



COULD MORE RESOURCES AND ACCESS IMPACT EFFICIENCY AND EFFECTIVENESS IN THE BRAZILIAN HEALTH MUNICIPALITIES?

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Abstract

The paper analyses the connection between resources, access, efficiency and effectiveness in 645 municipalities in the São Paulo State, Brazil, between 2009 and 2014. To achieve it, the essay has developed descriptive statistics, correlation analysis and principal component regression analysis. The descriptive statistics have shown high inequality in the health delivered services in resources, access and effectiveness. The correlation analysis has pointed out a possible financial dependence of the municipalities from the transferred funds. Finally, the regression analysis has demonstrated: a non-direct relation between resources and effectiveness in a public health system, a better capacity of the financial and human resources on explaining access and efficiency, and a higher impact of nurses in access and efficiency than physicians in the primary care.

Keywords: Public health. Health performance. National Health Service. Efficiency, Effectiveness.

PODEM MAIS RECURSOS E ACESSO IMPACTAR A EFICIÊNCIA E A EFICÁCIA NOS MUNICÍPIOS DE SAÚDE DO BRASIL?

Resumo

O artigo analisa a relação entre recursos, acesso, eficiência e eficácia em 645 municípios do Estado de São Paulo, Brasil, entre 2009 e 2014. Para tanto, o ensaio desenvolveu estatística descritiva, análise de correlação e análise de regressão de componentes principais. As estatísticas descritivas mostraram grande desigualdade nos serviços prestados de saúde em termos de recursos, acesso e eficácia. A análise de correlação apontou possível dependência financeira dos municípios dos recursos repassados. Finalmente, a análise de regressão demonstrou: uma relação não direta entre recursos e eficácia em um sistema público de saúde, uma melhor capacidade dos recursos financeiros e humanos em explicar o acesso e eficiência, e um maior impacto dos enfermeiros no acesso e eficiência do que os médicos na atenção primária.

Palavras-chave: Saúde Pública. Desempenho de saúde. Serviço Nacional de Saúde. Eficiência. Eficácia

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1 INTRODUCTION

The World Health Organization (WHO) (2018) debated the difficulty and importance of discussing the effectiveness of health delivered services. As well, the last report from the World Bank about the Brazilian National Health System (SUS) appointed as the necessity of improving the efficiency and effectiveness of health care services (World Bank, 2018).

One of the ways to improve the efficiency and effectiveness of these services is to increase the resources (human and financial) and access (CARRER; TOSO; GUIMARÃES; CONTERNO; MINOSSO, 2016; SANTOS; FRANCISCO; GONÇALVES, 2016; PASCHOALOTTO; PASSADOR; OLIVEIRA; LOPES, DANTAS; PASSADOR, 2018). Moreover, analyzing the relation between resources, access, efficiency and effectiveness have entered the public health agenda of scientific researchers (PALMER; MUELLER; GILSON; MILLS; HAINES, 2004).

According to Hjortdberg & Mwikisa (2002), more financial resources can have different effects on health care access, because of the distances between the cities. Also, stopping the financing of human resources, or just through reducing your salaries, could negatively impact the access to some services in a health care system (MCPAKE *et al.*, 2013).

The decrease of human resources to deliver health services has entered in crisis around the world, instigating much more the topics of efficiency and effectiveness (NARASIMHAN *et al.*, 2004). All these points can be seen in a financial crisis, as happened in Europe, where some countries decreased expenditures in Public Health and increased the control of human resources, with finality to improve efficiency (CORREIA; DUSSAULT; PONTES, 2015).

On the other side, the discussion about increasing the access in public health has appeared in different countries with the aim of providing a better sustainable health care system with fewer resources (PENNESTRÌ, 2017). The Lago, Moscoso, Eugenia & Ripari (2012) discusses the same point, although more resources were expended in different regions, the rates of child mortality and unsatisfied necessities did not decrease in all of them. Therefore, to provide a more accessible health care system is not enough to boost the expenditures, neither to develop new drugs, instead we should also pay attention in the efficiency and effectiveness of the delivered services (VODA; BOSTAN, 2018).

Being efficient has shown up as an important issue due to some financial crisis that have occurred in the world, such in Europe 2008/2009, which generated an unemployment boom and consequently necessity for public health services (MADUREIRA-LIMA; REEVES; CLAIR; STUCKLER, 2018). In China, after the health care reform in 2009, despite the increasing in health expenditures, the efficiency did not follow the same standard, showing problems with governance structure in the Chinese health care system (WU; WANG; ZHANG, 2015). A case of success is the National Health Service in

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England, that has performed with efficiency on financial resources and high-quality on treatments of diseases (FRIEBEL, 2018).

