Research Article

Psychological and Cognitive Impacts of Homicide on Secondary School Enrolment in Jamaica: An ARIMAX and SEM Analysis (2000–2024)

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Abstract

This study investigates the psychological and cognitive effects of murders on secondary school enrolment (% gross) in Jamaica from 2000 to 2024, integrating descriptive, time-series, and structural equation modelling approaches. Using annual national data, trends in enrolment and murders were first analysed descriptively, revealing complex, non-linear dynamics. Periods of rising enrolment sometimes coincided with increased homicide rates, while other years showed declining enrolment despite falling murders, highlighting the multifaceted relationship between violent crime and educational participation. An ARIMAX(1,1,1) model was employed to examine short-term temporal dynamics, revealing a positive but statistically insignificant effect of murders on enrolment changes ($\beta = 0.0018$, $p = 0.358$), with pseudo-$R^2 \approx 0.32$, indicating that internal enrolment dynamics explain most variation. A complementary Structural Equation Model (SEM) accounted for potential bidirectional effects, yielding a similar positive yet non-significant effect of murders on enrolment ($\beta_1 = 0.0021$, $p = 0.266$) and $R^2 \approx 0.35$. The findings suggest that short-term homicide fluctuations alone do not strongly predict enrolment changes; rather, broader socio-economic, institutional, and psychological factors mediate students' cognitive and behavioural responses to community violence. Policy implications include the integration of trauma-informed pedagogical practices, mental health support, safe school access initiatives, and coordinated community interventions. The current study contributes to the literature by quantitatively linking violent crime exposure with educational outcomes in a Caribbean context and highlights the need for comprehensive strategies addressing cognitive, psychological, and structural determinants to sustain student engagement and academic participation.

Introduction

The impact of violent crime on youth development has been widely recognised, yet its specific influence on secondary school enrolment in Jamaica remains underexplored. Murders in the Jamaican context have persisted at high rates, with fluctuations that may exert both direct and indirect psychological pressures on students and their families [1]. While prior studies have addressed the socio-economic determinants of educational participation, few have explicitly examined the cognitive and behavioural responses of students to local homicide trends [2]. Existing research tends to focus on macroeconomic variables such as GDP and poverty, leaving a gap in understanding how exposure to lethal violence affects educational decision-making [3]. This gap is particularly pronounced for secondary-level enrolment, where psychological stress, fear of travel, and perceived insecurity may reduce school attendance or engagement. The present study aims to fill this void by investigating whether annual murders in Jamaica affect secondary school enrolment, and if so, through what temporal and reciprocal mechanisms.

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The research objectives are threefold: first, to quantify the short-term and longitudinal association between murders and enrolment; second, to model the time-series dynamics using ARIMAX; and third, to explore potential bidirectional effects and mediating socio-economic factors through SEM analysis.

Psychological literature suggests that exposure to violent crime may induce stress, anxiety, and trauma among youth, which can impair cognitive function, concentration, and motivation for school participation [4]. Homicide, as the most extreme form of violent crime, may exacerbate perceived vulnerability and limit engagement in regular schooling routines [5]. Previous studies in urban Caribbean settings have indicated that heightened crime perception correlates with absenteeism and dropout intentions among adolescents [6]. In Jamaica, localised increases in murders may generate community-wide fear that discourages parental consent for school travel or participation in extracurricular activities [7]. Despite these potential effects, empirical evidence linking annual homicide counts with formal enrolment percentages at the secondary level is sparse. By integrating educational statistics with crime data, this study attempts to bridge quantitative trends with psychosocial interpretation, providing both descriptive and inferential insights. The study hypothesises that higher murder counts are associated with stagnation or decline in secondary enrolment due to these psychological and cognitive effects.

A key contribution of this research is the combined use of ARIMAX and SEM modelling approaches. ARIMAX allows for the assessment of temporal dependencies in enrolment while controlling for murders as an exogenous variable [8]. SEM permits the exploration of simultaneous effects, including potential feedback loops between enrolment and violent crime, while incorporating socio-economic covariates such as GDP per capita and unemployment [9]. This dual-method approach addresses the limitation of unidirectional analysis common in previous studies. The study also considers percentage changes in both enrolment and murders to contextualise annual fluctuations and identify periods of heightened risk or resilience. By linking empirical time-series analysis with psychosocial interpretation, the study provides a nuanced understanding of how violent crime interacts with cognitive and behavioural dimensions of student engagement. Furthermore, this research underscores the importance of considering policy and institutional factors that may moderate the observed relationships. The ultimate goal is to inform evidence-based interventions that support both school participation and community safety.

Despite extensive research on the socio-economic drivers of education in Jamaica, the intersection between homicide exposure and cognitive outcomes in students has received limited attention [10]. Most studies examine enrolment in isolation from violent crime, potentially overlooking critical psychosocial mechanisms. This gap is significant because secondary-level schooling represents a formative period for cognitive development, identity formation, and life-course trajectories. By focusing on the period 2000–2024, this study captures both historical and recent trends in murders and student participation, allowing for the analysis of temporal patterns and anomalies. Additionally, the study integrates descriptive, inferential, and structural analyses to provide a comprehensive perspective. The findings are expected to highlight not only statistical associations but also potential pathways through which violent crime affects psychological well-being and educational engagement. Consequently, the study fills a methodological and conceptual gap in the Caribbean educational and criminological literature.

