

Perception of security and spatiotemporal analysis of gender-based violence during the covid-19 lockdown

Percepción de seguridad y análisis espacio-temporal de la violencia de género durante el confinamiento por covid-19

Octavio Quintero Avila*

Onel Pérez Ávila**

Juan Antonio Caballero Delgadillo***

Analy Cervantes Vidaurri****

Recibido: 20 de abril 2024

Aceptado: 7 de enero 2025

Abstract

This research analyzes gender-based violence during the COVID-19 lockdown in colonia Fomerrey 25, Monterrey, through a quantitative, spatial and exploratory approach. Through perception surveys, 911 reports (2019-2022) and an exploratory march, temporal, spatial and environmental patterns associated with the phenomenon were identified. The findings reveal peaks of violence in the months of August and

December, with higher incidence on weekends and during the evenings, especially between 21:00 and 23:00 hours. The perception of insecurity is particularly high in public spaces such as the street, transportation and parks. The spatial overlap between the reports and areas of environmental deterioration (graffiti, garbage, excessive vegetation and abandoned houses) reinforces the hypothesis that urban disorder facilitates violence. More than 60% of the incidents are located within 100 m of vulnerable areas. It is concluded that it is necessary to implement situational prevention strategies that integrate urban actions (cleaning, lighting) with community policing measures. The study contributes to the design of targeted urban safety policies with a gender approach.

Cómo citar

Quintero Avila, O. ., Pérez Ávila , O., Caballero Delgadillo , J. A., & Cervantes Vidaurri , A. Percepción de seguridad y análisis espacio-temporal de la violencia de género durante el confinamiento por COVID-19. *Constructos Criminológicos*, 6(10). <https://doi.org/10.29105/cc6.10-126>

*<https://orcid.org/0000-0003-3922-9964>
Universidad Mariano Gálvez de Guatemala,
Guatemala.

**Escuela de geografía de Panamá
***Universidad Autónoma de Nuevo León
*<https://orcid.org/0009-0003-3834-0246>
Secretaría de las Mujeres

Keywords: *Crime analysis, Perception of security, Situational prevention, 911 reports, Gender violence.*

Resumen

Esta investigación analiza la violencia de género durante el confinamiento por COVID-19 en la

colonia Fomerrey 25, Monterrey, mediante un enfoque cuantitativo, espacial y exploratorio. A través de encuestas de percepción, reportes al 911 (2019–2022) y una marcha exploratoria, se identificaron patrones temporales, espaciales y ambientales asociados al fenómeno. Los hallazgos revelan picos de violencia en los meses de agosto y diciembre, con mayor incidencia los fines de semana y durante las noches, especialmente entre las 21:00 y 23:00 horas. El 87.3 % de los incidentes corresponde a violencia familiar y la percepción de inseguridad es especialmente alta en espacios públicos como la calle, el transporte y los parques. La superposición espacial entre los reportes y las áreas de deterioro ambiental (graffiti, basura, vegetación excesiva y casas abandonadas) refuerza la hipótesis de que el desorden urbano facilita la violencia. Más del 60 % de los incidentes se localiza a menos de 100 m de zonas vulnerables. Se concluye que es necesario implementar estrategias de prevención situacional que integren acciones urbanas (limpieza, iluminación) con medidas de vigilancia comunitaria. El estudio contribuye al diseño de políticas focalizadas de seguridad urbana con enfoque de género.

Palabras clave: Análisis delictivo, Percepción de seguridad, Prevención situacional, Reportes 911, Violencia de género

INTRODUCTION

The COVID-19 pandemic and associated confinement measures resulted in a global increase in gender-based violence, a phenomenon described as the "silent

pandemic" of violence against women. Recent reviews have documented that forced isolation and disruption of support services increased victims' exposure to their aggressors, limiting their ability to report and protect themselves (Ostadtaghizadeh et al., 2023); evidence gaps on the precise mechanisms linking the domestic environment to patterns of victimization have also been identified (Rocha et al., 2024).

In Mexico, the perception of insecurity reached high levels during the post-confinement recovery phase: in June 2023, 62.3 % of the population aged 18 and over considered that living in their city was unsafe (INEGI, 2023a), while the ENVIPE estimated that 31 % of households in Nuevo Leon had at least one victim of crime in 2022 (INEGI, 2023b). Although the Mexico Peace Index 2024 reported a 1.4 % improvement in the country's level of peace, the economic impact of violence remained at 19.8 % of national GDP, reflecting the persistence of high risk contexts (Institute for Economics & Peace [IEP], (IEP, 2024).

During the COVID-19 confinement, Madeira et al. (2021) developed an agent-based computational model (Agent-Based Model, ABM) called VIDA, with the objective of simulating domestic violence patterns in contexts of social distancing. This model incorporated socioeconomic, geographic and demographic variables at the intra-urban level, using census tracts in Brazil as the spatial unit. The simulation allowed estimating an approximate 10% increase in domestic violence incidents during

confinement, showing how factors such as population density, type of urban area (central or peripheral), and family structure have a significant impact on the spatial distribution of risk. In addition, the approach made it possible to identify spatio-temporal variations of events, simulating future scenarios and contributing to the design of targeted policies in vulnerable urban contexts. (Cristina Mejía Hernández, 2021).

In addition, studies in India show that districts with stricter confinements reported significant increases in domestic violence complaints up to 135 % in May 2020 effects that persisted for more than a year (Ravindran & Shah, 2023). A natural-effect based analysis in Brazil and a qualitative intervention further revealed that structural violence and pre-existing inequalities exacerbated by the pandemic intensified GBV in vulnerable populations (Vahedi et al., 2023).

Research with a spatio-temporal focus shows correlated geographic patterns: a Brazilian study on sexual violence against boys and male adolescents from 2013 to 2022 detected an annual increasing trend of 6.8 % and significant spatial dependence of high rates in municipalities with low human development index ($p < 0.001$)(Lima et al., 2024).

In Nairobi, analysis with GPS data identified that perception of insecurity correlates with factors such as being alone, time of day and characteristics of the physical space (hidden spaces, poor infrastructure), proving useful in the creation of citizen safety maps (Friedberg et al., 2020).

In Chicago and Los Angeles, community-level time series analyses reveal that certain types of crime (including domestic violence) had differential variations by community and crime type, suggesting spatial heterogeneity even within cities (Campedelli et al., 2020). Moreover, a recent meta-analysis noted that some crimes such as domestic violence and online fraud increased, while others decreased by stage of confinement and city. (Huang et al., 2025).

In sum, this line of research articulates a solid methodological path that starts from crime analysis with its geo-referencing techniques, hotspot mapping and modeling spatio-temporal to then delve into the specific dynamics of gender-based violence during COVID-19 confinement. By demonstrating how the perception of insecurity and crime patterns were modified in contexts of mobility restriction, these studies highlight the usefulness of crime analysis as a key tool for designing more targeted public policies and social prevention strategies (Ángel Soto Muñoz et al., 2025; Quintero Avila et al., 2025; Quintero Avila & Caballero Delgadillo, 2025; Quintero-Avila, 2024a, 2024b, 2025b, 2025a; Quintero-Avila, Alejandro Hernández-Valdez, et al., 2025; Quintero-Avila, Caballero-Delgadillo, et al., 2025; Quintero-Avila et al., 2024; Quintero-Avila & Caballero-Delgadillo, 2024, 2025b, 2025a; Quintero-Avila O & Caballero-Delgadillo JA., 2025).

