not dispose of information in all the researched period years, which led to the reduction of the sample in 137 municipalities, according to Figure 1.

Microregion	Municipalities	Quantity
Fortaleza	Amontada, Aracoiaba, Aquiraz, Barreira, Baturité, Beberibe, Capistrano, Cascavel, Caucaia, Chorozinho, Eusébio, Fortaleza, General Sampaio, Guaiuba, Horizonte, Itaitinga, Itapajé, Itapipoca, Itapiúna, Jaguaretama, Jaguaruana, Maracanaú, Maranguape, Morada Nova, Ocara, Pacajús, Pacatuba, Paracuru, Paraipaba, Pentecoste, Pindoretama, Redenção, Russas, São Gonçalo do Amarante, São Luiz do Curu, Tejuçuoca, Trairí, Tururu, Umirim e Uruburetama.	40
Sobral	Acaraú, Ararendá, Barroquinha, Bela Cruz, Camocim, Carnaubal, Chaval, Crateús, Cruz, Catunda, Coreaú, Forquilha, Frecheirinha, Granja, Guaraciaba do Norte, Hidrolândia, Ibiapina, Independência, Ipu, Ipueiras, Irauçuba, Itarema, Marco, Massapê, Meruoca, Monsenhor Tabosa, Moraújo, Morrinhos, Mucambo, Nova Russas, Novo Oriente, Poranga, Quiterianópolis, Reriutaba, Santa Quitéria, Santana do Acaraú, São Benedito, Sobral, Tamboril, Tianguá, Ubajara, Uruoca e Viçosa do Ceará.	43
Sertão Central	Banabuiú, Boa Viagem, Canindé, Choró, Ibaretama, Madalena, Milhã, Parambu, Pedra Branca, Quixadá, Quixeramobim, Senador Pompeu, Solonópole e Tauá.	14
Litoral Leste/ Jaguaribe	Alto Santo, Aracati, Iracema, Itaiçaba, Jaguaribara, Jaguaribe, Limoeiro do Norte, Pereiro, Quixeré e Tabuleiro do Norte.	10
Cariri	Acopiara, Araripe, Assaré, Barbalha, Barro, Brejo Santo, Campos Sales, Caririaçu, Cariús, Cedro, Crato, Farias Brito, Icó, Iguatu, Ipaumirim, Jardim, Juazeiro do Norte, Lavras da Mangabeira, Mauriti, Missão Velha, Mombaça, Nova Olinda, Orós, Penaforte, Porteiras, Quixelô, Salitre, Santana do Cariri, Tarrafas e Várzea Alegre.	30
Total		**137**

Figure 1 - Macro-regional breakdown of the survey sample
Source: Elaborated by authors based on data from the SESA Portal.

The DEA method was applied by first identifying the DMUs, then selecting the necessary factors (inputs and outputs) for obtaining efficiency scores, and finally choosing the most appropriate method for DEA application.

Figure 2 shows the selected variables to enable DEA and MPI application, verifying the congruence of the inputs and outputs factors with the DMUs, as well as with the purpose of the study (Macedo *et al.*, 2019; Nunes & Sousa, 2019; Oliveira, Mota, & Vasconcelos, 2022; Teles, 2018)

Input	**Description**	**Collection Source**	**Reference**
GasPubPC	Public spending on health per capita	IBGE and MS	Nunes & Sousa (2019), Teles (2018) and Trompieri Neto et al. (2009)
PercASPS	Percentage of application in Public Health Actions and Services	MS	Oliveira, Mota, & Vasconcelos (2022) and Teles (2018)
EquiSau/1000	Healthcare teams / 1000 inhabitants	DATASUS	Flach, Mattos, & Mendes (2017), Mazom, Mascarenhas, & Dallabrida (2015) and Oliveira, Mota, & Vasconcelos (2022)
Outputs	**Description**	**Collection Sources**	**Reference**
Cobvac	Vaccination coverage	DATASUS	Mazon, Mascarenhas, & Dallabrida (2015), Politelo, Rigo, & Hein (2014) and Schulz, Gollo, Rosa, & Scarpin (2014)
Imort	Inverse of infant mortality rate	IBGE/SESA/ IPCE	Silva, Moretti, & Schuster (2016), Teles (2018) and Tonelotto et al. (2019)
ProambPC	Outpatient production per capita	DATASUS	Ferreira & Pitta (2008) and Schulz et al. (2014)
NLeitos/1000	Number of SUS beds per 1000 inhabitants	DATASUS	Oliveira, Mota, & Vasconcelos (2022) e Queiroz et al. (2013)

Figure 2 - Variables considered in the study
Source: Elaborated by authors.

