

Fall in homicides in the City of São Paulo: an exploratory analysis of possible determinants

Queda dos homicídios no Município de São Paulo: uma análise exploratória de possíveis condicionantes

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Abstract

Throughout the first decade of the 2000s the homicide mortality rate (HMR) showed a significant reduction in the state and the city of São Paulo (MSP). The aim of this study is to describe the trend of HMR, socio-demographic indicators, and the investment in social and public security, and to analyze the correlation between HMR and independent variables in the MSP between 1996 and 2008. An exploratory time series ecological study was conducted. The following variables were included: HMR per 100,000 inhabitants, socio-demographic indicators, and investments in social and public security. The moving-averages for all variables were calculated and trends were analyzed through Simple Linear Regression models. Annual percentage changes, the average annual change and periodic percentage changes were calculated for all variables, and the associations between annual percentage changes were tested by Spearman's correlation analysis. Correlations were found for the proportion of youth in the population ($r = 0.69$), unemployment rate ($r = 0.60$), State budget for education and culture ($r = 0.87$) and health and sanitation ($r = 0.56$), municipal ($r = 0.68$) and State ($r = 0.53$) budget for Public Security, firearms seized ($r = 0.69$) and the incarceration rate ($r = 0.71$). The results allow us to support the hypothesis that demographic changes, acceleration of the economy, in particular the fall in unemployment, investment in social policies and changes in public security policies act synergistically to reduce HMR in São Paulo. Complex models of analysis, incorporating the joint action of different potential explanatory variables, should be developed.

Keywords: Aggression. Homicides. Mortality. Ecological study. Time series studies. Brazil.

Resumo

Ao longo da primeira década dos anos 2000, a taxa de mortalidade por homicídio (TMH) apresentou uma expressiva redução no Estado e no Município de São Paulo (MSP). O objetivo deste estudo é descrever a evolução das TMH e de indicadores sociodemográficos, de investimento em políticas sociais e segurança pública, e analisar a correlação entre a evolução das TMHs e das variáveis independentes no MSP entre 1996 e 2008. Foi realizado um estudo ecológico de série temporal, exploratório. As seguintes variáveis foram incluídas: TMH por 100.000 habitantes, indicadores sociodemográficos, investimentos em políticas sociais e de segurança pública. Foram calculadas as médias móveis de todas as variáveis e a tendência foi analisada através de Regressão Linear. Foram calculadas as variações percentual anual, média anual e percentual periódica, e a associação foi testada por meio da análise de correlação de Spearman entre a variação percentual anual das variáveis. Foram encontradas correlações com a proporção de jovens na população ($r = 0,69$), taxa de desemprego ($r = 0,60$), investimento estadual em educação e cultura ($r = 0,87$) e saúde e saneamento ($r = 0,56$), investimento municipal ($r = 0,68$) e estadual ($r = 0,53$) em segurança pública, armas apreendidas ($r = 0,69$) e taxa de encarceramento-aprisionamento ($r = 0,71$). Os resultados apresentados permitem sustentar a hipótese de que alterações demográficas, aceleração da economia, em especial a queda do desemprego, investimentos em políticas sociais e mudanças nas políticas de segurança pública atuam sinergicamente para a redução da TMH em São Paulo. Torna-se necessário o desenvolvimento de modelos de análise complexos que incorporem a atuação conjunta dos distintos fatores com potencial explicativo.

Palavra-chave: Agressões. Homicídios. Mortalidade. Estudo ecológico. Estudo de séries temporais. Brasil.

Introduction

Throughout the first decade of the 21st century, the homicide mortality rate (HMR) significantly decreased in the state of São Paulo^{1,2}. In the city of São Paulo, this rate dropped by 74% between 2001 and 2008, from 56.4 to 14.9 per 100,000 inhabitants³. According to Peres and cols. (2011)³, this reduction was widespread, reaching both urban areas and different population groups, with a trend towards approximation and reduction in inequalities in the risk of death.

The role of public security measures in the reduction in HMR has been widely discussed in studies conducted in the United States, especially in New York^{4,5,6,7,8}. The international literature also emphasizes the importance of demographic, socioeconomic and drug use pattern changes to reduce violence and crime levels^{4,8,9,10}.

In studies conducted in the state or metropolitan area of São Paulo, the increase in incarceration and disarmament rates and decrease in the proportion of adolescents in the population were tested and found to be associated with the reduction in HMR by Nadanovsky (2009)², Cerqueira & Mello (2010)* and Mello and Schneider (2007)¹¹, respectively. In addition to the factors mentioned above, authors have discussed other yet untested hypotheses: an improvement in socioeconomic development indicators, preventive actions implemented by the municipal government, and greater social participation through organized civil society actions are among the factors considered to be important^{1,3,11,12}. A possible role of stronger organized crime, which would function as a new social control mechanism that mediates local conflicts, has been pointed out in ethnographic studies as the factor responsible for the reduction in crime in São Paulo^{3,12,13,14,15}.

There are few, if any, studies that have analyzed the relationship between HMR and investment in social policies. It could be assumed that greater investment in social

*Cerqueira, D & Mello, JMP. Menos armas, menos crimes: o emblemático caso de São Paulo [presented in a seminar]. Available at: http://www.ence.ibge.gov.br/pos_graduacao/mestrado/seminarios/res30.ppt. Accessed on June 28th 2010.

actions, especially in areas where there are more disadvantages, could reduce the possibility of conflicts as a result of a greater positive presence of the State as a reference and mediating institution¹⁶. According to Kawachi and cols. (1997)¹⁷, investments in social policies reflect and contribute to greater social capital, which, in its turn, is associated with lower violence levels. In this way, it could be assumed that the increase in social actions, policies and programs has a positive impact on the reduction in violence levels, a hypothesis that has yet to be proved.