Using this same analytical perspective in the Latin American context, Pérez-Fernández et al. (2025) examined the

spatio-temporal patterns of violence against women in Monterrey, Mexico, by analysing 27,036 verified emergency reports from the 911 system during the period from 2019 to 2022. Using a methodological framework that integrated Kernel Density Estimation (KDE), the Getis-Ord Gi* statistic, and spatiotemporal cube analysis, the research identified the formation of persistent and statistically significant clusters of violence. The findings showed that victimisation is not distributed randomly, but is concentrated in areas characterised by high socioeconomic vulnerability, specifically in the northern and eastern sectors of the municipality, particularly in neighbourhoods such as San Bernabé, Solidaridad and Niños Héroes.

The study also revealed cyclical temporal patterns, with incidents peaking on weekends especially Sundays and during night-time hours between 6 p.m. and 11 p.m., corroborating the theory of routine activities in the local context. Likewise, the space-time cube analysis detected 'hot spots of intensification,' showing how confinement and structural stress during the pandemic not only maintained but also exacerbated the dynamics of violence in homes in these marginalised areas. These results underscore the operational relevance of geospatial crime analysis for micro-zoning risk, allowing local authorities to move from reactive models to the design of preventive interventions and targeted patrolling strategies in the most vulnerable territories of the Global South.

In this context, it is essential to analyze not only the objective incidence of gender-based violence during confinement, but also how it manifests itself spatially and temporally at the local scale, and how it is perceived by citizens. This study adopts a geo-criminological and environmental criminology perspective to examine the relationship between perception of insecurity, spatio-temporal distribution of gender-based violence and urban characteristics in the state of Nuevo Leon, Mexico, in the municipality of Monterrey in the colonia colionas de fomerrey 25, using spatial analysis techniques, hotspot modeling and crime pattern mapping in combination with sociodemographic data and victimization surveys. The research methodology and the main empirical findings derived from this analysis are presented below.

METHODOLOGY

This is a quantitative, cross-sectional, descriptive and correlational study, whose objective is to explore the association between subjective perception of insecurity and objective reports of gender-based violence during COVID-19 confinement. Perception data will be collected at a single time point (May-June 2020) and 911 reports will span the period January 2019-December 2022.

INCLUSION CRITERIA.

- Persons over 18 years of age residing in the Fomerrey 25 neighborhood.
- Minimum stay in the area since January 2019.
- Signed informed consent

EXCLUSION CRITERIA

- Under 18 years of age or non-residents of Fomerrey 25.
- Participants with more than 10% of missing responses.
- Participants who withdraw their consent before the completion of the form.

POPULATION AND SAMPLE

Adults (≥ 18 years) from the colonia Fomerrey 25 Monterrey Nuevo leon. The selection of participants was done by probability sampling. The sample size was calculated according to the formula of Sampieri (2016), establishing an effect size of 0.10 for a bilateral test, with a significance level = 0.05 and a statistical power of 95 %. Considering a nonresponse rate of 5 %, the resulting sample size was 366 participants.

DATA COLLECTION

Data collection was organized on three complementary fronts: perception survey, documentary base of 911 reports and exploratory field walk, which are described below in an integrated manner.

First, the perception of insecurity survey was implemented between May and June 2020 through a community management protocol. In an initial meeting with the block chief of Fomerrey 25, an institutional official letter was presented detailing the purpose and relevance of the study, after which she invited neighbors over the age of 18 and provided a preliminary list of participants. Each subject was contacted by WhatsApp, where the voluntariness and confidentiality of

their participation was reiterated; they were then sent a link to a questionnaire in Google Forms along with instructions for use and the researcher's contact details to clarify doubts. Once the questionnaire was completed, some respondents referred other neighbors who met the inclusion criteria, thus expanding the sample to 366 valid questionnaires. Once the capture was concluded, the collaboration of the block chief and all the participants was formally acknowledged.

In parallel, documentary research was conducted on the reports of gender violence obtained from the 911 emergency service (January 2019-December 2022). The original set of 151 644 records in CSV format included folio number, date, time, municipality, neighborhood, incident description, corporation involved, and geographic coordinates (latitude/longitude). After importing the data into ArcGIS Pro, the records corresponding to Fomerrey 25 were filtered, violence categories were normalized, duplicates were eliminated and missing fields were managed to ensure the quality of the dataset.

Simultaneously, an exploratory field walk was carried out with the objective of identifying urban conditions associated with the perception of insecurity. During systematic walks through all blocks of Fomerrey 25, GPS georeferenced (accuracy ≥ 5 m) areas of social vulnerability were recorded.

For the spatial analysis, two cartographic products were generated in ArcGIS Pro:

1. Georeferencing map, showing the exact location of each 911 report within the colony.
2. Kernel density map of incident concentration. The event density estimate was calculated according to the formula:

$$f(x, y) = \frac{1}{nh^2} \sum_{i=1}^n k\left(\frac{d_i}{h}\right)$$

Where

$f(x, y)$ = density value at location (x, y)

n = number of events

h = bandwidth

d_i = distance between crime event i and location (x, y)

k = kernel function

mean. Peak values are observed in August (19 reports, 11.4 %) and December (18 reports, 10.8 %), probably associated with holiday periods and greater family tensions derived from prolonged forced cohabitation during confinement; May (16 reports, 9.6 %) also exceeds the mean, perhaps as a consequence of the loosening of restrictions and the consequent increase in social interaction. In contrast, the months of January (9 reports, 5.4 %) and, especially, February (5 reports, 3.0 %) present the lowest frequencies, which could reflect both the tighter immobilization of the early phases of the pandemic and adverse weather conditions deterring reporting. Overall, the variability of the data throughout the year underscores the need to design continuous interventions tailored to each stage of containment, paying particular attention to periods of higher incidence.

RESULTS

The quantitative findings obtained from the analysis of the temporal distribution of reports of gender-based violence and its correspondence with the perception of insecurity during COVID-19 confinement are presented below. First, the monthly variation of incidents is presented, which will serve as a basis for interpreting seasonal patterns and proposing hypotheses about their possible triggers. As shown in Table 1, the descriptive statistical analysis of the monthly series of reports reveals that, on average, 13.8 incidents of gender-based violence were recorded each month ($SD = 3.9$), with a coefficient of variation of 28.3%, indicating a moderate dispersion around the

The descriptive analysis of the daily frequencies of reports shows a mean of 23.7 incidents per day ($SD = 4.4$), with a coefficient of variation of 18.5 %, indicating a relatively low dispersion around the mean. Sunday (30 reports, 18.1 %) and Saturday (29 reports, 17.5 %) are more than one standard deviation above the daily mean, while Friday (26 reports, 15.7 %) is also above the mean. This pattern confirms a concentration of gender-based violence on weekends, a period in which prolonged cohabitation, alcohol consumption and the lower availability of support services can exacerbate intrafamily conflicts.

