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Using Path Analysis to Estimate Self-inflicted Crimes in Period 2011–2018

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Abstract*: This study aimed to find out the extent of self-inflicted crimes using path analysis. As criminal statistics are one of the most common means of studying the criminal phenomenon and as a tool that reflects a true picture of the criminal situation in any population, by the logic that there is a close relationship between some crimes and their connections to each other, we find that there are a number of variables that represent self-inflicted crimes, which led us to use the method of path analysis model as one of the structural equation models applying to criminal crimes in Sudan, AMOS package was use in analysis data that collected from annual reports of the ministry of interior. The study concluded with several results, including that the path coefficients calculated using correlation coefficients are identical with the path coefficients computed from the regression, and that there is a direct and significant effect of terrorism and attempted murder, and using all criminal force on the murder crime, and there was indirect and significant effects through miscarriage and harm on the crime of murder. The study recommended that the state and those in charge of the matter work to prevent crime to limit its spread by extending the prestige of the law through horizontal spread to the police forces.*

Keywords: Causal Relationships, Path Analysis, Structural Equation Modeling, Murder, Goodness of Fit.

Introduction

Man has known crime since the dawn of humanity, since Abel and Cain, when the first murder in human history took place, and the more the means and methods of crime were multiplied, such as murder, theft, fraud, armed robbery, or terrorism, the more developed the means of detecting it [(1)]. A crime is defined as an act or omission to do something stipulated by law, and the perpetrator is punished with a criminal penalty. As for the crime, from the legal point of view, it is an illegal act resulting from a criminal will, and the law determines a penalty for it, while the crime from the social point of view is an act that violates the moral foundations that were established by the group, and the group made its penetration into an official penalty. This includes any breach of the group's system, harm to the interests or rights of individuals, or prejudice against values. In the general sense, it is every behavior that is socially punishable, and a crime is considered, in the legal sense, every violation of the rules of positive law in force, whether these rules are related to criminal law or other laws [(2)].

Research problem: The problem with the research lies in that crime is a threat to the security and safety of any society, and crime poses a great danger due to the negative consequences that it leaves behind and its devastating effects on human and social aspects at the level of the individual, family, and society. Address it by all possible means to reduce its destructive effects on society. Therefore, the problem of the study is represented by the following questions:

- Are the crimes of terrorism, attempted murder, and criminal force among the crimes that lead to murder?
- Does the crime of terrorism, the crime of attempted murder, and the crime of criminal force lead to murder through both harm and miscarriage?

Research importance: The importance of this research stems from the fact that it describes and analyzes a dangerous phenomenon, which is the criminalization of oneself, and that it has become a threat to the individual, society, and family, and has shown a significant increase due to several political, economic, and social factors. This research aims to use the complete cascade causal system for multi-response descriptive variables by using path analysis with conditional probability to describe the causal system for the classified variables and to explain those effects using the rules of the path analysis model as one of the structural equation models for estimating criminal crimes against oneself (terrorism, criminal force, attempted killing, harm, abortion) that leads to murder by applying to criminal data in Sudan.

Research objective: The main objective of preparing this research is to trace the path analysis of the crime of murder as one of the criminal crimes against the soul and the crimes that cause it, as they do not come out of the circle of crimes against the self, such as terrorism, criminal force, and attempted murder. Using the path analysis model as one of the structural equation models to estimate criminal crimes against oneself and matching the proposed model to the research data, introducing the methodology of the path analysis model and its characteristics and scientific foundations, and knowing its theoretical requirements, in addition to arriving at the form of direct and indirect relationships between the study variables as illustrated by the statistical model proposed.

Research hypotheses: This research is based on a number of hypotheses that the researcher hopes to verify their validity, which are:

1- There is a statistically significant relationship between the variables of the study observed among them.
2- There is a statistically significant relationship between the external variables and the dependent variable.
3- The proposed model matches the data of crimes against the self-inflicted.

Research Methodology: The data conducted from ministry of interior in Sudan deal to crimes of self-inflicted from 2001 up to 2018 to study the path analysis and to determine the affecting of more external variables which direct and indirect affected on the crime of murder such as: attempted murder, terrorism, miscarriage, harm and criminal force, a coupled with the analysis, interpretation, and explanation of the theoretical data in order to arrive at scientific results that can be used in the application and use of this methodology, the evaluation of the relative importance of the independent variables in determining or explaining the total differences of the dependent variable becomes clear when it is studied within the framework of path analysis, and the researcher uses this method because it is appropriate in achieving the goals studied.

