PAN AMERICAN JOURNAL OF PUBLIC HEALTH 100 YEARS

Original research

Estimating the economic impact of interpersonal violence in Mexico in 2021: projecting three hypothetical scenarios for 2030

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Suggested citation Cervantes A, Jhunjhunwala R, Castañeda Alcántara ID, Elizundia Cisneros ME, Ringel R, Cortes Rodriguez A, et al. Estimating the economic impact of interpersonal violence in Mexico in 2021: projecting three hypothetical scenarios for 2030. Rev Panam Salud Publica. 2023;47:e39. https://doi.org/10.26633/RPSP.2023.39

ABSTRACT

Objective. To calculate the economic impact of violence across Mexico in 2021 and project costs for 2021–2030.

Methods. Incidence data was obtained from the Executive Secretariat of the National Public Security System, (SESNSP), National Population Council (CONAPO), National Institute of Statistics and Geography (INEGI), and the National Survey of Victimization and Perception of Public Safety (ENVIPE). Our model incorporates incidence estimates of the costs of events associated with violence (e.g., homicides, hospitalizations, rapes, extortions, robbery, etc).

Results. The economic impact of crime and violence in Mexico for the year 2021 has been estimated at about $192 billion US dollars, which corresponds to 14.6% of the national GDP. By reducing violence 50% by 2030, we estimate savings of at least US$110 billion dollars. This represents a saving of US$1 376 372 for each company and more than US$66 771 for each Mexican.

Conclusion. Violence and homicides have become one of the most pressing public health and economic concerns for their effect on health, development, and economic growth. Due to low cost and high impact, prevention is the most efficient way to respond to crime and violence while also being an essential component of sustainable strategies aimed at improving citizen security.

Keywords Violence; gun violence; health economic; Mexico.

Despite increases in overall Mexican life expectancy at birth due to improved maternal and child health initiatives, adult mortality rates are rising and are partially attributed to increases in interpersonal violence and homicide (1,2). Mexico is one of the ten most violent countries in the world, reporting a homicide rate of 27.8 deaths per 100,00 people in 2020 (3). This rate was more than four times higher than the mean worldwide homicide rate (4), and was the highest rate among countries within the Organization for Economic Co-operation and Development (OECD) (5). Mexico is also home to the five most violent cities in the world: Tijuana, Juárez, Uruapan, Irapuato, and Obregon. The most violent city, Tijuana, had a homicide rate of 134 deaths per 100,000 citizens in 2019 – more than 20 times higher than the global average (3).

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The incidence of violence and criminal victimization has increased steadily in recent years, with higher rates of homicide and violent crime, and firearm-related crime specifically (6). According to the Mexico Peace Index (MPI), peace has steadily declined in Mexico. In 2018, there was a 14% increase in homicide rates, from 24 to 27 deaths per 100,000 people. Furthermore, the economic impact of violence rose 10% in 2018, reaching MXN$5.16 trillion (US$268 billion) - equivalent to 24% of the country's GDP (7). Official estimates for criminal victimization during 2020 report 21.2 million crimes with a rate of 23,520 per 100,000 persons. Homicide and criminal victimization affected 10.2 million homes in 2021, with only 28% of 36.6 million homes assessed (8). This increase in crime and violence has occurred in conjunction with the underfunding of the criminal justice systems, and increasing unemployment, corruption, and social insecurity. This has culminated in systemic and widespread repercussions to the economic and social fabric of Mexican life (9).

Crime and acts of violence have layers of financial implications for the Mexican government, private businesses, and individuals. Each homicide is associated with the loss of life and future earnings of the deceased individual, and with the costs of physical or emotional injuries that require medical and mental health care, cause disability, and produce other expenses such as legal costs and funeral services. Homicide has been described as the tip of the violence iceberg because it is associated with other types of violent crimes, including domestic battery, assaults, robberies, rapes, and kidnappings (10). The rising costs of violence are associated with increased judicial, police, security, and administrative needs, as well as social and mental health services for victims and their families (11,12). The costs also extend to businesses, as 30.5% of all businesses, and 51.5% of all large businesses, were victims of a crime in 2019 (13,14). Finally, there are indirect costs and intangible effects of violence that impact Mexican quality of life, institutional governance, and democracy.

With the understanding that violence has significant economic impact across multiple domains including the opportunity cost of not engaging in basic prevention policies, using 2003-2021 data on criminal victimization and violence, we aim to estimate the economic impact that interpersonal crime and violence had in Mexico in 2021. We also project future economic costs of crime and violence from 2022 to 2030 if observed trends remain the same (ceteris paribus), if they worsen, or if they improve.

METHODS

Study Design

We conducted an ecological analysis of publicly available data from 2003-2021 to estimate the economic costs of crime and violence in Mexico at a national level in 2021 and constructed a model to project three scenarios: 1) observed trend, 2) 50% reduction, 3) 50% increase of the estimated economic costs of crime and violence from 2020 to 2030.

Study Setting, Population and Data Source

Mexico, a country with a population of over 126 million people in 2020 (13), is composed of 32 federal entities (31 states and Mexico City) where states are free and sovereign, and more than 2,544 constitutionally autonomous municipalities. Our model only included adults (≥18 years).

Variables, costing parameters, and data sources were aggregated into the following categories: 1) Demographics; 2) Economics; 3) Costing; 4) Health, disability, and missing persons; 5) Government and justice; 6) Victimization underreporting rates. They are shown in Table 1.