But more important than improving the efficiency of resources or having a better access to health care, is forming an improved effectiveness multidisciplinary team to deliver public health services (SIMBA; MUKOSE; BAZEYO, 2014). The effectiveness can be affected by investments and resources expended through the health management and quantitative analysis (VERGUET; KIM; JAMISON, 2016).

In Brazil, the responsibility of executing the public health services are the municipalities, mainly the basic assistance, while medium and high complexity needs to involve the state and federal government (MENDES; CARNUT; GUERRA, 2018). Therefore, the health municipality indicators about performance are the most sensible to the primary conditions, in other words, the indicators related with basic attention health services (VIACAVA; UGÁ; PORTO; LAGUARDIA; MOREIRA, 2012; ALY; REIS, CARNEIRO; MORAES, 2017; ALBUQUERQUE; MARTINS, 2017).

Barros & Lima (2015) and Ribeiro, Moreira, Ouverney, Pinto & Silva (2018) pointed a big difference between the municipalities in Brazil among financial resources expended, human resources capacity, the effectiveness of the health care services and national coverage. At the same way, some regions and municipalities are being stratified into a more homogeneous group to apply resources and policies in public health (CALVO; LACERDA; COLUSSI; SCHNEIDER; ROCHA, 2016).

According to Barros & Lima (2015), there is a financial dependence of the municipalities with resources coming from the SUS, which has an impact on the coverage and efficiency of the system. Meanwhile, financial dependence has decreased with more autonomy and own taxes collected by the municipalities (SANTOS; MENDES; PEREIRA; PARANHOS, 2017). Last, more financial resources in the municipalities can generate more surgical procedures, impairing some strategies from the WHO, as decreasing the number of cesarean births (PASCHOALOTTO *et al.*, 2018).

Thus, in order to collaborate with the academic gap, our research question is “How resources and access could impact the efficiency and effectiveness in Public Health in the Brazilian municipalities?”. To answer the question, we have analyzed the relationship between resources and access with efficiency and effectiveness in the municipalities, in the São Paulo State, Brazil. The hypotheses of this study are:

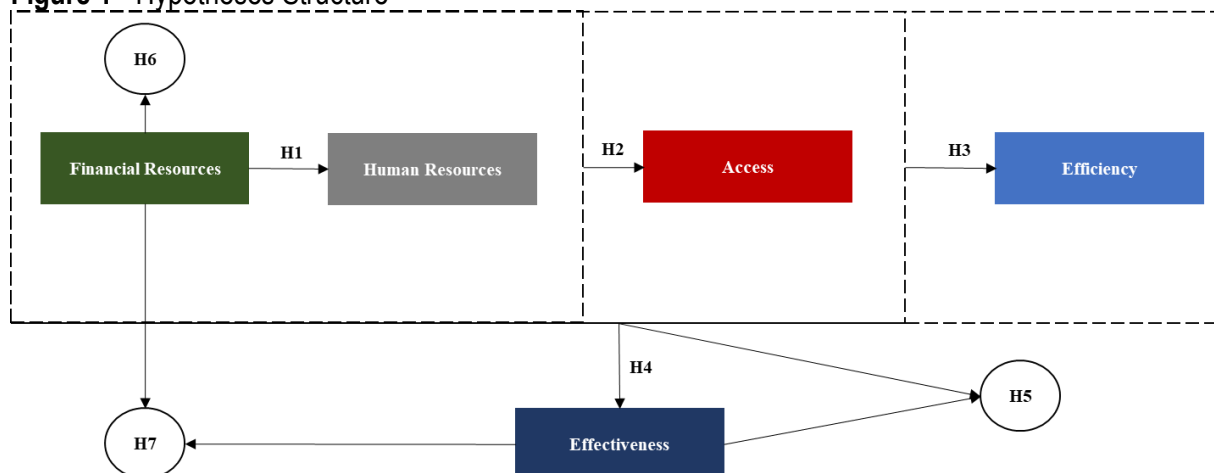
H1- More financial resources can provide more human resources in the Brazilian National Health System (SANTOS; FRANCISCO; GONÇALVES, 2016), H2- More financial and human resources can provide more access to the population in the Brazilian National Health System (SANTOS; FRANCISCO; GONÇALVES; PASCHOALOTTO *et al.*, 2018), H3- More resources and access can provide more efficiency to the Brazilian National Health System (SANTOS; FRANCISCO;

GONÇALVES, 2016; PASCHOALOTTO *et al.*, 2018), H4- More resources, access and efficiency can provide more effectiveness to the Brazilian National Health System (CARRER *et al.*, 2016; PASCHOALOTTO *et al.*, 2018).