In contrast, Thursday registers the lowest value (18 reports, 10.8 %), located 1.3 SD

below the mean, followed by Tuesday (19 reports, 11.4 %), suggesting that in the middle of the week the dynamics of reporting and precipitating factors are less intense. Monday

(23 reports, 13.9 %), Wednesday (21 reports, 12.7 %) and Thursday form a block of lower incidence compared to the weekend, but relatively uniform among themselves.

Table 1.
Month Frequencies

Month	Frequencies	% of Total	% Cumulative
April	15	9.0%	9.0%
August	19	11.4%	20.5%
December	18	10.8%	31.3%
January	9	5.4%	36.7%
February	5	3.0%	39.8%
July	14	8.4%	48.2%
June	13	7.8%	56.0%
March	13	7.8%	63.9%
May	16	9.6%	73.5%
November	15	9.0%	82.5%
October	12	7.2%	89.8%
September	17	10.2%	100.0%

Table 2.
Day Frequencies

Day	Frequencies	% of Total	% Cumulative
Sunday	30	18.1%	18.1%
Thursday	18	10.8%	28.9%
Monday	23	13.9%	42.8%
Tuesday	19	11.4%	54.2%
Wednesday	21	12.7%	66.9%
Saturday	29	17.5%	84.3%
Friday	26	15.7%	100.0%

As shown in Table 3, 87.3% of the cases correspond to family violence ($n = 145$), while the remaining 12.7% refer to intimate partner violence ($n = 21$). This predominance

reflects a broader expression of the phenomenon of gender violence, going beyond the strictly conjugal sphere and encompassing extended family dynamics.

Table 3.
Frequencies of reporting

Type of report	Frequency	% of Total	% Cumulative
Intimate partner violence	21	12.7%	12.7%
Family violence	145	87.3%	100.0%

Table 4 shows that reports occur throughout the 24 hours of the day, with a higher concentration at night, particularly at 23:00 h ($n = 19$, 11.4 %) and 21:00 h ($n = 16$, 9.6 %). These hours coincide with the

time after returning from work, which may intensify family conflicts. The hours with the least reported correspond to the early morning (05:00 h and 07:00 h, $n = 1$, 0.6 %).

Table 4.
Frequencies of Time

Time	Frequencies	% of Total	% Accumulated
00:00:00	3	1.8%	1.8%
01:00:00	7	4.2%	6.0%
02:00:00	8	4.8%	10.8%
03:00:00	11	6.6%	17.5%
04:00:00	2	1.2%	18.7%
05:00:00	1	0.6%	19.3%
06:00:00	4	2.4%	21.7%
07:00:00	1	0.6%	22.3%
08:00:00	3	1.8%	24.1%
09:00:00	5	3.0%	27.1%
10:00:00	3	1.8%	28.9%

11:00:00	7	4.2%	33.1%
12:00:00	8	4.8%	38.0%
13:00:00	7	4.2%	42.2%
14:00:00	6	3.6%	45.8%
15:00:00	6	3.6%	49.4%
16:00:00	8	4.8%	54.2%
17:00:00	8	4.8%	59.0%
18:00:00	8	4.8%	63.9%
19:00:00	9	5.4%	69.3%
20:00:00	9	5.4%	74.7%
21:00:00	16	9.6%	84.3%
22:00:00	7	4.2%	88.6%
23:00:00	19	11.4%	100.0%

In Table 5, a progressive increase in reports per year is observed: 2019 ($n = 20$, 12.0 %), 2020 ($n = 41$, 24.7 %), 2021 ($n = 57$, 34.3 %) and 2022 ($n = 48$, 28.9 %). This trend can be explained by both a real increase in cases and a greater willingness to report, influenced by institutional campaigns, visibility of the issue or improvements

in access to emergency services. Figure 2 (histogram) and Figure 3 (box plot) visually complement these observations, highlighting the distribution and density of annual reports. Figure 4 represents the relationship between type of violence and year, showing consistency in the prevalence of family violence.

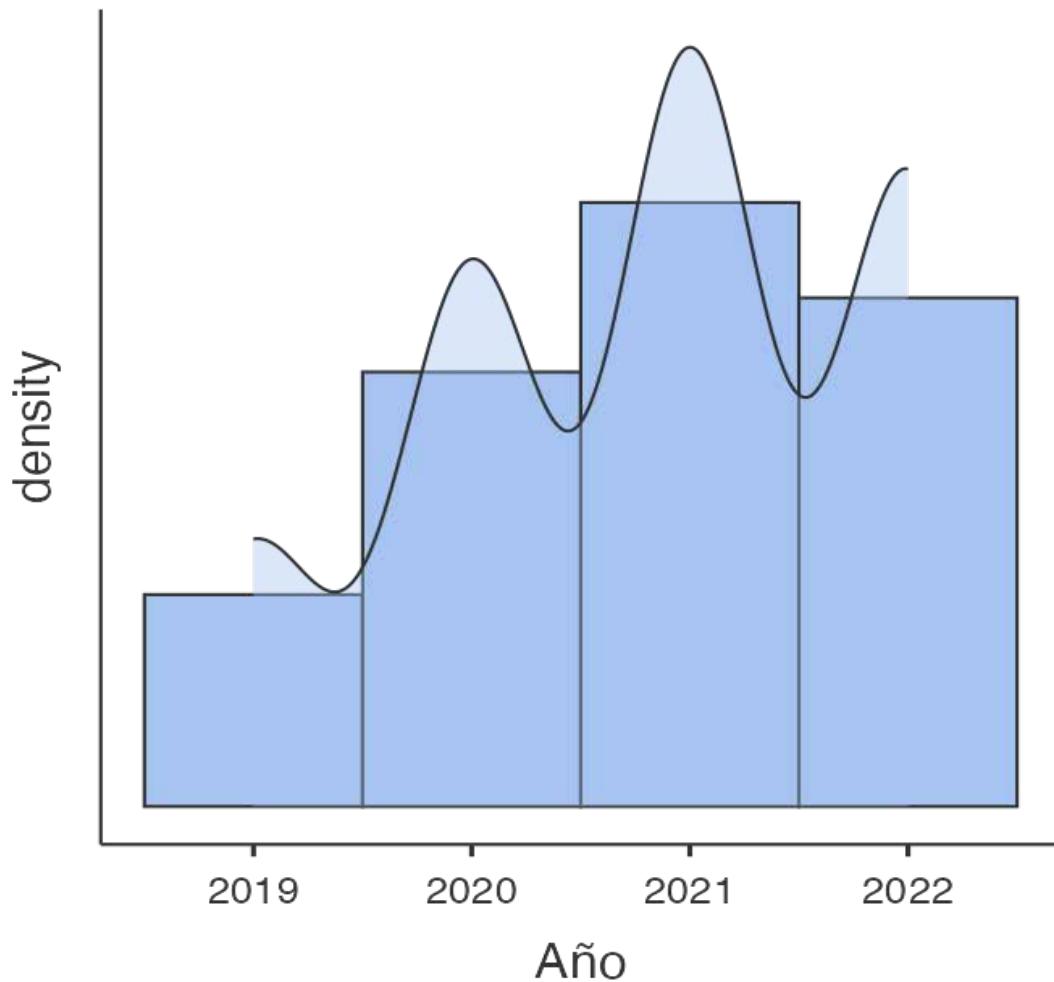
Table 5.
Frequencies of Year

Year	Frequencies	% of Total	Cumulative
2019	20	12.0%	12.0%
2020	41	24.7%	36.7%
2021	57	34.3%	71.1%
2022	48	28.9%	100.0%

Figure 2 shows the distribution of GBV reports over four years, using a smoothed histogram with overlaid density line. A steady growth is seen between 2019 ($n = 20, 12.0\%$) and 2021 ($n = 57, 34.3\%$), with a slight decline in 2022 ($n = 48, 28.9\%$). The density peak is concentrated in 2021, suggesting that this year was the

most critical in terms of reporting, possibly related to the social aftermath of COVID-19 confinement, economic stresses, and tighter family dynamics. The density curve indicates annual oscillations and allows inferring the presence of non-linear patterns in the reported phenomenon.