Literature review:

1-Path analysis:

The path analysis model can be applied as one of the structural equation models to estimate criminal crimes through a set of steps (3) and (4) and can be summarized as follows:

1. Build a causal model.
2. Create a pattern for the relationship between the variables in order.
3. Draw a schematic model for the path of relationships between the variables.
4. Calculation of path coefficients.
5. Goodness of fit test with the basic model.
6. Analysis and interpretation of results.

The model can be determined by equation [(5)]:

$$Y = p_{y1}x_1 + p_{y2}x_2 + p_{yu}u \quad \text{.....(1)}$$

Whereas the variables are variables that follow the standard normal distribution, and they are the path coefficients, and their value is equal to the standard regression coefficients [(10)].

This means that

$$p_{yi} = \beta_i \frac{\sigma_1}{\sigma_y} \quad \text{.....(2)}$$

And the path coefficients for the residuals are:

$$p_{yu} = \frac{\sigma_u}{\sigma_y} \quad \text{.....(3)}$$

To analyze causal models, there are two methods that lead to the same result in most cases, they are [(6)] The Tracing Rule

This rule is applied in sequential or repeated models only. The rule shows that the correlation between two variables is equal to the sum of the product of the possible path coefficients from the external variable $(x_j x_i)$ to the internal variable (x_i) and according to (xj) the following two conditions [(7)]:

a. One variable is not entered twice.
b. The variable does not enter through the head of the arrow but in the direction of the arrow.

Using the traceability rule to analyze equation (1), it results in:

$$r_{y1} = p_{y1} + p_{y2}r_{12} \quad \text{.....(4)}$$

$$r_{y2} = p_{y1}r_{12} + p_{y2} \quad \text{.....(5)}$$

$$r_{yu} = p_{yu} \quad \text{.....(6)}$$

By solving equations (4) and (5) simultaneously, we get the values of the path coefficients ($p_{y2}p_{y1}$), while the value of (p_{yu}) is calculated indirectly after estimating the values of all the path parameters as follows:

$$p_{yu} = (1 - R^2))^{1/2} \quad \text{.....(7)}$$

whereas:

R^2 is the coefficient of determination, which is equal to:

$$R_{Y(12)} = \text{cov}(Y,Y) = \text{cov}[Y, P_{Y1}X_1 + P_{Y2}X_2]$$

$$\therefore R^2 = p_{y1}r_{1y} + p_{y2}r_{2y} \quad \text{……..(8)}$$

where:

$E(x2,u) = 0 \quad E(x1,u) = 0$ From the assumptions of the simple linear regression model (8) and to prove equation (7), we extract the correlation of Y with itself (11), (12), and we get:

$$r_{yy} = p_{y1}^2 + p_{y2}^2 + 2p_{y1}p_{y2}r_{y1} + p_{yu}^2 \quad \text{……..(9)}$$

And since equation (9) is equal to its value of one, then

$$\therefore 1 = (p_{y1}^2 + p_{y2}^2 + 2p_{y1}p_{y2}r_{12}) + p_{yu}^2$$

$$\therefore p_{yu}^2 = 1 - (p_{y1}^2 + p_{y2}^2 + 2p_{y1}p_{y2}r_{12})$$

$$\therefore p_{yu} = \{(1 - R^2)\}1/2$$

$$\therefore R^2 = p_{y1}^2 + p_{y2}^2 + 2p_{y1}p_{y2}r_{12} \quad \text{……(10)}$$

It is equal to equation (8) after substituting for ($r_{2y}\, r_{1y}$) with their equivalent equations (4) and (5).

2- Structural Equation Modeling Theory for Basic Path Analysis:

He is [13] considered the first to give the name of the basic theory, and he relied on the application of the theory to verify the hypothesis that the residuals (ε) are not associated with any of the external variables [14].