To deepen the discussion about the relations between the above dimension, we have elaborated sub-hypotheses: H5- There is a health inequality between the municipalities about financial resources, human resources, access, efficiency and effectiveness (CALVO *et al.*, 2016; RIBEIRO *et al.*, 2018), H6- The municipalities are dependents of the SUS's financial resources (Barros & Lima, 2015), H7- Municipalities with more financial resources tend to spend more money with medical procedures (PASCHOALOTTO *et al.*, 2018).

The figure 1 shows the schematic relation between the hypothesis:

Figure 1 - Hypotheses Structure



Source: Created by the authors.

2 METHODS

2.1 Data and Samples

São Paulo State is localized in the Brazilian Southeast and has the main economy of the country, with the highest population, second-highest human development index and second highest number of municipalities (Brazilian Institute of Geography and Statistics [IBGE], 2018). The sample is composed of 645 municipalities in the São Paulo State, and data between 2009 and 2014, 2 periods of mayor's government. The data are 12 indicators collected from Department of Information Technology of SUS (DATASUS) and State System of Data Analysis (SEADE) Foundation (DATASUS, 2018; SEADE, 2018), divided by financial resources, human resources, access, efficiency and effectiveness

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(VIACAVA *et al.*, 2012; WHO, 2013; ALY *et al.*, 2017; ALBUQUERQUE; MARTINS, 2017). After exploring the database, we found 154 outliers, which were excluded from the sample, remaining 3,716 observations.

Table 1- Indicators and dimensions

Indicators	Dimensions
A - Financial transfers from SUS to the municipality, per inhabitant B - Health expenditures, with own resources, by the municipality, per inhabitant C- Personal Expenditures divided for the Total Expenditures in Public Health by the municipality	Financial resources
D - Number of nurses per 1,000 inhabitants E - Number of physicians per 1,000 inhabitants	Human resources
F - Percentual of <i>Bolsa Família</i> Program Coverage G - Percentual of Immunization Coverage	Access
H - Cytopathologic exams Rate I - Mammography exams Rate	Efficiency
J - Percentual of Normal Births K - Percentual of Live Births with more than 7 consults L - Percentual of hospitalization by sensible conditions	Effectiveness

Source: Indicators by DATASUS and SEADE Foundation and Dimensions.

The division of the indicators, in dimensions, is based in the municipality's responsibilities, which is the primary care of the public health delivered services (Viacava *et al.*, 2012; WHO, 2013; Aly *et al.*, 2017; Albuquerque & Martins, 2017). All the data management process, before the statistical analysis, were realized in the *Microsoft Excel* software.

2.2 Variables

The variables reflected the inputs and outcomes of the public health in the municipalities, with a possible association between them. Therefore, the dependent variables were created using the principal component analysis in the indicators. To analyze the hypothesis, the independent variables are the indicators with a possible effect in the dependent variable.

$$\text{Human resources} = \beta_0 + \beta_A + \beta_B + \beta_C + \epsilon \quad (1)$$

The first equation shows the possible cause-effect between financial resources invested with the human resources in the public health municipalities. With the regression analysis, we can also observe the difference of the effect in the dependent variable between the independent variables, as expenditures with own resources or not.

$$Access = \beta_0 + \beta_A + \beta_B + \beta_C + \beta_D + \beta_E + \epsilon \quad (2)$$

In the second equation, we want to see the influence of the resources in the access. Therefore, the regression analysis can show a possible cause-effect between resources and more access to the public health delivered services in the municipalities.

$$Efficiency = \beta_0 + \beta_A + \beta_B + \beta_C + \beta_D + \beta_E + \beta_F + \beta_G + \epsilon \quad (3)$$

Following, the third equation is adding the access indicators, together to the resources, to analyze the possible impacts in the efficiency.

$$Effectiveness = \beta_0 + \beta_A + \beta_B + \beta_C + \beta_D + \beta_E + \beta_F + \beta_G + \beta_H + \beta_I + \epsilon \quad (4)$$

Finally, the last regression analysis evaluates the effects of all the indicators with the effectiveness of the municipal health service.