Figure 2
Histogram of density by year



The boxplot Figure 3 allows us to observe the dispersion of the annual data and the presence of possible outliers. In general, a higher variability is identified in 2021, a year that also shows a high median with respect to the others. This coincides with the findings of the histogram and reinforces the idea of a specific upturn in that year.

Likewise, the diagram shows some stability between 2020 and 2022, which may indicate a consolidation of the trend of actual reports or events. The absence of extreme values suggests that crime behavior as measured by 911 reports remains within expected ranges for the time series.

Figure 3
Boxplot by Year

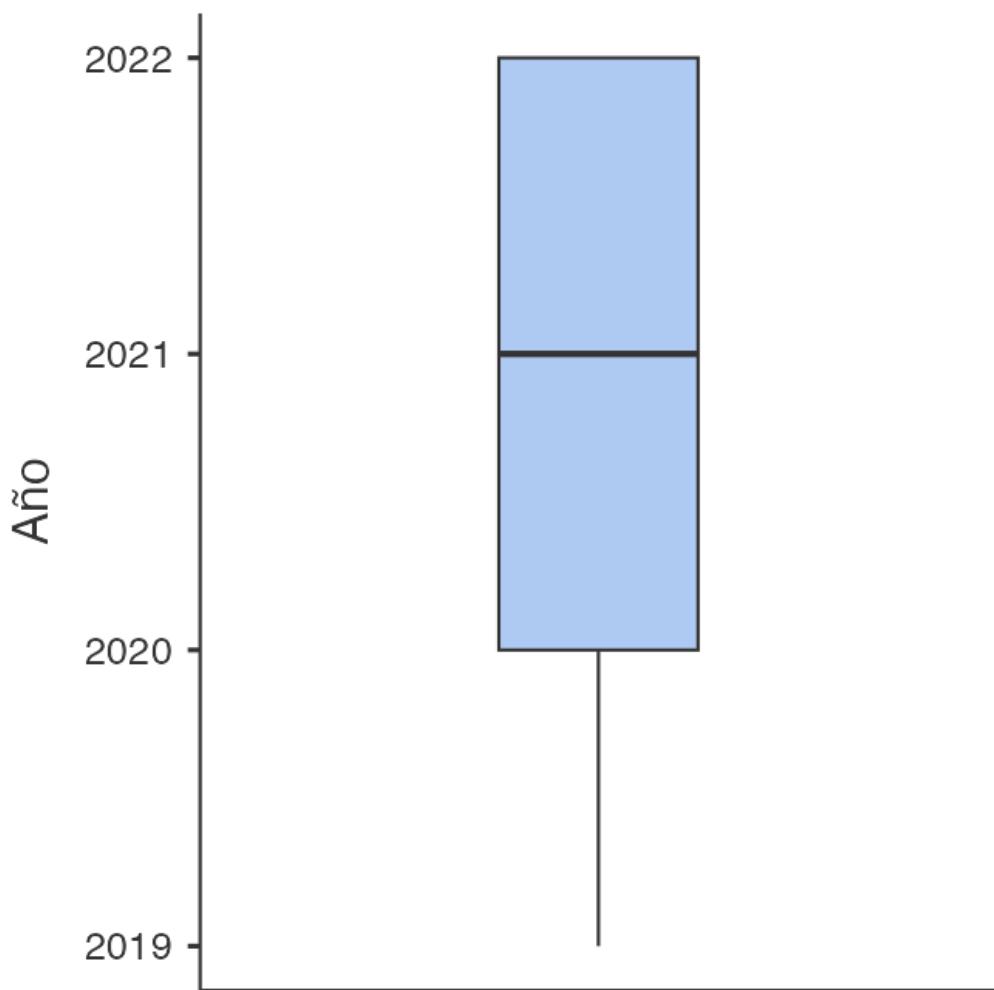
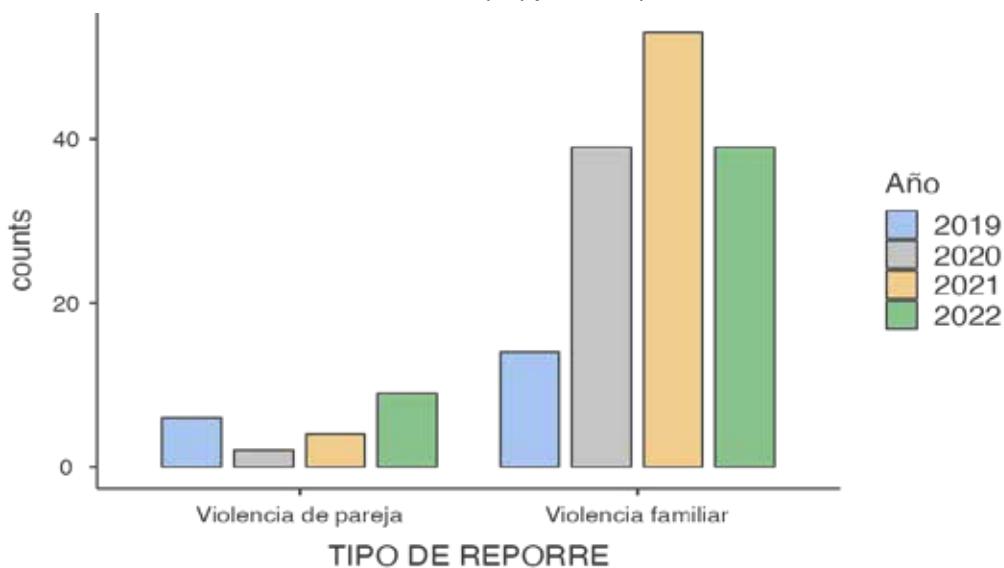


Figure 4 segments the variable “type of violence” (family vs. intimate partner) by year, which allows us to visualize internal trends in the nature of the reports. In the four years analyzed, family violence remains the predominant type of incident, consistently exceeding 80% of the annual

cases. In contrast, intimate partner violence represents a constant minority, with slight variations. This stability in the typology could reflect a more established reporting culture for cases of domestic violence, or a greater institutional visibility of this type of incident.