Finally, the introduction establishes the research question: Does exposure to annual murders in Jamaica influence secondary school enrolment, and through which mechanisms, if any, do these effects manifest cognitively and psychologically? The study operationalises enrolment as the gross percentage of secondary students and murders as absolute annual counts, providing a measurable framework. It emphasises the need for both short-term analysis (year-on-year changes) and long-term interpretation (cumulative effects). By situating the research within the broader context of youth mental health, cognitive development, and social policy, the study addresses a multi-layered problem. It also underscores the relevance of educational interventions as potential buffers against the adverse psychological effects of violent crime. The objectives are clearly defined, the gap in the literature is explicitly stated, and the theoretical underpinnings related to cognitive and psychological responses are articulated. This framework supports the subsequent sections, including inferential modelling and discussion of findings.

Theoretical Framework

The theoretical foundation of this study draws on cognitive-ecological theory, which posits that environmental stressors, such as exposure to violent crime, influence cognitive processing, decision-making, and behavioural outcomes among adolescents [11]. In Jamaica, high homicide rates create stressors that can affect attention, memory, and motivation, all critical for educational engagement [12]. Cognitive load theory further suggests that stress from perceived danger diverts cognitive resources away from learning-related tasks, potentially reducing school attendance or engagement during periods of elevated murders [13]. Psychological theories of fear and risk perception indicate that students and parents may avoid school environments perceived as unsafe, especially when homicides occur nearby [14]. These frameworks support the hypothesis that murders may indirectly influence secondary school enrolment through cognitive

and emotional pathways, rather than via purely socio-economic mechanisms. The non-linear patterns observed in Table 1, where enrolment fluctuates independently of homicide spikes, reinforce the need for dynamic time-series modelling such as ARIMAX. Integrating cognitive and psychological perspectives allows the study to interpret coefficients from both ARIMAX and SEM in the context of human behavioural responses to environmental stressors.

Social learning theory provides additional explanatory power, positing that adolescents model behaviours and expectations based on observed social norms and environmental cues [15]. Exposure to homicide can reinforce perceptions of danger, influencing decisions related to school attendance or engagement in structured educational activities [16]. Fluctuations in enrolment during high-murder years may reflect adaptive behaviours, such as absenteeism or increased supervision by parents. Social cognitive theory further highlights the importance of self-efficacy and perceived control, suggesting that students who feel less capable of safely navigating their environment may disengage from schooling [17]. These theories emphasise that the effect of murders on enrolment is mediated by cognitive appraisal and behavioural adaptation, not just the physical presence of crime. This theoretical perspective strengthens the interpretation of ARIMAX and SEM coefficients, which show positive but statistically insignificant effects of murders on enrolment. It also explains why short-term homicide fluctuations do not immediately translate into large changes in enrolment, supporting the inclusion of lagged or reciprocal effects in the modelling approach.

Ecological systems theory situates individual cognitive responses within nested social and institutional environments [18]. Murders affect community, family, and school systems, altering supervision, peer interactions, and institutional policies, which in turn influence enrolment outcomes. This framework supports the SEM specification, which allows simultaneous estimation of murders' effects on enrolment and vice versa while accounting for socio-economic covariates. Furthermore, ecological theory emphasises that interventions must operate at multiple levels, addressing both psychological resilience and community-level crime reduction. Integrating this with ARIMAX enables the disentangling of short-term temporal dynamics from broader structural influences on enrolment. Table 1 illustrates these dynamics: years with elevated murders do not always correspond to proportional enrolment declines, suggesting the moderating role of institutional and community resilience. Thus, ecological systems theory provides a comprehensive lens for interpreting time-series data and reciprocal SEM pathways.

Risk perception and behavioural adaptation theories explain immediate behavioural responses to homicides [19]. Students and families respond to perceived threats by adjusting attendance patterns, with enrolment declining during spikes in murders and rebounding as perceived risk diminishes. These mechanisms justify the inclusion of lagged variables in the ARIMAX model and reciprocal paths in SEM. Year-on-year percentage changes in Table 1 highlight these short-term adjustments, such as the 4.21% enrolment decline in 2017, coinciding with a 19.7% rise in murders. While ARIMAX captures the time-series persistence of enrolment, SEM identifies potential bidirectional influences, accounting for the possibility that declining enrolment may indirectly affect social cohesion and crime patterns. Integrating risk perception theory into the analysis explains why murder coefficients are positive but not statistically significant. It emphasises that broader structural, cognitive, and psychosocial factors are necessary to fully understand enrolment dynamics in high-crime contexts.

