

Does Homicide Influence Psychiatric Hospitalization to a Mental Health Facility? A Mathematical Approach

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Abstract

Introduction: Psychiatric hospitalization has been being studied homicide in Jamaica, particular the role of murder influencing admissions to mental health facility. Despite the high rates of homicide in Jamaica, the discourse of homicide has been either in the area of criminology or public health, with there being a gap between the studies of both.

Objectives: This research evaluates the role of homicide on psychiatric hospitalization, determines probabilities of homicide and psychiatric hospitalization, and examines best fit functions for the relationship between homicide rates and psychiatric hospitalization rates.

Methods and materials: Panel data for 1 10-year period, 2006-2015, were used to establish probabilities, functions and relationships between homicide and psychiatric hospitalization rates per 100,000.

Findings: A statistical relationship exists between psychiatric hospitalization and homicide rates. The association is a complex one as it is explained by a cyclical function. The majority of psychiatric hospitalization elasticities of homicide were inelastic and this means that a 1% change in homicide rate will produce a less than 1% change in psychiatric hospitalization.

Conclusion: There is a psychology of homicide that is unfolding in Jamaica. People are negatively influenced by the homicide pandemic. Although the effects of the murder pandemic are low, it is still accounting for psychiatric disorders among Jamaicans. The effects are not necessarily felt today (i.e., short-term effect); but there is the delayed effect (i.e., long-term effect) of murder that is accounting for additional hospitalization to a mental health institution.

Keywords: Violence; Homicide; Crime; Psychotic disorders; Jamaica

Introduction

There have been much public discussions on the state of crime, especially homicide, in the Caribbean) [1-10]. In 2007, a group of scholars from the University of the West Indies, Mona campus, Jamaica, West Indies, conducted a national stratified random sample cross-sectional survey of 1,338 respondents. They found that crime was the leading national problem identified by the respondents (i.e., 44/100) [11]. Prior to 2007, the issue of crime was a problem in the Caribbean to the point where a conference was held in Barbados in 1999 - Tourism and Crime Conference in the Barbados - in order to address the challenges, find solutions, examine the consequences and control the escalating crime and violence phenomena [10].

Despite the efforts of criminologists, demographers, sociologists and public policy specialists, the crime problem persist following the meeting of scholars in 1999. Then in 2012, a new group of academicians empirically linked murders and politics [12], and in 2015, Bourne and colleagues [13] examined the psychology of homicide in Jamaica and argued that crime is at a pandemic stage. Such disclosures speak to the continued unresolved difficulty to address the crime problem, especially homicide, by governments.

Undoubtedly, the rate of homicide in the Caribbean is an issue and rightfully so; but, there is no such focus on psychiatric conditions. The issue of homicidal behaviour and mental disorders is widely studied in health literature [14-21]. In fact, the issue of the association between homicidal behaviour and mental disorder goes back to 1857 by Dr. John Gray who found this tendency among 49 patients with mental disorder [14]. Furthermore, a comprehensive search the authors did

not find a single study that examined the role of homicide on psychiatric hospitalization in the Caribbean; but many emerged outside of the Caribbean [22-26].

Steadman, et al. [27] examined a cross-institutionalization between prisoners and mental health patients of a sample of 3,897 and 2,376 males respectively and found (New York, Arizona, and Massachusetts prisoners) a relative decline in the percent of former mental health patients who were incarcerated in 1978. They summarized that “[I]ittle evidence was found to support the idea that mental hospital deinstitutionalization was a significant factor in the rise of prison populations during [the] period [from 1968 to 1978]” [27]. With the rate of homicide in Jamaica being so high compared to the rest of the world, there is a need to examine homicide and psychiatric hospitalization in order to understand the extent of murders on psychiatric conditions. Thus, this research bridges the gap in the literature by evaluating the role of homicide on psychiatric hospitalization, determining probabilities of homicide and psychiatric hospitalization, and examining best fit functions for the relationship between homicide rates and psychiatric hospitalization rates.