Figure 4
Bar chart by type and year



Respondents' perception of safety varies significantly depending on the environment in which they are located. Table 5 shows that the home is perceived as the safest environment, where 83.6% (n = 306) of people report feeling

safe, compared to 15.8% (n = 58) who feel unsafe, and 0.5% (n = 2) who did not respond. These data suggest that the home retains its function as a shelter, associated with stability, privacy and control of the environment.

Table 5.
Frequencies of Do you feel safe or unsafe in your home?

Feeling safe or insecure in your home	Frequencies	% of Total	Cumulative %
Unsafe	58	15.8%	15.8%
Unresponsive	2	0.5%	16.4%
Insurance	306	83.6%	100.0%

In contrast, Table 6 shows that in the work environment the perception of security is divided. 49.7 % (n = 182) expressed feeling safe, while 45.6 % (n = 167) feel unsafe. In addition, 4.1 % (n = 15) did not respond and 0.5 % (n = 2) indicated not applicable. This polarization could be related to labor factors such as economic sector, contractual conditions or geographical location of the workplace.

Table 6.
Frequencies of Do you feel secure or insecure in your job?

	Frequencies	% of Total	% Cumulative
Insecure	167	45.6%	45.6%
Not applicable	2	0.5%	46.2%
No answer	15	4.1%	50.3%
Insurance	182	49.7%	100.0%

The perception of insecurity is considerably intensified in open public spaces. According to Table 7, 85.2% (n = 312) of the respondents feel unsafe when walking on the street, compared to 13.9% (n = 51) who feel safe and 0.8% (n = 3) who did not respond. This environment represents the one with the highest risk perception, possibly associated with property crime, harassment, visible violence or lack of formal surveillance.

Table 7.
Frequencies of Feeling safe or unsafe on the street.

	Frequencies	% of Total	Cumulative
Unsafe	312	85.2%	85.2%
No response	3	0.8%	86.1%
Insurance	51	13.9%	100.0%

Regarding school spaces Table 8, 44.8 % (n = 164) of the participants expressed feeling safe, 35.0 % (n = 128) unsafe, and 20.2 % (n = 74) did not respond. This last proportion suggests that a portion of the

respondents do not have a direct relationship with educational institutions, or that there is some level of ambiguity regarding this space as a protective environment.

Table 8.
Frequencies of Feeling safe or unsafe at school.

	Frequencies	% of Total	% Cumulative
Unsafe	128	35.0%	35.0%
No response	74	20.2%	55.2%
Insurance	164	44.8%	100.0%

Regarding public transportation, Table 9 reflects that 82.2% ($n = 301$) perceive it as unsafe, 16.4% ($n = 60$) feel safe and 1.4% ($n = 5$) did not respond. This environment appears as one of the most problematic, coinciding with previous studies that link it to crimes such as robbery, sexual harassment and lack of adequate infrastructure for safe mobility.

Table 9.
Frequencies of Do you feel safe or unsafe in public transportation?

	Frequencies	% of Total	% Cumulative
Unsafe	301	82.2%	82.2%
No response	5	1.4%	83.6%
Insurance	60	16.4%	100.0%

Table 10 evidences that 74.3 % ($n = 272$) of respondents feel unsafe in public parks, while only 24.0 % ($n = 88$) report feeling safe; in addition, 1.1 % ($n = 4$) did not respond and 0.5 % ($n = 2$) responded that

it does not apply. These results reflect the lack of maintenance, lighting, surveillance or community ownership of these green spaces.

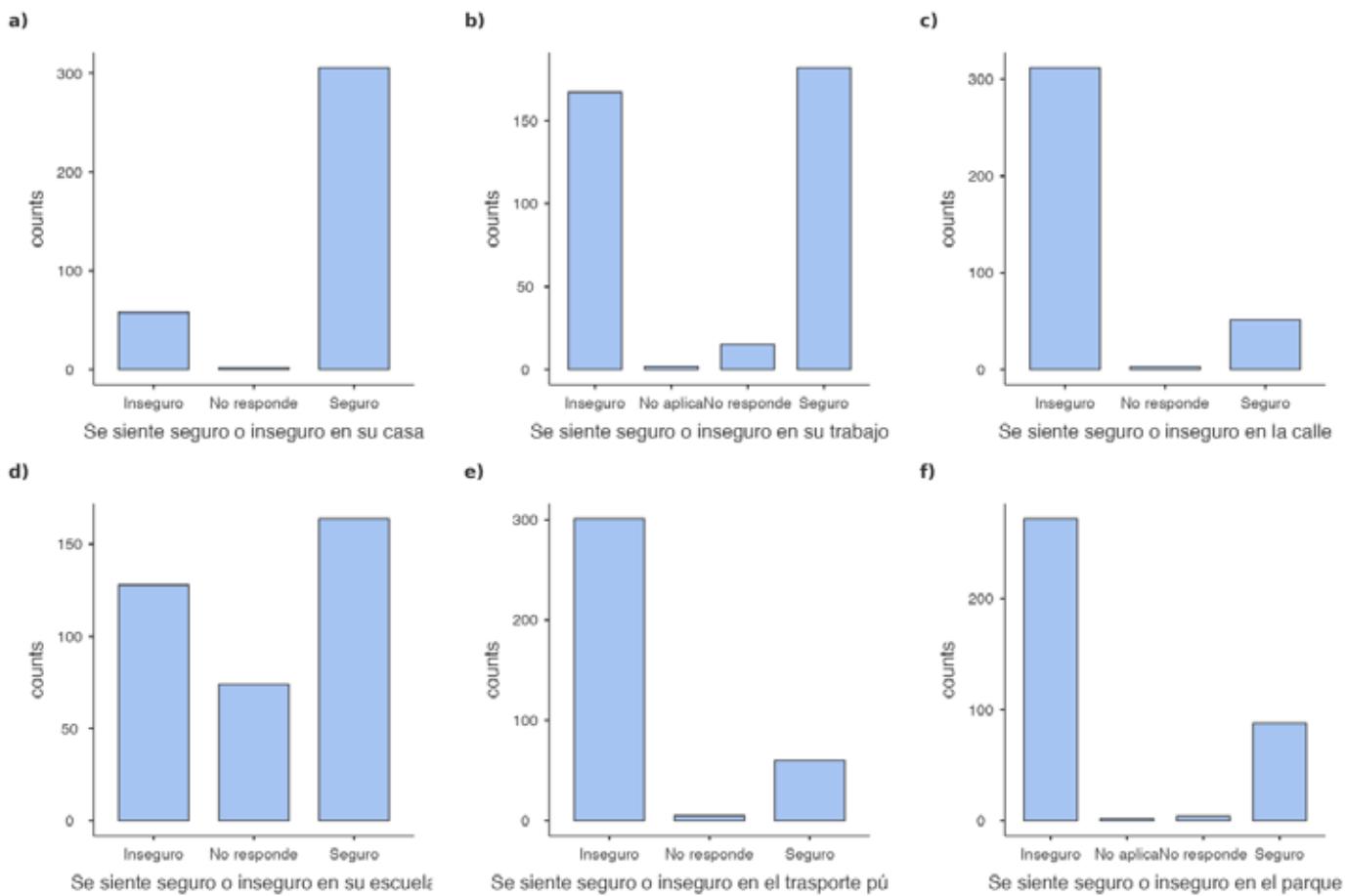
Table 10.
Frequencies of Do you feel safe or unsafe in the park?