After the execution of the DMUs, which was the definition and selection stage, and the factors of entries and exits (inputs and outputs), it proceeded to the last stage, in other words, the choice and application of the DEA model. In this research, it was opted by the Variable Returns to Scale (model DEA-BCC), proposed by Banker, Charnes and Cooper (1984). This model makes the attainment of superior results from the same input level possible. This option is justified by considering that in healthcare public services resources are not expected to be reduced. However, the services provided for the population were maximized from a set of available inputs (Marinho & Façanha, 2001).

The model application sought to obtain results aimed at maximizing the performance of Ceará municipalities while keeping the levels of input indicators in

the health sector stable, as employed by Brambilla and Carvalho (2017) and Queiroz *et al.* (2013). It is pointed out that the result analysis was classified into five efficiency levels, adapted from Nunes and Sousa's study (2019).

After analyzing efficiency, the next step was to assess the productivity level throughout the period. This way, the dynamic efficiency was calculated through the MPI, aiming to compare the efficiency of DMUs in different periods and to show its variations, which were broken down into two components: technical efficiency variation (catch-up) and technological efficiency variation (frontier-shift effect). Thus, the indicator verifies if efficiency frontier displacement results from the increase in technical efficiency or incorporation of new technologies / technological variation effect (Marinho & Ataliba, 2000).

Through the Man-Whitney test of differences between means, it was verified if there were any significant differences between levels of efficiency (**H_1**) and productivity (**H_2**) in the periods before and after the Amendment 95/2016, also known as the spending ceiling amendment, has come into force.

In conclusion, to examine **H_3**, it was sought to verify if municipalities that increased productivity in healthcare services differ significantly regarding the amount of spending in the area considering the periods before and after the Amendment 95/2016. By doing so, the municipalities were sorted in two groups based on the analysis of the two periods of interest in this research (before and after the Amendment). Group 1 gathered municipalities that increased health expenditure per capita; Group 2 consisted of municipalities that did not.

For data analysis through DEA methods (model DEA-BCC) and IPM, the software Frontier Analyst, version 4.1, was used. In contrast, for the conduction of the test of differences between means and correlation, Stata, version 14, was used.

4 ANALYSIS AND DISCUSSION OF RESULTS

At first, there is a descriptive statistic of variables (Table 1), in which the inputs and outputs are presented before and after Constitutional Amendment nº 95/2016 enforcement.

Table 1
Descriptive statistics of variables before and after Amendment 95/2016

Indicator	Before Amendment 95/2016				
	Minimum	**Maximum**	**Average**	**Standard deviation**	**Coefficient of variation (%)**
GasPubPC (I)	59,52	777,62	253,12	95,20	37,61
PercASPS (I)	12,05	35,00	24,14	4,52	18,74
EquiSau/1000 (I)	0,13	3,15	0,45	0,22	50,62
Cobvac (O)	28,34	157,18	89,46	27,06	30,25
Imort (O)	0,02	0,38	0,09	0,06	60,66
ProambPC (O)	0,00	38,84	0,83	1,95	23,45
NLeitos/1000 (O)	0,24	6,08	1,47	0,85	57,71
Indicator	**After Amendment 95/2016**				
	Minimum	**Maximum**	**Average**	**Standard deviation**	**Coefficient of variation (%)**

GasPubPC (I)	110,75	966,03	269,69	107,02	39,68
PercASPS (I)	15,01	35,00	23,53	5,04	21,43
EquiSau/1000 (I)	0,19	1,00	0,45	0,11	24,17
Cobvac (O)	12,19	118,82	68,31	19,14	28,02
Imort (O)	0,00	9,11	0,13	0,51	398,61
ProambPC (O)	0,00	22,69	0,65	1,26	192,24
NLeitos/1000 (O)	0,23	5,83	1,42	0,80	56,72

Caption: I: *Input*; O: *Output*; GasPubPC: Public spending on health per capita; PercASPS: Percentage of application in Public Health Actions and Services; EquiSau/1000: Healthcare teams/1000 inhabitants; Cobvac: Vaccination coverage; Imort: Inverse of infant mortality rate; ProambPC: Outpatient production per capita; NLeitos/1000: Number of SUS beds by 1000 inhabits.
Source: Research data.