The theorem was used to estimate the coefficients for the path and the possibility of segmenting the simple correlation between any two variables in the causal model according to the following equation:

$$r_{iy} = \sum_j r_{ij}\, p_{yi} \quad \text{…….(11)}$$

To prove the theory, we use the following general linear regression equation:

$$Y = XB + \text{E} \quad \text{…….(12)}$$

We get the estimated values of the regression coefficients using the least squares method as follows:

$$\Rightarrow \hat{\beta} = (X'X)^{-1}X'Y \quad \text{……(13)}$$

When using standard variables:

$$E(x,y) = x'y$$

$$(x'x) = E(x)^2 \quad \text{……(14)}$$

We assume that (σ_{iy}) is the i element in the vector ($x'y$), and that it is the (i,j) element in the matrix ($X'X$), then equation (13) [15] can be written as follows:

$$\sigma_{iy} = \sum_j \sigma_{ij} B_J \quad \text{…….(15)}$$

Since the covariance is ($\sigma_{ij}\sigma_{iy}$), it can be written as follows:

$$\sigma_{ij} = r_{ij}\sigma_i\sigma_j \quad \text{.....(16)}$$

$$\sigma_{iy} = r_{ijy}\sigma_i\sigma_y \quad \text{…...(17)}$$

Substituting it into equation (15), we get:

$$r_{ij}\sigma_i\sigma_y = \sum_j r_{ij}\sigma_i\sigma_j\beta_J \quad \text{……(18)}$$

Or in other words [16]:

$$r_{iy} = \sum_j r_{ij} \beta_J \frac{\sigma_i}{\sigma_j}$$

$$r_{iy} = \sum_j r_{ij} p_{yi}$$

$$p_{yi} = B_J \frac{\sigma_i}{\sigma_j} \qquad \text{…….(19)}$$

3- Indicators of good fit:

When using path analysis, the researcher is usually interested in the suitability of the theoretical model that he proposes to the real and observed data that he obtains. To do this here, it is called "good fit indicators," which are defined as statistical or descriptive indicators that determine a value that helps the researcher determine the quality of his model and its conformity with the data [(3), (9), (17),] and the most .

The importance of these indicators, as in Table No. (1)

cutting edges	Pointer
3≤	χ^2 chi- square
0.95≥	NFI Normed Fit Index
0.90≥	IFI Incremental Fit Index
0.90≥	TLI Tucker-Lewis Index
0.90≥	CFI Comparative Fit Index
0.08≤0.05	RMSEA Root Mean Square Error of Approximation

