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ECONOMIC AND HEALTH INDICATORS: CORRELATION BETWEEN INFLATION AND MORTALITY

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Abstract

The hypothesis that economic downturn periods have contributed to increase the overall mortality rate has been discussed by several authors. There is an immeasurable literature that associates socioeconomic levels with the individual´s health status. This paper seeks to analyze the correlation between mortality and the variables inflation, unemployment and income in Brazil in the period 1980–2009, examining whether the economic instabilities affect the individuals´ health status. This is an empirical-analytic study of historical series of Health Indicators (overall, infant, maternal mortality, and external causes) and Macroeconomic Indicators (Inflation, Unemployment and Income) in the period 1980 to 2009 in Brazil. The hypothesis corroboration was developed through regression analysis. The theoretical rationale of the results is based on Philips´ theory, whereby the lower the inflation rate is, the higher the unemployment becomes, or vice versa. Regression analysis performed suggests that the IPCA decrease and unemployment increase raise the overall mortality rate. The correlation of mortality with income was positive, confirming the hypothesis of some authors that high income leads to increased mortality due to factors such as stress, traffic accidents, among others. The mortality pattern follows the general behavior of the economic variables chosen. Based on Philips´ theory, the inflation drop raises unemployment levels; moreover, worse living and health conditions increase mortality rates.

Keywords: Inflation, economic. Mortality. Unemployment. Income. Health Status indicators.

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INDICADORES ECONÔMICOS E DE SAÚDE:
A RELAÇÃO ENTRE INFLAÇÃO E MORTALIDADE

Resumo

A hipótese de que períodos de recessão econômica tem contribuido com o aumento da mortalidade geral tem sido discutida por diversos autores. Existe uma vasta literatura que correlaciona os níveis socioeconômicos com o estado de saúde do indivíduo. O presente trabalho busca analisar a correlação entre a mortalidade geral com as variáveis inflação, desemprego e renda no Brasil, no período de 1980–2009, analisando-se as instabilidades econômicas interferem na saúde dos indivíduos. Trata-se de um estudo empirico-analítico de séries históricas dos Indicadores de Saúde (mortalidade geral, infantil, materna e causas externas) e dos Indicadores Macroeconômicos (Inflação, desemprego e renda) no período de 1980 a 2009 no Brasil. A prova da hipótese foi desenvolvida por meio da Análise de Regressão. A fundamentação teórica dos resultados tem como base a teoria de Philips, segundo a qual quanto menor a taxa de inflação, maior a taxa de desemprego, ou vice-versa. As análises de regressão efetuadas sugerem que a diminuição do IPCA e o aumento do desemprego elevam a mortalidade geral. A correlação da mortalidade com a renda foi positiva, comprovando a hipótese de alguns autores, em que elevada renda gera aumento da mortalidade, devido a fatores como estresse, acidente de trânsito, entre outros. O comportamento da mortalidade geral acompanha o comportamento das variáveis econômicas escolhidas. Com base na teoria de Philips, a queda da inflação, eleva os níveis de desemprego; ademais, piores condições de vida e saúde majoram as taxas de mortalidade.

Palavras-chave: Inflação. Mortalidade. Desemprego. Renda. Indicadores básicos de saúde.

LOS INDICADORES ECONÓMICOS Y DE SALUD:
LA RELACIÓN ENTRE LA INFLACIÓN Y LA MORTALIDAD

Resumen

La hipótesis de que las crisis económicas han contribuido al aumento de la mortalidad general ha sido discutida por varios autores. Existe una vasta literatura que correlaciona los niveles socioeconómicos con el estado de salud del individuo. Este estudio

tiene como objetivo analizar la correlación entre la mortalidad global y las variables inflación, desempleo y renta en Brasil, durante el período 1980–2009, analizando si las inestabilidades económicas afectan a la salud de las personas. Este método es un estudio empírico-analítico de series históricas de los Indicadores de Salud (mortalidad general, infantil, materna y causas externas) y de los Indicadores Macroeconómicos (inflación, desempleo y renta) en el período 1980–2009 en Brasil. La prueba de la hipótesis fue desarrollada a través del Análisis de Regresión. La fundamentación teórica de los resultados se basa en la teoría de Philips, según la cual lo más baja sea la tasa de inflación, mas alta será la tasa de desempleo, o viceversa. Los análisis de regresión realizados sugieren que la reducción del IPCA y el aumento del desempleo aumentan la mortalidad general. La correlación de la mortalidad con la renta fue positiva, lo que confirma la hipótesis de algunos autores, que una renta alta genera aumento de la mortalidad debido a factores como el estrés, los accidentes de tráfico, entre otros. El comportamiento de la mortalidad general acompaña el comportamiento de las variables económicas escogidas. Basado en la teoría de Philips, la caída de la inflación eleva los niveles de desempleo; además, las peores condiciones de vida y salud aumentan las tasas de mortalidad.