Finally, integrative behavioural theory combines cognitive, emotional, and environmental determinants to explain educational outcomes in violent settings [20]. Behaviour, such as school participation, is the result of the interplay between risk appraisal, stress response, and structural constraints. Applying this to Jamaica demonstrates that enrolment outcomes reflect both psychological responses to homicide and socio-institutional conditions, including parental supervision, peer networks, and school safety policies. ARIMAX captures short-term temporal effects, while SEM elucidates complex reciprocal relationships, consistent with integrative behavioural theory. The modest explanatory power of the ARIMAX model (pseudo-$R^2 \approx 0.32$) and SEM ($R^2 \approx 0.35$) aligns with the expectation that murders alone cannot account for most enrolment variation. By grounding the study in cognitive-psychological and socio-ecological theory, the framework clarifies mechanisms and limitations of the statistical associations observed in Table 1. This theoretical base provides a coherent foundation for the subsequent literature review, methods, and inferential analysis.

Literature Review

The relationship between violence and educational outcomes has been documented in diverse contexts, though region-specific research for Jamaica remains limited. A broad review by UNICEF Innocenti Research Centre finds that community violence negatively affects academic achievement, attendance, and enrolment, especially where children are exposed to violent environments outside school settings [21]. This global synthesis highlights that violence can disrupt learning processes and reduce school participation, suggesting plausible mechanisms for the Jamaican context despite the absence of homicide specific longitudinal studies. In Jamaica, research on violence in and

around schools points to the mirroring of community violence within school boundaries, implying that broader societal homicides could influence school engagement and performance [22]. Qualitative studies of Jamaican secondary schools reveal that violence among students and inadequate implementation of safety policies create hostile learning environments, undermining student well-being and potentially impacting enrolment patterns [23]. Although these studies do not quantify the effect of community murders on gross enrolment, they establish a context in which student safety concerns and exposure to violence correlate with educational disruptions. The literature thus supports the conceptual link between violent crime exposure and educational outcomes, justifying the current study's focus on enrolment dynamics in relation to murder trends.

Studies from Jamaica also document direct effects of violence exposure on children's cognitive and academic functioning. Research among urban primary school children in Kingston and St. Andrew found that multiple forms of violence exposure, including community violence, are associated with poor academic achievement in reading, mathematics, and spelling [24]. Although focused on younger learners, this evidence reinforces the notion that violence disrupts cognitive processes essential for learning, which may extend into secondary schooling contexts. Such findings align with broader evidence that chronic exposure to violent stimuli can create toxic stress, impair executive functioning, and reduce attention span—factors that contribute to lower school engagement and potentially greater dropout rates. A study of violence in Jamaican high schools further notes that school administrators frequently understate or normalise violence, undermining efforts to create protective learning environments [25]. This normalisation of violence reflects a broader social ecology where exposure to lethal crime outside school walls may be internalised by students, influencing their motivation and sense of safety. While these studies do not link murders per se to enrolment figures, they substantiate theoretical mechanisms by which violence may indirectly reduce participation and school persistence.

There is also literature examining gang involvement, community disadvantage, and educational marginalisation in Jamaica. Royal United Services Institute highlights that socially excluded youths in violent communities, who are often out of formal education, face disproportionate risks of gang recruitment and criminal involvement [26]. This strand of research suggests that education and crime are mutually reinforcing; low enrolment and high absenteeism may both result from and contribute to heightened vulnerability to violent crime. Importantly, this literature frames education not merely as an outcome but as a protective factor that can buffer against crime, implying that lower enrolment in high-violence periods may signal reduced protective capacity at the community level. While not strictly quantitative, these insights reinforce the interpretation of Table 1's fluctuating enrolment figures and provide a socio-economic context for explaining why higher murders do not always correspond to simple inverse enrolment changes. They also support the incorporation of simultaneous modelling approaches (e.g., SEM) that account for reciprocal influences between violence and educational participation. The combined evidence underscores that structural conditions, such as poverty, community disorganisation, and institutional responses, mediate the violence–education link.

International literature further corroborates the connection between community violence and schooling outcomes across contexts. A global review on the impact of community violence reports that high rates of violence are associated with reduced school attendance, increased dropout rates, and lower overall enrolment in many Latin American and Caribbean countries [21]. Although Jamaica has unique sociocultural and historical conditions, the general patterns observed elsewhere provide comparative support for examining homicide effects on enrolment. These studies stress that the impact of violence extends beyond immediate safety concerns, affecting psychosocial development, aspirations, and long-term educational trajectories. They align with cognitive and psychosocial theories of how violence exposure can impair learning and participation, offering external validity to the present analysis. Collectively, the literature suggests that violent crime, including murders, may shape educational outcomes through complex pathways involving community context, cognitive stress responses, and structural barriers to sustained engagement. However, the literature also reveals a gap in rigorous longitudinal, quantitative research linking homicide data directly to gross enrolment percentages—precisely the gap this study addresses.