The present study aimed to describe the trend of the HMR, socio-demographic indicators and investments in social policies and public security, and to analyze the correlation between the trend of the HMR and the independent variables in the city of São Paulo, between 1996 and 2008. This study had an exploratory design and its results will contribute to the refinement of explanatory hypotheses about the sharp reduction in mortality from homicide observed in São Paulo in recent years.

Methods

An exploratory, ecological time-series study was conducted and the unit of analysis was the city of São Paulo, between 1996 and 2008.

Data on death by homicide of residents occurred in this city were collected from the database of the *Programa de Aprimoramento das Informações sobre Mortalidade da Prefeitura do Município de São Paulo* (PROAIM – City of São Paulo Mortality Information Improvement Program)*. The PROAIM uses the Death Certificate (DC) as the primary source of data and all causes of death are coded according to the International Classification of Diseases – 10th revision (ICD-10). Cases coded as death by Assault (X85 to Y09) and Legal Intervention (Y35 to

Y36) were considered as death by homicide. Population data from the IBGE (Brazilian Institute of Geography and Statistics) and projections made by the *Fundação SEADE* (State Data Analysis System Foundation) for the inter-census years were obtained from São Paulo City Hall website**. HMRs per 100,000 inhabitants were standardized per age according to the direct method, using the population of the city of São Paulo in 2000 as the standard population.

Population data from the IBGE and projections of the *Fundação SEADE* were used to calculate the proportions of adolescents in the population of the city of São Paulo³. The rate of unemployment in this city was obtained from the *Secretaria Municipal de Planejamento Urbano* (Sempla – City of São Paulo Department of Urban Planning) website for 1991 and the period between 2000 and 2007***. Time-series gaps were filled with projections made in STATA 10.0, using the linear interpolation and extrapolation method with the *ipolate y x, gen(newvar) epolate* command. Time-series gaps were filled using this command, assuming there is a linear relationship between the variable of interest (unemployment) and, in this case, the “year” variable. According to Sempla, the unemployment rate takes into consideration open unemployment – which includes all individuals who sought a job during a period of 30 days and did not perform any work – and hidden unemployment – which includes those who performed precarious and unpaid work and who are not working, although they sought a job in the previous 12 months.

Data on state and municipal spending on education and culture, health and sanitation, and public security were obtained from the Department of National Treasury website for the period between 1997 and 2008****.

The proportion of state and municipal budgets was calculated according to the

*Available at: <http://portal.prefeitura.sp.gov.br/secretarias/saude/tabnet/0019>. Accessed on August 5th 2009.

**Available at: <http://ww2.prefeitura.sp.gov.br/cgi/deftohtm.exe?secretarias/saude/TABNET/POP/pop.def>. Accessed on August 5th 2009.

***Available at: http://sempla.prefeitura.sp.gov.br/infocidade/htmls/18_taxa_de_desemprego_por_tipo_1991_483.html/ [Accessed on August 5th 2009].

****Available at: http://www.tesouro.fazenda.gov.br/estados_municipios/index.asp. Accessed on August 10th 2009.

total state and municipal spending, and the total spending of each department (education and culture, health and sanitation and public security) per unit (State and City) per year. The values found in 1997 were repeated in 1996 to complete the time series.

Data on the number of firearms seized by the police in the city of São Paulo were collected from the *Secretaria de Segurança Pública* (SSP/SP – State of São Paulo Department of Public Security) website*. The number of firearms seized per 100,000 inhabitants was calculated, according to the IBGE population census data and *Fundação SEADE* projections for the city of São Paulo. The number of arrests made while in the act or with a warrant in the city of São Paulo was obtained from the SSP/SP website⁶ as an indicator of police activity in this city; the respective rate per 100,000 inhabitants was calculated from population data on the city of São Paulo.

In the context of the penitentiary system, all prisoners (temporary or sentenced) found in temporary detention centers and police stations were considered in the calculation of the arrest-incarceration rate. Such information was available on the Department of Penitentiary Administration website**. The population aged 18 years or more living in the state of São Paulo was considered in this study, including the arrest-incarceration rate per 100,000 inhabitants aged 18 years or more.

Data were processed using Microsoft Excel. Annual percentage variations, annual mean variations and periodical percentage variations of all variables were calculated for the three periods: global (1996 to 2008), initial (1996 to 2001) and final (2001 to 2008). Data were transferred to STATA 10.0 to describe the distribution and to analyze the existence of a possible association between the HMR trend and the independent variables. Moving averages of all study variables were calculated to analyze the trend. Simple linear regression models were

constructed with each of the variables, using the year variable as independent variable. Line graphs were also constructed with the moving averages to make a visual analysis of trend curves. Spearman's correlation analysis was performed among annual percentage variations of variables to make an exploratory investigation of the association.

The present study was approved by the *Comissão de Ética para Análise de Projetos de Pesquisa* (CAPPesq – Research Project Analysis Ethics Committee) of the HCF-MUSP (*Universidade de São Paulo* School of Medicine Clinical Hospital) (Protocol number 1358/09). Authors declared there were no conflicts of interest.

Results

The HMR decreased 68.8%, from 47.6 in 1996 to 14.9 per 100,000 inhabitants in 2008 (Table 1; Graph 1). The curve tends to decrease, as shown in Table 2, with a mean reduction in HMR of 3.08 per year and coefficient of determination (R^2) of 84.4% (Table 2). Graph 1 shows that the fall begins in 2001 and becomes sharper in 2003. In the final period of the series, the percentage reduction was -73.7% and the mean annual reduction was -17% (Table 1).