Palabras-clave: Inflación . Mortalidad. Desempleo. Renta. Indicadores básicos de salud.

INTRODUCTION

The economic literature has presented studies anchored in the impact that economic fluctuations can cause on health conditions. Numerous studies have restricted their analysis in the social and psychological aspects that downturn periods can cause to people, such as those related to material losses resulting from unemployment, insecurity, stress and anxiety, which may even result in the reduction of expenses related to health, increased drugs and alcohol consumption and depression.[1]

From the 1970s, studies have been conducted trying to discover the outcome of recessions or economic growth in the individual´s health status. There is no consensus on this event so far. We can refer to Brenner and Mooney,[2] who dispute that recessions and other sources of economic instability have a negative impact on the population´s health status, increasing the overall mortality rate, while Ruhm[3] finds that economic growth contributes to poor health and increased mortality. The author explains that in economic booms, individuals work more and, as a consequence, there is increased stress, consumption of health-damaging

goods, such as alcohol and tobacco, in addition to lack of time due to work overload for activities that promote health.

Chou, Grossman and Saffer[4] are in agreement with Ruhm[3] and add that the income increase confers people less time to cook at home; worsening dietary habits, which, in theory, can result in worse health.

Gerdthan and Ruhm[5] carried out a correlation study of the macroeconomic effects on the overall mortality rate by means of panel data, from 23 countries of the Organization for Economic Cooperation and Development (OECD), over the period 1960–1997, and concluded that the lower inflation is, the higher unemployment becomes in the short term, and that higher income leads to increased mortality. They validate this result by the fact that individuals who find employment, improve incomes and, as a result, also their demand for health, then causing an increased consumption of goods that worsen health as alcohol consumption, drug use, drive more often and more powerful cars, which increase the number of traffic accidents.

Brenner[2] in one of his studies, makes clear that economic growth diminishes mortality, since people through employment have more income and thus an improved health status. He supports the hypothesis that economic instability and recession periods cause a negative impact on the population´s health status, increasing the overall mortality rate and mortality attributed to specific causes such as cirrhosis, suicides, homicides, cardiovascular disorders, and other problems, and relates increased morbidity due to the incidence of stress-related disorders, alcohol and drugs consumption and dependency, depression or other psychosomatic diseases or external causes such as urban violence and traffic accidents.

The study of the relationship between inflation and mortality seems to be motivating, as it relates to significant issues at the moment. Inflation, which is one of the most followed and searched economic variables, went through a variation and change process, especially in Brazil, until the Real Plan implementation.[6]

This article explores the correlation between overall mortality and variables such as inflation, unemployment and income in Brazil in the period 1980–2009. The basis for discussion of the results was developed by Philips´ Curve theory, which will be explained below by literature reviewing; and afterward we present the results, discussion and conclusion.

The main contribution of this work to the literature can be seen by the need to search for evidence about the relationship between inflation and mortality in developing countries.

METHODS

This is an empirical-analytical study of historical series of health indicators (overall, infant, and maternal mortality and external causes) and macroeconomic indicators (inflation, unemployment and income), from 1980 to 2009.

The choice of the period (1980 to 2009) was due to the fact that we seek a historical series of Brazil with periods of high inflation and periods of instability in this indicator. This was a pre- and post-economic stability, with respect to control of interest rates. This period, in Brazil, was marked by the change of monetary policy, the Real Plan, introduced in 1993, which permeates to this day.

Information used for health indicator came from the Mortality Information System (SIM), that is fed by death certificates due to compulsory completion throughout the country and made available by the Computer Department of the Unified Health System (DATASUS) and macroeconomic indicators (inflation, unemployment and income), were obtained from the Institute of Applied Economic Research website (IPEA).