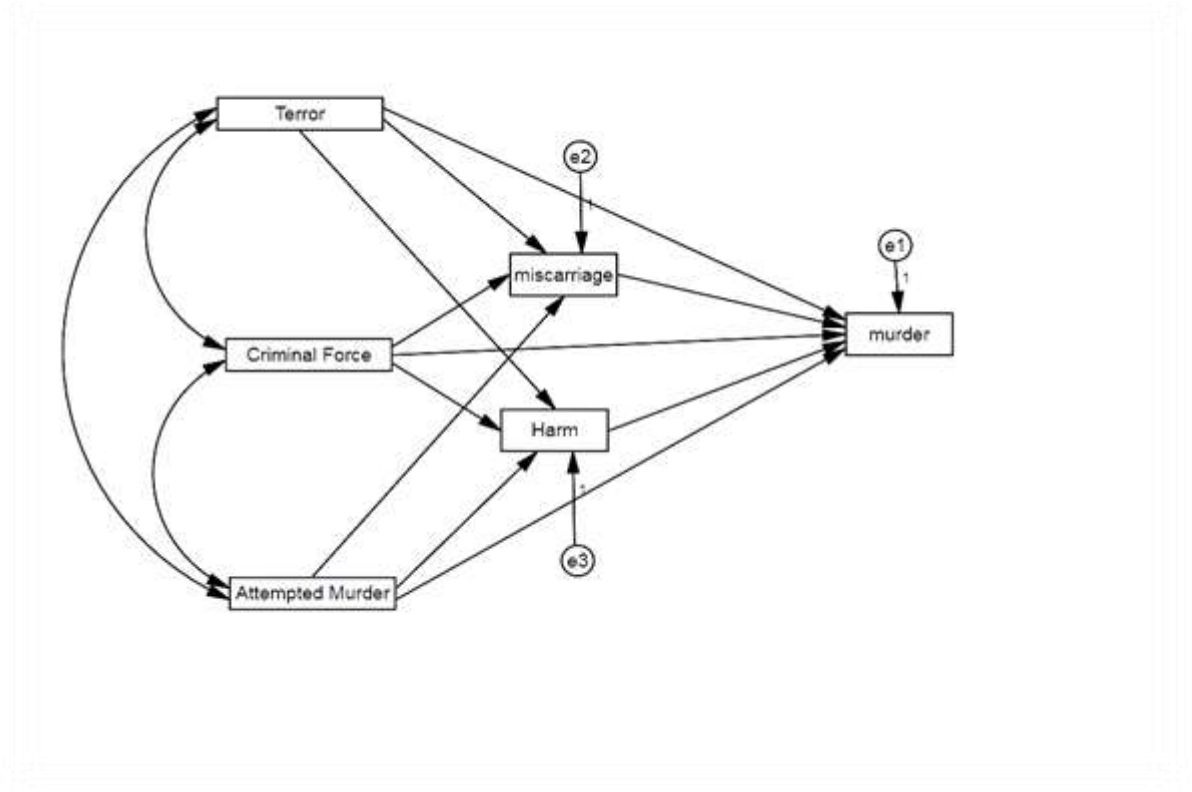

Figure No. (1) The proposed path analysis model for the studied variables

Figure No. 1 shows an illustration of the study variables as a model proposed by the researcher to clarify the interactions between the study's external variables and the dependent variable and to identify the paths for all those variables, as the arrowhead shows the effect of the external variable or mediator on the dependent variable.

The strategy of building and developing the model is based on the priority of the model and on the assumption that the researcher begins to formulate the initial model, which is based on the theory of knowledge and the extent to which the model matches the data. Find the best model; it is the model that has a theoretical explanation and is characterized by simplicity, and its credibility is achieved through other samples.

Terms used:

External variables:

It means those variables for which we do not attempt to explain their variance or the internal causal relationships that exist between them in the proposed model, or those variables whose differences are determined by variables outside the scope of the causal model.

internal variables:

They are those variables whose variance can be explained given the external and other internal variables.

residual variables:

The rest is the random error that indicates the effect of variables that cannot be measured and are contained explicitly in the causal model but are measured indirectly.

Figure No. 2 is a hypothetical path analysis model for the studied variables.

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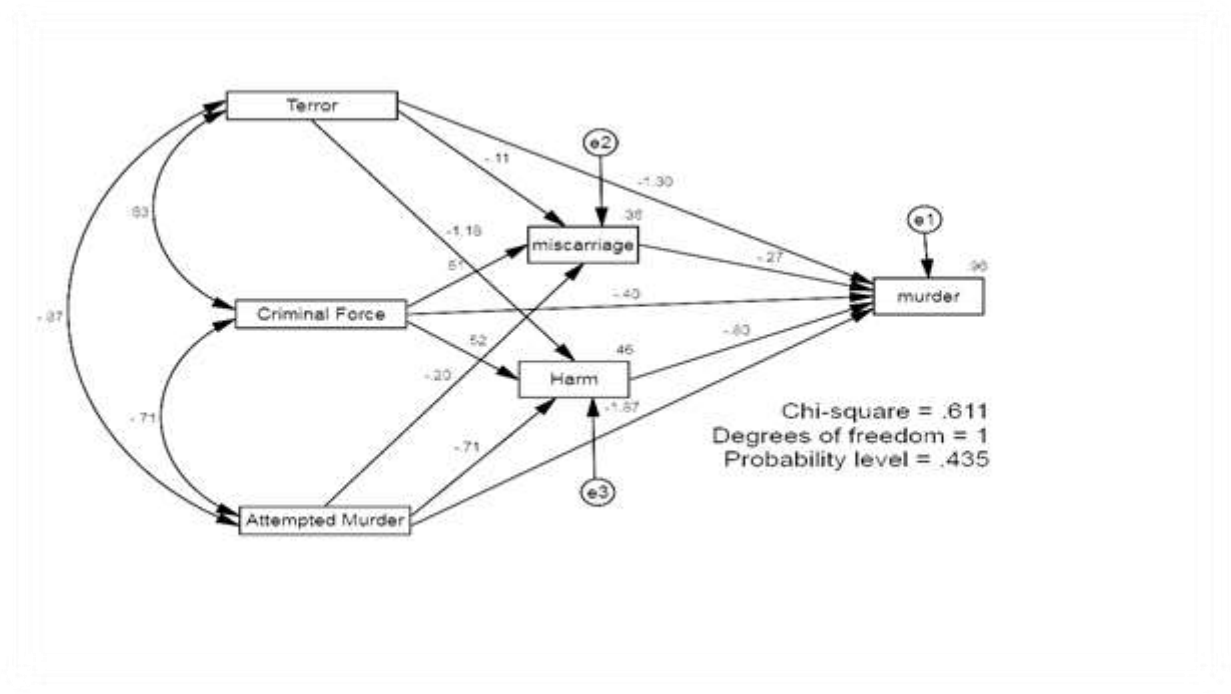