The participation of adolescents (15 to 24 years) in the population living in the city of São Paulo also shows a decreasing trend (19.7%), especially between 2001 and 2008 (Table 1; Graph 1). The regression coefficient confirms the falling trend ($\beta=-0.3$; $R^2=95.5\%$) (Table 2). In contrast, the unemployment rate increased in the beginning of the series, but showed a decreasing trend between 2001 and 2008 (Table 1; Graph 1). Considering the entire period analyzed, the unemployment rate showed a slight increase of 0.3% (Table 1). However, the regression analysis shows the lack of a rising or falling trend in the evolution of the unemployment rate in the city of São Paulo ($\beta=-0.04$; $p=0.6$; $R^2=2.2\%$) (Table 2).

*Available at: <http://www.ssp.sp.gov.br/estatisticas>. Accessed on August 17th 2010.

**Available at: <http://www.sap.sp.gov.br/common/dti/estatisticas/populacao.htm>. Data were corrected through direct correspondence with the Department of Penitentiary Administration, on February 8th 2010.

Table 1 - Periodic percentage change and average annual change of Homicide mortality rates, socio structural indicators and investments in social and public security policies in the Municipality of São Paulo, 1996 to 2008

Tabela 1 – Mudança percentual periódica e annual média das TMH, indicadores sócio-estruturais, de segurança pública e de investimento em políticas sociais no MSP, 1996 a 2008

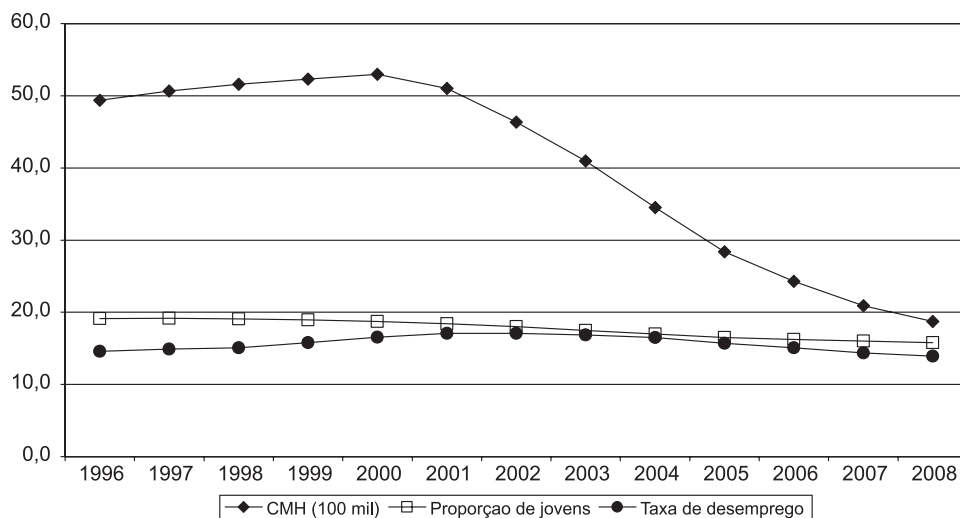
	Change (%) 1996/2008	Change (%) 1996/2001	Change (%) 2001/2008	Mean annual change (%) 1996/2008	Mean annual change (%) 1996/2001	Mean annual change (%) 2001/2008
Dependent variable						
Homicide mortality rate	-68.8	18.6	-73.7	-8.4	3.7	-17.0
Socio-structural indicators						
Adolescents in the population (%)	-19.7	-1.1	-18.8	-1.8	-0.2	-2.9
Unemployment (%)	-4.4	17.5	-18.6	-0.2	3.3	-2.6
Investment in social policies						
Municipal investment in education and culture	47.1	35.4	8.6	3.6	6.6	1.4
Municipal investment in health and sanitation	28.4	-4.8	34.8	3.2	-0.7	6.1
State investment in education and culture	300.9	370.3	-14.8	21.1	53.8	-2.2
State investment in health and sanitation	368.1	287.5	20.8	21.9	48.3	3.1
Public security						
Municipal investment in public security	38.5	73.6	-20.2	3.4	12.1	-2.8
State investment in public security	169.5	219.3	-15.6	12.0	31.8	-2.2
Arrests (per 100,000 inhabitants)	11.6	39.6	-20.0	1.7	8.0	-2.8
Firearms seized (per 100,000 inhabitants)	-47.7	16.2	-55.0	4.6	3.4	-10.3
Arrest-incarceration rate	89.7	39.8	35.7	5.6	7.0	4.5

With regard to the evolution of the percentage of the budget invested in social policies, Table 2 shows an increasing trend of investment in the area of education and culture by the municipal ($\beta=0.6$; $R^2=86.8\%$) and state governments ($\beta=0.8$; $R^2=61.4\%$). In the city of São Paulo, such increase occurred especially between 1996 and 2001, when the mean annual change was 6.6%. In the state of São Paulo, the percentage of the budget invested in education and culture rose 301% between 1996 and 2008. This increase occurred particularly between 1996 and 2001, when the percentage change was positive (370%). Between 2001 and 2008, the variation was negative, decreasing 14.8% (Table 1). Graphs 2 and 3 show that the increase in the percentage of the budget invested in the areas of education and culture precedes the reduction in the HMR, in the city and state of São Paulo.