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Received June 21, 2016; **Accepted** June 25, 2016; **Published** June 30, 2016

Citation: Bourne PA, Hudson-Davis A (2016) Does Homicide Influence Psychiatric Hospitalization to a Mental Health Facility? A Mathematical Approach. J Ment Disord Treat 2: 109. doi:[10.4172/2471-271X.1000109](https://doi.org/10.4172/2471-271X.1000109)

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Theoretical Framework

Using state-level panel-data for a 68-year period (1934-2001) and controlling for youth population rates, macro-economic conditions, demographic characteristics and criminal justice enforcement, Harcourt [22] established a mathematical model that examine the relationship between homicide rates and institutionalization at a mental health facilities in the United States. He used clustered regression models as presented in equation (1):

$$\text{Log Homicide Rates}_{sy} = \alpha + \beta \text{ Institutionalization Rate}_{sy} + \theta \text{ Controls}_{sy} + \gamma_s + \delta_y + \epsilon_{sy} \quad (1)$$

“Where *s* represents states and *y* reflects the year. The dependent variable of interest in this class of models is the natural log of the annual homicide rate for each state, which is obtained using vital statistics measures of death by homicide. The key explanatory variable of interest is the 1-year-lagged rate of aggregated institutionalization in state and federal prisons, in public mental hospitals, and in other institutions for the mentally ill. The model uses a weighted least squares regression, with weights equal to the annual population of the states, clustering standard errors at the state level. The model conditions on state and year fixed effects (γ_s and δ_y) to account for unmeasured factors that influence crime and either are constant within states over the study period or change over time but exert a constant influence over the entire set of states [22].

For this study, we also loghomicide rate and so, equation (2) will the linkage between loghomicide rate and hospitalization rate to the national psychiatric hospital in Jamaica in time period *t*:

$$\text{logHomicide Rates}_t = \alpha + \beta \text{ Institutionalization Rate}_t \quad (2)$$

For this paper, we also modeled the data based loghomicide, but expanded it to non-linear model.

Methods and Materials

The data for this study were taken from various Jamaica Government Publications including the Demographic Statistics, which provided data on population. Jamaica Constabulary Force and Economic and Social Survey of Jamaica (ESSJ) provided the data for murders, and mid-year population. Data were also obtained from the Ministry of Health (2005-2015) on admissions to a national mental health public hospital in Jamaica; the Bellevue Hospital (referred to as Bellevue). The period for this work is from 2000 through to 2015. Data were recorded, stored and retrieved using the Statistical Packages for the Social Sciences (SPSS) for Windows, Version 24.0. The level of significance that is used to determine statistical significance is less than 5% (0.05) at the 2-tailed level of significance. Ordinary Least Square (OLS) regression was used to determine whether rape and carnal abuse rate is a factor of homicide as well as the strength of the relationship, using R^2 .

Psychiatric admissions elasticity of homicide is calculated by annual percent change in hospitalization to the national psychiatric hospital in Jamaica divided by the annual percent change in homicide:

Psychiatric admissions elasticity of homicide = Annual% in hospitalization / Annual % change in homicide

Probabilities of hospitalization to national psychiatric hospital in Jamaica is the total number those hospitalized to the Bellevue Hospital for time period *i* divided by the mid-year population for time period *i*-P(H).

Probabilities of homicide in Jamaica are the total number murders for time period *i* divided by the mid-year population for time period *i*-P(A).

Independent probability was used to compute those who were hospitalized to the national psychiatric hospital in Jamaica following a homicide – P(A).P(H)

Findings

Table 1 summarizes data for psychiatric admissions to national mental health hospital, homicide, rates of psychiatric admissions and homicide for a 10-year period (2006-2015). For the studied period, the average number of hospitalized mental health patients was $1,012 \pm 49$ compared to $1,324 \pm 224$ homicides, with the hospitalization rate being 37.4 per 100,000 populations and 48.99 ± 8.6 homicide per 100,000 populations. In the first five years (2006-2010), the average number of hospitalized people to the national mental health hospital was $1,036 \pm 59$ compared to 988 \pm 16 in the latter 5 years (2011-2015). Comparatively, the average numbers of homicide were $1,525 \pm 123$ in the first 5 years and $1,123 \pm 71$. Such findings indicate that both the hospitalization of people to the national psychiatric hospital and homicide in Jamaica have been declining in the last 5 years. Furthermore, in 2006, there rate of admission to the national mental health hospital was 41.7 per 100,000 population and the rate fell by 14.62% in 2015 (to 35.6 per 100,000).