2.3 Statistical Analysis

First, we developed a descriptive study to better understand the indicators distribution on the sample (FÁVERO; BELFIORE, 2017). Second, we ran a correlation analysis to identify the standards between the indicators, through the Pearson correlation (HAIR; BLACK; BABIN; ANDERSON; TATHAM, 2010). After, we executed a principal component regression analysis to verify a possible relationship and causality between resources and access, with efficiency and effectiveness (LI; YOU; ZHANG; ZHENG, 2018; TRAN; KIM; KIM; CHOI; CHOI, 2018). For all the statistical analysis we used the *SPSS Software v.25*, last version of the program.

To better understand the principal component regression analysis, we used the following steps:

1) To create the dependent variables “human resources”, “access”, “efficiency” and “effectiveness” we used the technique principal component analysis with the Varimax method (Hair *et al.*, 2010; Fávero & Belfiore, 2017). With the PCA realized, we had just one dependent variable for all the equations (Tu, Kramer & Leec, 2012). Thus, for the dimensions “human resources”, “access”, “efficiency” and “effectiveness” we created a “new” factor to represent the concept (FÁVERO; BELFIORE, 2017).

2) After, with dependent variables created, we ran a regression analysis for the 4 hypotheses (TRAN *et al.*, 2018). All the independent variables in the 4 equations did not pass for the component analysis. In the end, our 4 equations had a standard form, as follows: “Component created

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(dep.v) = Pure indicators (indep.v)". In the multiple linear regression analysis, we applied the insert technique with the following statistics: the setting model, R^2 , adjusted R^2 , collinearity diagnostic, the Dursin-Watson technique to residuals, diagnostic per case (-3 and 3) and confidence interval of 95% (Hair *et al.*, 2010).

3 RESULTS

3.1 Health Inequality In The Brazilian Municipalities (Hypothesis 5)

As we can remark (Table 2), the municipalities in Brazil are heterogeneous on aspects linked with financial and human resources, access and effectiveness. The standards deviations of most parts of the indicators have high values: financial indicators (72.503 and 236.103), human resources (0.513 and 1.848), access (20.035 and 16.926) and effectiveness (15.099).

Table 2 - Descriptive Statistics

Indicators	Min.	Max.	Mean	Std. Deviation
T.SUS p.hab.	24.870	523.540	139.641	72.503
H.cost p.hab (own)	88.950	2032.300	452.143	236.103
Personal cost (%)	2.300	83.610	47.002	13.193
Nurses x 1000	0.004	5.859	0.880	0.513
Physician x 1000	0.007	15.473	2.938	1.848
PBF coverage (%)	2.130	100.000	71.528	20.035
Immunization coverage (%)	38.520	186.870	83.357	16.926
Cytopathologic exam rate	0.010	1.890	0.653	0.263
Mammography rate	0.010	2.010	0.374	0.275
Normal births (%)	0.920	83.930	32.403	15.099
Live births 7+ consult.	26.520	100.000	78.455	10.303
Hosp. by sensible cond (%)	5.410	71.050	27.410	9.280

Source: Created by the authors.

We can also point out the good means of some human resources (2.938), higher than United Kingdom in 2016 (MOBERLY, 2017), access (71.528 and 83.357) and effectiveness indicators (78.455). However, other effectiveness indicators had low means, as the percentage of normal births (32.403), lower than recommended by WHO (WHO, 2015), and hospitalization by sensible conditions (27.410).

Therefore, according to the discussion above, we can support the hypothesis 5 showing the different levels on mean and standard deviation in the Brazilian municipalities (Calvo *et al.*, 2016; Ribeiro *et al.*, 2018).

3.2 Dependency and capacity of the Brazilian municipalities (Hypotheses 6 and 7)

There is a high positive significant correlation between financial indicators (0.389), human resources (0.379), efficiency indicators (0.309), financial and human resources indicators (0.368 and 0.366), financial and access indicators (0.271), financial and efficiency indicators (0.234, 0.340 and 0.363), and human resources and efficiency indicators (0.300). On the other side, there is a high negative significant correlation between effectiveness indicators (-0.320), and efficiency and effectiveness indicators (-0.211).