In contrast, the investment in health and sanitation rose by 28.4% in the city of São Paulo, especially between 2001 and 2008 (Table 1). The regression analysis re-

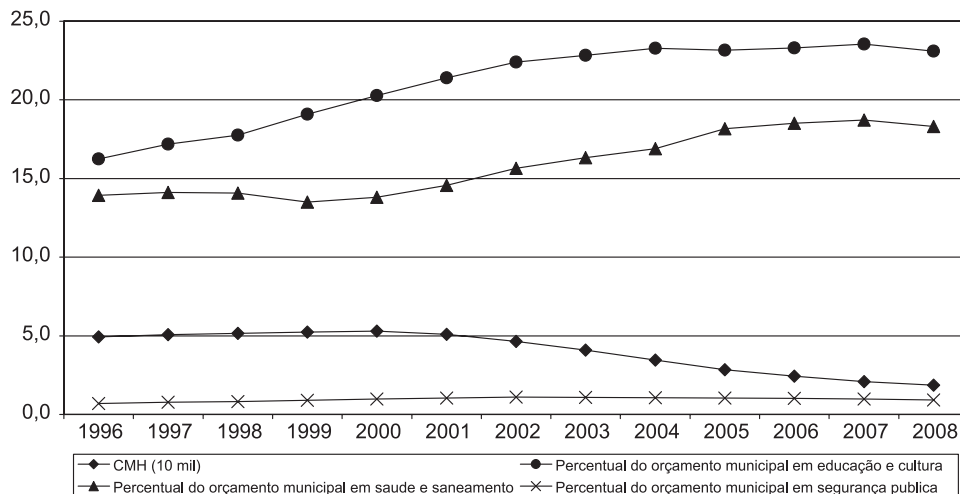
vealed the trend towards increase ($\beta=0.5$; $R^2=88.4\%$). Graph 2 shows that the rise in the percentage of municipal budget invested in health and sanitation occurred one year before the decrease in the HMR. In the state of São Paulo, the increase in the investment in health and sanitation was 368% between 1996 and 2008 (Table 1). In this state, such increase began in 1996, it was more significant in the beginning of the time series and it remained constant until the end of the period (Table 1; Graph 3). The trend towards increase can be observed in Table 2. Based on the regression model, researchers observed that the increase in one year was associated with an increase of 0.6% in the budget aimed at health and sanitation ($p<0.001$; $R^2=88.7\%$).

In addition, an increase in the investment in public security was also observed, both in the city and state of São Paulo (Graphs 2 and 3). In this city, the investment in security measures rose from 0.6% to 1.2% in 2003, subsequently decreasing to 0.9% in 2008 (data not shown). Although



Graph 1 - Development of age-adjusted homicide mortality rates (/100 thousand), ratio of youth in the population and unemployment rates in MSP, 1996 to 2008

Gráfico 1 - Evolução da taxa de mortalidade por homicídio ajustada por idade (/100 mil), da proporção de jovens na população e da taxa de desemprego no MSP, 1996 a 2008

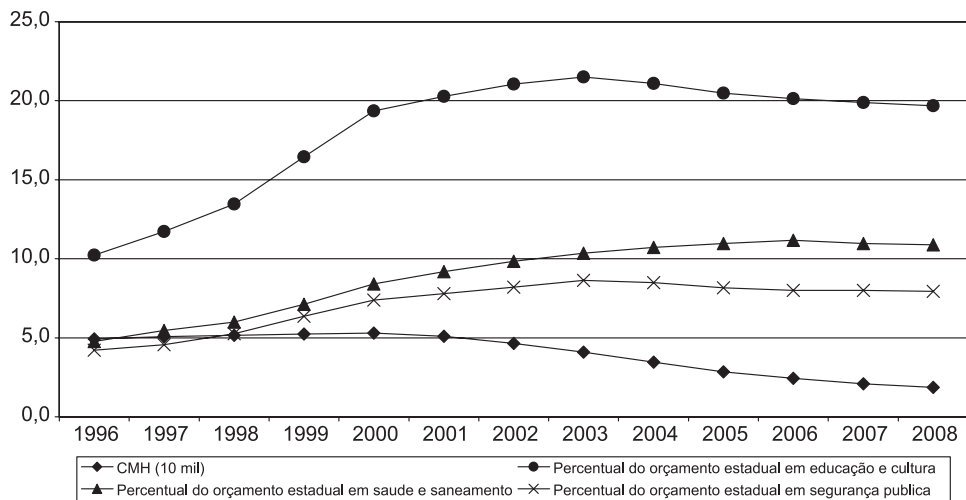


Graph 2 - Development of age-adjusted homicide mortality rates (/10 thousand) and the percentage of the municipal budget invested in education, culture, health and sanitation and public security, MSP, 1996 to 2008

Gráfico 2 - Evolução da taxa de mortalidade por homicídio ajustada por idade (/10 mil) e do percentual do orçamento municipal investido em educação e cultura, saúde e saneamento e segurança pública, MSP, 1996 a 2008