As for total health expenditure per capita, it is observed that during the period before Amendment 95/2016, the values varied between R$ 59,52 (Tauá) in 2014 and R$ 777,62 (Eusébio) in 2016. In 2014, Itapipoca, with R$ 97,34, and Santa Quitéria, with R$ 83,90, made expenditures close to the minimum, which contributed that the average in the period was R$ 253,12, which was 6.5% lower than the average registered in the period that Amendment has been in force, once they varied between R$ 110,75 (Itapipoca) in 2018 and R$ 966,03 (Eusébio) in 2019.

For the percentage of application in ASPS, almost all cities showed value superior to that required by the Amendment 29/2000, except for Itapiúna and Pacatuba, which 2016 applied 12,1% and 14,4%, respectively. However, in general, findings corroborate Carvalho (2013) when assuring that states and municipalities are ultimately responsible for the ASPS and that in virtue of the federal underfunding, municipalities increased application above the legal floor (15%), some passing over 20%.

Regarding the variable Healthcare Teams/1000, before Amendment 95/2016, Quixadá obtained the lowest proportional value, while Carnaubal attained the highest value in 2016. The mean values demonstrate a positive variation of 4,6% after the amendment. In turn, the vaccination coverage showed a reduction of 23,6% after the amendment, with minimum and maximum values presenting negative variations of 56,9% and 24,4%, respectively. In light of exposed facts, it is possible to check that a decrease in vaccination coverage has occurred over the last decade and has been accentuated after the Amendment 95/2026 has been in force, based on claims by Arroyo *et al.* (2020).

The variables outpatient production per capita and number of SUS beds by 1000 residents also showed a reduction on average in the period after the Amendment 95/2016, with 21.7% and 3.4%, respectively. Concerning NLeitos/1000, even though the period variation has been negligible, the decrease in bed availability, linked with the use of inadequate contributed resources, increases the adverse effects of investment reduction and aggravates the restrictions faced by the users of the public system.

The rate of infant mortality did not show a significant difference between averages of the periods in question; however, it is worth noting that after more than two decades of consecutive reduction, the indicator has grown again in Ceará,

notably in 2017 (Madeira, 2018; Marinho & Façanha, 2001), but followed by light recovery in 2018.

The Mann-Whitney test was done to verify any significant statistical differences, whose results are shown in Table 2.

Table 2
Mann-Whitney test results

Proxy	**Prob > |z|**
GasPubPC (I)	0.0161(**)
PercASPS (I)	0.0365(**)
EquiSau/1000 (I)	0.0005(*)
Cobvac (O)	0.0000(*)
Imort (O)	0.8223
ProambPC (O)	0.0000(*)
NLeitos/1000 (O)	0.3772

Caption: (*) significance to 1%; (**) significance to 5%.
Source: Research data.

Based on Table 2 results, it can be verified that only the dimensions inverse of infant mortality rate and number of beds showed differences of medians, statistically significant in comparing indicators before and after Amendment 95/2016.

4.1 Efficiency in Municipalities before na after Constitutional Amendment nº 95/2016

Table 3 presents a descriptive analysis of the efficiency levels in municipalities calculated by DEA.

Table 3
Descriptive analysis of efficiency before and after the Amendment 95/2016

Descriptive analysis	**Efficiency before Amendment 95/2016**	**Efficiency after Amendment 95/2016**
Average	83,21	80,40
Median	83,18	80,24
Standard deviation	13,02	15,40
Minimum	42,76	26,30
Maximum	100,00	100,00
Coefficient of variation (%)	0,15	0,19

Source: Research data.

It is noted that the cities obtained higher average efficiency scores before the Amendment 95/2016 (0,832) compared to the period after it came into force (0,804), with a difference of 3.38%. Concerning minimum values, the municipality of Chorozinho (macro-region of Fortaleza) obtained the lowest efficiency score in 2016 (0,4276), and Irauçuba (macro-region of Sobral) attained the lowest value after the onset of the Amendment (0,2630) in 2019.