All calculations were performed using 2021 Mexican pesos and are presented in 2021 US dollars using the Bank of Mexico´s exchange rate (15). Historical data on GDP for Mexico

TABLE 1. Assumptions and parameters used for estimating costs of interpersonal violence in Mexico

Demographics		
Mexico's population in 2021. (1)		129,824,235
Population older than 18 years old in 2021. (1)		94,762,546
Number of Mexican homes in 2020. (1)		35,200,000
Economics	**Currency**	
Number of businesses in Mexico in 2021 (2)	$	4,571,753
Gross Domestic Product (GDP) of Mexico in 2021 Pesos (3)	$	26,212,980,800,000
Gross Domestic Product (GDP) of Mexico in 2021 in US Dollars (3)	$	1,319,157,606,562
GDP per capita in Mexico 2021 Pesos (4)	$	208,016
GDP per capita in Mexico 2021, USD (5)	$	10,468
Average annual salary of a Mexican > 18 years (in Mx Pesos) (6)	$	276,618
Average monthly salary of a Mexican > 18 years (in Mx Pesos) (6)	$	23,051
Average cost of prevention per business (in Mx Pesos) (8)	$	19,069
Average direct economic loss per business (in Mx Pesos) (8)	$	1,041
Average economic loss per business due to corruption (in Mx Pesos) (8)	$	16,682
Average cost of violence and crime per business (in Mx Pesos) (8)	$	36,807
Costing parameters		
Expected growth of Gross Domestic Product (GDP) (7)		2.5%
Pesos to dollars exchange in 2021. (9)		$19.87
Expected annual dollar slip. (10)		2.5%

TABLE 1. (Cont.)

Expected inflation rate. (10)	4.5%
Discount rate for calculating Net Present Value. (10)	6.0%
Expected annual growth of registered businesses. (10)	2.5%
Growth of violence and crime from 2022 to 2030 (Worst case scenario). (10)	50.0%
Annual smoothing rate of growth curve. (10)	6.3%
Reduction of violence and crime from 2022 to 2030 (Best case scenario). (10)	50.0%
Annual rate of smoothing of the reduction curve. (10)	6.3%
Health, disability, and missing persons	# and %
Number of hospitalizations per each homicide (multiplier). (11)	30
Number of persons requiring medical care per homicide (multiplier). (11)	300
Number of disabilities per homicide (multiplier). (11)	2
Average hospitalization days due to violent injuries (days). (12)	6.5
Number of missing persons in 2021. (13)	2,968
Percentage of disappeared individuals divided by homicides each year. (14)	10.5%
Government and justice	% of GDP
Percentage of national GDP lost from fear of insecurity. (15)	0.19%
Percentage of national GDP spent on self-protection & prevention. (15)	0.95%
Percentage of national GDP spent on the military. (15)	1.12%
Percentage of national GDP spent on public security. (15)	0.95%
Percentage of national GDP spent on judicial system and imprisonment. (15)	0.92%
Victimization underreporting rates	%
Loaded transport robbery. (16)	74.8%
Passerby robbery. (16)	91.6%
Vehicle theft. (16)	18.6%
Business theft. (16)	93.5%
Damage to other's property. (16)	84.0%
Extorsion. (16)	96.7%
Kidnappings. (16)	84.9%
Consumer fraud. (16)	94.5%
Car accessory theft. (16)	91.1%
Robberies different from previous (other). (16)	89.7%
Verbal threats. (16)	83.0%
Injuries (lesiones). (16)	77.4%
Rape. (16)	85.7%

Notes: Table prepared by authors based on published data and personal calculations.
1. INEGI. Censo de Población y Vivienda 2020.
2. INEGI. National Statistical Directory of Economic Units (DENUE) 2022.
3. Current Mexican Pesos of 2021: INEGI Sistema de Cuentas Nacionales de México. Producto Interno Bruto (PIB). Series 2020-2021.
4. Author estimation based on Mexico's GDP divided by 2021 population.
5. Author estimation based on Mexico's GDP divided by 2021 population, with exchange rate 2021.
6. Author estimation from Sistema de Cuentas Nacionales de México. Producto Interno Bruto (PIB). Series 2020–2021, with exchange rate 2021 and CONAPO´s Proyecciones de la Población de México y de las Entidades Federativas, 2016-2050.
7. Author estimation based on a historical series tendency from INEGI Sistema de Cuentas Nacionales de México. Producto Interno Bruto (PIB).
8. $ 2021 Mx Pesos. Own calculations with INEGI´s 2020 Encuesta Nacional de Victimización de Empresas.
9. Author estimation based on official exchange rate from Bank of Mexico, 2022.
10. Author selection of annual rate of crime and violence reduction.
11. Krug E, et al. World Report on Violence and Health. Geneva: WHO, 2002.
12. Ávila-Burgos L, et al., Las lesiones por causa externa en México. Lecciones aprendidas y desafíos para el Sistema Nacional de Salud Mexicano. Instituto Nacional de Salud Pública, Mexico, 2010.
13. Author estimation from Registro Nacional de Datos de Personas Extraviadas o Desaparecidas (RPED) (May 2022).
14. Author estimation based on missing persons divided by number of homicides.
15. Author estimation based on Institute for Economics and Peace. Mexico Peace Index 2021: identificación y medición de los factores que impulsan la paz, Sidney, May 2021.
16. INEGI, Encuesta Nacional de Victimización y Percepción sobre Seguridad Pública (ENVIPE) 2019.

from 2000 - 2021 was obtained from INEGI (8). Inflation data was obtained from the National Consumer Price Index (INPC) of the Bank of Mexico, published by INEGI. Health related expenditures and other direct costs were calculated using data from the National Business Victimization Survey (ENVE 2020) (16) and the National Survey of Victimization and Perception of Public Security (ENVIPE 2020) (13), including expenses incurred for private security and prevention measures. For every death, it was estimated that a proportion of people incur costs in emergency medical care, and others with more severe injuries require hospitalization with an average length of stay of 6.5 days (17).The cost of living with disability and expenses in case of funerals were also estimated using official costing information from the Unitary Costs by Level of Care of the National Institute for Social Security (IMSS). Missing persons were considered as deaths, in terms of yearly income from lost productivity.