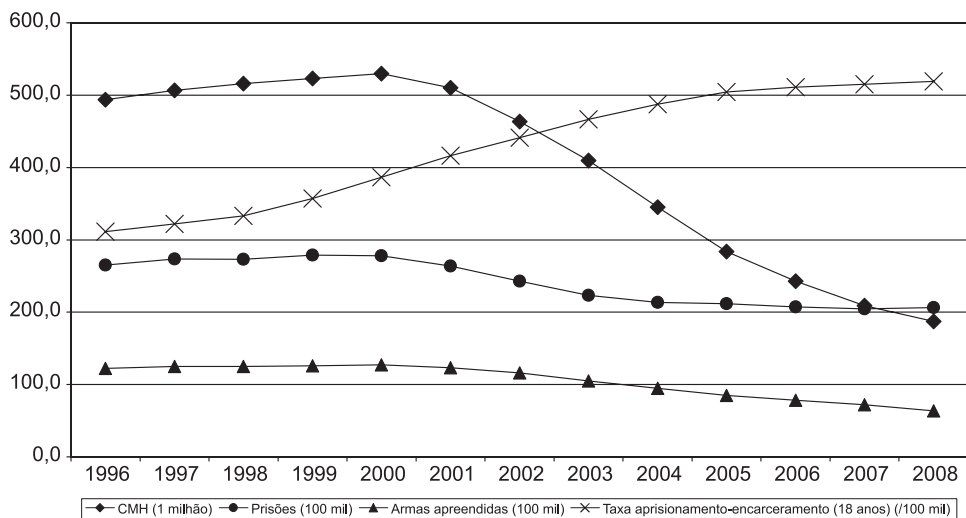
slight, there is a trend towards increase in this period ($\beta=0.02$; $R^2=42\%$). In contrast, in the state of São Paulo, the percentage of investment rose from 2.8% of the budget to 9.4% in 2001, subsequently decreasing to 7.4% in 2008 (data not shown). When the entire study period is considered (from 1996 to 2008), there was an increase of 179% in

this state (Table 1). The trend towards increase was also observed in Table 2 ($\beta=0.3$; $R^2=67.8\%$). By analyzing both periods separately, 1996-2001 and 2001-2008, an increase in investment is observed, especially in the beginning of the series, when the mean annual change was positive. On the other hand, in the final period between 2001 and



Graph 3 - Development of age-adjusted homicide mortality rates (/10 thousand) and the percentage of the São Paulo State budget invested in education, culture, health and sanitation and public security, MSP, 1996 to 2008

Gráfico 3 - Evolução da taxa de mortalidade por homicídio ajustada por idade (/10 mil) e dos percentuais do orçamento do Estado de São Paulo investido em educação e cultura, saúde e saneamento e segurança pública, MSP, 1996 a 2008



Graph 4 - Development of age-adjusted homicide mortality rates (/1 million) and of public security indicators, MSP, 1996 to 2008

Gráfico 4 - Evolução da taxa de mortalidade por homicídio ajustada por idade (/1 milhão) e dos indicadores de segurança pública, MSP, 1996 a 2008

2008, there was a reduction in the proportion of the budget aimed at public security measures of -20% in the city and -16% in the state of São Paulo. The mean annual change was negative in this period (Table 1).

The seizure of firearms by the police decreased from 106 in 1996 to 56 per 100,000 inhabitants in 2008, a reduction of -47.7%

(Table 1). Graph 4 shows the stabilization in the seizure of firearms between 1996 and 2001. In this period, there was a slight increase of 16% in the rate of firearms seized, as observed in Table 2. At the end of the series, between 2001 and 2008, there was a reduction of 55% in the seizure of firearms by the police of the city of São Paulo. When

Table 2 - Trend of homicide mortality rates, socio structural indicators and investments in social and public security policies in the Municipality of São Paulo, 1996 to 2008

Tabela 2 - Tendência das evoluções dos coeficientes de mortalidade por homicídio, indicadores sócio-estruturais, de segurança pública e investimento em políticas sociais no MSP, 1996 a 2008

	β	95%CI	t	p	R2	
Homicide mortality rate	-3.08	-3.96	-2.2	-7.7	<0.001	84.4
Socio-structural indicators						
Adolescents in the population (%)	-0.3	-0.4	-0.3	-15.3	<0.001	95.5
Unemployment (%)	-0.04	-0.2	0.1	-0.5	0.6	2.2
Investment in social policies						
Municipal investment in education and culture	0.6	0.5	0.8	8.52	<0.001	86.8
Municipal investment in health and sanitation	0.5	0.4	0.6	9.2	<0.001	88.4
State investment in education and culture	0.8	0.4	1.2	4.2	0.002	61.4
State investment in health and sanitation	0.6	0.4	0.7	9.27	<0.001	88.7
Public security						
Municipal investment in public security	0.02	0.004	0.04	2.8	0.017	42.0
State investment in public security	0.3	0.2	0.5	4.8	<0.001	67.8
Arrests (per 100,000 inhabitants)	-7.3	-9.4	-5.2	-7.7	<0.001	84.3
Firearms seized (per 100,000 inhabitants)	-6	-7	-4	-8.3	<0.001	86.0
Arrest-incarceration rate	19.9	17.4	22.4	17.3	<0.001	96.4

the entire study period is considered, there was a trend towards reduction in firearms seized, whose regression coefficient indicated a mean reduction of six firearms seized per 100,000 inhabitants, with annual increases in the time series studied ($\beta = -6$; $R^2=86\%$) (Table 2).

Police activity, measured by the number of arrests made per 100,000 inhabitants, rose 11.6% in this period. This increase took place especially between 1996 and 1999, as observed in Graph 4, when there is a reversal of the trend towards reduction until 2008. Between 1996 and 2001, police activity rose 39.6%, whereas there was a decrease of -20% between 2001 and 2008 (Table 1). During this period, the trend is towards reduction ($\beta = -7.3$; $R^2=84.3\%$).

In addition, with regard to public security, Graph 4 shows the clear pattern of increase in arrest-incarceration rates in the state of São Paulo, which precedes the fall in the HMR. The arrest-incarceration rate rose 89.7% between 1996 and 2008, and the increase was greater between 1996 and 2001 (39.8%), when the mean annual percentage change was 7% (Table 1). According to

Table 2, the increase in one year in the time series is associated with a mean increase of 19.9 per 100,000 inhabitants, with a high coefficient of determination (R^2) of 96.4%.

