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ORIGINAL

# Forensic Medical Analysis in Deceased Persons with Ballistic Indications from Firearms in the City of Guayaquil: Case Study from January to June 2024 and its Impact on Clinical Management in Emergency Situations

## Análisis Médico Forense en Fallecidos con Indicios Balísticos por Armas de Fuego en la Ciudad de Guayaquil: estudio de Casos de Enero a Junio de 2024 y su Impacto en el Manejo Clínico en Situaciones de Emergencia

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## ABSTRACT

**Introduction:** armed violence represents a significant challenge to public safety and community health, with devastating consequences for both victims and society as a whole.
**Objective:** statistical analysis of deaths with ballistic evidence from firearms in Guayaquil during the first half of 2024, with the aim of understanding armed violence, and the medical-forensic implications of this type of cases.
**Method:** a cross-sectional study was carried out, with a mixed approach (qualitative and quantitative), using a descriptive and exploratory methodology. The universe was made up of the cases of deaths in the city of Guayaquil registered in the Criminalistics and Forensic Sciences Laboratory, during the period from January to June 2024
**Results**: there is a universe of 1919 cases reported and investigated by the Criminalistics and Forensic Sciences Laboratory, in the city of Guayaquil, during the period from January to June 2024, of which 1435 met the inclusion criteria, where the average age was 33 years, 89,12 % corresponded to males and 10,87 % to females; the month of January with 20,83 % was the month with the highest percentage of deaths with the use of firearms; according to the medical-legal causes of death, hypovolemic shock 50,38 % corresponded to the main cause of death in corpses with the use of firearms that generated ballistic evidence.
**Conclusions:** there is an alarming prevalence of deaths with the use of firearms that generate ballistic evidence in the city of Guayaquil, during the first half of 2024, so, in our opinion, to fight against this criminal modality, more control over arms trafficking is necessary. Doctors as health professionals in Ecuador face this great challenge, so it is imperative to have qualified personnel to control critical situations, and thus provide a possibility of survival.

**Keywords:** Forensic Doctor; Armed Violence; Firearms; Guayaquil; Ballistic Evidence; Firearms Injuries; Arms Trafficking; Hypovolemic Shock.

**RESUMEN**

**Introducción**: la violencia armada representa un desafío significativo para la seguridad pública y la salud comunitaria, con consecuencias devastadoras tanto para las víctimas como para la sociedad en su conjunto.
**Objetivo:** análisis estadístico de los fallecidos con indicios balísticos por armas de fuego en Guayaquil durante el primer semestre de 2024, con el objetivo de comprender la violencia armada, y las implicaciones médico-forenses de este tipo de casos.
**Método:** se realizó un estudio transversal, con un enfoque mixto (cualitativo y cuantitativo), utilizando una metodología descriptiva y exploratoria. El universo estuvo conformado por los casos de fallecimientos en la ciudad de Guayaquil registrados en el Laboratorio de Criminalística y Ciencias Forenses, durante el periodo de enero a junio 2024
**Resultados:** se cuenta con un universo de 1919 casos reportados e investigados por parte del Laboratorio de Criminalística y Ciencias Forenses, en la ciudad de Guayaquil, durante el periodo enero a junio 2024, de los cuales 1435 cumplieron con los criterios de inclusión, donde el promedio de edad fue de 33 años, el 89,12 % corresponde al masculino y el 10,87 % al sexo femenino; el mes de enero con 20,83 % fue el mes con mayor porcentaje de muertes con el uso de armas de fuego; de acuerdo a las causas de muerte médico legal, el shock hipovolémico 50,38 % correspondió a la principal causa de muerte en cadáveres con el uso de armas de fuego que generaron indicios balístico.
**Conclusiones:** existe una prevalencia alarmante de muertes con el uso de armas de fuego que generan indicios balísticos en la ciudad de Guayaquil, durante el primer semestre de 2024, por lo que, a nuestro criterio para luchar contra esta modalidad delictiva, es necesario más control sobre el tráfico de armas. Los médicos como profesionales de salud, en Ecuador enfrentan este gran desafío, por lo que es imperativo contar con personal calificado para controlar situaciones críticas, y así brindar una posibilidad de supervivencia.