Grounded on the Mann-Whitney test, it was checked that, at the confidence level of 95%, populational medians are different between the two periods (Prob > |z| = 0,0115). The findings are similar to those of Oliveira, Mota,

and Vasconcelos (2022). When analyzing the 36 largest municipalities in Ceará, they demonstrated that the average group efficiency and productivity were superior before implementing the Amendment and its spending ceiling.

Analyses suggest that, due to Amendment 95/2016, the health sector may have been less prioritized in budgets and in the process of executing services, which is reflected in efficiency. In line with this, Vieira and Benevides (2016) point out that a 20-year freeze on federal primary expenditure could lead to declining sector efficiency. Table 4 displays the average efficiency scores of the DMUs (municipalities) in the periods before and after Amendment 95/2016.

Table 4
Municipalities by discrimination range and efficiency before and after Amendment 95/2016

Range	Level of discrimination	Efficiency before		Efficiency after	
		Nº of municipalities	Proportion (%)	Nº of municipalities	Proportion (%)
E ≤ 0,25	Extremely low efficiency	-	-	-	-
0,26 ≤ E ≤ 0,50	Low efficiency	-	-	-	-
0,51 ≤ E ≤ 0,75	Medium-low efficiency	31	22,6	46	33,6
0,76 ≤ E ≤ 0,99	Medium-high efficiency	100	73,0	86	62,8
E = 1,0	High efficiency	6	4,4	5	3,6
Total		**137**	**100,0**	**137**	**100,0**

Source: Research data.

There was a decrease in the number of municipalities that reached maximum average efficiency between the periods before and after Amendment 95/2016. As observed, of the 137 analyzed municipalities, 6 obtained maximum efficiency before Amendment 95/2016 and five (3.6%) after the Amendment. These findings are linked with those by Nunes and Sousa (2019), who analyzed 162 cities in Ceará, of which only seven (4.3%) attained the maximum efficiency score. Macedo *et al.* (2019), in turn, verified that 20 cities in Ceará obtained maximum efficiency in the use of health resources in the period from 2013 to 2017.

After Amendment has been in force, an increase in the number of municipalities that obtained medium-low efficiency is seen, compared to the period before the amendment, with 46 (33.6%) and 31 municipalities (22.6%), respectively.

As for the number of municipalities that attained medium-high efficiency, 100 (73.0%) were classified at this level before the Amendment 95/2016 was in force. At that moment, the number was reduced to 86 municipalities (62.8%). Oliveira, Mota, and Vasconcelos's results (2022) coexist with the findings in this study because they show a reduction in the number of maximum efficient municipalities, with the number of 29 in 2016 and 27 in 2017.

To facilitate a comprehensive discussion, efficiency measurements corresponding to each year were obtained (Figure 3). On average, there was a drop in efficiency during the amendment enforcement, from 0,832 to 0,804, even though there was a slight recovery in 2017.