Table 2 presents psychiatric admissions elasticity of homicide in Jamaica for 2006-2015. Generally, psychiatric admissions elasticity of homicide for Jamaica is mostly inelastic (or irresponsive) to changes in homicide. In 2007, 2008, 2011, 2013-2015, psychiatric admissions elasticities to homicide were irresponsive to a 1 percent change in homicide (i.e., $\eta < 1.0$). Simply put, murders did not significantly influence hospitalization to the psychiatric national hospital in Jamaica. However, hospitalizations to the national psychiatric hospital significantly respond to 1 percent change in homicide for 2009 and 2012.

Table 3 presents probabilities of hospitalization to national psychiatric hospital and homicide in Jamaica for 2006-2015. Using probabilities to determine the likelihood of being hospitalized to the national mental health hospital who are influenced by a homicide, these were outlined in intersection [(P(A).P(H)]. Based on the probabilities for the intersection, it can be concluded that hospitalization of people to the national mental health hospital in Jamaica is very low, with the probabilities declining in the last five years (2011-2015) compared to the first five years (2006-2010). Such findings provide empirical results to establish the homicide is not causally related to the hospitalization of people to the national psychiatric hospital in Jamaica; but that a relationship exists anyway.

On average, 3 ± 0 people are hospitalized daily to the national mental health hospital in Jamaica over the studied period compared to 4 ± 1 murder on a daily basis (Table 3). In the last five years in Jamaica (2011-2015), the numbers of daily homicide were 3 compared to 4 and 5 in the first five years (2006-2010). For the studied period, the most homicide in Jamaica occurred in 2009 compared to 2007 for hospitalization to the national psychiatric hospital (Table 4).

Figure 1 depicts the hospitalization rate to national psychiatric hospital and homicide rate per 100,000 populations in Jamaica for 2006-2015. The curves in Figure 1, for both hospitalization and homicide rates, non-linear and are best fitted by polynomial functions.

Year	Psychiatric Admission	Homicide	Mid-Year Population	Psychiatric Admission rate (per 100,000)	Homicide rate (per 100,000)
2006	1,110	1,340	2,663,100	41.7	50.3
2007	965	1,574	2,675,800	36.1	58.8
2008	972	1,601	2,687,200	36.2	59.6
2009	1,087	1,680	2,695,600	40.3	62.3
2010	1,045	1,428	2,695,543	38.8	53.0
2011	957	1,125	2,699,838	35.4	41.7
2012	995	1,095	2,707,805	36.7	40.4
2013	991	1,200	2,714,734	36.5	44.2
2014	1,005	1,005	2,720,554	36.9	36.9
2015	994	1,192	2,793,335	35.6	42.7
Mean	1,012	1,324	2,705,351	37.4	49.0

Table 1: Psychiatric admission, homicide and rates In Jamaica, 2006-2015.

Year	Psychiatric Admission	Homicide	Annual % change in Psychiatric admission	Annual % change in Homicide	Elasticity (η)
2006	1,110	1,340	-	-	-
2007	965	1,574	-13.06	17.46	-0.75
2008	972	1,601	0.73	1.72	0.42
2009	1,087	1,680	11.83	4.93	2.40
2010	1,045	1,428	-3.86	-15.00	0.26
2011	957	1,125	-8.42	-21.22	0.40
2012	995	1,095	3.97	-2.67	-1.49
2013	991	1,200	-0.40	9.59	-0.04
2014	1,005	1,005	1.41	-16.25	-0.09
2015	994	1,192	-1.09	18.61	-0.06

Table 2: Psychiatric Admissions Elasticity of Homicide in Jamaica, 2006-2015.

The function for homicide rate is a cubic function [Equation (2) – $R^2=0.8787$] and hospitalization by a 5 degree polynomial [Equation (3)] – $R^2=0.825$:

$$H_t = 0.2598x^3 - 4.443x^2 + 19.211x + 35.799$$

$$A = 0.0138x^5 + 0.3971x^4 - 4.2221x^3 + 20.281x^2 + 42.686x + 67.931 \quad (3)$$

Table 5 presents an Ordinary Least Square (OLS) regression of the loghomicide rate per 100,000 population and psychiatric hospitalization rate per 100,000 for Jamaica, using data for 10 years (2006 to 2015). Using the OLS, no linear relationship existed between psychiatric hospitalization rate and homicide rate ($P=0.272$; $F [1, 8]=1.393$, $P>0.05$). Based on the OLS regression model, no statistical association between loghomicide rate per 100,000 and psychiatric hospitalization rate per 100,000 provides a rationale for further examination by other functions.