The average income from lost productivity each year due to a death was estimated from the total GDP divided by the number of Mexicans over 18 years of age. The Net Present Value (NPV) of future losses for individuals who die violently each year was calculated considering an average age at death

from homicide of 34 years, a lifetime expectancy of 75 years (14), and a 6% discount rate. The cost of business victimization was calculated using micro data from the National Business Victimization Survey (ENVE)(16), conducted by INEGI, and the number of private sector businesses in the country was obtained from the 2022 National Statistical Directory of Economic Units (DENUE) (18).

The historical costs to the government in prevention and containment were obtained using the Public Account and the Expenditure Budget of the Federation, the expenses of the Attorney General's Office, the Judiciary and the National Census of Municipal and Delegation Governments. Finally, the estimates of government spending on violence containment were obtained from the 2021 MPI, of the Institute for Economic and Peace Studies (IEP) (15).

Outcomes

The primary outcome for this study was to estimate the cost of crime and violence for Mexico in 2021, defined as total cost, percent gross domestic product (GDP), and cost per adult person per year in US dollars. These costs were further categorized into three agents: 1) cost to individuals, 2) cost to the private sector, 3) cost to the government (direct and indirect), as shown in Table 2; at three moments in time: 1) past (i.e., prevention), 2) present (i.e., health costs and material losses), and 3) future (i.e., cost related to future lost income and productivity, long-term health expenses related to the crime).

Secondary outcomes include unitary cost estimation of the twenty-three victimization parameters for Mexico in 2021, in Mexican pesos and US dollars; and cost projections for 2022 - 2030 using the above-mentioned scenarios (observed trend, 50% reduction, 50% increase).

Analysis: financial estimates and projections

Cost of crime and violence 2021

To estimate the cost of violence for 2021 we used data from the above-mentioned sources and applied them to our theoretical framework to break down spending into more elementary components. A cost is considered the direct expense caused by a violent act, as well as the expense incurred in preventing such acts, and what is spent after the occurrence. In the first instance, it has been divided into social and private costs. The social cost represents costs to society, while a private cost only affects the legal person or entity who suffers the loss.

In general, the government suffers direct costs of violence that are reflected throughout society in the absence of benefits it could otherwise obtain if resources were used for other social objectives such as social services, education, healthcare, and security. Individuals, on the other hand, suffer both private and social costs, while private businesses generally undergo losses in the form of loss of profit, which are not categorized as social expense. This leads to the interaction of three agents (government, businesses, and individuals) as the entities who suffer losses. In addition, costs related to a violent act can be classified as expenses incurred at the time of the assault (present), those incurred before the violent act in the form of expenses related to violence prevention (past), and those incurred after the assault (future). The estimation of the total cost must add the agents per victimizing moments as well as each one of the crimes (i) in each space (e). Thus, there are three agents (government[G], businesses[E], individuals[F]), and three periods in time[t] (past[a], present[p], future[f]) used in the calculation, as follows:

$$C_e^t(a=government)=C_e^f(a)+C_e^p(a)+C_e^a(a)$$
$$C_e^t(a=businesses)=C_e^f(a)+C_e^p(a)+C_e^a(a)$$
$$C_e^t(a=individuals)=C_e^f(a)+C_e^p(a)+C_e^a(a)$$

That is, the national cost of violence is the sum of the costs of the agents, in the spaces at each time period:

$$C=\sum_{a=1}^{3}\sum_{t=1}^{3}\sum_{e=1}^{32}C_e^t$$

It is important to note that the future cost denotes the cost of future expenses, the past cost is the cost undertaken for violence prevention, and the current cost describes the direct cost of the loss that may involve immediate or persistent losses such as years of life lost, as well as all costs occurred in the moment of the violent act. In addition, there are different sources x that suffer the loss: the government (G), businesses (E), and individuals (I).

$$C_e^x=C_e^G+C_e^E+C_e^I$$

For example, a violent robbery of a store accumulates a cost at full cost.

$$C_e^i=(C_e^{fG}+C_e^{fE}+C_e^{fF})+(C_e^{pG}+C_e^{pE}+C_e^{pF})+(C_e^{aG}+C_e^{aE}+C_e^{aF})$$

In other words, the cost of violence for a crime (i), is the sum of past, present, and future costs for the government, business, and individuals. And, the cost to the economy is the cost of all (n) violent crimes (i) which occurred in a given space (e) and time (t).

$$\sum_{i=1}^{n}C_e^i$$

Cost of crime and violence projections 2030

To estimate the projected cost of violence from 2022–2030, we used historical data concerning crimes from 2003–2021. Linear estimates for each crime category were made for the years 2022–2030, considering that trends remain the same. Subsequently, two additional hypothetical scenarios were conducted for illustrative purposes: one with a uniform 50% increase by 2030, and the other with a 50% decrease by 2030, in all types of victimization respectively.

In the macroeconomic scenario, the projections assume moderate growth for the country, a stable political situation, moderate inflation, and an exchange rate that will change gradually until 2030 under the following macroeconomic assumptions: a) expected annual inflation rate of 4.5%; b) expected annual growth of the GDP of 2.5%; c) exchange rate pesos per dollar (2022–2030) fluctuating between MXN $19 to $25 per dollar; d) Percent Annual Depreciation at 2%; e) annual interest rate at 5% (based on 28-day Mexican Federal Treasury Certificate trends) and; f) expected growth in the number of businesses per year

at 3%. To estimate the exchange rate trend in Mexico, average annual depreciation was used, calculated from the projections of IHS Markit 2019–2023. For the forecast of the interest rate of the 28-day cetes, we estimated a real rate of 1% per year. For all violent deaths and missing persons, average annual salaries are discounted as yearly cost from lost productivity.