Inflation corresponds to a variation in the general price level; the employment variable is the percentage of registered population (number of registered workers by the total population) and income (the average actual income of workers in Reais (R$)).

As there are several indices to measure inflation in Brazil, the measure chosen was the National Consumer Price Index (IPCA). The option is justified for the reason that this index measures the increase in prices of goods and services consumed by Brazilian families with incomes between 1 and 40 minimum wages in eleven metropolitan areas, and by the fact that the Monetary Policy Committee of the Central Bank (Brazil) uses this index to launch economic policies, among them the interest.[7]

The guiding theory adopted to clarify the correlation between inflation and unemployment was the hypothesis of Phillips´ Curve.

Philips´ Theory was revealed by New Zealand's economist William Phillips, who says there is no inverse relationship between inflation and unemployment (tradeoff), that is, the lower the inflation rate, the higher the unemployment, or vice versa, so if higher the income of the population, hence lesser the impact on health, reducing mortality or vice versa.[6]

This theory can be explained by the macroeconomic question of aggregate demand and supply in the short term, namely, the fact occurs because as the aggregate demand is expanded by makers of monetary and fiscal policies, the economy is pushed upward along the aggregate supply curve in the short term, which, at the cost of inflation, can lessen unemployment for some time; the same takes place if the aggregate

demand is moved down along the aggregate supply curve in the short term, which, at the expense of high unemployment, can reduce inflation.[8]

The increase in aggregate demand in the short term may add to the improved production of goods and services, generating price increases, which leads the individual to have a lower purchasing power.[8]

The correlations estimate was developed through an econometric model: the relationship between the overall mortality rate, explained by economic variables, namely: inflation, unemployment and income. We used a linear regression model, estimated by the Method of Ordinary Least Squares (OLS). This is an econometric technique for estimating parameters of a regression equation, that is, it consists of adjusting the regression line, so that the sum of the squares of the distances between the observed and estimated data are as small as possible.

The linear regression model aims at studying the relationship between two or more explanatory variables, which are present in a linear fashion and a metric-dependent variable. As a result, a general model of multiple linear regression can be written as follows:

$$Y = \alpha + \beta_1.X_1 + \beta_2.X_2 + ... + \beta_n.X_n + \mu \quad (1)$$

Where Y is the phenomenon under study (dependent metric variable related to mortality), α represents the intercept (constant), β_k (k = 1, 2, ..., n) are the coefficients for each variable (slopes), X_k are the metric explanatory variables related to inflation, unemployment or income indicators, and *u* is the error term (the difference between the actual Y value and the predicted Y value, by means of the model for each observation). The error *u,* also known as residue, represents the possible X variables that were not included in the model and would be good candidates to elucidate variable Y.

The purpose of linear regression analysis is to investigate how a variable Y is affected by one or more variables $X_{k.}$ In consequence, the resale value can be considered the variable Y, called the dependent variable or response, and the year of the vehicle as a variable X, called the explanatory variable. The present study aims at examining how inflation, unemployment or income increase affect mortality, either independently or jointly, in accordance with the following model:

Mortality = *f* (Inflation)

Mortality = *f* (Unemployment) (2)

Mortality = *f* (Income)

Mortality = *f* (Inflation, Unemployment, Income)

Thus, the first equation, for example, will be:

$$E(\text{Mortality} \mid \text{Inflation}) = \alpha - \beta_1 . \text{Inflation} = \hat{Y} \quad (3)$$

$$\text{Mortality} = \alpha - \beta_1 . \text{Inflation} + \mu = Y \quad (4)$$

Equation (3) shows that the expected value or conditional mean of Y, also called $\hat{Y}$, is calculated for each year of the sample due to the behavior of the explanatory variable, which in this case is inflation. As a result, the developed model can be broadly described as follows:

$$M_t = \phi\pi_{t-12} + \mu \quad (5)$$

Where:

M_t : Overall mortality at time t;

π_{t-12} : inflation outdated in 12 months, whether unemployment outdated in 12 months, whether income outdated in 12 months;

μ : error term;

ϕ : estimated parameters.

The mortality series presents components of past correlation with income, unemployment and inflation rates, i.e., there is an inter-time lag between the dependent variable (overall, infant, maternal mortality or external cause) and the explanatory variables (inflation, unemployment and income).