	Frequencies	% of Total	% Cumulative
Unsafe	272	74.3%	74.3%
Not applicable	2	0.5%	74.9%
No response	4	1.1%	76.0%
Insurance	88	24.0%	100.0%

Figure 5 graphically synthesizes this information through a representation of bars, where it is clearly observed that home and work are perceived as the environments with the greatest subjective security, while the street, public transportation and the park are those that generate the greatest perception

of insecurity. This segmentation evidences the need for targeted and differential public policies according to the type of environment, prioritizing intervention in open spaces through preventive urbanism strategies, community policing and recovery of public space.

Figure 5
Security perception bar chart



During the exploratory march, 51 observation points were identified that reflect conditions of social vulnerability in the Fomerrey 25 neighborhood. The identification of areas of social vulnerability is fundamental to understand the territorial

context in which criminal phenomena are inserted and to design preventive intervention strategies. Table 11 presents the distribution of these areas observed during the field survey, classified into four main categories.

The category with the highest presence corresponds to Areas of Urban Deterioration by Graffiti, which represent 47.1 % (n = 24) of the total recorded. These areas reflect signs of physical and visual abandonment.

Second, both Areas of Environmental Deterioration due to Excessive Vegetation and Abandoned Houses were reported, each with a frequency of n = 11 (21.6 %). Uncontrolled vegetation can obstruct visibility and provide spaces conducive to the commission of crimes, while abandoned houses constitute risk areas due to their possible use for illicit activities, substance use or sexual aggression.

Finally, Areas of Environmental Deterioration by Garbage represent 9.8% (n = 5). Although less frequent, these areas also have a negative impact on the perception of security, reflecting institutional negligence and the breakdown of informal control of public space.

100% of the identified sites present at least one indicator of environmental or urban vulnerability, which reinforces the need to integrate situational crime prevention strategies through the recovery of public space, improved lighting, cleanliness, environmental intervention and promotion of a sense of community.

Table 11.
Frequency of Social Vulnerability Areas

Areas of Social Vulnerability	Frequencies	% of Total	% Cumulative
Areas of Environmental Deterioration due to Garbage	5	9.8%	9.8%
Areas of Environmental Deterioration due to Excessive Vegetation	11	21.6%	31.4%
Areas of Urban Deterioration by Graffiti	24	47.1%	78.4%
Abandoned house	11	21.6%	100.0%

The geo-referenced map (Figure 6) shows that the reports of gender-based violence (red dots) are not evenly distributed, but are mainly concentrated in the central axis and in the southwestern portion of the neighborhood. These areas coincide with several of the social vulnerability hotspots identified in the exploratory walk (blue dots), especially those related to graffiti and overgrown vegetation. This spatial overlap suggests that environments with visible

signs of abandonment and physical disorder may act as facilitators of violence.

Beyond simple coincidence, a proximity analysis reveals that a high percentage of reports (more than 60%) are located within 100 m of at least one urban vulnerability indicator, which reinforces the hypothesis of correlation between environmental deterioration and incident occurrence. Similarly, the kernel densities generated show

clear “hotspots” where multiple reports and graffiti points converge, delimiting priority zones for intervention. These findings point to the need for situational prevention

approaches that combine urban cleanup, graffiti removal and vegetation pruning with targeted patrolling and community space appropriation campaigns.

Figure 6
Map of 911 Reports and Social Vulnerability Areas
Georreferenciación reportes 911 y Marcha Exploratoria

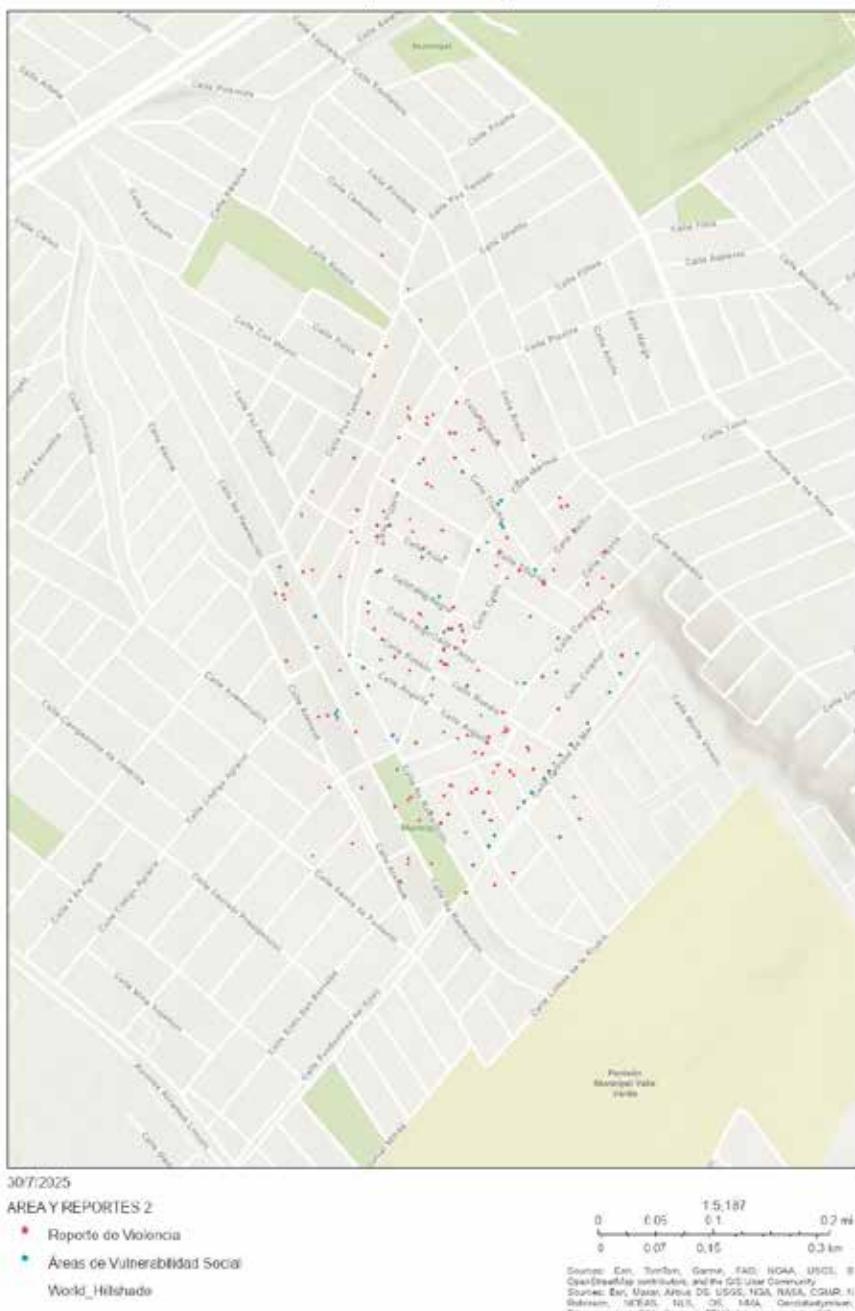
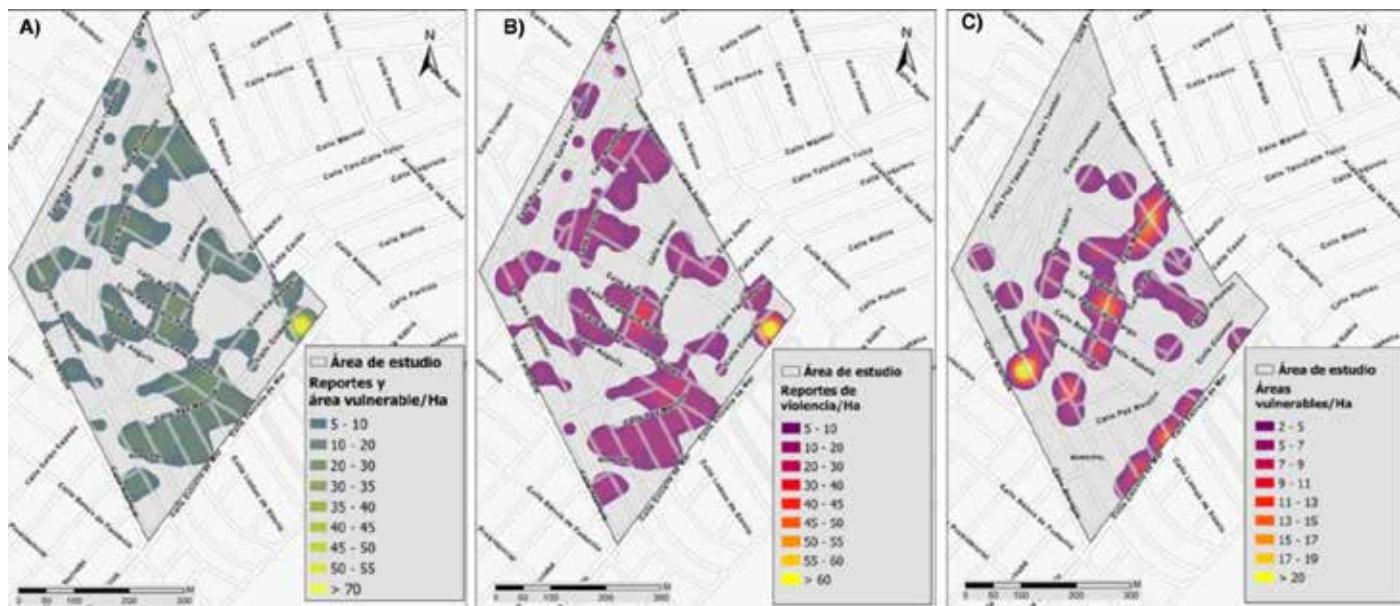