Figure No. 2 is a hypothetical path analysis model for the studied variables.

Figure (2) shows the assumed model of the problem, which is represented in the interactions and interdependence between those variables on the basis of which the model was built, and that the aim of this model is to know the reasons that lead to a very large criminal crime, such as the crime of murder, where we note that there are variables that have direct effects on the crime of murder, such as the terrorism variable, the criminal force variable, and the attempted murder variable, while there are variables that play the role of mediator, which in turn leads to murder, and they are the variables of abortion and harm.

After conducting the analysis on the data and drawing the direction of the trajectories for the variables, it was concluded that the value of any square ($\chi^2 = 0.611$) with a degree of freedom equal to 1 and a level of significance ($P = 0.435$), which indicates the existence of a relationship between the study variables, or in other words that the variables represent a linear relationship among them.

Table (2) ANOVA

s.o.v	Sum of Squares	d.f	Mean Square	F	Sig.
Between Groups	20296351530.417	5	4059270306.083	878.318	0.000
Within Groups	194109017.500	42	4621643.274		
Total	20490460547.917	47			

Table (2) shows how significant the model is and whether there is a statistically significant relationship between the observed study variables, and since the F-value amounted to (878.318) with a probability value of (0.000), which is less than the level of significance ($\alpha = 0.05$), this means that there is a relationship between the study variables. Watching each other.

Table (3) Regression Weights

variable	path	variable	Estimate	S.E.	C.R.	P.value	Interpret
miscarriage	<---	Terror	-.001	.004	-.177	0.859	Non function
Harm	<---	Terror	-.572	.272	-2.102	0.036	function
Harm	<---	Power	.386	.293	1.317	0.188	Non function
miscarriage	<---	Power	.005	.004	1.190	0.234	Non function
Harm	<---	Getting started	-10.351	8.999	-1.150	0.250	Non function
miscarriage	<---	Getting started	-.037	.124	-.299	0.765	Non function
Murder	<---	miscarriage	-.021	.031	-.690	0.490	Non function
Murder	<---	Harm	-2.543	1.028	-2.474	0.013	function
Murder	<---	Getting started	-.100	.033	-2.976	0.003	function

Table(3) shows the relationship between the variables and the value of the estimated parameter, the estimate of the standard error and the critical ratio that represents the product of dividing the estimated parameter by the standard error and the probabilistic value of each relationship, where we note that the relationship between the mediating variable represented in the harm variable and the external variable represented in the terrorism variable is weak and that It is statistically significant, which means that terrorism leads to harm and thus to murder. As for the effect of all variables (intermediate variables and exogenous variables) on the dependent variable, we note that the relationship was significant between killing as a dependent variable and harm and abortion as mediating variables and between each of the attempts. In the case of studying the mediating roles of both abortion and harm as intermediate variables, we note that the relationship between attempted murder and criminal force and terrorism using the mediating variable abortion is a relationship that has no statistical significance, which means that this variable has no mediating role in mediating the relationship between attempted murder, criminal force and terrorism to kill, and that the harmful variable has only a mediating role with terrorism in mediating the relationship with It prohibits murder and has no role in both attempted murder and criminal force and murder.