Table 3 - Correlation Matrix

	A	B	C	D	E	F	G	H	I	J	K	L
A	1											
B	.398**	1										
C	-	.127**	1									
D	.184**			1								
E	.368**	.366**	.000		1							
F	.093**	-	-	.379**		1						
G	.043**	.136**					1					
H	.164**	.182**	.008	.138**	-			1				
I					.097**				1			
J	.271**	.298**	-.009	.150**	-	.129**				1		
K					.093**						1	
L	.192**	.234**	.017	.190**	-	.151**	.100**					1
					.116**							
	.340**	.363**	.028	.300**	-.028	.172**	.249**	.309**	1			
	-	-	-.040*	-	-	-	-	.051**	-	1		
	.133**	.179**		.150**	.148**	.105**	.095**		.211**		1	
	.111**	.079**	-	.100**	.145**	.063**	.072**	.180**	.142**	-		1
			.066**							.320**		
	-	-	-	.022	.011	-.001	-.010	.024	-.006	-	.024	1
	.078**	.076**	.044**							.133**		

** The correlation is significant at the 0.01 level (2 extremities).

* The correlation is significant at the 0.05 level (2 extremities).

Source: Created by the authors.

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Looking deeper on these correlations, we can highlight 2 main points:

1) The high positive correlation between the transferred resources, not own resources, with human resources, access, and efficiency, indicates a possible dependence of the municipalities to execute the public health policies.

2) The high negative correlation among the normal births with mammography rate and live births (more than 7 appointments) can show a tendency of richer municipalities spending more money with medical procedures, as for example the cesarean procedures. The high positive correlation between mammography rate and financial indicators corroborates with the tendency.

Thereby, we can go back to the hypothesis 6 and 7 about two propensities: the municipalities depend on the resources transferred from the national health system (Barros & Lima, 2015), and municipalities with more financial power tend to expend more resources with medical procedures than the necessary (Paschoalotto *et al.*, 2018).

3.3 Financial resources, Human resources, Access, Efficiency and Effectiveness (Hypotheses 1, 2, 3 and 4)

The first point to analyze (Table 4) is about the R^2 and Adjusted R^2 . In the 4 models, we can observe a low value of both statistics (0.088, 0.162 and 0.161, 0.231 and 0.230, 0.086 and 0.083), which could report an incapacity of the models in explaining the dependent variables. But, as we are dealing with macro indicators and component principal analysis, it is acceptable to have low R^2 (Allan, Mooney & Ling, 2018).

Table 4 - Standardized Coefficients (Beta) of the 4 equations

Variables	H1	H2	H3	H4
T.SUS p.hab.	0.222***	0.179***	0.164***	0.000
H.cost p.hab (own)	0.113***	0.198***	0.182***	0.055**
Personal cost (%)	-0.055**	-0.180	0.013	-0.010
Nurses x 1000	-	0.123***	0.216***	-0.013
Physicians x 1000	-	-0.184***	-0.163***	0.197***
PBF coverage (%)	-	-	0.086***	0.071***
Immunization coverage (%)	-	-	0.059***	0.046**
Cytopathologic exam rate	-	-	-	0.023
Mammographies rate	-	-	-	0.162***
<i>Number of observations</i>	3,716	3,716	3,716	3,716
R^2	0.088	0.162	0.231	0.086
Adjusted R^2	0.088	0.161	0.230	0.083
VIF	1.273	1.363	1.407	1.450

<i>Durbin-Watson</i>	2.078	1.767	1.979	1.887
<i>Prob.>F</i>	0.000	0.000	0.000	0.000
*** $p < .001$				
** $p < .05$				
* $p < .01$				

Source: Created by the authors.

The first model, which test hypothesis 1, has a low R^2 and adjusted R^2 (0.088). The low result shows the incapacity of the financial indicators explain human resources in the Brazilian municipalities.

Thus, hypothesis 1 is denied: More financial resources cannot provide more human resources in the Brazilian National Health System (HJORTDBERG; MWIKISA, 2002; CORREIA; DUSSAULT; PONTES, 2015). To finish the discussion of the first model, even with a low capacity of explaining the human resources dependent variable, we can point out the displaced resources to the municipalities (0.222) has more impact in human resources than in the own municipality resources (0.113).

In the second model, to test hypothesis 2, we can observe a higher R^2 and Adjusted R^2 than the first model (0.162 and 0.161). About the standardized coefficients (Beta), the results show closest Betas between transferred and own financial resources (0.179 and 0.198), a capacity of better explaining the access to the health services with more nurses (0.123), but an inverse relationship with the physicians (-0,184). Therefore, about access, financial resources can better explain human resources.