Since there are different t's, it is possible to presume the existence of some linear trend that allows predicting, using the following formula:

$$C(e,r,t) = mC(e,r,t1) + b$$

There are n number of facts e(*i*), of type d(*i*), in state E(*i*) that are added with the weight given by the expansion factor of each event F(*i*), as follows:

$$cf_{d,E} = \sum_{i}^{n} e_i^{d(i),E(i)} F_i$$

$$cf_{d,E,g} = \sum_{i}^{n} e_i^{d(i),E(i),g(i)} F_i$$

$$c_{d,e,g} = \sum_{d=1}^{D}\sum_{e=1}^{E}\sum_{g=1}^{G} c_{d,e,g} F_{d,e,g}$$

Where "d" is the type of crime within D types of crimes; "e" is the state from the total set of 32 states E; G is the total of g business units. F is the type of business; n is the type of events from a set of N types of events sampled. $\bar{C}_e^n$ is the average cost of each type of event.

The projections seeks to estimate what would happen in a certain ceteris paribus condition for time Q (on another date) through a linear assumption:

$$CQ(T)_e^{tA} = m(C(T)_e^{tA}) + b$$

Thus, we used the 2000–2021 time series of crimes for the estimation of m with the estimated rates of crime for 2022–2030. All analyses and projections were performed using Excel (MS Office Pro 2019).

RESULTS

Table 2 shows twenty-three victimization parameters for 2021 in Mexico, with the number of events, crude rates, and unitary cost estimates, in Mexican pesos and US dollars. There were an estimated 21.2 million victims of crimes and almost a third of all homes had at least one victim. There were more than 2,968 missing persons. A quarter of the adult population spent an average of US$385 in 2021 on private security and crime prevention measures. We estimated more than 1.3 million hospitalizations with unitary costs of US$5,406 per patient (mean length of stay of 6.5 days). There were more than 190 thousand rapes, with an estimated lifetime cost of around US$36,000 per victim.

Table 3 shows the cost of crime and violence in Mexico for 2021, which is estimated at US$192,584,744,483, corresponding to 14.6% of the national GDP. This is equivalent to each of the

TABLE 2. Crime and violence victimization numbers, rate, and unitary costs in 2021

Event	Number	Rate per 100,000	Unit Cost (MXN $)	Unit Cost (US$)
Homicides	28,266	22.4	276,618	13,921
Manslaughter (involuntary)	15,697	12.5	276,618	13,921
Funerals	43,963	34.9	29,844	1,502
Missing persons	2,968	2.4	276,618	13,921
Disability from violence related injuries	87,926	69.8	71,626	3,605
Kidnappings	4,142	3.3	35,813	1,802
Bank robbery	212	0.2	298,440	15,019
Vehicle theft	172,715	137.1	83,563	4,205
Lifetime cost of rape, for victim	193,778	153.8	718,105	36,138
Car accessory theft	228,618	181.4	4,775	240
Extorsion	266,700	211.6	1,194	60
Verbal threats	703,767	558.5	2,388	120
Passerby robbery	810,392	643.1	4,178	210
Damage to other people's property	860,173	682.6	10,744	541
Strikes and physical aggression	890,201	706.4	1,194	60
Hospital care (average of 6.5 days)	1,318,890	1,046.6	107,438	5,407
Property crimes and business theft	1,340,701	1,063.9	18,503	931
Fraud	1,717,498	1,362.9	10,744	541
Other theft (not vehicle, passerby or car accessory)	1,739,527	1,380.4	4,775	240
Number of homes victims of a crime	10,400,000	8,253.0	N/A	N/A
Emergency department visits	13,188,900	10,466.2	9,550	481
Number of victims of crime	21,200,000	16,823.5	N/A	N/A
Number of people who spend in private security	32,033,224	25,420.4	7,656	385

NOTE: Table prepared by authors based on published data.
The number of persons and homes that are victims of crimes is for reference only.
These do not have a unitary cost per event in the costing model.

TABLE 3. Economic impact of crime and violence in Mexico in 2021 and proportion of Gross Domestic Product

Direct costs to businesses	Cost in US dollars in 2021	% of GDP
Direct costs to businesses		
Cost of security and preventive measures	4,387,219,109	0.33%
Cost due to direct crime-related losses	3,838,151,964	0.29%
Cost due to crime-related corruption	239,478,155	0.02%
Total direct cost to businesses	**8,468,132,465**	**0.6%**
Direct and indirect costs to government		
Judicial system and imprisonment	12,139,895,325	0.92%
Military spending	14,742,972,841	1.12%
Internal security	4,089,830,406	0.31%
Fear of insecurity	2,467,721,806	0.19%
Crimes committed with a firearm	93,161,448,006	7.06%
Private security	12,521,843,222	0.95%
Total direct and indirect costs to government	**139,123,711,607**	**10.55%**
Direct cost to individuals (1)		
Personal expenditure in private security	12,341,254,985	0.94%
Hospitalizations	7,130,968,503	0.54%
Emergency Trauma Care	6,338,638,669	0.48%
Annual living cost for disabled people	4,753,979,002	0.36%
Other crimes	2,410,009,152	0.18%
Rape	7,002,824,254	0.53%
Health expenditure associated with a crime	1,371,008,010	0.10%
Vehicle theft	726,316,583	0.06%
Other types of theft (not vehicle theft)	418,011,864	0.03%
Consumer fraud	928,616,223	0.07%
Loss of income from homicides	393,481,502	0.03%
Damage to others property	465,078,109	0.04%
Loss of income from involuntary manslaughter	218,512,670	0.02%
Passerby robbery	170,396,425	0.01%
Funerals for homicide victims	66,027,486	0.01%
Verbal threats	84,558,370	0.01%
Loss of income due to disappearance	41,315,558	0.00%
Physical injury from violence	53,479,292	0.00%
Kidnapping	7,464,327	0.00%
Extorsion	16,022,165	0.00%
Theft of car accessory	54,937,262	0.00%
Total cost to people	**44,992,900,411**	**3.41%**
Economic impact of violence and crime in 2021	**192,584,744,483**	**14.6%**

Note: Table prepared by authors based on personal calculations.

more than 4.5 million business units spending US$42,000 per annum, or to each adult person spending US$2,032 each year. Of this figure, the greatest portion corresponds to direct and indirect costs to the government, which amounts to 72% of the total annual cost to the country. Next, 23% of the cost is borne from the direct cost of victimization to adult persons and their families. Around half the annual cost, or 7%, corresponds to crimes committed with firearms. Lastly, the cost of crime and violence to private businesses amounts to 4.4% of the total cost, at US$8,468 million in 2021.