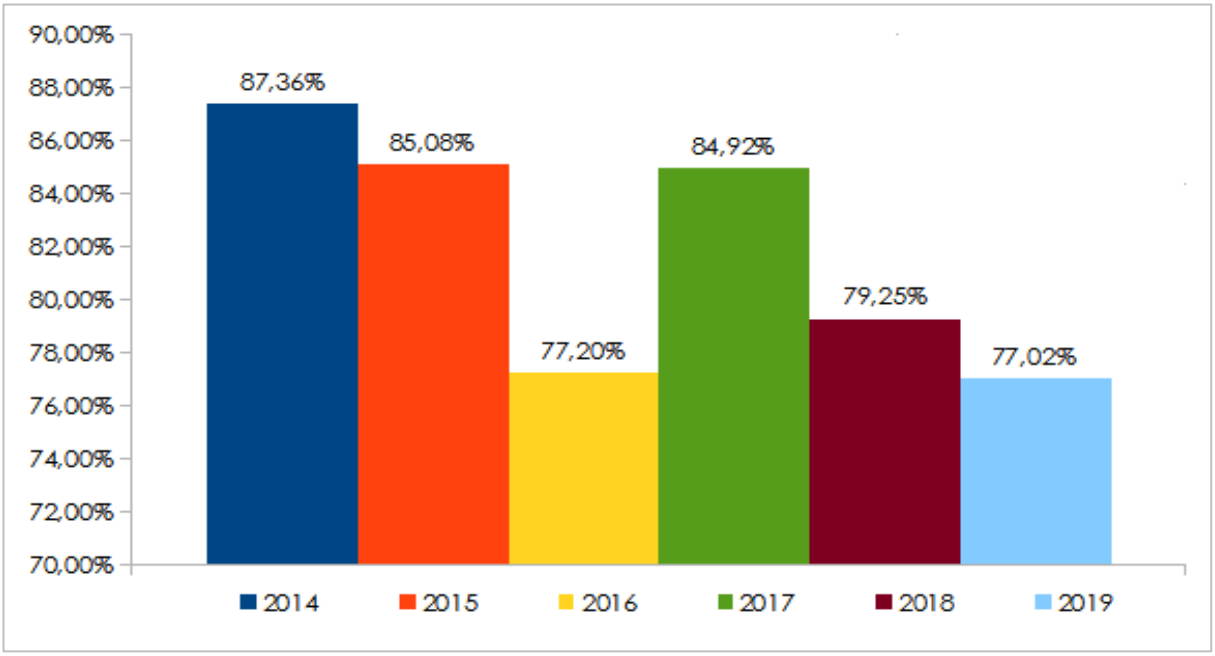

Figura 3 – Annual average efficiency of municipalities in health services – 2014–2019
Source: Research data.

It can be verified that 2014 and 2015 were the years that registered the highest average efficiency, with 0,873 and 0,850, respectively, and it is necessary to point out that in the mentioned biennium, the financing norms defined by the Amendment 29/2000 were observed. The reduction reported in 2016 (0,772) was due to the Amendment 86/2015, since the norm would guarantee during that exercise year the minimum application of ASPS correspondent to 13.2% of RCL.

From the remarks exposed, hypothesis **H1** has been confirmed once there is a negative relationship between the validity of Amendment 95/2016 and the level of efficiency of the municipalities in the sample since there was a decrease in average efficiency scores as well as the number of efficient municipalities during the validity of the Amendment mentioned above.

As for the period in which the Amendment has been in force, 2017 is highlighted as the year in which the third highest grade was marked (0,849) overall. However, it is worth clarifying that the increase to 2016 is due to the alteration of the minimum calculation in ASPS to 15% of RCL.

In general, 2018 and 2019 are characterized by reduced efficiency levels in Ceará municipalities. Since 2018, a drop was noted (0,792), and 2019 showed the lowest efficiency average (0,770) compared to all the years. Overall, the efficiency fall is similar to the predictions by Vieira and Benevides (2016) because the two mentioned authors point out that the Amendment 95/2016 would create obstacles towards the realization of the right to health, encouraging those with resources to hire health insurance and, in the meantime, the most vulnerable would be subjected to shortage of offer and low productivity of health public services, increasingly precarious.

4.2 Productivity Level Before and After Constitutional Amendment nº 95/2016

Productivity is assessed employing the MPI from the DMU change between two periods through comparative statistical analysis (Sánchez, 2018). This way, the results of the descriptive statistics of the MPI estimation are found in Table 5, alongside its breakdown into pairing effects (technical efficiency) and frontier shift (technological variation). In general, the MPI average signals an elevation of 3,5% in the productivity of municipalities, comparing the periods before and after the implementation of the spending ceiling Amendment, with 0,881 and 0,913, respectively.

Table 5
Descriptive analysis of productivity before and after Amendment 95/2016

IPM	Before				After			
	Average	Standard deviation	Maximum	Minimum	Average	Standard deviation	Maximum	Minimum
Technical efficiency	0,949	0,105	1,182	0,687	0,960	0,125	1,350	0,551
Technological variation	0,914	0,118	1,727	0,521	0,954	0,120	1,714	0,601
Overall productivity	0,881	0,169	1,834	0,634	0,913	0,163	1,899	0,625

Source: Research data.

Based on the findings shown in Table 5, it can be verified that, on average, in neither of the periods can it be considered that the municipalities in the sample increased overall productivity, given that no city has obtained an index superior to 1. However, maximum values attest that some municipalities attained positive variation individually.

After the validity of Amendment 95/2016 had begun, Mauriti (Cariri macro-region) obtained 0,625, the lowest productivity score. It should be emphasized that the output vaccination coverage had the lowest reduction in the period, with 90,46 in 2017, 83,33 in 2018, and 52,70 in 2019, contributing to the low productivity.