Table (4) Correlations:

variable	correlation	variable	Estimate
attempted murder	<-->	criminal force	-0.71
criminal force	<-->	Terror	0.63
attempted murder	<-->	Terror	-0.87

Table(4) shows that the relationship among the external variables among themselves is one of the relationships on which the model is built, where we note that the relationship between criminal force and attempted murder amounted to -0.71 and this relationship indicates that it is an inverse relationship, as the greater the force, the more This resulted in a 71% decrease in attempted murder. As for the relationship between terrorism and criminal force, it reached 0.63, which is a direct relationship, meaning that the more terrorism increases, this leads to an increase in criminal force by 63%, and with regard to the relationship between terrorism and attempted In terms of murder, we can see that there is an inverse relationship between them, which means that as terrorism rises, so does attempted murder, with its value reaching 87%.

Table (5) Standardized Total Effects

Variable	attempted murder	attempted murder	Terror	Harm	Miscarriage
Harm	-10.351	0.386	-0.572	.000	0.000
miscarriage	-0.037	0.005	-0.001	0.000	0.000
Murder	-2.543*	-0.100*	-0.021*	*-0.113	-3.001*

* The test value is significant at the level of significance0.05

Table (5) shows the normative effects of the external variables and their impact on the dependent variable in the presence of intermediate variables, as we can see that each of the external variables (attempt to kill, criminal force, terrorism) has a significant relationship on the dependent variable of murder. The case for the intermediate variables (harm and abortion) having a significant relationship with murder, but we note that abortion is the most influential variable on the crime of murder, followed by attempted murder and then harm in terms of the overall effect on the crime of murder, then the crime of criminal force, and finally the crime of terrorism.

Table (6) Standardized Direct Effects

variable	attempted murder	attempted murder	Terror	Harm	miscarriage
Harm	−.714	.519	*−1.185	.000	.000
miscarriage	−.203	.513	−.109	.000	.000
Murder	*−1.875	*−0.399	*−1.297	*−.803	*−.268