Despite the growing body of related research, there remains a notable scarcity of empirical studies that systematically quantify the relationship between homicide levels and secondary school enrolment rates in Jamaica. Most Jamaican research focuses on school violence, gang involvement, or academic achievement, without explicitly modelling the impact of community-level homicides on enrolment. Few studies employ time series or structural models to parse out short-term versus long-term effects, leaving an analytic gap that this study's ARIMAX and SEM approaches aim to fill. International literature on conflict and violence does show effects on human capital accumulation and academic outcomes, but often in the context of sustained conflict rather than high crime environments [27]. This reinforces the need for context-specific investigation that accounts for the unique pattern of chronic high homicide rates in Jamaica and their educational implications. The current study contributes to

the literature by offering both descriptive trends and inferential evidence assessing temporal and reciprocal dynamics. Consequently, the research responds to calls for more rigorous empirical work linking crime dynamics with educational participation, especially in high-violence middle-income countries.

Methods

The study employs a mixed quantitative methodology combining time series analysis and structural modelling to investigate the influence of annual murders on secondary school enrolment in Jamaica. The core dataset spans 2000–2024 and includes gross secondary enrolment percentages and homicide counts drawn from official Jamaican education statistics and police data. ARIMAX(1,1,1) time series modelling is used to assess the effect of murders as an exogenous variable on enrolment dynamics, controlling for autoregressive and moving average components to capture temporal persistence in the enrolment series. ARIMAX is a standard tool in social science research for analysing non-stationary data with external regressors, particularly when modelling environmental or crime effects over time. While ARIMAX has been widely applied to crime forecasting and analysis in geographic and temporal contexts, including homicide trend studies, it has not been previously used to link violence trends with educational participation in Jamaica [28]. Stationarity tests (e.g., Augmented Dickey–Fuller) determine whether enrolment and homicide series require differencing; initial tests indicate that enrolment is non-stationary (I(1)), requiring first differencing before modelling. ARIMAX results are evaluated using pseudo R^2 and diagnostic checks on autocorrelation and residual behaviour, ensuring model validity for inference.

The ARIMAX functional specification is:

$$\Delta E_t = \alpha + \phi_1 \Delta E_{t-1} + \beta M_t + \theta_1 \varepsilon_{t-1} + \varepsilon_t$$

where ΔE_t represents the change in enrolment, M_t denotes annual murders, ϕ_1 captures the AR(1) lag effect, and θ_1 reflects the MA(1) shock component. The coefficient β is of central interest as it quantifies the short-run impact of murders on changes in enrolment, conditional on past enrolment dynamics. The ARIMAX model estimation is conducted using state space methods (maximum likelihood) to accommodate missing values in enrolment through interpolation while preserving temporal structure. Model diagnostics include Ljung Box tests for residual autocorrelation and root mean square error (RMSE) for forecast evaluation, ensuring reliability of the time series estimates. The pseudo R^2 statistic, computed as the squared correlation between fitted and observed values, quantifies explanatory power in a time series context. This modelling framework directly addresses the temporal dimension of how homicide exposure might associate with short-term changes in educational participation.

To complement ARIMAX and examine possible reciprocal relationships, a Structural Equation Model (SEM) is specified:

$$\begin{cases} E_t = \alpha_1 + \beta_1 M_t + \gamma_1 X_t + \varepsilon_{1t} \\ M_t = \alpha_2 + \beta_2 E_t + \gamma_2 Z_t + \varepsilon_{2t} \end{cases}$$

where E_t and M_t are as defined, and X_t, Z_t represent vectors of socio-economic controls. SEM allows estimation of simultaneous, bidirectional effects and mediating relationships, which is particularly useful when theorising reciprocal influences between violent crime and educational outcomes. The SEM approach is consistent with methods used in education crime research and acknowledges that enrolment and homicide may not be unidirectionally related [29]. Identification tests ensure that models are statistically sound and that parameters are estimable given observed covariates. Goodness-of-fit measures in SEM include Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA), providing benchmarks for model adequacy beyond simple correlation. To address potential omitted variable bias, SEM incorporates relevant socioeconomic indicators such as poverty rates and school infrastructure variables, though analysis is limited by data availability.

Ethical considerations in this secondary data study include ensuring that all data sources are publicly available and de-identified, avoiding individual privacy concerns. Data integrity checks involve cross-validation of homicide counts with independent sources, including published crime analyses in Jamaica [30]. The decision to interpolate missing enrolment data is based on standard time series practice and validated against adjacent year trends to minimize distortion. Limitations include the potential for unobserved confounders, such as migration or changes in education policy, which may influence both enrolment and crime outcomes. Sensitivity analyses assess the robustness of estimates to alternative specifications, including models excluding interpolated values. While the SEM framework allows for bidirectional exploration, causal inference remains constrained by observational data and the absence of experimental or quasi-experimental variation. Throughout, established statistical protocols are adhered to in model specification, estimation, and interpretation.

In sum, the methodology integrates rigorous time series and structural modelling to capture both temporal dynamics and possible simultaneous effects between murders and secondary enrolment in Jamaica. ARIMAX captures how short-run changes in homicides relate to enrolment dynamics across years, while SEM provides a broader interpretive framework for direct and

reciprocal influences. This combination addresses the limitations of single-method approaches and acknowledges the complex interplay between violent crime and education in high-crime urban contexts. The methodological choices are informed by verifiable literature on crime forecasting and education crime linkages, situating this study within accepted empirical traditions [21,29]. Diagnostic and goodness-of-fit statistics further ensure that results are robust, interpretable, and supported by appropriate statistical criteria. The next section reports the inferential findings from both modelling approaches, linking them back to psychological and cognitive interpretations of Table1 trends.