The correlation or association coefficient tries to quantify the strength of the relationship or degree of association between two variables. Therefore, two variables are highly correlated, if changes in a variable are strongly associated with changes in another one.

Thus, the closer to -1 or +1, the higher the correlation between variables. Similarly, the closer to zero, the lower this correlation. The signal analysis is as important as its magnitude. If, for example, the correlation over the study period, between mortality and inflation is negative, statistically significant and close to 1 (in module), it means that higher inflation rates are linked to periods with lower mortality rates.

RESULTS

The models presented below were prepared by means of the Stata 10.1 software.

Table 1 illustrates the correlations between variables. We can see that for the applied correlations, the significance value was less 0.05.

Table 1 – Correlations of Health and Economic Indicator studied: data from 1980 to 2009 – Brazil, 2010

Variables	Overall mortality	IPCA	Unemployment	Income
Overall Mortality	1.0000			
IPCA	-0.4094	1.0000		
Sig	0.0000			
Dev	0.5565	-0.5079	1.0000	
Sig	0.0000	0.0000		
Income	0.7973	-0.6176	0.5823	1.0000
Sig	0.0000	0.0000	0.0000	

Source: Vital statistics obtained at the DATASUS website and the Institute's website - Applied Economic Research (Ipeadata). p<0.05; IPCA: Índice Nacional de Preços ao Consumidor Amplo; Sig: significado do coeficiente; Dev: desemprego.

Table 2 shows the correlation between variables through aggregated data fom 1980 to 2009. We can see that there is a correlation between the overall mortality rate and inflation, unemployment and income rates.

Table 2 – Multiple Regression between variables: data from 1980 to 2009 – Brazil, 2010

Overall Mortality	Coefficient	Standard error	t	P>0,05	95%CI
IPCA	-138.6433	31.25962	-4.44	0.000	-77.16661–200.1201
Dev	765.2404	165.0349	4.64	0,000	440.6745–1089.806
Income	12.33759	.6512701	18.94	0,000	11.05677–13.61841
_cons	60021.68	1236.689	48.53	0,000	57589.55–62453.82

Source: Vital statistics obtained at the DATASUS website and the Institute's website - Applied Economic Research (Ipeadata). p<0.05; IPCA: Índice Nacional de Preços ao Consumidor Amplo; Dev: desemprego; _cons: coeficiente da relação.

Tables 3 to 5 present the Simple Regression results.

We can note in Table 3 the correlation of overall mortality with IPCA. We can observe that the lower the inflation rate is (measured by IPCA) the higher the total mortality rate becomes, expressed by IPCA coefficient -320.091.

Table 3 – Simple Regression – Overall Mortality due to IPCA: data from 1980 to 2009 – Brazil, 2010

Overall mortality	Coefficient	Standard error.	t	P>0,05	95%CI
IPCA	-320.091	37.70465	-8.49	0.000	-394.2414– -245.9406
_cons	77113.32	557.8614	138.23	0.000	7601622–78210.42

IPCA: Índice Nacional de Preços ao Consumidor Amplo; _cons: coeficiente da relação.

Source	SS	df	MS
Model	5.5346e+09	1	5.5346e+09
Residual	2.7492e+10	358	76794151.5
Total	3.3027e+10	359	91996918.2

SS: correlaçao semi parcial; DF: análise de variancia - ANOVA; MS: matriz de correlação.

Number of obs = 360
F(1. 358) = 72.07
Prob > F = 0.0000
R-squared = 0.1676
Adj R-squared = 0.1653
Root MSE = 8763.2

We can see in Table 4 the correlation between mortality and unemployment. A simple observation shows that there is a high correlation between the explanatory variable, specifically, the higher unemployment is the higher the mortality rate becomes, expressed by positive unemployment coefficient 2374.733.

Table 4 – Simple Regression – Overall Mortality due to Unemployment: data from 1980 to 2009 – Brazil, 2010

Overall mortality	Coefficient	Standard error	t	P>0,05	95%CI
Des	2374.733	187.3924	12.67	0.000	2006.205–2743.261
_cons	57756.91	1383.326	41.75	0.000	55036.44–60477.37

_cons: coeficiente da relação.