Figure 1 presents the observed rates of nine high-impact crimes in Mexico from 2003–2021 (per 100,000 population), and estimations from 2022–2030. Note the changes in the vertical scale, which correspond to the crime rate per 100,000 population for each category once adjustments for underreporting have been made.

Figure 2 presents the three scenarios of the cost of crime victimization and armed violence in Mexico from 2020–2030, and the proportion that this cost represents in relation to the nation's GDP. In the worst-case scenario, where violence and crime grow at 6.3% annually, the total cost of violence will reach US$2.6 trillion. In 2022 the cost of violence in proportion to the GDP could rise to 15.7%. In contrast, the best-case scenario is one in which Mexico manages to reduce the crime and violence victimization trends by 6.3% per year, up to a 50% reduction by the year 2030. In this scenario, crime will still cost about US$1.3 trillion between 2022 and 2030, which represents 11.9% of GDP on average each year. The total cost-per-capita for the 2022–2030 period could range from a low of US$10,258 per person in the best-case scenario, US$15,216 per person in the baseline scenario, and up to US$20,175 per person in the worst-case scenario.

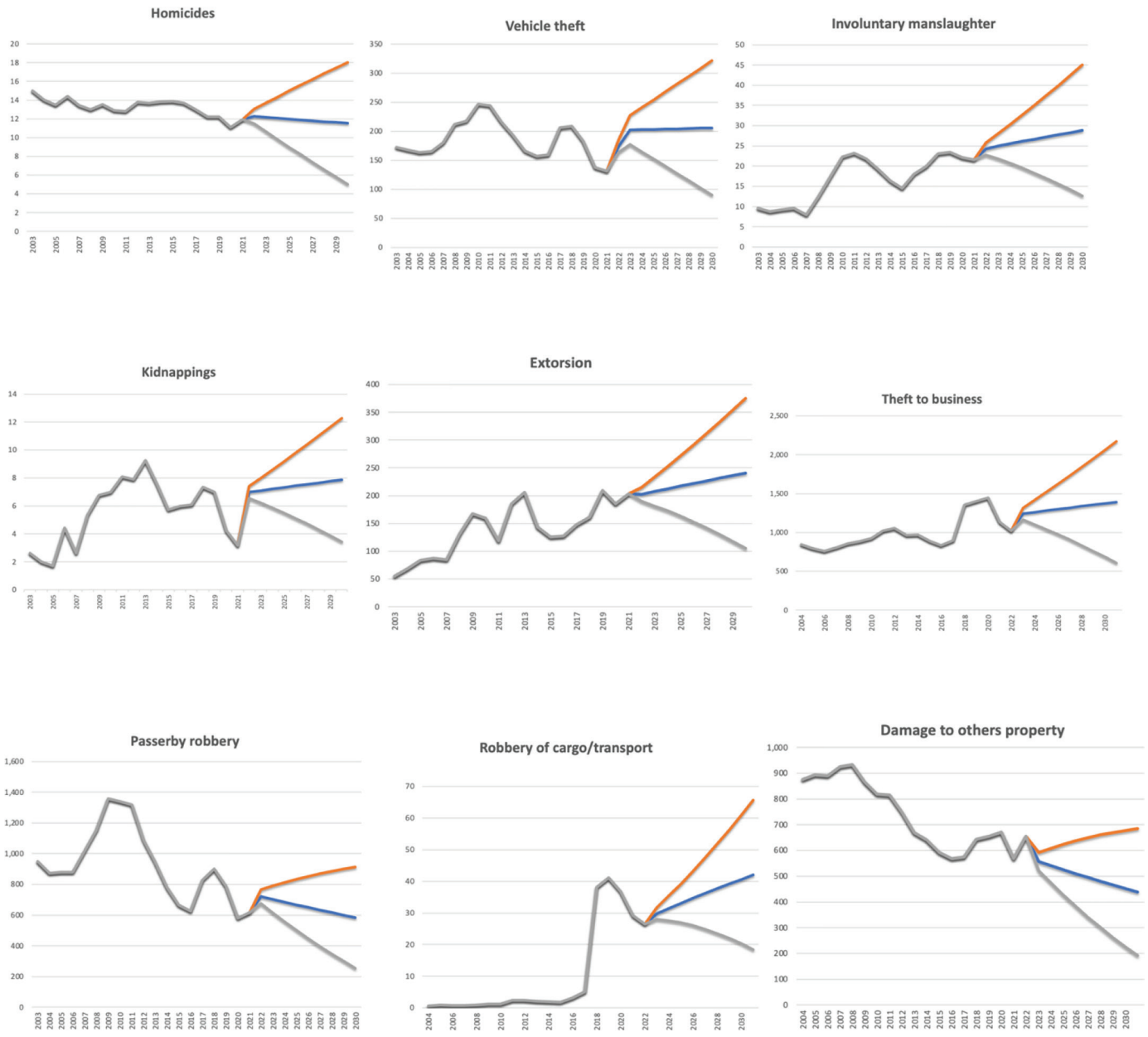
In the baseline scenario, the accumulated cost of crime and violence between 2022 and 2030 is US$1,975,469,733,279, an average of 16% of the annual GDP per year. The NPV of that amount at a 6% discount rate is US$1,474,604,545,799. If we consider the NPV of the worst-case scenario versus the best-case scenario, potential savings could be in the order of US$888,984,416,527. If we consider the NPV of the baseline scenario versus best-case scenario, cost savings could be up to US$444,492,208,264 over the 9-year period (**Figure 2**). Considering that victims of violent deaths could have had a lifetime of economic productivity, we used the average annual GDP per capita of MXN$276,617, an average age at death of 34 years, and a life expectancy of 75 years to calculate the NPV of future losses of individuals, which amounts to MXN$55,600,985, equivalent to US$2,798,097 in 2021.