Table 6 presents a summary of various model operations on the relationship between loghomicide rate (dependent variable) and psychiatric hospitalization rate (independent variable). It is clear from the exploration that none of the options would best fit the data ($P>0.05$). Hence, the researchers explored other alternatives that were captured in Figures 2 and 3.

Figure 2 shows a super-imposed polynomial function on data points of loghomicide and psychiatric hospitalization rate per 100,000, with an 88.8% explanatory power expressed by equation (4):

$$\log H_t = -0.0001x^5 + 0.003x^4 - 0.0206x^3 + 0.0024x^2 + 0.2569x + 3.6728 \quad (4)$$

where $\log H_t$ denotes lagged homicide rate per 100,000 population and x being psychiatric hospitalization rate per 100,000

Figure 3 depicts a super-imposed polynomial function on data points of psychiatric hospitalization and loghomicide rate per 100,000, with an 82.5% explanatory power expressed by equation (5):

$$A_t = -0.0138x^5 + 0.3971x^4 - 4.2221x^3 + 20.28x^2 - 42.686x + 67.931 \quad (5)$$

where A_t denotes psychiatric hospitalization rate per 100,000 population and x being lagged homicide rate per 100,000

Discussion

The issue as to whether homicide influences hospitalization to the national psychiatric hospital is answered by the current study. Like Harcourt’s study [22], homicide affects the mental health status of people. Harcourt found large robust statistical relationship between mental health institutionalization and homicide rate, which is not supported by the same method of Harcourt [22]. Similarities existed for this study and Harcourt’s work as follows: 1) functions for homicide and institutionalization rates in Jamaica and the United States; and 2) statistical association between hospitalization to a mental health facility and homicide. Unlike Harcourt’s work, this study examines the elasticities of institutionalization to a mental health facility and homicide and found that for the 10-year period, institutionalization to the national mental health hospital in Jamaica were mostly irresponsive to changes in homicide. This research went further by showing that homicide is influence the psychiatric state of Jamaica; but that the matter is cyclical one that was not discovered by Harcourt [22].

The relationship between institutionalization and homicide is a cyclical one irrespective of whether homicide is lagged or otherwise. Such findings as are unearthed by this research indicate that there is a time effect as revealed by the troughs and peaks. The fact is homicide does not necessarily influence institutionalization to a mental health hospital; but that there is a time effect before it begins to show up in the form of hospitalization to a psychiatric facility. Such findings were not discussed or revealed by Harcourt’s study and this is a critical finding to the health literature. It can be deduced from the present work that people will absorb some of the negative psychology effect of the murder of someone (i.e. love one or close friend) and this will show up in a later period.

Unlike Harcourt’s work, this paper did not examine 1) macroeconomic effects, 2) demographic effects, and 3) police office effect, which could provide more explanation for the effect of homicide on institutionalization to a mental health facility. However, the rate of homicide negatively affecting population is very low; but this provides an empirical basis for arguing about the psychosocial conditions of homicide on the population. Some people are able to rise against the challenge of a murdered love one or friend; but there are few people who are adversely affected by this reality and as such must be catered for in policy planning.

There is enough evidence from the current findings to support a change in the emotional intelligence of Jamaicans as it relates to homicide. Such a perspective is supported by the probabilities which show a decline in the last five years (2011-2015) compared to 2006-2010. This means that there is a homicide-psychology effect that is arising in the people of Jamaica as they adopt to the homicide pandemic. Such a state can be expanded to 1) internal-psychological defense mechanism, 2) immune defense mechanism, 3) anticipated effect of homicide, and 4) expected homicide effect of some people. Those are all psychological

Year	Psychiatric Admission	Homicide	Mid-Year Population	P(A)	P(H)	P(A).P(H)
2006	1,110	1,340	2,663,100	0.000416807	0.000503173	0.000002097
2007	965	1,574	2,675,800	0.00036064	0.000588235	0.000002121
2008	972	1,601	2,687,200	0.000361715	0.000595787	0.000002155
2009	1,087	1,680	2,695,600	0.00040325	0.000623238	0.000002513
2010	1,045	1,428	2,695,543	0.000387677	0.000529763	0.000002054
2011	957	1,125	2,699,838	0.000354466	0.000416692	0.000001477
2012	995	1,095	2,707,805	0.000367456	0.000404387	0.000001486
2013	991	1,200	2,714,734	0.000365045	0.000442032	0.000001614
2014	1,005	1,005	2,720,554	0.00036941	0.00036941	0.000001365
2015	994	1,192	2,793,335	0.000355847	0.00042673	0.000001519