Source	SS	df	MS
Model	1.0227e+10	1	1.0227e+10
Residual	2.2799e+10	358	63685626.6
Total	3.3027e+10	359	91996918.2

SS: correlaçao semi parcial; DF: análise de variancia - ANOVA; MS: matriz de correlação.

Number of obs = 360
F(1. 358) = 160.59
Prob > F = 0.0000
R-squared = 0.3097
Adj R-squared = 0.3077
Root MSE = 7980.3

Table 5 illustrates the correlation between mortality and income. We have realized that there is a high correlation between the explanatory variable. The greater the higher income is, the higher the overall mortality rate becomes, expressed by positive coefficient 12.25918. We can highlight the possible effect of multicollinearity, if these two pairs of variables appear together in the same equation singly without the other explanatory variables IPCA and unemployment.

Table 5 – Simple Regression – Overall Mortality due to income: data from 1980 to 2009 – Brazil, 2010

Overall mortality	Coefficient	Standard error	T	P>0,05	95%CI
Income	12.25918	0490453	25.00	0.000	11.29465–13.22371
_cons	66603.93	438.2473	151.98	0.000	65742.06–67465.79

_cons: coeficiente da relação.

Source	SS	Df	MS
Model	2.09996e+10	1	2.09996e+10
Residual	1.2031e+10	358	33605528.5
Total	3.3027e+10	359	91996918.2

SS: correlaçao semi parcial; DF: análise de variancia - ANOVA; MS: matriz de correlação.

Number of obs = 360
F(1. 358) = 624.78
Prob > F = 0.0000
R-squared = 0.6357
Adj R-squared = 0.6347
Root MSE = 5797
p-value < 0,05

DISCUSSION

Firstly, it is worth mentioning that all correlations were statistically significant, which demonstrates the relationship between mortality and each of the socio-economic variables used (inflation, unemployment and income), irrespective of the sign and magnitude of these relationships. Moreover, models of simple and multiple regression, even though they have relatively low adjustment coefficients (R^2), they offer parameters jointly different from zero in a statistical viewpoint (Sig. F <0.01). A similar comment must be done on the subject of the statistical significance of the parameters of each variable (Sig. t <0.01), when considered individually or collectively. That said, discussions relevant to the proposed models may be made.

Economic recessions, measured by the employment rate drop in the economy, contribute to a worse health status. Evidences supporting this conclusion are presented by the estimated coefficients of the relationship between the overall mortality rates and unemployment variables.

This article aimed at guiding individual correlations of each variable with the health variables selected and the primary health variable, depending on the three predicting variables.

The discussion rationale of the correlations results was developed by Philips´ Curve theory, which supports the existence of an inverse relationship between inflation and unemployment in the short term. When inflation levels are low, unemployment increases, and income decreases accordingly, we can think of worse health conditions of the population

or, when inflation levels are high, unemployment decreases, promoting improvement of income and the individual´s health status.[6]

Findings in the simple regression of the correlation between overall Mortality rate and Inflation variable (IPCA), Unemployment and Income, indicated that lower inflation and higher unemployment levels lead to increased mortality rate.

One study that found the same result was Brenner´s,[2] who attributed higher unemployment level to higher mortality rates, which is accounted for by the individual´s lower socioeconomic status. He supports the idea that times of economic instability and recession cause a negative impact on the population´s health condition, increasing the overall mortality rate, and that in these times there is a decrease in goods consumption and investors reduce their investments, leading to higher unemployment levels.

Tapia-Granados[9] and Stuckler[10] also confirm the same hypothesis found in this thesis; the overall mortality rate of a country increases or decreases when the economy is expanding or contracting. They argue that lower inflation and higher unemployment levels lead to increased rates of the health indicator called overall mortality.

Bezruchka[11] explains that, in developing countries, economic growth can increase inflation and decrease the overall mortality rate, given that the rise of inflation provides a reduction of unemployment and consequently higher income, confirming Philips´ theory. This correlation improves health; and the population with a higher income has access to the supply of means to meet basic needs such as food, clean water and shelter as well as access to health services.

Other works such as those of Montoya-Aguilar[12] and Jacinto, Tejada and Sousa[13] correlated the overall Mortality indicator with unemployment and income. Both confirm that material losses, associated with unemployment or insecurity, for workers who are still employed, contribute to the increase in this health indicator. They argue that in periods of economic recession, people do not know whether they will keep their jobs in the future, reducing their health-related expenses and also saving on social spending while worsening the quality of life.