**Palabras clave:** Médico Forense; Violencia Armada; Armas de Fuego; Guayaquil; Indicios Balísticos; Heridas por Armas de Fuego; Tráfico de Armas; Shock Hipovolémico.

## INTRODUCTION

Armed violence, particularly deaths caused by firearm projectile impacts, has emerged as a significant public health and safety concern in urban areas of Latin America. It is vitally important to address the phenomenon of armed violence in a comprehensive and multidisciplinary way, especially in urban contexts such as the city of Guayaquil, the second most populous city in Ecuador, as it is ranked as one of the most violent cities in the world.[1] The dynamics of (direct) armed violence in the city of Guayaquil allow us to briefly visualize its impact in Ecuador and adopt strategies to reduce it, specialized medical care, and encourage a culture of peace, making use of the theoretical perspective of Johan Galtung, who proposes that "violence is like an iceberg, only a small part of the conflict is visible".[2,3] At the same time, submerged is structural violence (poverty, repression, pollution, alienation) and cultural violence (ideas, norms, values, tradition).[4]

In this sense, the present article focuses on the statistical analysis of deaths by firearms in Guayaquil during the first semester of 2024 to understand armed violence and the medico-forensic implications of this type of case. Armed violence represents a significant challenge to public safety and community health, with devastating consequences for both the victims and society as a whole. Armed violence is more deadly than other forms of violence, as it produces much more fatal injuries, and as it is considered lethal, this type of violence is regarded as a public health problem.[5] In this context, medical-forensic research plays a crucial role in collecting, analyzing, and interpreting physical evidence related to incidents of armed violence, which is essential for a multidisciplinary evaluation and in-depth study of violence in Ecuador.[6] Structural violence manifested itself in the conditions of poverty in which the victims lived, as well as the violent and unsafe environment of the city of Guayaquil, the restricted access to quality public medical care, free medicines, psychological care, and impunity. Cultural violence in Ecuador allows direct and structural violence to continue to prevail and not diminish.

In the context of this crisis of violence, it is essential to address the problem from a multidisciplinary approach, including both public safety and forensics, to understand the clinical and forensic complexities of firearm-related deaths. Detailed analysis of the injuries and ballistic evidence provides invaluable information about the circumstances and the dynamics of the events, allowing the reconstruction of the scenarios and contributing to the solving of crimes, as well as the prevention of future acts of violence. Numerous factors influence the capacity of a projectile to threaten life, such as the region of the body hit, the distance from which it was fired, the speed at the moment of impact, the physical characteristics of the projectile (such as its mass and shape), the type of weapon used, the stability of the projectile in flight and any angular deviation at the moment of impact.[7]

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Knowing about fatal gunshot wounds is relevant for healthcare personnel, as it provides an overview that allows them to act quickly in similar cases where the person with gunshot wounds is still alive and can be given emergency care. Rapid diagnosis of vascular injury is critical to prevent complications from prolonged limb ischemia, including compartment syndrome.[8] Wounds caused by traumatic weapon projectiles can be penetrating or blunt, and their trajectories and characteristics can appear superficial or lethal, with projectiles lodged in the subcutaneous and muscular tissues, as observed in some cases. There may also be minor ecchymosis and lacerations accompanied by visceral or vascular injuries, requiring a systematic priority-based medical approach.

This study focuses specifically on the city of Guayaquil, a metropolis characterized by its social complexity and problems related to crime and violence, which is currently facing a growing rate of homicides and violent deaths. During the period from January to June 2024, numerous cases of deaths with gunshot wounds were recorded, which highlights the urgency of addressing this issue from a scientific and clinical perspective, making this type of direct violence present in Ecuador statistically visible. This study seeks to delve into the nature of projectile injuries and how they affect the ability of medical teams to provide effective emergency care. In particular, the research addresses the impact of these traumas on clinical practice and plays a crucial role in designing preventive strategies in public health. Understanding the dynamics of these injuries is not only essential for the reconstruction of events in the forensic field but also for medical personnel in the field of emergencies.