* The test value is significant at the level of significance0.05

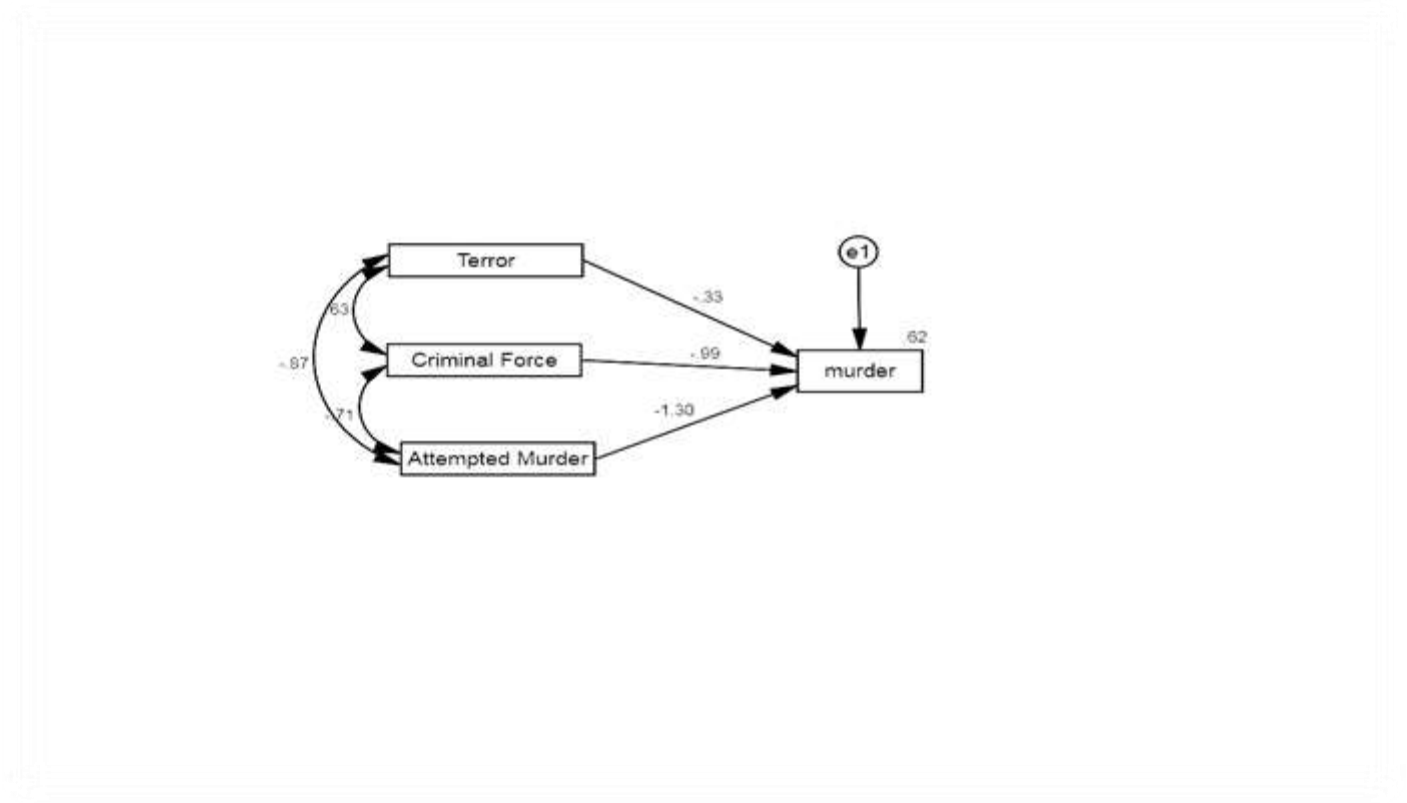

Figure (3) Standard direct effects model

From Table (6) and Figure (3), which show the direct effects of the external variables on the dependent variable murder without the presence of a mediator for any other variable, we note that these direct effects between the external variables (terrorism, criminal force, and attempted murder) are moral and significant effects. Statistics on the dependent variable (the kill)

Table (7) Indirect Effects

Variable	attempted murder	attempted murder	Terror	Harm	miscarriage
Harm	0.000	0.000	0.000	0.000	0.000

miscarriage	0.000	0.000	0.000	0.000	0.000
Murder	1.280	-0.058	*0.067	0.000	0.000

* The test value is significant at the level of significance0.05

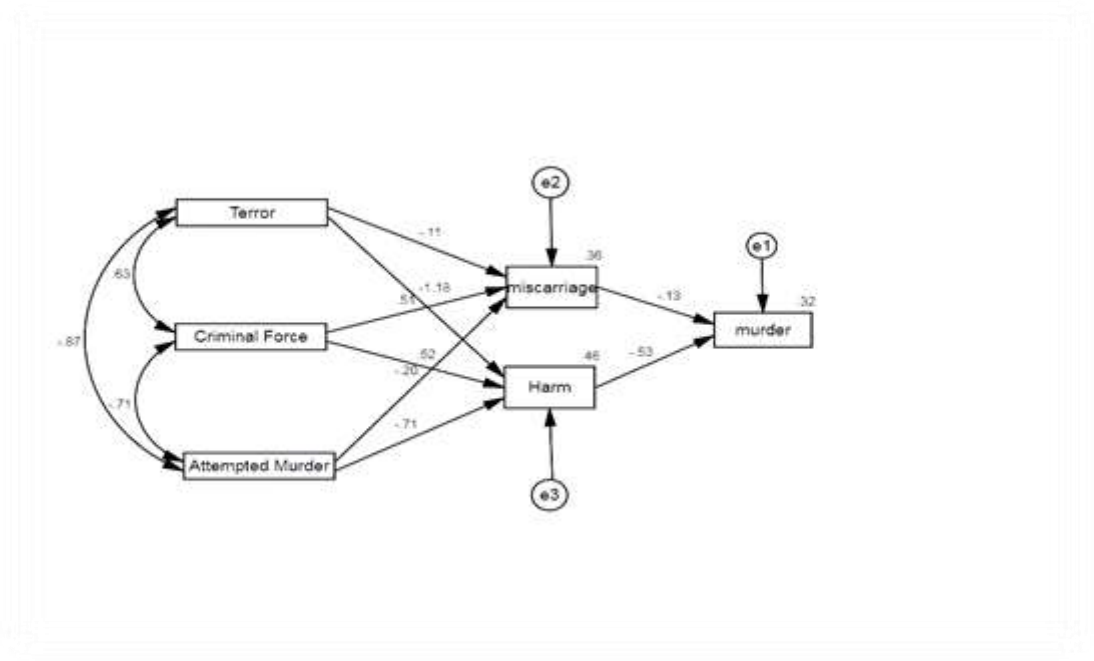

Figure (4) Indirect Effects

Table (7) and Figure (4) show the standard indirect effects of the external variables on the dependent variable, where we note that the variable (terrorism) as an external variable only has a significant effect on the dependent variable (murder) in an indirect way through the mediating harm variable, while the rest of the variables (external) have no indirect effects through the mediating variables (injury and abortion) on the dependent variable (murder).