From 2022 to 2030, the accumulated cost-per-person ranges from a best case of US$8,175, a baseline of US$11,702, and a worst case of US$15,229. The NPV of the savings per capita in 2022, of the different scenarios versus the best case, range from US$3,386 to US$6,771 saved per person. In the case of private business units, the estimated cost savings in the three scenarios and NPV associated with violence reduction ranges from US$94,854 (baseline minus best case) to US$137,372 (worst case minus baseline), to US$189,709 (worst case minus best case) per business in 2022.

DISCUSSION

Violence, which is often linked with crime, consists of intentional acts of force or use of power that result in harm (19). Our analysis provided a novel estimation of the economic impact of violence and crime in Mexico, incorporating the past, present, and future expenditures made by the government, businesses, and individuals in response to violent acts. This analysis revealed a total cost of US$192.6 billion in 2021, equating to 14.6% of the GDP. At the current rate of violence, up to 19.1% of the GDP will be spent on violence and crime related costs in 2030. However, if violent crime could be reduced by 50%, spending could be reduced to 8.3% of GDP by the end of the decade—a 43% reduction in spending saving approximately US$110 billion in the year 2030.

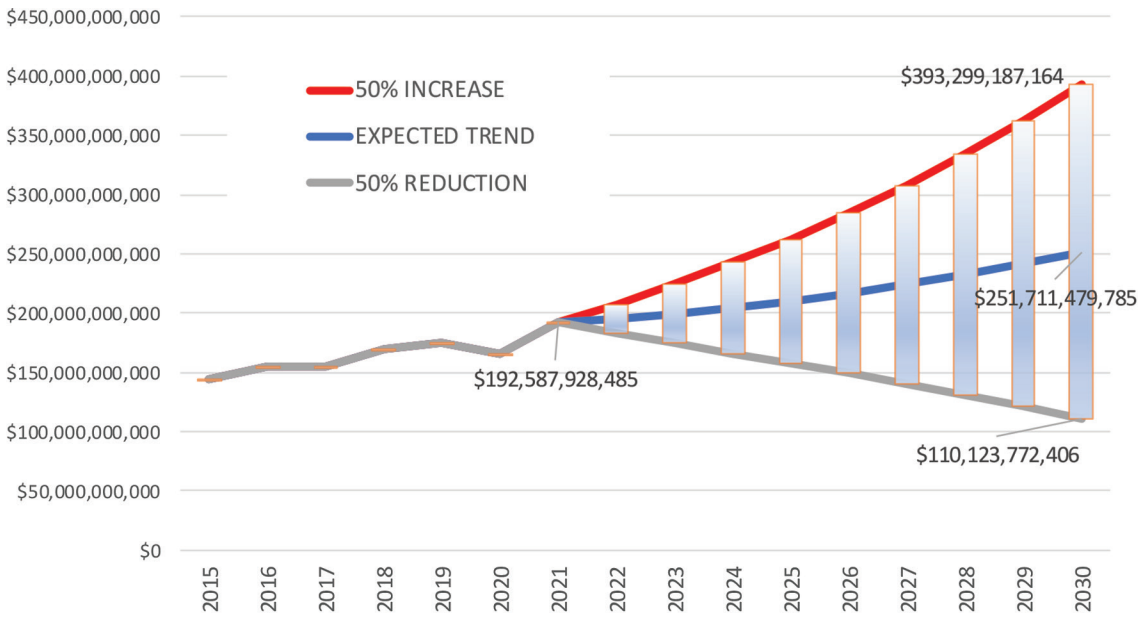
FIGURE 1. Rates of high-impact crimes in Mexico 2003-2021, and projections 2022-2030, with three scenarios (per 100,000 population)



Note: Figure prepared by authors based on published data and personal calculations.

These data highlight the disproportionate expenditure allocated to managing violent crime in Mexico, and the effect violence has on different sectors of the population. While our model shows that many of the expenses are assumed by the government, there is significant personal cost to Mexican families and the private sector as well. As described by Vargas et al, Mexican counties experience an increased likelihood of 5.21% of hospital utilization with each additional homicide per 100,000 population. In urban spaces with a population equal or greater than 100,000, there was an increase of 11.76% in likelihood of hospital and healthcare service utilization (20). Given that the Mexican health system is funded in part by the government as well as individuals, this finding reinforces the concept that significant expenditure is undertaken by individuals as well as society in direct relation to violence. As a consequence of using limited resources for security tasks (judicial, military, and police), or prevention and containment of violence, the government fails to invest in other social programs that should be prioritized, such as education, infrastructure, and social development. In 2013 the total expenditure due to health damages caused by violence and insecurity in Mexico was reported as MXN$7.98 billion, and in total the cost of insecurity and crime totaled MXN$6,799 per capita, 5.69% of the GDP; $15.447 trillion in total. Variables included in this analysis include cost of reporting crime, estimated cost of private security, losses for families and enterprises, public security expenses per state,

FIGURE 2. Hypothetical scenarios of the cost of crime and violence in Mexico, 2020 – 2030