Table 3 shows the result of the correlation analysis between annual percentage variations in the HMR and the remaining variables studied. There were positive correlations with the proportion of adolescents in the population ($r=0.69$), unemployment rate ($r=0.60$), state investment in education and culture ($r=0.87$) and health and sanitation ($r=0.56$). In contrast, among the public security indicators, there were high levels of correlations with state ($r=0.53$) and municipal investment ($r=0.69$) in public security, firearms seized ($r=0.69$) and arrest-incarceration rate ($r=0.71$) (Table 3).

Discussion

Based on the results of the present study, the reduction in the HMR found in the city of São Paulo showed a high correlation with the proportion of adolescents in the population, unemployment rate, state investments in education and culture and those in health

Table 3 – Spearman’s correlation between annual percentage change in Homicide mortality rates, socio structural indicators and investments in social and public security policies in the Municipality of São Paulo, 1996 to 2008

Tabela 3 - Correlação de spearman entre as variações anuais das TMH, indicadores sócio-estruturais, de segurança pública e de investimento em políticas sociais no MSP, 1996 a 2008

	r	p
Socio-structural indicators		
Adolescents in the population (%)	0.6947	0.012
Unemployment (%)	0.6014	0.038
Investment in social policies		
Municipal		
Education and culture	0.2378	0.4568
Health and sanitation	-0.2168	0.4986
State		
Education and culture	0.8741	<0.001
Health and sanitation	0.5639	0.0562
Public security		
Municipal investment in public security	0.6853	0.0139
State investment in public security	0.5315	0.075
Arrests (per 100,000 inhabitants)	0.2258	0.4845
Firearms seized (per 100,000 inhabitants)	0.6923	0.0126
Arrest-incarceration rate	0.7133	0.009

and sanitation. Among the public security indicators, the percentage of state and municipal budgets for security, seizure of firearms and arrest-incarceration rate were correlated with the reduction in the HMR.

The results shown should be considered with caution. The correlation analysis only enables the assessment of the existence of association between two variables. It is not possible to make definitive conclusions about the causality of associations. However, exploratory descriptive studies could be extremely useful to formulate and refine hypotheses. Another factor that limits the conclusions of this study is the small size of the time series, which could compromise the accuracy of the results. Data from 1996 on were selected because this period is uniform in terms of the criteria used to categorize deaths (ICD-10) and because it shows a lower variation in data quality, especially with regard to the use of the “deaths from undetermined intent” category, a problem that has been widely

discussed in the literature (Mello Jorge and cols., 2002)¹⁸. The following are some of the reasons for the selection of a short period of time in this study: changes in the methodology used to calculate unemployment rates, budgets and expenses of states and cities that have occurred throughout time; lack of a systematic system to record information about firearms seized; and the unavailability of data on police activity and arrest-incarceration rate.

There are many explanatory variables for the HMR time trends. The role of the reduction in the proportion of adolescents in the population has been widely discussed in the literature^{19,20,21}, as this is the age group at the highest risk of death by homicide in the population. In the present study, the correlation between the proportion of adolescents and the HMR emphasizes the hypothesis about the importance of demographic changes as an explanatory factor for the decrease in homicides. This result is in agreement with the findings of Mello & Schneider (2007) in

the state of São Paulo, after controlling for school drop-out and population size¹¹. The international literature has not reached a consensus on the existence of a causal relationship between the reduced number of adolescents and the decrease in homicides. According to Pampel & Gartner (1995)²¹ and Phillips (2006)⁹, the association between homicide indices and the age composition of populations becomes irrelevant when other social indicators are controlled.

The expansion of the economy is among the other factors considered to be important, with a resulting reduction in unemployment and increase in income and purchasing power of the population^{6,7,10,22}. In the city of São Paulo, based on the results shown, the unemployment rate was significantly correlated with the HMR, although the temporal relationship between the curves puts into question the causality of this relationship, as the reduction in the HMR occurred two years before the beginning of the decrease in unemployment. Nonetheless, it could be assumed that the reduction in unemployment levels, which has been constant since 2004, is contributing to the trend towards decrease, a hypothesis that has yet to be tested in subsequent analyses.

The literature has not reached a consensus on the effect of the economic expansion on homicides. According to Levitt (2004)⁷, factors such as unemployment and income are important to understand crimes against property, although having a weak or insignificant relationship with homicides. Certain studies, however, emphasize the economic expansion as one of the important factors for the reduction in the HMR in the United States, in the 1990s⁶. According to the authors, the involvement of adolescents with drug trafficking decreases with the increase in formal job opportunities. This is the main pathway to explain the relationship between economic expansion and the reduction in the HMR.

In addition to the economic expansion, investments in social policies with a resulting improvement in quality of life and greater presence of the State in areas with

more disadvantages could lead to a reduction in violence and homicide levels. The relationship between investments in social policies and social capital (Kawachi and cols. 1997)¹⁷ supports this hypothesis. In São Paulo, although the relationship between the HMR curves and the percentage of the budget invested in education and culture suggests a possible effect of state and municipal investments on the reduction in the HMR, only state investment in educational and cultural actions was associated with this reduction in the correlation analysis.

State investments in education and culture go beyond the general effect on the improvement in quality of life of the population, directly reaching the age group at the highest risk of death by homicide, which could explain the association found. However, additional analyses with the construction of multivariate models need to be performed to control possible confounding factors.