When analyzing technical efficiency variation, it was observed that, on average, values indicate an evolution of 1,15% (1.1% or 1.25%) since before the Amendment 95/2016, the average value was 0,949, and afterward, 0,960. As highlighted by Ferreira and Silva (2015), the improvement of the level of technical efficiency, in other words, is marked by improvements in the production process justified by the use of the same technology.

As in overall productivity, the maximum technical efficiency value was also higher after the amendment, signaling a difference of 12,4%. The municipality that best increased production was Aracati, with 1,350, resulting from a reduction in infant mortality once in 2015, it was 13,73, becoming 9,19 in 2018 and 2,04 in 2019.

The technological variation presented a positive evolution of 4.2% when comparing the two periods; before the amendment, the average was 0,914, and after, the value was 0,954. This way, it can be affirmed that productivity growth is due to the evolution of this effect.

Based on the Mann-Whitney test, which checks non-parametric data equity (Fávero & Belfiore, 2017), it is observed that the variables overall productivity, technical efficiency, and technological efficiency present $p < 0,001$, rejecting the

null hypothesis, which leads to the conclusion that, to the level of confidence of 99%, the medians before and after the Amendment 95/2016 are different.

Table 6 shows the number of municipalities that increased overall productivity yearly during the periods before and after Constitutional Amendment nº 95/2016.

Table 6
Number of municipalities with an increase in total productivity before and after the Amendment 95/2016 by period and year

Item	Number of municipalities/period					
	Before/Year			After/Year		
	2015	2016	Média	2018	2019	Média
Total productivity	80	13	21	75	20	40
Total	**93**		**-**	**95**		**-**

Source: Research data.

From a general point of view, it is noted that the production evolution of the sample municipalities in the period in which the Amendment 95/2016 has been in force is in virtue of the displacement effect (technological variation), for the most part; however, values are pretty similar as the increase was of 2,1%. It can be realized, though, that total productivity is affected chiefly by technological variation, especially in 2018, since the increase registered in that year exceeds the sum of 2015 and 2016 by 3.2%.

In short, by comparing the periods before and after the validity of Amendment 95/2016, the technical efficiency effect increase was 8.5%, and the one of technological variation was 13.4%. These findings are similar to those by Ferreira and Silva (2015) because the productive evolution was affected by technological variation for the most part due to the fact that 93.6% of the *potiguares* municipalities obtained an increase in this effect.

The number of municipalities that achieved an increase in total productivity was representative, unlike the findings of Costa, Balbinotto, and Sampaio (2014), who, when evaluating the Brazilian public kidney transplant system and the change in productivity between 2006 and 2011, indicated that only Alagoas achieved an index of 1.05. In addition, 20 other states and the Federal District decreased in productivity.

The productivity analyses also made it possible to see a 47.5% increase in the number of municipalities that had a positive variation on average in the two years after the Amendment. However, when checking the scores, it was observed that although the number of municipalities was lower before the CE, on average, they had a better MPI, with 1.180 before and 1.118 after the Amendment. Table 7 shows the results of the IPM estimation.

Table 7
IPM panel for municipalities from 2015 to 2019

Year	Technical efficiency variation	Technological variation	Overall productivity
2015	0,987	1,058	1,046
2016	0,916	0,777	0,716
2017	1,130	1,083	1,226

2018	0,951	1,121	1,067
2019	0,978	0,791	0,767

Source: Research data.

It can be seen that between 2015 and 2016, there was a decrease in technical efficiency. In 2017, there was an increase, with a score of 1.130, indicating that the municipalities increased their technical efficiency by 13.0%. The following years, 2018 and 2019, showed no positive variation, with average scores below 1. The results differ from the findings of Duarte and Diniz (2018), which indicated an increase from 0.979 to 1.018 in the states.

Concerning technological change, the most significant increase was 12.1% in 2018, followed by 2017 with an increase of 8.3%. In 2016 and 2019, the effect decreased. This finding reveals that municipalities have been working below their productive capacity, with the possibility of expanding health services only by increasing the scale of production.

As for total productivity, there was a 22.6% increase in 2017, while in the other periods in which there was a positive variation, this result was less significant, standing at 6.7% in 2018 and 4.6% in 2015. In 2016 and 2019, it remained practically unchanged, as the scores totaled 0.716 and 0.767, respectively. Thus, despite the increase in this item, municipalities did not continue with this performance over the periods, showing weaknesses in managing health resources, especially in 2019.