**Theoretical-conceptual perspective**

The theoretical framework used to analyze armed violence in this paper is:

Criminal organizations in Ecuador are not limited to drug trafficking. According to a report by the United Nations Office on Drugs and Crime (UNODC, 2020), they are also involved in crimes such as arms trafficking, human trafficking, money laundering, and extortion. The phenomenon's complexity increases with this diverse criminal portfolio, but it also poses a significant challenge for the authorities responsible for tackling it.[9]

Firearms trafficking affects the world, influencing society in various ways. It constitutes one of the main problems in the context of human security and is at the center of efforts to maintain order and enforce the law. Firearms contribute decisively to violence, especially homicides, play a fundamental role in organized crime, and amplify the incidence of armed conflicts and terrorism. The most common form of illicit arms trafficking is that of small arms and light weapons (SALW). However, the nature of the trafficking can vary considerably from one geographical context to another and according to the type of weapon.[10] Ecuador is facing an unprecedented increase in violence and crime and is among the 10 countries with the highest crime rate in the world. It currently has the highest rate of violent deaths in Latin America, with 47,25 deaths per 100 000 inhabitants, eight times higher than in 2016, the year in which Ecuador registered its lowest rate since 1980. Once the second safest country in South America, Ecuador has become the most violent in less than a decade.[11]

We have experienced an unprecedented increase in violence in recent years, to the point that it currently has the highest number of violent deaths in the whole of the Americas (47 per 100,000 inhabitants), an increase of 8,33 times compared to 2016, when it registered its lowest violence rate since 1980. The number of homicides has practically doubled year on year, as has the recurrence of the use of firearms.[12] Firearm injuries are increasingly common and represent a challenge in emergencies. After the initial assessment of the traumatized patient, it is essential to determine their hemodynamic status, the trajectory of the projectile, the type of projectile involved, and the presence of signs of vascular or airway injury. However, it is crucial to remember that not all bruises or bullet marks on the skin indicate a possible vascular, visceral, or bone injury. The patient's clinical context, the characteristics of the affected anatomical region, the elasticity of the tissue, and the support of diagnostic images should always be considered, as these are fundamental to understanding the projectile material and its trajectory.[13]

Firearm injuries are defined as the set of modifications produced in the body by the effect of the elements that make up the shot; these injuries have peculiar characteristics that allow us to anticipate the injuries we will find and organize the intervention we will carry out, for which imaging plays a vital role since these projectiles are radiopaque. Firearms are devices designed to violently launch projectiles by exploiting the expansive force of the gases generated inside them by the deflagration of gunpowder. These projectiles have a high kinetic energy, which allows them to reach long distances and have great penetrating power. One of the main characteristics of firearm wounds is the entry wound since a detailed examination of this will reveal the distance at which the shot was fired and provide information on the trajectory and the medico-legal etiology. It is worth mentioning that the type of weapon can modify the entry wound in a few ways.[14,15]

From a medical and surgical point of view, gunshot wounds are considered blunt injuries and are described as simple contusions with a break in continuity. These injuries have three main components: the entry wound, the trajectory, and the exit wound. The entry wound is a blunt injury and is made up of constant elements: the cleaning wound, the erosive blunt wound, and blood infiltration. Other elements are the carbonaceous

halo, the tattoo, and the burn (depending on the distance from which the shot was fired and whether or not clothing was worn). The projectile's trajectory inside the body can be rectilinear or deviate when it collides with bones. The exit wound is created by the pressure the projectile exerts from the inside out, entering the skin. It, therefore, does not present the characteristics of the entry wound (clean entry wound or contused-erosive wound).[15]

There are countless causes of death caused by firearms, for the purposes of this study the following are taken into account:

Hypovolemic shock is characterized by a state of tissue hypoperfusion, which can be classified as hemorrhagic (loss of erythrocytes) and non-hemorrhagic (caused by dehydration), caused by trauma and bleeding. In terms of its pathophysiology, bleeding is the central component, and the extent of damage to the soft tissues will determine whether it is hemorrhagic or non-hemorrhagic shock. This pathophysiological mechanism begins with a reduction in cardiac output, as a reduction in blood volume causes a decrease in systemic venous pressure and cardiac filling. Therefore, a reduction in cardiac output, without an adequate compensatory response and accompanied by a decrease in vascular resistance, will result in generalized hypotension. This reduces perfusion pressure, limiting blood flow to the tissues and causing a critical reduction in the supply of oxygen, which can eventually trigger cellular ischemia, resulting in ischemia of organs essential for survival.[16,17]