Table (8) Implied Correlations

	x6	x5	x4	x3	x2	x1
x6	1.000					
x5	-.710	1.000				
x4	-.870	.631	1.000			
x3	-.052	.278	-.236	1.000		
x2	-.472	.588	.391	.179	1.000	
x1	-.296	-.268	.167	-.559	-.269	1.000

Table(8) shows the matrix of simple correlations between the variables of the study, where we note that the simple and partial correlation coefficients have direct and inverse relations and that the correlation matrix has clear changes in the correlation coefficients, which is evidence that there are relationships and other effects between the variables that led to these changes, and they are noticeable. There is a strong inverse relationship between attempted murder and both criminal force (-0.71) and terrorism (-0.87) and a medium inverse relationship between attempted murder and abortion (-0.47) and a very weak relationship between attempted murder and harm (-0.05) and this relationship is almost There is no relationship between the two variables, and between attempted murder and murder (0.30), which is also a weak relationship. As for the relationship between criminal force and the rest of the variables, we note that there is a median direct relationship (0.63) between each of the criminal forces and terrorism, and between force and In terms of the relationship between terrorism and harm, we observe a weak inverse relationship (-0.24) between terrorism and abortion. We note that there is a weak direct correlation (0.39) between terrorism and murder, and a weak direct relationship (0.17) between terrorism and murder, as well as with regard to the relationship between injury and abortion, we note that there is a weak direct correlation (0.18) between injury and murder, and a medium inverse relationship (-0.56) between injury and murder. and a weak inverse relationship (-0.27) between abortion and homicide.

Table (9) Indicators of good fit:

χ^2 chi-square	NFI Normed Fit Index	IFI Incremental Fit Index	TLI Tucker-Lewis Index	CFI Comparative Fit Index	RMSEA Root Mean Square Error of Approximation
0.61	0.99	1.01	1.19	1.00	0.00

Table (9) shows the quality of the model proposed by the researcher according to the data of the study, where all indicators confirm that the proposed model is completely identical to the data and, according to the interpretation in Table No. (1), we note that the chi-square index reached 0.611, which is less than the value of 3, which means that the model is The proposed model has good data conformance. The standard conformity index is 0.987, which is greater than 0.95, and this is evidence of the quality of conformity. The supplementary conformity index was 1.009, which is greater than 0.90, indicating that the data conform to the model. The Tucker Lewis index reached 1.190, which is greater than 0.90, indicating a large match of the data with the model. We note that all the values in the proposed model are identical to those values in the indicator matching table.

Results and Recommendations:

There is identical path coefficients calculated between correlation coefficients and regression coefficients, as well as there is a strong inverse relationship between each of attempted murder and: criminal strength, terrorism, and moderate inverse with abortion, but a very weak inverse relationship with a harm, and murder, as for the relationship between criminal force and the rest of the variables, we note that there is a moderate direct relationship with a terrorism, abortion, and a weak positive with a harm, and a weak inverse with murder. and the more external variables which **direct** affected on the crime of murder are: crime of attempted murder, crime of terrorism, and crime of criminal force, also the most external variables with **indirectly** affected with the crime of murder are: crime of attempted murder, crime of terrorism, and crime of criminal force, but the most external variables that have a total impact on the crime of murder are the crime of attempted murder, crime of criminal force, and the crime of terrorism, finally the attempted murder is most variables affecting with the crime of murder directly, indirectly and completely is the crime of attempted murder.

as well as the importance of using the path analysis method in data analysis Classified by assuming a causal model that contributes to predicting the values of a variable or group of variables and studying the direct and indirect effects between variables and determining the extent of the impact of each variable, and also the most variables related to murder are the crime of attempted murder, which makes those interested in the matter treat this crime quickly, which reduces its occurrence.

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