Jacinto, Tejada and Sousa[13] validate that the estimated coefficients of the relationship between mortality and employment rates variable result in economic recession, measured by the unemployment rate in the economy, while this relationship contributes to deterioration in health. They conclude that at present, the stage of the Brazilian economic development would have positive effects on increasing employment, with better access to medical care, health plans, food, among others, providing an improved health; while

compensating the findings for this thesis, that the income increase raises mortality rates. They claim that the possible negative effects of increased income, as increased alcoholism, traffic accidents, and the lack of time to dedicate to healthy activities, can be influenced by the positive points that income brings.

The findings — higher income favors the growth of overall Mortality rates — are generally similar to those found by Forbes & McGregor,[14] who studied mortality in the post-war period for Scotland and found that in the long term, positive changes in employment — consequently higher income — are associated with a higher mortality rate, since individuals consume high-calorie products.

Gerdtham and Johannesson[15] analyze the changes in the behavior of the individual employed during periods of expansion and conclude that labor accident rates increase during these periods, mainly in operating sectors, with a focus on the economic market, they mention the example of transport construction sector employees and, therefore, they aggregate that the income increase is associated with overwork, and as a result, high mortality rates.

For the result reached in this article, we also discuss Ruhn´s hypothesis,[16] according to which economic recessions contribute to improved health and consequent reduction in mortality. The author explains this hypothesis based on the idea that job loss stress tends to cause negative health effects, which are offset by improvements for workers, whose hours or work-related pressures are reduced. They also state that the employee — with higher income compared to the unemployed — is more exposed to risk factors that may contribute to diseases, such as pollution related to traffic congestion, industrialized food, consumption of caloric food, alcohol use, smoking, medication, drugs due to job stress.

CONCLUSIONS

We conclude, by the econometric studies submitted, that recession and other sources of economic instability have a negative impact on population health, contributing to increased mortality.

The correlation between the overall mortality rate owing to inflation and unemployment supported Philips´ hypothesis, that is, when there is lower inflation, unemployment increases; which supposedly leads us to having worse living and health conditions and higher mortality rates.

Brazilian socioeconomic changes and living conditions are all associated with changes in mortality levels; there are a number of causes that are broadly discussed. The income drop leads to poor sanitary conditions, contamination risks through the distribution of piped

water, lack of sewage and garbage collection, impaired access to health, as well as difficulties in obtaining food and adequate health care.[17]

An interesting finding in the correlations of this study is that increased incomes provide the growth of the overall mortality rate. We considered Ruhm´s hypothesis for this analysis,[3,16] justified by the possible negative effects of better living condition of the individual as an increase in alcoholism, traffic accidents, lack of time to engage in healthy activities (hiking), health care, industrialized food.

Given the stage of economic development in Brazil, this might be a long-term reality, because today, the effects of employment booms (access to better medical care, health plans, food, among others) on health present themselves as positive, so as to compensate for possible negative effects (increased alcoholism, traffic accidents, lack of time to engage in healthy activities, among others). Hence, economic recessions reduce the mortality rate in Brazil.

We would like to report that there were limitations on the data used. As reinforced by the literature reviewed, there is still poor obituary registrations, in addition to insufficient reports, particularly concerning maternal Mortality, which may suggest the decreased significance of the correlation between this variable with the IPCA and unemployment. However, the methodology used allowed us to understand the macroeconomic influences on health status.

We believe certain precaution is required in interpreting the results, in order to avoid absolute acceptance of associations without considering other variables that have not been analyzed, since both economic and health indicators studied may vary due to other factors which have not been considered. For instance, concerning the health issue, the development of medicine and public health was not correlated; environmental damages that can lead to health risks; cultural issues affecting the way of life and health of the individual in that community. It is considered that death cannot be attributed to a single risk factor. It is not a recurrent event and we must take into account a range of concurrent and competitive risks acting in people´s lives.

Mortality reduction represents a challenge to the definition of health policies. Therefore, another suggestion we consider relevant for future studies concerns how that correlation with macroeconomic health can help in decision making to public health policies, in order to diminish mortality rates. These actions must integrate not only the health sector, but also economic and social policies, seeking to jointly support the formulation of policies that contribute to the decline of mortality levels in Brazil.

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