Clinical evaluation of the patient is crucial; timely diagnosis is essential and must be based on a detailed medical history, thorough physical examination, and complementary studies to identify life-threatening injuries; continuous monitoring of vital signs, neurological status, and diuresis is essential to maintain hemodynamic stability and blood volume. The timely and accurate identification of the degree of severity of hypovolemic shock is fundamental since moderate or severe cases are usually evident. In contrast, mild shock can be more challenging to diagnose. In mild shock, the loss of blood volume is less than 20 %, and symptoms such as paleness and cold sweating in the extremities appear; in moderate shock, characterized by a volume loss of 20 to 40 %, oliguria, restlessness, and anxiety are added; in severe shock, blood loss exceeds 40 %, manifesting itself with hypotension, oliguria and cold sweating on the skin. These symptoms lead to a state of drowsiness, decreased cerebral flow, and, in the absence of timely treatment, death.[16,17]

In the therapeutic approach, early fluid therapy constitutes the basis of treatment. In the case of hypovolemic shock of hemorrhagic origin, the solution of choice is Ringer's Lactate. This crystalloid allows for transient intravascular expansion, stabilizing blood volume by redistributing fluids toward the interstitial and intracellular spaces. Among the most commonly used vasopressor agents are norepinephrine, dopamine, and epinephrine, while dobutamine is the inotropic of choice due to its vasodilatory effect and its usefulness in cases of hypoperfusion.[17] Timely treatment is essential, as is the use of appropriate tools and techniques, such as fluid replacement of blood in cases of hemoglobin levels below 9g% with caution, control of bleeding through tourniquets or vessel ligatures, preserving oxygen exchange, using an anti-shock pneumatic suit and drug therapy; it is also worth mentioning first aid for this type of shock, including the recommendation to loosen any clothing or object that is pressing against the neck, chest or waist; the anti-shock position, which means lying on your back with your legs raised at a 45-degree angle; avoiding hypothermia, that is, the loss of heat; controlling bleeding; optimal transportation with vital signs monitoring.[16,18]

Cerebral hemorrhage is defined as the sudden accumulation of blood in the brain parenchyma due to the rupture of a blood vessel. It is the most common form of hemorrhagic stroke and, together with subarachnoid hemorrhage (SAH), accounts for approximately 20 % of strokes. It is considered the most serious type of stroke as it carries a high risk of disability and mortality. Nearly half of the deaths occur in the acute phase, mainly within the first 48 hours, while between 30 % and 35 % of those affected die within the first month.[19] Imaging is beneficial, as computed tomography (CT) is the method of choice in the evaluation of penetrating head trauma and its complications. In addition, the concepts of lesion ballistics help understand the imaging findings.[20]

Traumatic brain injury (TBI) is one of the most common neurological conditions today, especially among young people who suffer head injuries. As it is a time-dependent condition, rapid attention is crucial. The main objective of management is to prevent the progression of primary injuries to secondary injuries. To this end, in the pre-hospital setting, the initial assessment is based on the ABCD model, while in cases of circulatory compromise, C-ABC.[21] The severity of this type of injury can be measured with the Glasgow Coma Scale (GCS) if the injury is not fatal.

Spinal cord injury (SCI) covers all traumatic injuries that affect the bones, ligaments, muscles, cartilage, as well as vascular, radicular or meningeal structures at any level of the spinal cord[22] this type of trauma is usually fatal when there is a serious injury to the upper cervical regions (C1-C4) of the spinal cord, in the upper cervical regions (C1-C4), as it causes paralysis of the respiratory center, or at the level of (C3-C5) it can damage the phrenic nerve, which controls the diaphragm, which stops breathing, causing acute respiratory failure and, if not treated quickly, death.[23]