Estimated cost of crime and violence in US dollars

Year	Expected trend	% GDP	Worst case	% GDP	Best case	% GDP
2020	$ 165,532,232,429	*14.1%*	$ 165,532,232,429	*14.1%*	$ 165,532,232,429	*14.1%*
2021	$ 192,587,928,485	*14.6%*	$ 192,587,928,485	*14.6%*	$ 192,587,928,485	*14.6%*
2022	**$ 195,284,071,135**	***14.8%***	**$ 207,489,325,581**	***15.7%***	**$ 183,078,816,689**	***13.9%***
2023	$ 199,452,503,533	*15.1%*	$ 224,384,066,474	*17.0%*	$ 174,520,940,591	*13.2%*
2024	$ 204,315,000,054	*15.5%*	$ 242,624,062,564	*18.4%*	$ 166,005,937,544	*12.6%*
2025	$ 210,033,433,721	*15.9%*	$ 262,541,792,152	*19.9%*	$ 157,525,075,291	*11.9%*
2026	$ 216,614,115,664	*16.4%*	$ 284,306,026,809	*21.6%*	$ 148,922,204,519	*11.3%*
2027	$ 224,064,096,095	*17.0%*	$ 308,088,132,131	*23.4%*	$ 140,040,060,060	*10.6%*
2028	$ 232,391,167,130	*17.6%*	$ 334,062,302,750	*25.3%*	$ 130,720,031,511	*9.9%*
2029	$ 241,603,866,161	*18.3%*	$ 362,405,799,242	*27.5%*	$ 120,801,933,081	*9.2%*
2030	$ 251,711,479,785	*19.1%*	$ 393,299,187,164	*29.8%*	$ 110,123,772,406	*8.3%*
TOTAL 2022-2030	**$ 1,975,469,733,279**	*16.1%*	**$ 2,619,200,694,867**	*20.4%*	**$ 1,331,738,771,691**	***11.9%***
*NPV IN 2022 **	*$ 1,474,604,545,799*		*$ 1,919,096,754,063*		*$ 1,030,112,337,536*	

Source: prepared by authors based on published data and personal calculations.
Note: all figures are presented in current 2021 US dollars. Percent GDP Total corresponds to the 9 year average (2022-2030). The blue bars in the figure represent the savings that could be achieved with violence and crime reduction from baseline to 50% less by 2030.
NPV, Net Present Value in 2022 of the accumulated 2022-2030 cost of violence, at 6% discount rate.

health damages, and cost of corruption This showcases the multifaceted costs and expenses related to violence (21).

Furthermore, when businesses invest in private security, they suffer from doubled expenses for violence prevention by paying taxes and expecting to be beneficiaries of public security measures, but also having to privately invest in anti-theft measures. Hence, by investing in the creation of safe communities, government and private spending on violence prevention could decrease, freeing up capital to circulate in the economy. In fact, OECD countries with higher GDP per capita and lower income inequality spend more on crime control programs and criminal justice and have a smaller criminal sector (22).

Many health economists have turned to Value of a Statistical Life (VSL) calculations to estimate national costs to the economy based on loss of life or livelihood. On average, the VSL in Latin America and Asia ranges from US$3.16 to $4.19 million, respectively (23). The 2021 VSL in Mexico has been calculated at US$ 403,833 (24) whereas this value was estimated at US$11.8 million in the USA (25). Our calculations of lost income from violent deaths resulted in an NPV of US$2.8 million for each Mexican life lost; much less than the average VSL for North America, but higher than official VSL estimations. Furthermore, we chose to use a Human Capital approach to our estimate as VSL calculations are agnostic with regards to the way a person

dies; and the downstream effects of a violent death are central to our model's approach.

Alternatively, as described in the introduction, the MPI has proposed higher estimates of the proportional cost of homicides in their cost of violence estimates for the country. Their analyses show that 22.5% of Mexico's GDP was lost to the cost of violence in 2021, with 47% of that sum corresponding exclusively to homicides (3). Similar GDP losses were described for 2017 and 2018 (7). However, the methodology used in the MPI estimation of total economic impact differs from our approach in that the IEP uses a peace multiplier to estimate additional economic activity that would have taken place should the index violent act not have occurred. This multiplier incorporates the opportunity costs to all parties, thus expanding the estimation beyond the scope of what we have included in our analysis. We believe that their method results in a large overestimation of the proportional cost of homicides each year, and that discounting yearly income lost by the victims of homicides represents a more accurate cost estimation.

This work highlights the vital need for violence reduction policies to be implemented widely across Mexico; not only for the inherent value of reducing crime and violence in the country, but also as a method of increasing available spending capacity for other investments (26). For decades, experts have promoted a public health approach to violence prevention and reduction (10,27,28), and many good practices have recently demonstrated the enormous value of prevention (29).

It is known that violence has multiple consequences in the short, medium, and long terms, with direct and indirect impacts and repercussions nested across the human ecology. In exploring the spread of violence, researchers have also recognized the tendency for violent acts to be preceded or followed by other violent acts, to cluster, to spread from place to place, and to mutate from one type to another (30). Health-economic evaluations create opportunities to routinely include economic considerations in identifying interventions that can be targeted to generate high long-term value by maximizing violence reduction (31). Initiatives have been implemented in select Latin American countries that have successfully reduced the amount of violent crime in their respective locations and have subsequently created increased capital to be applied to other public spending initiatives. One example is the Brazilian conditional cash transfer initiative. This program, called "Bolsa Familia Programme", uses conditional incentives such as minimum required days of school attendance, attendance at health care visits, and other positive health and education related behaviors to award financial assistance and simultaneously increase the chances of breaking out of poverty. The program has been shown not only to reduce poverty, inequality, crime, and child mortality, but is also associated with reduced rates of homicide and hospitalizations due to violence (32).