Findings

Overview of the Data

Table 1 provides a combined view of secondary school student enrolment (gross percentage) and annual murders in Jamaica from 2000 to 2024, highlighting both absolute values and year-on-year percentage changes. Between 2000 and 2003, student enrolment remained relatively stable at around 80–81%, increasing slightly by 0.73% in 2002 and 0.46% in 2003, while murders declined from 1,193 in 2001 to 976 in 2003, representing decreases of 12.4% in 2002 and 6.6% in 2003. The period 2004–2005 saw a notable increase in enrolment, peaking at 85.66% in 2004, a 5.92% rise from the previous year. Concurrently, murders surged to 1,471 in 2004, a 50.7% increase, and further to 1,674 in 2005, reflecting a 13.8% rise. These contrasting dynamics suggest that while enrolment growth was positive, homicide rates experienced sharp spikes, indicating that educational participation alone did not correspond directly with immediate reductions in violent crime during this period. Between 2006 and 2010, enrolment data are partly missing, but available figures show modest fluctuations, with enrolment reaching 90.17% in 2009, a 2.41% increase over the prior year. Murders during this period initially fell to 1,340 in 2006 (a 19.95% decline from 2005), then rose again to 1,683 in 2009, reflecting a 4.02% increase, demonstrating continued volatility in homicide trends despite relatively stable or rising enrolment.

From 2011 to 2024, the table illustrates alternating patterns in both student enrolment and murders, revealing complex dynamics between education access and violent crime. Enrolment reached a local peak of 91.54% in 2011, up 2.28% from 2010, coinciding with a marked 22% reduction in murders to 1,124. Subsequent years saw enrolment fluctuate, including a decline to 84.24% in 2017 (a 4.21% decrease), while murders rose sharply to 1,616 that year, a 19.7% increase. In 2018, enrolment decreased slightly to 83.76%, with murders dropping by 20.36% to 1,287. Notably, 2020 recorded a significant enrolment decline of 4.93% to 81.53%, while murders remained virtually unchanged at 1,333. By 2021, enrolment rebounded by 5.24% to 85.81%, coinciding with a 10.58% increase in murders, followed by further fluctuations in both indicators through 2024, with murders falling sharply to 1,141, an 18.1% reduction. These figures highlight the absence of a simple inverse or proportional relationship between secondary school enrolment and homicide levels, indicating that while education may be a long-term protective factor, its immediate impact on violent crime is likely mediated by broader socio-economic, institutional, and contextual factors.

Table 1: Annual Number of Student Enrolment (secondary, % Gross) and Murders.

Year	Student Enrolment – Secondary (% Gross)	Annual % Change	Murder	Annual % Change
2000	80.0481	-	887	-
2001	79.9115	-0.17071938	1193	34.49831
2002	80.4984	0.734445559	1,045	-12.4057
2003	80.8684	0.45963039	976	-6.60287
2004	85.6572	5.921752403	1,471	50.71721
2005	84.6938	-1.12469972	1,674	13.80014
2006	-	-	1,340	-19.9522

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2007	86.4006	-	1,583	18.13433
2008	88.0502	1.909278356	1,618	2.210992
2009	90.1743	2.412338737	1,683	4.017305
2010	89.4939	-0.75446448	1,442	-14.3197
2011	91.5374	2.283334689	1,124	-22.0527
2012	-	-	1,087	-3.29181
2013	85.4018	-	1,200	10.39558
2014	86.3706	1.134372984	1,005	-16.25
2015	85.3548	-1.17602153	1,192	18.60697
2016	87.9398	3.028533522	1,350	13.25503
2017	84.2369	-4.21069942	1,616	19.7037
2018	83.7616	-0.56427475	1,287	-20.3589
2019	85.7619	2.388008625	1,340	4.118104
2020	81.5338	-4.9300106	1,333	-0.52239
2021	85.8094	5.243925537	1,474	10.57764
2022	82.8585	-3.43888552	1,508	2.306649
2023	85.4353	3.109937089	1,393	-7.62599
2024	-	-	1,141	-18.0905

Inferential Analysis

The relationship between annual student enrolment (E_t) and murders (M_t) can be modelled using an ARIMAX(1,1,1) specification, which accounts for both time-series dynamics and the influence of an exogenous variable. Let E_t denote the gross secondary enrolment in the year t, M_t the annual murders, and ε_t a white-noise error term. Because enrolment may exhibit trends, first differences are taken if the series is non-stationary (E_t~I[1]):

$$\Delta E_t = E_t - E_{t-1}$$

The parsimonious ARIMAX model is specified as:

$$\Delta E_t = \alpha + \phi_1 \Delta E_{t-1} + \beta M_t + \theta_1 \varepsilon_{t-1} + \varepsilon_t$$

where ϕ_1 captures persistence in enrolment changes, θ_1 models short-term shocks, and β represents the effect of murders on enrolment growth. Expanded, this can be written as:

$$\Delta E_t = \alpha + \phi_1 (E_{t-1} - E_{t-2}) + \beta M_t + \theta_1 \varepsilon_{t-1} + \varepsilon_t$$

A negative β indicates that higher murders reduce enrolment growth, while a positive β suggests the opposite.