Septic shock is the most serious form of infection and overstrain as a result of an intense systemic inflammatory response, which causes cardiovascular and/or microcirculatory collapse together with tissue hypoperfusion. Hypoperfusion is the key factor in this condition and must be urgently identified and treated from

the first moment of care. Tools such as assessment of peripheral perfusion, diuresis, lactate measurement, and central venous saturation are used to evaluate systemic perfusion. Treatment should be initiated immediately with aggressive fluid replacement, guided by dynamic response parameters, and maintained until perfusion targets are reached or improved. If the hypotension is significant, vasopressors should be administered, with noradrenaline as the first-choice drug. In cases of severe hypoperfusion that does not respond to fluids or increased respiratory effort, it is essential to initiate mechanical ventilation early. In addition, it is imperative to aggressively treat the infectious focus by early antibiotic administration.[24]

Firearm impacts on the oral cavity in deceased individuals are complex and require detailed forensic analysis, not only to help determine the cause and circumstances of death but also crucially for victim identification (forensic reconstruction or dental comparison) and to provide evidence in criminal investigations. Within forensic odontological analysis, we find physical impacts such as jaw fractures, bone displacement, soft tissue injuries such as lacerations, tears, and gunpowder burns, and dental injuries such as tooth loss.[25] Forensic odontology is a science that uses the dentist's knowledge in the service of the judicial system. Dentists with a deep understanding of forensic dentistry play an essential role in criminal investigations by providing expert advice on human identification, analysis of bite marks, craniofacial trauma, and negligence. The unique nature of dental anatomy and the placement of personalized restorations help dentists eventually identify an individual in the event of accidents, mass disasters, malpractice, child abuse, etc. Forensic dentistry has established itself as an essential and often indispensable science in medico-legal matters, particularly identifying the dead. Bite marks can be found in cases of sexual violence in typical areas of the human body, genitals, and breasts, but also in cases of child abuse.[26]

Forensic odontologists analyze bite marks, which can be found on victims of violent crimes such as assaults or homicides and can be imprinted on various materials such as skin, food, and other objects. By comparing the patterns of bite marks with the dental profiles of suspects, forensic odontologists can help to link or exclude individuals from a crime scene.[27] The appearance of the bite mark on human skin can be classified as a partial bite mark, an avulsive bite mark, multiple bite marks, and an indistinct bite mark (also called a "smoke ring"). The scientific basis for identifying bite marks is to find the best match between the bite pattern and the suspected dentition pattern.[28]

The properties of teeth make them ideal for collecting post-mortem data for human identification. To gain proper access to the oral cavity of the deceased, a solid knowledge of dental autopsy techniques is essential.[29] Regarding sex identification, it is important to point out that forensic dentistry has been used since Egyptian populations; men showed significantly greater palatal widths and lengths than women of the same ethnicity. Excluding the mesiodistal and buccolingual dimensions of the teeth, the intermolar dimensions, especially the distal intermolar length,[30] are the same that currently assist in identifying undetermined bodies. Forensic dentistry is a science that helps to link a suspect to a crime scene or to identify a victim. Dental evidence can also establish a chronology of events, such as when a person was last seen alive or when a body was moved to a different location.[31] It is also important to mention the wrinkles and grooves of the labial mucosa that form a distinctive pattern, known as "labial prints"; this study is known as coloscopy. These are unique to each individual, like fingerprints.[32]

## METHOD

A cross-sectional study used a mixed approach (qualitative and quantitative), using a descriptive and exploratory methodology. The universe was made up of the cases of deaths in the city of Guayaquil registered in the Laboratory of Criminalistics and Forensic Sciences during the period from January to June 2024; the variables of both the universe and the sample were operationalized, and it was in this sample that the exclusion criteria were applied: deaths without ballistic evidence and elimination criteria: manner of death: natural. The sample size was non-probabilistic. The variables include typology, sex, age, place of removal, manner of death, month of admission, cause of death (medical-legal diagnosis), and ballistic evidence, which was operationalized as "yes" and "no."