Table 3: Probabilities of hospitalization to national psychiatric hospital and homicide in Jamaica, 2006-2015

Year	Psychiatric Admission	Homicide	Monthly Hospitalization	Monthly Homicide	Daily Hospitalization	Daily Murder
2006	1,110	1,340	93	112	3	4
2007	965	1,574	80	131	3	4
2008	972	1,601	81	133	3	4
2009	1,087	1,680	91	140	3	5
2010	1,045	1,428	87	119	3	4
2011	957	1,125	80	94	3	3
2012	995	1,095	83	91	3	3
2013	991	1,200	83	100	3	3
2014	1,005	1,005	84	84	3	3
2015	994	1,192	83	99	3	3

Table 4: Monthly and daily hospitalization and homicide in Jamaica, 2006-2015.

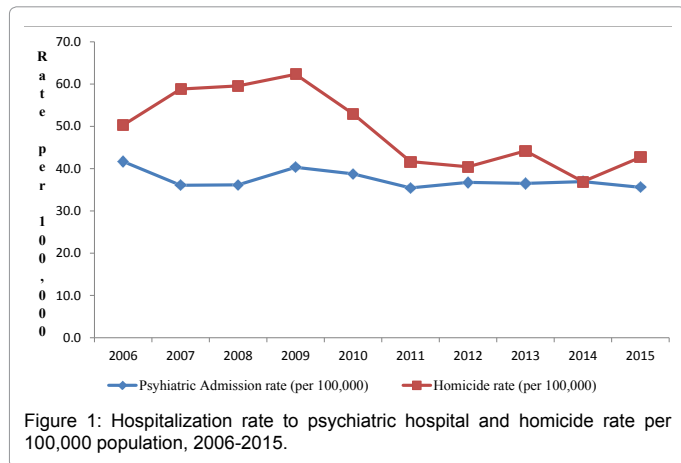


Figure 1: Hospitalization rate to psychiatric hospital and homicide rate per 100,000 population, 2006-2015.

Details	Unstandardized Coefficients		Beta	t	P value	95% CI Lower-Upper
	B	Std. Error				
Psychiatric Hospitalization rate	0.033	0.028	.385	1.180	0.272	-0.032 - 0.099

Table 5: OLS regression of loghomicide rate and psychiatric hospitalization rate, 2006-2015.

states to cushion the homicide pandemic. While those psychological conditionings are occurring in Jamaicans, there are some people who are still affected by the reality of a murder.

In Harcourt's work nothing was done on the continuous responsivity of psychiatric hospitalization to homicide changes. However, he established a strong statistical association (i.e., $R^2 > 0.7$) between psychiatric hospitalization and homicide rates for the United

States, using 68 years of data (1934 to 2001), which was referred to an institutionalized effect. When other socio-demographic and macroeconomic variables were controlled for, the relationship between psychiatric hospitalization and homicide was still a strong one (i.e., $R^2 = 0.78$). Logging the homicide rates, Harcourt used OLS (Ordinary Least Square regression model) to determine his valuation. This study found that OLS cannot be used to model relationship between loghomicide rate and psychiatric hospitalization rate as there association is a non-linear one. However, the association is a 5 or 4 degree polynomial functions that account for the relationship between loghomicide and psychiatric hospitalization rates in Jamaica. In this paper, both loghomicide and psychiatric hospitalization rates were used as dependent and independent variables unlike Harcourt's work. The present work showed that increases in homicide rates are related to both rise and fall in psychiatric hospitalization and vice versa. Such findings mean that there is a time effect, which is captured by the cyclical nature of both phenomena. Thus, the matter of the relationship between psychiatric hospitalization and homicide rates is a complex one, which cannot be a simple logging of homicide rate to examine the effect of institutionalization thereon.