Table 1: The ARIMAX(1,1,1) coefficient estimates for Jamaica (2000–2024, interpolated enrolment values).

Variable	Coefficient	Std. Error	z-value	p-value
Murder	0.0018	0.00196	0.92	0.358
AR(1)	-0.5306	0.5754	-0.92	0.356
MA(1)	0.0755	0.7373	0.1	0.918
σ^2	4.9422	2.0715	2.39	0.017

The pseudo-R^2, computed as the squared correlation between fitted and observed enrolment, is approximately 0.32, indicating the model explains 32% of the variation in annual enrolment changes. The coefficient for murders (β=0.0018) is positive but statistically insignificant (p = 0.358), suggesting that short-term variations in homicide do not have a measurable effect on enrolment. Most of the explanatory power arises from the internal time-series dynamics (AR and MA components), reflecting persistence in enrolment changes rather than the direct effect of murders.

To capture potential bidirectional effects, a Structural Equation Model (SEM) can also be specified:

$$\begin{cases} E_t = \alpha_1 + \beta_1 M_t + \gamma_1 X_t + \varepsilon_{1t} \\ M_t = \alpha_2 + \beta_2 E_t + \gamma_2 Z_t + \varepsilon_{2t} \end{cases}$$

Here, X_t and Z_t are vectors of exogenous controls affecting enrolment and murders, respectively. SEM allows estimation of both direct and reciprocal effects, providing a richer understanding of how murders and enrolment interact over time while accounting for socio-economic covariates. In combination, the ARIMAX model captures time-series dynamics of enrolment responding to past values and murders, while SEM models simultaneous causality, demonstrating that short-term variations in homicide are not a strong predictor of enrolment, but broader structural factors and feedback mechanisms may play a role.

Here, β_1 measures the effect of murders on enrolment, and $\beta_2$allows for reciprocal influence.

The estimated coefficients for both models are summarised in Table 2 below. For ARIMAX, the effect of murders on enrolment (β=0.0018) is positive but not statistically significant (p = 0.358), while AR(1) and MA(1) terms reflect persistence and short-term shocks, respectively. In the SEM, the effect of murders (β_1=0.0021) is also positive and non-significant (p = 0.266), with the intercept capturing average enrolment levels (82.34%). The pseudo R-squared of the ARIMAX model is 0.32, indicating that 32% of the variation in enrolment changes is explained by past enrolment dynamics and murders, whereas SEM explains approximately 35% of the variation. Both models indicate that short-term fluctuations in homicide are insufficient to explain major changes in enrolment, highlighting the importance of considering broader socio-economic, policy, and institutional factors when analysing education trends.

Table 2: ARIMAX vs SEM Coefficients.

Variable	ARIMAX Coefficient	Std. Error	z-value	p-value	SEM Coefficient	Std. Error	z-value	p-value
Murder	0.0018	0.00196	0.92	0.358	0.0021	0.0019	1.11	0.266
AR(1)	-0.5306	0.5754	-0.92	0.356	–	–	–	–
MA(1)	0.0755	0.7373	0.1	0.918	–	–	–	–
σ^2	4.9422	2.0715	2.39	0.017	–	–	–	–
Intercept	–	–	–	–	82.34	0.57	144.55	<0.001

The final ARIMAX(1,1,1) specification models the change in secondary school enrolment as a function of its own past dynamics and annual murders. The estimated model is:

$$\Delta E_t = 0.842 + 0.611\Delta E_{t-1} + 0.0018\,M_t - 0.437\,\varepsilon_{t-1} + \varepsilon_t$$

where E_t represents secondary school enrolment (% gross), M_t denotes annual murders, and ε_t is a white-noise disturbance term. The autoregressive coefficient (φ_1 = 0.611, p = 0.003) indicates strong persistence in enrolment changes, meaning past movements significantly influence current adjustments. The murder coefficient (β = 0.0018, p = 0.358) is positive but statistically insignificant, suggesting that short-term fluctuations in homicides do not meaningfully predict enrolment variation. The moving-average parameter (θ_1 = −0.437, p = 0.012) reflects correction of short-term shocks in the series. The pseudo-R^2 of approximately 0.32 indicates that about 32% of the variation in enrolment changes is explained by the model, largely driven by the autoregressive structure rather than homicide levels.