It should be emphasized that, according to the manner of natural death, only those in which collaboration was requested from the Laboratory of Criminalistics and Forensic Sciences are recorded. The data was collected from the Laboratory of Criminalistics and Forensic Sciences matrix through the analysis of forensic and ballistic reports, post-mortem examinations, and wound analysis. Thanks to the approval of the Criminalistics and Forensic Sciences Laboratory, which provided the database for use in this research while guaranteeing the confidentiality and anonymity of the victims' information and complying with current ethical and legal regulations. The ethical handling of all the information collected is ensured in the present study.

This methodology allowed for accurate and up-to-date research, which managed to statistically reflect violent deaths within the city of Guayaquil, with deaths by firearm being the most common.

## RESULTS

There is a universe of 1919 cases reported and investigated by the Criminalistics and Forensic Sciences

Laboratory in the city of Guayaquil during the period from January to June 2024, of which 1435 met the inclusion criteria, that is to say, they are deaths involving the use of firearms, which represents 74 % of the universe. The exclusion criteria applied were deaths from natural causes, deaths by knife, asphyxiation, falling, traffic accidents, dismemberment, and undetermined; of the violent deaths, those that were not due to the use of firearms were excluded.

It should be emphasized that this study reflects two tables. Table 1 shows the results of the entire universe of cases registered in the Laboratory of Criminalistics and Forensic Sciences. In contrast, table 2 shows only the deaths with the use of firearms that result in ballistic evidence. Both tables are presented to better understand.

The total number of cases identified and admitted to the Laboratory of Criminalistics and Forensic Sciences from January to June 2024 was 1919. The average age was 34,71 years, 86,9 % of which were males and 11,4 % females. Ballistic evidence represents 74 % of deaths involving the use of firearms and 25 % of deaths where firearms are not involved (table 1).

**Table 1.** Characteristics of deaths reported by the Criminalistics and Forensic Sciences Laboratory, Guayaquil

| | **Frequency (%)** |
|---|---|
| Average Age | 34,71 |
| Type | |
| Corpse | 1798 (93,69) |
| Anatomical Piece | 115 (5,99) |
| Bones | 6 (0,31) |
| Sex | |
| Male | 1668 (86,92) |
| Female | 219 (11,41) |
| Undetermined | 32 (1,66) |
| Place of Removal | |
| Public Street | 1107 (57,68) |
| Health Center | 714 (37,20) |
| Home | 67 (3,49) |
| Prison | 23 (1,19) |
| Rivers/Creeks | 7 (0,36) |
| Airport | 1 (0,05) |
| Manner of Death | |
| Violent | 1900 (99) |
| Natural | 19 (0,99) |
| Ballistic Evidence | |
| Present | 1435 (74,77) |
| Absent | 484 (25,22) |

Applying the inclusion and exclusion criteria, the sample obtained is 1435 deaths with the use of firearms identified and admitted to the Forensic Science and Criminalistics Laboratory, from January to June 2024. The average age was 33,41 years, 89,12 % correspond to males and 10,87 % to females. It is visible that 100 % of the typology corresponds to a corpse, as well as 100 % of the manner of violent death, this being due to the fact that the entire sample was used (table 2).

**Table 2.** Characteristics of deaths with the use of firearms reported by the Laboratory of Criminalistics and Forensic Sciences, Guayaquil, January-June 2024

| | **Frequency (%)** |
|---|---|
| Average age | 33,41 |
| Type | |
| Corpse | 1435 (100) |
| Gender | |
| Male | 1279 (89,12) |

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| | |
|---|---|
| Female | 156 (10,87) |
| Place of recovery | |
| Public street | 826 (57,56) |
| Health center | 553 (38,53) |
| Home | 29 (2,02) |
| Prison | 21 (1,46) |
| River/stream | 6 (0,41) |
| Way of death | |
| Violent | 1435 (100) |
| Month of admission | |
| January | 299 (20,83) |
| February | 164 (11,42) |
| March | 223 (15,54) |
| April | 250 (17,42) |
| May | 243 (16,93) |
| June | 256 (17,83) |
| Causes of death | |
| Hypovolemic shock | 723 (50,38) |
| Cerebral hemorrhage | 442 (30,80) |
| Traumatic Brain Injury | 218 (15,19) |
| Spinal Cord Injury | 29 (2,02) |
| Septic Shock | 23 (1,60) |

When investigating which sex was predominant in deaths involving the use of firearms, the male sex stands out, well above the female sex, from the same it is inferred that armed violence in the city of Guayaquil attacks mostly the male sex.