So, the hypothesis 2 is supported but with reservations: More financial and human resources can provide more access to the population in the Brazilian National Health System, with exception of the physician's indicator (SANTOS; FRANCISCO; GONÇALVES, 2016; PASCHOALOTTO *et al.*, 2018).

Following, the third model, testing hypothesis 3, has the best explanation model, with better R^2 (0.231) and adjusted R^2 (0.230). As we saw in the model 2, nurses also have an important capacity of better explain the efficiency (0.216), in contrast with the physician's independent variable, which decreases the model's capacity of explaining (-0,163). The financial resources indicators expound a good capacity with the model (0.164 and 0.182), but this time with less power than human resources. The access indicators have not helped to have a better model, with modest coefficients (0.086 and 0.059).

In the end, as the second model, we support the hypothesis with reservations: More resources can provide more efficiency to the Brazilian National Health System, excluding access and physician's indicators (WU; WANG; ZHANG, 2015, PASCHOALOTTO *et al.*, 2018).

Finally, the last model tested the hypothesis 4, and it was denied: More resources, access, and efficiency cannot provide more effectiveness to the Brazilian National Health System (Simba, Mukose & Bazeyo, 2014). The R^2 and adjusted R^2 were the worst between the 4 models (0.086 and 0.083), and all the indicators, with exception of "Physician's Rate" (0.197) and "Mammography rate" (0.162), had been a low capacity to expound the effectiveness model.

4 CONCLUSION

Therefore, the research has 4 principal findings. First, there is no direct relation between increasing the financial resources and having a more effectiveness public health system in the Brazilian municipalities, as we saw from the low values of R^2 and adjusted R^2 in the models and low correlation between the indicators (SIMBA; MUKOSE; BAZEYO, 2014, PASCHOALOTTO *et al.*, 2018).

Second, financial and human resources have more impact on access and efficiency than effectiveness, except for the number of physicians (SANTOS; FRANCISCO; GONÇALVES, 2016). Thereby, it's important to highlight the nurse's action in the SUS. The nurses have a strong impact on primary care, and we can observe through of the results, in access as well as efficiency (TURCI; LIMA-COSTA; MACINKO, 2015).

After, we observed a high inequality between the municipalities in the São Paulo State among financial resources, access and, effectiveness (RIBEIRO *et al.*, 2018). One of the causes could be the dependence of the municipalities from the transferred resources (Barros & Lima, 2015) and the culture of doing medical procedures (spending more resources) instead of following the WHO orientations (PASCHOALOTTO *et al.*, 2018), as higher level of normal births against lower level of cesarean births (WHO, 2015).

Fourth and last, when we are using the "principal components" as a dependent variable, it is not difficult to find lower values for R^2 and adjusted R^2 , because of your "representative" value and not being a direct indicator (ALLAN; MOONEY; LING, 2018, Li *et al.*, 2018). The method corroborates with the attempt of creating studies about efficiency and effectiveness in a public health system (WORLD BANK, 2018).

The limitations of the study involve historical data series, missing data, indicators' discontinuation, sample, a different type of regression and macrolevel analyses. In Brazil, we have problems with the historical data series, as missing, the quality and discontinuation of the data, mainly in

the municipalities (ALBUQUERQUE; MARTINS, 2017). Another point is the restrict sample, about the municipalities, years and types of indicators. We have used the municipalities of one Brazilian state due to be the most organized state and with more longitudinal data, with the SEADE Foundation (SEADE, 2018), and we did not use another indicator about equipment, access, efficiency, and effectiveness because of the missing data during the time series. Finally, the method utilized, principal component regression analysis, reduces the explication capacity of the model, because of the macro level analyses (ALLAN; MOONEY; LING, 2018).

To futures studies would be interesting to increase the number and time series of the indicators to represent the dimensions addressed in the study, as well as to add new dimensions and possibilities about explaining the dependent variable (VIACAVA *et al.*, 2012; WHO, 2013; ALY *et al.*, 2017; ALBUQUERQUE; MARTINS, 2017). Besides, testing a new methodology with the linear regression analyses, using the insert technique and in a micro level, could generate more significant and explicate results (LI *et al.*, 2018; TRAN *et al.*, 2018). And, the possibility of comparing different municipalities in the Brazilian states and other countries, to discover new findings to the academic world (ANDRADE *et al.*, 2015).

In the end, we could answer the question: "Could more resources and access impact the efficiency and effectiveness in the municipalities of a Public Health System?". A: Yes, but with no direct and strong relationship between the resources and access, with efficiency and effectiveness, and with less impact in effectiveness than efficiency.

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