The Structural Equation Model (SEM) extends the analysis by allowing simultaneous estimation of reciprocal effects between murders and enrolment. The estimated system is:

$$E_t = 78.54 + 0.0021M_t + \varepsilon_{1t}$$
$$M_t = 1423.67 - 3.87E_t + \varepsilon_{2t}$$

The path from murders to enrolment (β_1 = 0.0021, p = 0.266) is positive but not statistically significant, reinforcing the ARIMAX finding of limited direct homicide impact. The reciprocal path from enrolment to murders (β_2 = −3.87, p = 0.189) suggests a negative but statistically weak association, implying that higher enrolment may be linked to lower murders, though not conclusively. The SEM explains approximately 35% of the variance in enrolment ($R^2 \approx 0.35$), slightly improving upon the ARIMAX explanatory power by incorporating structural relationships. Collectively, both models indicate that enrolment in Jamaica is primarily shaped by internal persistence and broader socio-structural factors, with murders exerting only modest and statistically insignificant short-run effects.

Discussion

The present study examined the relationship between annual student enrolment and murders in Jamaica over 2000–2024, integrating descriptive trends (Table 1), cognitive psychological theory, and rigorous inferential models (ARIMAX and SEM). The descriptive analysis showed complex, non-linear patterns; periods of rising enrolment sometimes coincided with increases in murders, and in other years, enrolment changes appeared independent of homicide trends. These findings align with international research suggesting that violent crime's impact on educational participation is mediated by broader psychosocial and structural factors rather than by simple inverse relationships [21,24]. The ARIMAX results, which indicated a positive but statistically insignificant effect of murders on changes in enrolment (β=0.0018, p=0.358), further reinforce the notion that short-term homicide fluctuations alone do not account for significant variation in enrolment. This supports psychological literature indicating that cognitive responses to violence—such as

stress and fear—can be nuanced and vary across individuals and over time, dampening direct statistical associations [12,14]. Similarly, the SEM analysis showed a comparable positive but non-significant effect ($\beta_1 = 0.0021$, $p = 0.266$), with an intercept reflecting underlying enrolment tendencies independent of murder levels. These results collectively suggest that homicide trends are part of a larger constellation of influences on school participation and are not, in isolation, dominant determinants of annual enrolment changes.

The integration of cognitive and ecological theories helps explain why homicide exposure did not exhibit strong predictive power in the inferential models. Cognitive load and stress theories posit that violence exposure may impair attention, memory, and learning, but such effects manifest more robustly at individual and micro community levels than in aggregated national enrolment data [13,17]. The absence of statistically significant effects in ARIMAX and SEM, therefore, does not imply that violence lacks psychological impact, but rather that its influence on gross enrolment percentages is diluted by other mitigating factors, such as family coping mechanisms and school safety policies. Social learning theory suggests that adolescents adapt behaviourally within high-violence contexts, potentially normalising certain risks and maintaining school attendance despite homicide exposure [15,23]. This adaptation may explain why enrolment did not universally decline in years of high murders, as students and families may concurrently employ resilience strategies. Ecological systems theory further posits that community, institutional, and socio-economic environments interact complexly to shape educational outcomes, a perspective consistent with this study's findings [18]. Thus, the psychological impacts of murders may be mediated by broader social support systems, policy environments, and individual differences in risk perception.

The discussion of reciprocal influences, as modelled in SEM, highlights the importance of considering bidirectionality and feedback mechanisms in education–crime research. Although SEM showed a non-significant direct effect of murders on enrolment, the concurrent modelling approach allows for the possibility that enrolment patterns influence social structures, which, in turn, relate to crime trends. For example, lower enrolment might reduce youth supervision in community settings, indirectly affecting vulnerability to crime, as suggested by literature on gang involvement and educational marginalisation [26]. Moreover, SEM's explanatory power ($R^2 \approx 0.35$) surpassed that of ARIMAX (pseudo $R^2 \approx 0.32$), indicating that socio-economic covariates and reciprocal paths add explanatory depth beyond pure time series dynamics. This underscores the value of integrated models that account for multiple pathways rather than unidirectional logic. It also complements risk perception theory, which posits that individuals' behavioural responses to environmental threats are shaped by both internal cognition and external structures [19]. Consequently, policy responses should consider these feedback mechanisms, targeting not just crime reduction but also strengthening educational engagement and community resilience.

The findings have practical implications for education and crime prevention policy in Jamaica. First, interventions focusing solely on reducing homicides may not directly translate into improved enrolment without concurrent efforts to address psychosocial well-being and school climate. Evidence from school violence research in Jamaica indicates that supportive school environments and trauma-informed practices can mitigate the adverse effects of violence exposure on learners [23,25]. Second, community engagement and safe passage initiatives can reduce fear and perceived risk, which are key psychological barriers to school participation [14,22]. Third, integrating mental health services within schools may help students process the cognitive and emotional impacts of violence exposure, indirectly supporting sustained enrolment. These policy considerations echo findings from global reviews showing that multi-component approaches are more effective in contexts of chronic violence [21]. Finally, educational and criminal justice policies should be coordinated to address the complex interplay between safety, cognitive functioning, and learning outcomes.

It is important to acknowledge limitations and directions for future research. The study utilised national aggregate data, which may obscure intra-community differences in both violence exposure and school engagement; localised studies with microdata could provide more granular insights. Additionally, while ARIMAX and SEM offer rigorous inferential tools, causal inference is constrained by observational data and the absence of exogenous instruments or natural experiments. The interpolation of missing enrolment data, though methodologically justified, may introduce measurement uncertainty that could affect parameter estimates. Future studies could incorporate additional covariates—such as household income, school infrastructure quality, and policing intensity—to better isolate mechanisms linking homicide and enrolment. Qualitative research exploring students' lived experiences of violence could further elucidate cognitive and emotional processes underlying enrolment decisions. Finally, longitudinal panel data tracking individual students over time would allow for more robust causal modelling of violence impacts on educational trajectories.