In terms of productivity in 2019, there was an increase of 6.6% compared to 2016. This way, the impact on the minimum health funding rule could be attested to form the change implemented by Amendment 86/2015, which set a staggered percentage of the RCL in 2016.

The results obtained through the MPI point to a slight increase in the period after Amendment 95/2016. Thus, hypothesis **H_2** was rejected since there is a relationship between the validity of Amendment 95/2016 and the increase in the level of productivity of health services in the municipalities of Ceará.

However, it should be noted that in 2018 and 2019, the impacts of the above amendment can already be seen in the reduction of 13.0% and 37.4%, respectively, compared to 2017. The negative implications of Amendment 95/2016 on productivity are noteworthy, corroborating the idea that the most significant impacts will occur over the 20 years of its validity, as Funcia and Ocké-Reis (2018) and Rasella *et al*. (2019) conjecture.

4.3 Per Capita Spending on Health and Productivity

To meet the additional objective, an examination was conducted to determine whether there were significant differences in the volume of health spending among the municipalities in Ceará that increased the productivity of health services, considering the periods before and after Amendment 95/2016. Table 8 shows the results of the correlation test.

Table 8
Correlation between per capita health spending and productivity scores

Variable	**Malmquist Total Productivity**

	Spearman correlation	Sig
Municipalities' per capita health expenditure	0,117	0,226

Source: Research data.

The analysis shows no statistically significant correlation between the level of productivity and per capita spending on health in the municipalities of Ceará over the period considered. Therefore, it is impossible to infer that higher per capita spending on health is reflected in higher total productivity as measured by the MPI.

To broaden the scope of this discussion, Table 9 shows the results of the non-parametric test of differences between means - t-test, checking whether there is (or not) a significant difference in the volume of health spending between the municipalities in Ceará that increased the productivity of services in the area, compared to those that did not.

Table 9
Independent samples t-test

Variances		Levene test for equality of variances		T-test for equality of means		
		F	Sig.	t	Gl	Sig. (bilateral)
Var	Assumed equal variances	,326	,568	,136	545	,042(*)
	Equal variances not assumed			,114	378,98	,040(*)

Caption: (*) statistical significance to 5%.
Source: Research data.

When analyzing the result of Levene's test for equality of variances, it can be seen that, as the Sig. showed a result of 0.568, the groups have equal variances. In this sense, the bilateral Sig. value of the t-test is 0.042. It can therefore be concluded that there is a statistically significant difference between the groups at the 5% significance level.

The results are similar to those of Silva *et al*. (2019), according to which the minimum economic expenditure negatively affects efficiency; as well as those of Oliveira, Mota and Vasconcelos (2022), according to which greater efficiency does not necessarily occur in municipalities that have been spending more resources on health.

It is possible to state that higher productivity does not necessarily occur in municipalities that have invested more resources in health, since the average of the two groups is less than 0.05, in line with the findings of Flach, Mattos and Mendes (2017) and Diniz and Duarte (2018). In view of the above, and despite the fact that municipalities have increased their per capita spending on health in recent years and the results indicate statistical significance, it can be seen that the municipalities with the highest average growth in per capita spending on health do not record the same average growth in the MPI. Therefore, since there is a significant difference between the two groups of municipalities in terms of productivity, hypothesis **H_3** was rejected.

5 CONCLUSIONS

The advent of Constitutional Amendment nº 95/2016 could have a significant impact on the health indicators of Brazilian municipalities, especially those that demand more public revenue from the Federal Government due to their low municipal revenue capacity. With this in mind, this study looked at the impact of the aforementioned EC (spending cap amendment) on the efficiency and productivity of 137 municipalities in Ceará in terms of resource allocation and the provision of health services, using DEA, IPM, the test of differences between means and correlation.

In terms of measuring efficiency before and after Amendment 95/2016 came into force, it was found that in the 137 municipalities in the sample, the period before the Amendment had an average efficiency 3.4% higher than the period when it came into force. Based on the parameters adopted in the research, it was possible to observe that Ceará has no municipalities in the low efficiency range, while the highest average efficiency was found in the largest group of municipalities in both periods, 100 (73%) before and 86 (62.8%) after the Amendment. In addition, it was found that six municipalities (4.4%) achieved high efficiency before Amendment 95/2016 came into force and five (3.6%) during the period when it came into force. There was also a reduction in efficiency in the 2018-2019 biennium: in 2018, 0.7925, and 2019, 0.7925, with 2019 being the year with the lowest average efficiency of the municipalities surveyed when comparing all the years before and after Amendment 95/2016 came into force. Hypothesis **H1** is therefore confirmed, as the level of relative efficiency of health services in the municipalities in the sample before Amendment 95/2016 came into force is lower than in the period when it came into force.