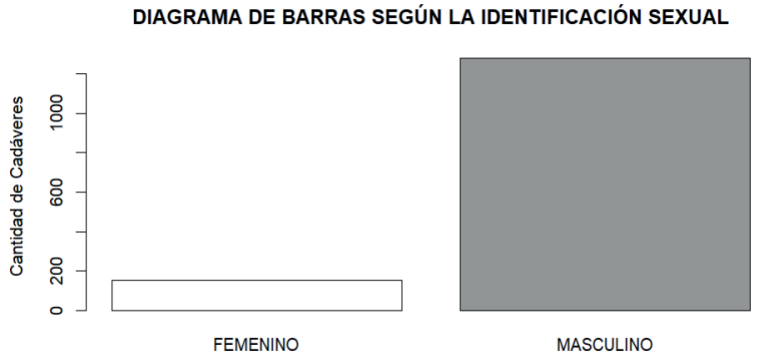


**Figure 1.** Distribution by age

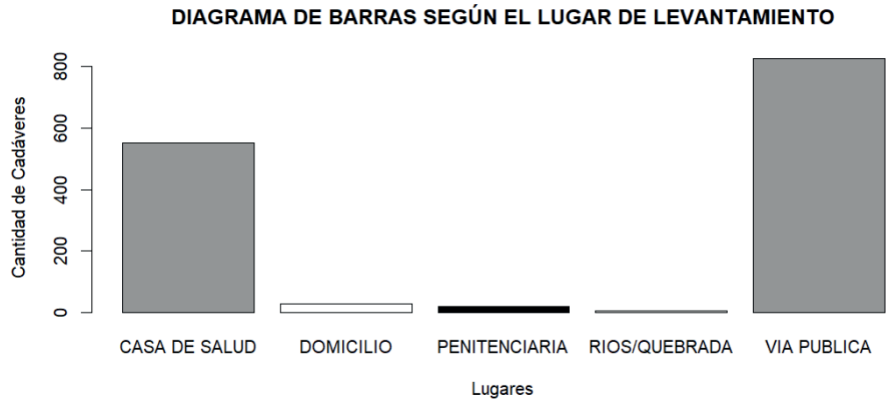


**Figure 2.** Distribution according to place of removal

With regard to the place of removal, the majority of bodies with evidence of gunshot wounds were found on public roads in the city of Guayaquil, followed by healthcare facilities (health centers and hospitals) (figure 2).

Regarding the month with the highest number of corpses with firearms and ballistic evidence sent to the Forensic Science and Criminalistics Laboratory, January stands out with 20,83 %, followed by June with 17,83 %. February saw the lowest number of corpses with firearms (figure 3).

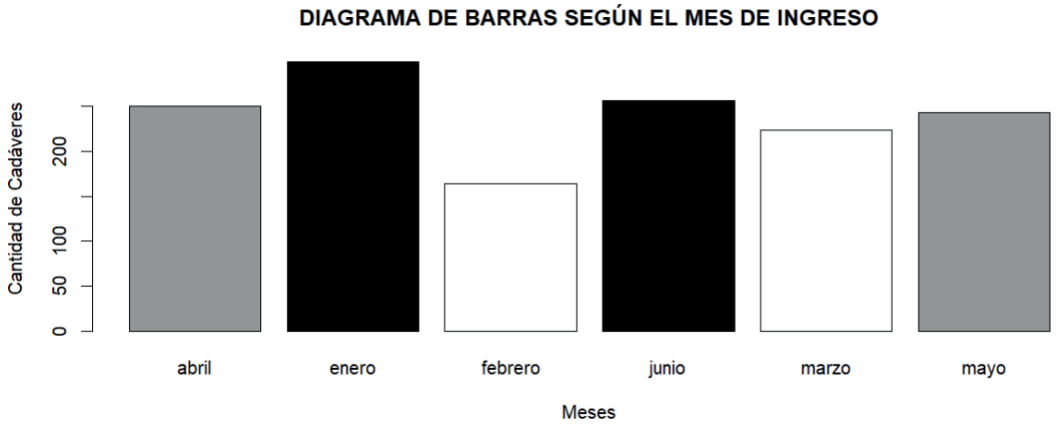


**Figure 3.** Diagram according to month of entry

Regarding the results on the causes of death according to the medical examiner, hypovolemic shock (50,38 %) was the main cause of death in corpses with gunshot wounds, followed by cerebral hemorrhage (30,80 %) (figure 4).