Likewise, only state investments in health and sanitation had a significant correlation with HMR, revealing an association between the annual variation in budget investment in this area and the HMR. This effect could be the result of the improvement in health care, especially extra-hospital, urgent and emergency, and hospital care. In this case, the reduction in the HMR would not indicate a reduction in violence levels, but rather the lethality by violence in the city of São Paulo. The analysis of curves of evolution of other crimes is required to test this hypothesis, as exemplified by body injuries and crimes against property and more specific indicators used to evaluate health actions, with a possible impact on curves of mortality by homicide.

The correlation between state and municipal investments in public security and the reduction in the HMR should also be emphasized. In both cases, the increase in budget funds occurred before the reduction in the HMR, which emphasizes the hypothesis of a causal relationship between investments in public security and the decrease in homicide levels. The important

role of the police has been pointed out as one of the specific actions performed in the area of security, in the United States^{4,5,6,7,8}. In the present study, results showed that there was not an association between the rate of arrests made by the police and the HMR. Based on the graphs and regression analysis, researchers observed that both police activity and the HMR decreased in the city of São Paulo. In this case, reverse causality could be a possibility, when the reduction in violence levels results in the decrease in police activity⁷. However, the reduction in police activity occurred two years before the beginning of the decrease in the HMR, which consequently proves this hypothesis to be wrong.

Thus, the results weaken the hypothesis of a causal relationship between these two phenomena in the city of São Paulo, which is in disagreement with what the international literature has shown^{4,5,6,7,8}. This divergence could be explained by the differences in police activity indicators used. International studies use the increase in the number of police officers^{6,7}. The rate of arrests made by the police per 100,000 inhabitants was used in the present study. The use of this indicator is justified by the lack of available information about the number of police officers. Likewise, there are no available systematic data on possible qualitative changes in the way of policing, a question that has been pointed out as key to explain the decrease in the number of homicides in the United States and in New York^{4;5;8}.

There are many studies that point to the importance of the presence of firearms at home and the access to firearms as a risk factor for homicides^{23,24}. In the present study, the correlation between annual percentage variations in the HMR and those in the number of firearms seized was high and significant. It should be emphasized that a slight increase in this number occurred in the period before the disarmament campaign, with a progressive and constant reduction during the period that coincided with the campaign and the approval of the Statute of Disarmament. As the seizure of

firearms is restricted to illegal firearms and there is no available information about legally registered firearms, it is not possible to be certain about the changes in the number of firearms available or those circulating in the population. Likewise, it is not possible to know whether the reduction in the number of firearms seized reflects the lower number of illegal firearms in circulation (a positive effect of disarmament actions) or the reduction in police activity. Once again, limited data affected the reach of the analysis and conclusions.

In Brazil, Souza and Cols. (2007)²⁵ found a reduction in the HMR and hospital admissions due to firearm injuries after the approval of the Statute of Disarmament, in 2003. Cerqueira & Mello (2010)¹ found a significant positive association between disarmament and the reduction in the number of homicides in the state of São Paulo. The association between global disarmament measures, which reflects the adoption of laws that limit the ownership and carrying of firearms, and the reduction in the HMR is controversial (Levitt, 2004)⁷. According to Blumstein, Rivara & Rosenfeld (2000)⁶ and LaFree (1999)⁸, firearm control actions aimed at adolescents seem to be more promising for the reduction in global violence levels.

The association between the HMR and arrest-incarceration rate should also be mentioned. The effect of the increase in the incarceration rate on the reduction in violent crimes is emphasized by LaFree (1999)⁸, Levitt (2004)⁷ and Blumstein, Rivara & Rosenfeld (2000)⁶. In the present study, the correlation between the HMR and arrest-incarceration rate was high and significant, thus indicating that the rise in the arrest-incarceration rate is associated with the decrease in the HMR, as it was expected. This result confirms that found by Nadanovisky (2009)² in the state of São Paulo. In addition, in the case of São Paulo, it should be emphasized that that the increase in the arrest-incarceration rate precedes the fall in the HMR and that the curve continues to rise until the end of the period. Therefore,

the data emphasize the hypothesis of the important role that the increase in the arrest-incarceration rate has in the reduction in the number of homicides in São Paulo. Further analyses with the construction of multivariate models are required to confirm or refute this hypothesis.

It is important to consider aspects associated with the quality of data on the incarcerated population in São Paulo. The Department of Penitentiary Administration (DPA) provides data separated per department, and the population found in institutions affiliated with the DPA is theoretically comprised of prisoners who have been sentenced, while the population found in institutions affiliated with the Department of Public Security (DPS) is theoretically comprised of temporary prisoners who have not been sentenced yet. However, sentenced prisoners are frequently present in the DPS units, causing the division of the incarcerated population to be inaccurate and preventing the specific rate of such prisoners from being calculated.

In addition, during the 2000s, there was a substantial investment in the construction of prison units with the transfer of sentenced prisoners from DPS units to DPA units. Thus, the use of one of these specific rates would result in a trend that does not reflect the change in the incarceration policy of the state of São Paulo, whether due to an overestimation of increase (specific-DPA rate) or to the indication of a trend towards reduction (specific-DPS rate). Consequently, it could be concluded that the inclusion of temporary prisoners overestimates the incarceration rate. Nonetheless, the effect of such problem on the time series does not

seem to be significant, as this overestimation remains during the entire period and probably does not interfere with the curve of evolution of the arrest-incarceration rate.

Another limitation to be considered is that the arrest-incarceration rate uses the state of São Paulo as point of reference, whereas the HMR uses the city of São Paulo as point of reference. Unfortunately, it was not possible to have access to data that only considered prisoners living in this city. However, researchers expect to find an equivalence between the movements of curves of evolution of the arrest-incarceration rate in the state and city of São Paulo, as nothing suggests that there is a different effect of incarceration policies in this city, which minimizes the possible effect of this problem on the results found.