This study is not without limitations. First, underreporting of crime and violence to national databases limits the ability to rely wholly on these numbers for an accurate cross-section of the amount of crime present at any given time. Second, we did not include suicide, domestic violence, child abuse, elder abuse in our analysis of interpersonal violence. We did not conduct any sub-analyses based on gender, but we do note that while homicide disproportionately affects Mexican males, women are disproportionately affected by nonfatal violence as well as fear of other crimes (33). Finally, costs of mental health services for victims and perpetrators, orphanage care, and other catastrophic health expenditures are also missing from these data and would increase the overall cost of these violent crimes to the government, businesses, and individuals. Despite the detailed analysis conducted in this work, we propose that these numbers remain an underestimation of the true cost of violence in Mexico.

CONCLUSION

We have shown that the economic cost of violence to Mexican government, private businesses, and individuals could reach 19% of GDP by 2030 if current trends persist. If crime and violence can be reduced by 50%, this could lead to a reduction in spending to about 8.3% of GDP, saving billions annually. We recommend up-front investment in violence prevention strategies in order to free up capital that can be redirected to other government services, to strategic and science-based prevention, and to rebuild the social fabric by investing in other national priorities such as education, health, poverty, and inequality.

Author contributions. ACT conceived of the presented idea. ACT, ICD, developed the theory and performed the computations. MEEC, ICD, and ACT verified the analytical methods. RJ and ACT wrote the manuscript with input from all authors and special contribution from RR. TUL and JGM encouraged RJ and ACR to investigate VSL methodology and supervised the findings of this work. SH, DdV, RR, RJ, and ACR performed literature review and contributed to the drafting of the manuscript. RJ, ACT, and PTUL led the revisions to the manuscript with input and review from all authors. All authors conducted iterative review of the paper. All authors reviewed and approved the final version.

Acknowledgements. The authors would like to acknowledge Stephen Hargarten, MD who reviewed the document and provided comments.

Funding. There were no financial sponsors for this work. Thus, financial sponsors did not influence in any way the design, data collection, analysis, writing, or decision to publish these results

Conflicts of Interest. None declared.

Disclaimer. Authors hold sole responsibility for the views expressed in the manuscript, which may not necessarily reflect the opinion or policy of the Revista Panamericana de Salud Pública / Pan American Journal of Public Health and/or those of the Pan American Health Organization.

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Manuscript submitted on 15 May 2022. Revised version accepted for publication on 1 December 2022.

Estimación del impacto económico de la violencia interpersonal en México en el 2021: proyección de tres escenarios hipotéticos para el 2030

RESUMEN

Objetivo. Calcular el impacto económico de la violencia en el 2021 en todo México y proyectar sus costos para el período 2021–2030.

Métodos. Los datos de incidencia se obtuvieron del Secretariado Ejecutivo del Sistema Nacional de Seguridad Pública (SESNSP), el Consejo Nacional de Población (CONAPO), el Instituto Nacional de Estadística y Geografía (INEGI), y la Encuesta Nacional de Victimización y Percepción sobre Seguridad Pública (ENVIPE). Nuestro modelo incorpora estimaciones de la incidencia de los costos de los eventos asociados a la violencia (por ejemplo, homicidios, hospitalizaciones, violaciones, extorsiones, robos, etc.)

Resultados. Se ha estimado que el impacto económico del delito y la violencia en México para el año 2021 es de alrededor de US$ 192 000 millones de dólares estadounidenses, lo que corresponde al 14,6% del PIB nacional. Estimamos que una reducción del 50% de la violencia para el 2030 supondría un ahorro de al menos US$110 000 millones. Esto representa un ahorro de US$1 376 372 para cada empresa y de más de US$66 771 para cada mexicano.

Conclusión. La violencia y los homicidios se han convertido en una de las preocupaciones económicas y de salud pública más apremiantes por su efecto sobre la salud, el desarrollo y el crecimiento económico. Debido a su bajo costo y alto impacto, la prevención es la forma más eficiente de responder al delito y la violencia, al tiempo que es un componente esencial de las estrategias sostenibles dirigidas a mejorar la seguridad ciudadana.

Palabras clave Violencia; violencia con armas; economía y organizaciones para la atención de la salud; México.

Estimativa do impacto econômico da violência interpessoal no México em 2021: projeção de três cenários hipotéticos para 2030

RESUMO

Objetivo. Estimar o impacto econômico da violência no México em 2021 e fazer a projeção de custos para o período 2021–2030.

Métodos. Os dados de incidência da violência no país foram obtidos da Secretaria Executiva do Sistema Nacional de Segurança Pública (SESNSP), do Conselho Nacional de População (CONAPO), do Instituto Nacional de Estatística e Geografia (INEGI) e da Pesquisa Nacional de Vitimização e Percepção de Segurança Pública (ENVIPE). O modelo incorpora estimativas de incidência de custos de eventos associados à violência (como homicídios, internações hospitalares, estupros, extorsões e roubos).

Resultados. O impacto econômico da criminalidade e da violência no México foi estimado em torno de US$192 bilhões em 2021, o que equivale a 14,6% do produto interno bruto (PIB) nacional. Estima-se que reduzir a violência em 50% até 2030 pode resultar em uma economia de US$ 110 bilhões ou mais, o que representa uma redução de gastos de US$1 376 372 para cada empresa e de mais de US$66 771 para cada cidadão do México.

Conclusão. A violência e os homicídios são um dos problemas econômicos e de saúde pública mais prementes por suas consequências à saúde, ao desenvolvimento e ao crescimento econômico do país. Devido ao seu baixo custo e alto impacto, a prevenção é a forma mais eficiente de combater a criminalidade e a violência, além de ser um componente essencial de qualquer estratégia sustentável para aumentar a segurança da população.

Palavras-chave Violência; violência com arma de fogo; economia e organizações de saúde; México.