Figure 7 shows three normalized kernel density maps per hectare that reveal the spatial relationship between reports of gender-based violence and areas of social vulnerability. In panel A, where both sets of points overlap, it is clear how the resulting "hotspots" mostly coincide with areas of urban and environmental deterioration. Panel B, focused exclusively on the density of 911 reports, identifies two hotspots of high incidence: one in the central axis of the colony, where the density exceeds 60 reports/ha, and another to the southwest, with values of 40-50 reports/ha. Panel C, which illustrates the density of vulnerability indicators (graffiti, overgrown vegetation, abandoned houses and garbage), also shows concentrations above 15-20 events/ha in those same areas, which reinforces the hypothesis that physical abandonment facilitates the occurrence of GBV incidents. However, in the northeast intersection, a high density core of reports (panel B) is detected without a corresponding vulnerability hotspot (panel C), suggesting the intervention of additional factors e.g., high population density or immediate escape routes. These findings indicate that situational prevention strategies should combine recovery and maintenance of public space.

Figure 7
Kernel density density 911 reports and Areas of Social Vulnerability



CONCLUSION

This study integrated subjective data on perception of insecurity and objective reports of gender-based violence during COVID-19 confinement in colonia Fomerrey 25, applying spatio-temporal analysis and exploratory walking. The findings reveal seasonal patterns (peaks in August and December, in January-February), weekly concentrations (weekends) and night hours (21:00-23:00 h) with higher incidence of 911 reports, along with high levels of perception of insecurity in the street, public transport and green spaces.

The spatial overlap between hotspots of violence and areas of urban vulnerability (graffiti, overgrown vegetation, abandoned houses and garbage) reinforces the hypothesis that physical and environmental deterioration acts as a facilitating factor for gender incidents. Proximity analysis and kernel densities show that more than 60% of the reports are located near abandonment indicators, evidencing a strong correlation between territorial disorder and violence.

In terms of situational prevention, these results suggest the convenience of dual strategies: first, urban recovery interventions (graffiti removal, vegetation pruning, cleaning and improvement of lighting) in overlapping hotspots; second, strengthening of targeted patrolling and promotion of community policing in high incidence areas that are not exclusively explained by physical vulnerability. Likewise, the polarization of the perception

of security between private (home, work) and public (street, transportation, park) environments points to the need for differential policies according to the risk context

BIBLIOGRAPHY

Ángel Soto Muñoz, M., Quintero Avila, O., & Antonio Caballero Delgadillo, J. (2025). *Prevención situacional del delito: Percepción de menores sobre riesgos en su entorno escolar* (Vol. 11).

Campedelli, G. M., Favarin, S., Aziani, A., & Piquero, A. R. (2020). Disentangling community-level changes in crime trends during the COVID-19 pandemic in Chicago. *Crime Science*, 9(1). <https://doi.org/10.1186/s40163-020-00131-8>

Cristina Mejía Hernández, M. (2021). *Confinamiento y Violencia de Género en el Contexto de la Pandemia Covid-19 Confinement and Gender Violence Due to the Covid-19 Pandemic*.

Friedberg, R., Sarnquist, C., Nyairo, G., Amuyunzu-Nyamongo, M., & Baiocchi, M. (s/f). *Understanding the spatial burden of gender-based violence: Modelling patterns of violence in Nairobi, Kenya through geospatial information*.

Huang, X., Long, D., & Liu, H. (2025). Different lockdowns and theft: a Bayesian analysis of COVID-19's impact on urban crime in ZG City, China. *Computational Urban Science*, 5(1), 24. <https://doi.org/10.1007/s43762-025-00182-0>

IEP. (2024). *Institute for Economics & Peace*. www.economicsandpeace.org.

INEGI. (2023a). *Encuesta Nacional de Seguridad Pública Urbana Segundo Trimestre 2023 Principales Resultados*.

INEGI. (2023b). *Encuesta Nacional de Victimización y Percepción sobre Seguridad Pública Principales Resultados Nuevo León*.