Outside of the time effect that emerged from this study, there are 'seemingly sane people' who are suffering from psychiatric disorders in Jamaica and they are contributing to the high homicide rates. This finding is concurring the extensive literature on the matter that psychiatric people are accounting for some of the homicide [14,28-33]. Asnia, et al. offered explanations such as alcohol abuse, substance abuse and antisocial personal disorder among some of the reasons for the relationship between homicidal behaviour among mental health patients [15], which provides justifications for what, is unfolding in Jamaica, especially in keeping with the current findings. This disclosure in Jamaica now must be extended to the Caribbean, suggesting that issue of homicide must be expanded from criminology to health

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	P value	Constant	b ¹	b ²	b ³
Linear	0.148	1.393	1	8	.272	2.624	.033		
Logarithmic	0.149	1.398	1	8	.271	-0.783	1.287		
Inverse	0.149	1.401	1	8	.271	5.198	-49.339		
Quadratic	0.150	.619	2	7	.565	-1.189	.232	-0.003	
Cubic	0.151	.622	2	7	.564	-0.183	.143	0.000	-2.473E-5
Power	0.150	1.412	1	8	.269	1.159	.333		
Growth	0.150	1.408	1	8	.269	1.030	.009		
Exponential	0.150	1.408	1	8	.269	2.800	.009		
Logistic	0.150	1.408	1	8	.269	.357	.991		

The independent variable is Hospitalization rate.

Table 6: Model Summary and Parameter Estimates of loghomicide rate (dependent variable) and psychiatric hospitalization rate (independent variable).

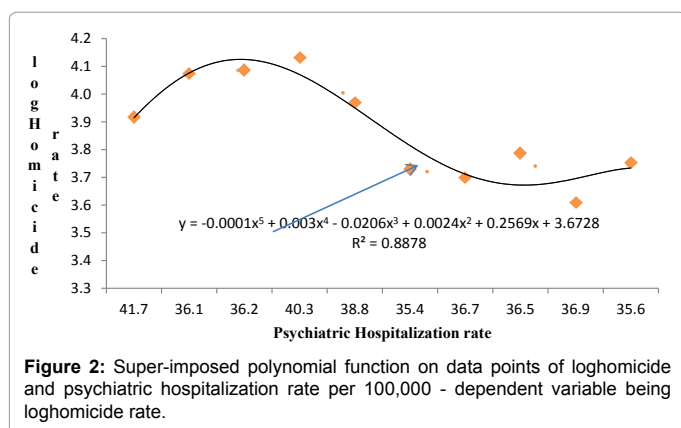


Figure 2: Super-imposed polynomial function on data points of loghomicide and psychiatric hospitalization rate per 100,000 - dependent variable being loghomicide rate.

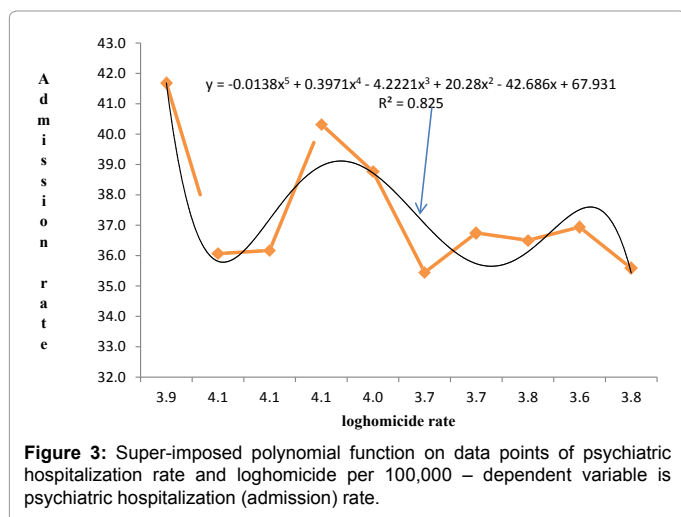


Figure 3: Super-imposed polynomial function on data points of psychiatric hospitalization rate and loghomicide per 100,000 - dependent variable is psychiatric hospitalization (admission) rate.

psychology, medical and social epidemiology, demography and psychiatric symptomology to provide a better understanding of the homicide pandemic in the society.

There is a psychology of homicide that is unfolding in Jamaica. People are negatively influenced by the homicide pandemic. Although the effects of the murder pandemic are low, it is still accounting for psychiatric disorders among Jamaicans. The effects are not necessarily

felt today (i.e., short-term effect); but there is the delayed effect (i.e., long-term effect) of murder that is accounting for additional hospitalization to a mental health institution. Homicide is, therefore, a factor in psychiatric disorder and so we need to widen the scope of the homicide literature. Undoubtedly policies to address homicide must be twofold to include the sociology as well as the psychology of homicide.

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