The results shown support the hypothesis that demographic changes; acceleration of the economy, especially the decrease in unemployment; investment in social policies; and changes in public security policies function concomitantly to reduce the HMR in São Paulo. Thus, it is necessary to develop complex analysis models that incorporate the joint functioning of different factors with an explanatory potential. The inclusion of other socioeconomic variables with 2010 census data will enable the refinement of hypotheses associated with greater socioeconomic development. The understanding of the causes of the drastic reduction in the number of homicides in São Paulo is a key step towards searching for answers to one of the most serious problems for the Brazilian population and the main cause of death among adolescents in Brazil: interpersonal violence.

References

1. Goertzel, T, Kahn, T. The Great São Paulo Homicide Drop. *Homicide Stud* 2009; 13 (4): 398-410.
2. Nadanovsky, P. O aumento no encarceramento e a redução nos homicídios em São Paulo, Brasil, entre 1996 e 2005. *Cad Saude Publica* 2009; 25(8): 1859-64.
3. Peres, MFT, Vicentin, D, Nery, MB, Lima, RS de, Souza, ER, Cerda, M, et al.. Queda dos homicídios em São Paulo: uma análise descritiva. *Rev Panam Salud Publica* 2011; 29(1):17-26.
4. Messner, SF, Galea, S, Tardiff, KJ., Tracy, M., Bucchiarelli, A., Markham Piper, T., et al.. Policing, drugs and the homicide decline in New York city in the 1990s. *Criminology* 2007; 45(2): 385-413.

5. Cerda, M, Tracy, M, Messner, S.F, Vlahov, D., Tardiff, K., Galea, S. Misdemeanor Policing, Physical disorder, and Gun-related Homicide. A Spatial Analytical test of "Broken-Windows" Theory. *Epidemiol.* 2009; 20(4): 533-41.
6. Blumstein, A, Rivara, FP, Rosenfeld, R. The rise and decline of homicide – and why. *Annu Rev Public Health* 2000; 21:505-541.
7. Levitt, SD. Understanding why crime fell in the 1990s: four factors that explain the decline and six that do not. *Journal Econom Perspectives* 2004; 18(1):163-190.
8. LaFree, G. Declining Violent Crime rates in the 1990s: predicting crime booms and busts. *Annu Rev of Sociol* 1999; 25:145-168.
9. Phillips, JA. The relationship between age structure and homicide rates in the United States, 1970 to 1999. *Journal of Research in Crime and Delinquency*, 2006; 43(3):230-260.
10. McCall, PL, Parker, K, MacDonald, JM. The dynamic relationship between homicide rates and social, economic, and political factors from 1970 to 2000. *Soc Sci Res* 2008; 37: 721-735.
11. Mello, JMP, Schneider, A. Mudança demográfica e a dinâmica dos homicídios no Estado de São Paulo. *São Paulo Perspec* 2007; 21(1):19-30.
12. Lima, RS. Homicídios em São Paulo. In: Lima, RS. *Entre Palavras e Números. Violência, democracia e Segurança Pública no Brasil*. São Paulo: Alameda; 2011. p. 173-91.
13. Hirata, DV. *Sobreviver na adversidade: entre o mercado e a vida. [Tese de doutorado]. São Paulo, Faculdade de Filosofia, Letras e ciências humanas da USP; 2010.*
14. Dias, CCN. Ocupando as brechas do direito formal: o PCC como instância alternativa de resolução de conflitos. *Dilemas* 2009; 2(4):83-105.
15. Feltran, GS. Crime e castigo na cidade: os repertórios da justice e a questão do homicídio nas periferias de São Paulo. *Caderno CRH*, 2010; 23(58):59-73.
16. Cardia N, Adorno S, Poletto F. Homicídio e violação de direitos humanos em São Paulo. *Est Avançados*. 2003;17(47):43–73.
17. Kawachi, I, Kennedy, BP, Lochner, K, & Prothrow-Stith, D. Social capital, income inequality, and mortality. *Am J Public Health*, 1997; 87(9), 1491-98.
18. Jorge, MHPM, Gotlieb, SLD, Laurenti, R. O sistema de informações sobre mortalidade: problemas e propostas para o seu enfrentamento II - Mortes por causas externas. *Rev bras epidemiol* 2002; 5(2): 212-223.
19. Land, KC, Cohen, LE. Age structure and Crime: Symmetry versus asymmetry and the projection of crime rates through the 1990s. *Am Sociol Review* 1987; 52: 170-183.
20. Maxim, PS. Cohort Size and juvenile delinquency. *Social Forces* 1985; 63(3):661-681.
21. Pampel, FC, Gartner, R. Age Structure, socio-political institutions, and national homicide rates. *Eur sociol review* 1995; 11(3): 243-260.
22. Brush, J. Does income inequality lead to more crime? A comparison of cross-sectional and time-series analysis of United States counties. *Econ Lett* 2007; 96:264-268.
23. Cook, P. The effect of gun availability on robbery and robbery murder: a cross-section study of fifty cities. *Police Studies Review Annual* 1978; 2: 743-81.
24. Miller, MAD, Hamenway, D. Rates of firearm ownership and homicide across United States regions and states, 1988-1997. *Am J Public Health* 2002; 92(12):1988-1993.
25. Souza, M FM, Macinko, J, Alencar, AP, Malta, D,C, Neto, OL M. Reductions in Firearm-related mortality and hospitalizations in Brazil after gun control. *Health Aff.* 2007; 26(1): 575-84.

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