Lima, B. C. L., Miranda, C. E. S., Do Nascimento, F. F., Andrade, J. X., Rodrigues, M. T. P., & Borges, J. W. P. (2024). Temporal and spatial analysis of notifications of sexual violence against male children and adolescents in Brazil, 2013 to 2022: an

ecological study. *Epidemiologia e Servicos de Saude*, 33. <https://doi.org/10.1590/S2237-96222024v33e20231439.en>

Pérez-Fernández, O., Quintero Ávila, O., Barros, C., & Rosario Michel, G. (2025). Spatio-Temporal Mapping of Violence Against Women: An Urban Geographic Analysis Based on 911 Emergency Reports in Monterrey. *ISPRS International Journal of Geo-Information*, 14(10), 367. <https://doi.org/10.3390/ijgi14100367>

Ostadtaghizadeh, A., Zarei, M., Saniee, N., & Rasouli, M. A. (2023). Gender-based violence against women during the COVID-19 pandemic: recommendations for future. *BMC Women's Health*, 23(1), 219. <https://doi.org/10.1186/s12905-023-02372-6>

Quintero Avila, O., & Caballero Delgadillo, J. A. (2025). Redes sociales e instituciones ante el ciberdelito: análisis de la percepción de confianza digital. *Dilemas contemporáneos: Educación, Política y Valores*, 1–22. <https://doi.org/10.46377/dilemas.v13i1.4760>

Quintero Avila, O., García Herrera, D. G., & Caballero Delgadillo, J. A. (2025). Cybercriminología e perfil del cybercriminales. En *LA RICOSTRUZIONE CRIMINOLOGICA DELL'EVENTO* (Vol. 1, Número 1, pp. 288–310). Diritto Più.

Quintero-Avila, O. (2024a). El Análisis y mapeo delictivo para el desarrollo de políticas públicas de seguridad en México. *Constructos Criminológicos*, 4(7), 159–170. <https://doi.org/10.29105/cc4.7-86>

Quintero-Avila, O. (2024b). Un análisis de la percepción de seguridad durante la pandemia de COVID-19 en la colonia México Lindo en San Nicolás de los Garza, Nuevo León, México. *Estudios de la Seguridad Ciudadana*, 9(7), 149–178. <https://revista.ucs.edu.mx/wp-content/uploads/2024/08/Art-7-Vol-9.pdf>

Quintero-Avila, O. (2025a). Análisis espacial del delito: violencia de género en Monterrey, Nuevo León. En Mario Alberto Garza Catillo, Octavio Quintero Avila, & Juan Antonio Caballero Delgadillo (Eds.), *Perspectivas criminológicas. En la inteligencia criminal estratégica* (1a ed., Vol. 1, Número 1, pp. 63–104). Tirant Humanidades.

<http://eprints.uanl.mx/29410/7/29410.pdf>

Quintero-Avila, O. (2025b). Análisis espacial del delito: violencia de género en Monterrey, Nuevo León. En Tirant lo Blanch (Ed.), *Perspectivas criminológicas. En la inteligencia criminal estratégica* (1a ed., pp. 63–104).

Quintero-Avila, O., Alejandro Hernández-Valdez, O., & Soto-Muñoz, M. Á. (2025). Análisis geoespacial de la percepción de inseguridad en el campus Ciudad Universitaria de San Nicolás de los Garza, Nuevo León. *Revista CienciaUANL*, 28, 43–47. <https://doi.org/10.29105/cienciauanl28.133-5>

Quintero-Avila, O., & Caballero-Delgadillo, J. A. (2024). Análisis Espacial de la Violencia de Género contra la Mujer: Estudio de Reportes de emergencias 911 mediante Sistemas de Información Geográfica. *REVISTA VERITAS ET SCIENTIA-UPT*, 13(2), 179–193. <https://doi.org/10.47796/ves.v13i2.1111>

Quintero-Avila, O., & Caballero-Delgadillo, J. A. (2025a). El análisis delictivo como herramienta en la construcción de estrategias de prevención social y delincuencial. *Constructos Criminológicos*, 5(8), 55–74. <https://doi.org/10.29105/cc5.8-101>

Quintero-Avila, O., & Caballero-Delgadillo, J. A. (2025b). Percepción de Inseguridad Urbana: Enfoque Geoespacial para el análisis criminológico. *Dilemas contemporáneos: Educación, Política y Valores*, 12(3), 1–25. <https://doi.org/10.46377/dilemas.v12i3.4692>

Quintero-Avila, O., Caballero-Delgadillo, J. A., & García-Herrera, D. G. (2025). Visualización de la inseguridad. *Divulgación de Ciencia y Educación*, 2(3), 38–40. <https://redicie.upeg.edu.mx/2025/01/22/visualizacion-de-la-inseguridad/>

Quintero-Avila, O., Caballero-Delgadillo, J. A., Hernández-Valdez, O. A., MÁ., S.-M., & García-Herrera, D. G. (2024). Estrategias metodológicas para el análisis y mapeo delictivo en las ciencias sociales. *Perspectivas*, 9(24), 257–280. <https://doi.org/10.26620/uniminuto.perspectivas.9.24.2024.257-280>

Quintero-Avila O, & Caballero-Delgadillo JA. (2025). *Perspectivas criminológicas En la inteligencia criminal*

estratégica (Tirant Humanidades, Ed.; 1a ed., Vol. 1). Tirant Humanidades.

Ravindran, S., & Shah, M. (2023). Unintended consequences of lockdowns, COVID-19 and the Shadow Pandemic in India. *Nature Human Behaviour*, 7(3), 323–331. <https://doi.org/10.1038/s41562-022-01513-5>

Rocha, F., Diaz, M. D. M., Pereda, P. C., Árabe, I. B., Cavalcanti, F., Lordemus, S., Kreif, N., & Moreno-Serra, R. (2024). COVID-19 and violence against women: Current knowledge, gaps, and implications for public policy. *World Development*, 174, 106461. <https://doi.org/https://doi.org/10.1016/j.worlddev.2023.106461>

Vahedi, L., McNelly, S., Lukow, N., Fonseca, A. C., Erskine, D., Poulton, C., Stark, L., & Seff, I. (2023). “The pandemic only gave visibility to what is invisible”: a qualitative analysis of structural violence during COVID-19 and impacts on gender-based violence in Brazil. *BMC Public Health*, 23(1), 1854. <https://doi.org/10.1186/s12889-023-16675-8>

Octavio Quintero Avila

Afiliación: Universidad Autónoma De Nuevo Leon
 Lic. en Criminología, Mtro. en Criminología, Dr. en Criminología por la Universidad Autónoma de Nuevo León (UANL). Miembro del Sistema Nacional de Investigadoras e Investigadores (SNI Nivel candidato). Docente de Licenciatura y Posgrado en la Facultad de Derecho y Criminología de la UANL. Investigador en la Facultad de Derecho y Criminología de la UANL. Correo electrónico: oquinteroa@uanl.edu.mx Octavioquinteroavila@gmail.com ORCID:<https://orcid.org/0000-0003-3922-9964>

Onel Pérez Ávila

Afiliación: Escuela de geografía de Panamá.
 Escuela de Geografía, Departamento de Cartografía, Universidad de Panamá, Panamá City 0824, Panama;
 onel.perez@up.ac.pa

Juan Antonio Caballero Delgadillo

Afiliación: Universidad Autónoma de Nuevo León.
 Profesor Investigador

Analy Cervantes Vidaurri

Afiliación: Secretaría de las Mujeres
 Profesora Investigadora, Secretaría de las Mujeres del Estado de Nuevo León