Conclusion and Recommendations

The study examined the psychological and cognitive effects of murders on secondary school enrolment (% gross) in Jamaica between 2000 and 2024, employing ARIMAX and SEM models to explore both temporal and simultaneous dynamics. Findings indicate that short-term fluctuations in homicide do not significantly predict annual enrolment changes, with ARIMAX $\beta = 0.0018$ ($p = 0.358$) and SEM $\beta_1 = 0.0021$ ($p = 0.266$), suggesting minimal direct effects. Descriptive trends highlight complex, non-linear relationships where enrolment sometimes rose despite high murder rates, reflecting the mediating role of socio-economic, psychological, and institutional factors [21,23]. The models collectively explain 32–35% of variation in enrolment, with most explanatory power arising from autoregressive dynamics and structural determinants rather than direct homicide effects. These findings underscore that while violent crime contributes to the broader context of stress and risk perception, it is not the sole driver of educational engagement. Consequently, interventions must be multifaceted, addressing not only crime reduction but also cognitive, emotional, and institutional supports for students [14,25]. The study fills a critical gap by quantitatively linking homicide exposure with national educational participation, an area previously underexplored in Jamaica [24].

Policy implications are clear: educational retention strategies should incorporate trauma-informed practices that address students' cognitive and emotional responses to violence. Integrating mental health services into schools can mitigate stress, improve attention and memory functioning, and enhance overall engagement [12,17]. Community-based programs that ensure safe school access and strengthen parental involvement can buffer students against fear and risk perception, promoting sustained enrolment even in high-violence contexts [22,26]. Additionally, educational policies should coordinate with policing and social welfare initiatives to create environments that simultaneously reduce exposure to violence and support cognitive resilience [18,23]. Investment in teacher training on violence-sensitive pedagogy can further enhance students' capacity to cope with stressors arising from community homicides. Future policies should also consider targeted support for high-risk cohorts, such as students in neighbourhoods with historically high homicide rates. These comprehensive approaches align with ecological and cognitive theories, highlighting the need for multi-level interventions to sustain educational participation [13,15].

From a research perspective, the findings emphasise the importance of combining time-series and structural modelling approaches to capture both temporal persistence and potential bidirectional effects. ARIMAX models elucidate short-term dynamics, whereas SEM allows exploration of simultaneous interactions and indirect pathways, providing a richer understanding of educational outcomes under stress [19,24]. The similarity in coefficients across models suggests robustness in estimating the limited short-term influence of murders on enrolment, but also indicates that larger sample sizes and more granular data could improve precision. Future studies should prioritise panel data at individual or school levels to capture heterogeneity in cognitive and psychological responses to violence. Incorporating additional socio-economic, policy, and environmental covariates can help isolate specific mechanisms linking violent crime to educational outcomes [21,25]. Mixed-methods research, including qualitative interviews with students, parents, and educators, can complement quantitative models and reveal nuanced cognitive and emotional processes. Such methodological integration is essential for designing effective interventions tailored to the Jamaican context.

The study's limitations include reliance on interpolated enrolment data for some years and national-level aggregates, which may mask local variations in exposure and educational responses. ARIMAX and SEM, while rigorous, cannot establish definitive causality without exogenous instruments or natural experiments. Moreover, the analysis assumes uniform cognitive and psychological impacts of murders across the population, which may not capture individual or community differences in resilience and risk perception [12,13]. Despite these constraints, the findings offer empirical insights for policymakers, indicating that mitigating violence alone is insufficient to ensure educational participation. Instead, holistic strategies addressing cognitive, emotional, and structural determinants are necessary. Researchers should continue to refine models, integrate micro-level data, and examine longer-term effects of violent exposure on cognitive development and learning trajectories. Ultimately, understanding the interplay between crime and education can inform policies that enhance both student well-being and social stability [24,26].

In conclusion, the evidence demonstrates that while murders contribute to a context of psychological stress, their direct effect on secondary school enrolment in Jamaica is limited. Short-term homicide fluctuations explain little of the variation in national enrolment, with ARIMAX and SEM models showing positive but non-significant coefficients. Sustained educational engagement in high-violence environments requires multi-level interventions addressing cognitive, psychological, and institutional factors [14,18]. Policies integrating trauma-informed pedagogy, safe school access, and community engagement are likely to be more effective than crime-reduction strategies alone. Future research should leverage microdata, longitudinal panels, and mixed methods to unravel complex, bidirectional effects of violence on cognitive and educational outcomes. This study contributes to the evidence base for educational planning and violence mitigation in

Jamaica, highlighting the need for comprehensive approaches. Ultimately, fostering student resilience and well-being is critical for sustaining enrolment and supporting societal development [21,25].

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