Regarding the productivity levels of the municipalities in the sample when it comes to allocating resources and providing health services before and after Amendment 95/2016, the MPI results indicate that, on average, in neither period did the municipalities increase their productivity in health services, nor did they achieve an index higher than 1. However, it was possible to verify that there was a 3.5% increase in the productivity of the municipalities under analysis, comparing the periods before and after the implementation of the aforementioned Amendment, with 0.881 and 0.913, respectively. Thus, hypothesis **H_2** was rejected. After the implementation of the Spending Cap, there was an increase in the productivity of health services in the municipalities of Ceará. However, the findings by year indicate that there was a reduction in average productivity in 2018 and a consolidation in 2019, corroborating the findings of other studies, which indicate that the most significant impacts will occur over the 20 years of the Amendment (Funcia & Ocké-Reis, 2018; Rasella *et al*., 2019).

Next, when checking whether the municipalities in Ceará that increased the productivity of health services differ significantly in terms of the volume of health spending, considering the periods before and after Amendment 95/2016, it was found that in the municipalities that increased spending between 2015 and 2019 (before and after Amendment 95/2016) the impact on productivity was not directly proportional to the amount used. Some even increased their productivity

index, but most suffered a reduction in this indicator. In this respect, the test of differences between means revealed no equality between the averages of per capita spending on health and the Total Productivity Index. In this sense, hypothesis **H3** was rejected, as there was a significant difference between municipalities in Ceará that did (or did not) increase the productivity of health services and the volume of per capita spending on health.

Based on the conducted research, it is possible to conclude that, in general, after EC 95/2016 came into force, the efficiency of Ceará's municipalities in health worsened, while total productivity improved, considering the sample and the period analyzed. Furthermore, it was observed that the increase in public spending per capita on health is unrelated to the positive productivity variation.

The results of the research can be used to propose improvements to health management strategies in the municipalities of Ceará since they can serve as indications for discussions aimed at making the most of the public resources earmarked for the health sector by the less efficient and less productive municipalities, as well as considering the potential for improving health services as a whole.

The research contributes to further discussions on the impacts of the spending cap amendment on municipal efficiency and productivity, considering the few empirical studies published to date addressing the issues in question in the light of the Economic Theory of Efficiency. From an academic point of view, the combined use of DEA and IPM techniques helps municipal public health managers to identify efficiency in a given period and, through the dynamics of productivity, can assess the impact of a change in a given technology on the services offered to the population, in this specific case the change in federal legislation, and can serve as a starting point for further research or for a deeper understanding of the relationship between the issues in question.

In addition, as immediate actions, municipalities can intensify vaccination campaigns and increase the number of professionals in order to improve the "vaccination coverage" indicator, as well as structure health facilities and implement training plans for professionals in order to encourage improvements in outpatient production, taking into account the guidelines of the National Immunization Plan (PNI). Another factor that requires improvement is the infant mortality rate, through access to basic sanitation (treated water and sewage), increased education for women, oral rehydration and breastfeeding, and investments in medical research.

The limitations of this study include the large number of municipalities with insufficient data, making it impossible to analyze all 184, and the adoption of seven municipal indicators. Furthermore, the lack of up-to-date socioeconomic indicators limited the use of other statistical techniques.

As a suggestion for future research, it is recommended that this study be replicated in the years 2020 onwards to verify the impacts of Amendment 95/2016 and to analyze the effects of the Sars-Cov-2 (Coronavirus - Covid-19) pandemic. It is also recommended that the same municipalities and input and output factors be utilized in municipalities in other federation states. In addition, it is suggested that studies be carried out considering primary and financial expenditure,

expenditure on social assistance, social security, health, education, citizenship rights, and interest and amortization of public debt, in public policies that were not subject to a constitutional ceiling with Amendment 95/2016. It is also suggested that the variables be expanded, using those related to the number of doctors, nurses, and ICU beds offered by the SUS. Another approach could be to use qualitative research in the municipalities that achieved maximum efficiency and positive variation in total Malmquist productivity.

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