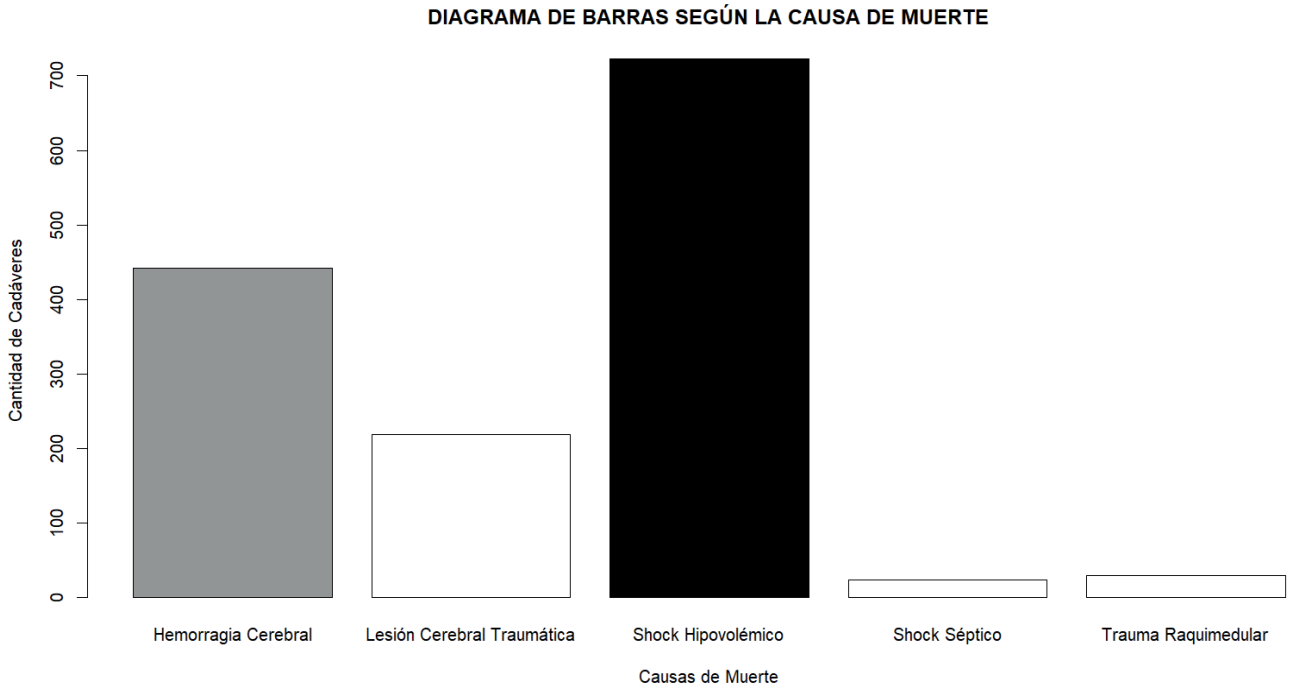


**Figure 4.** Diagram according to cause of death

## DISCUSSION

According to the results of deaths in Guayaquil in the first half of 2024 reported in the Laboratory of Criminalistics and Forensic Sciences, most of them were deaths with the use of firearms, which all were lethal, which can be compared with the study reflected in the article, Abdominal penetrating trauma: A comparison of morbidity and mortality in wounds caused by firearms and sharp weapons, where the results show that mortality is higher in firearm wounds compared to stab wounds, which have a better prognosis. Gunshot wounds have a worse prognosis because they have a higher rate of subsequent complications such as sepsis; this is reflected in the higher number of deaths with ballistic evidence compared to deaths from natural causes.[33]

The deaths involving the use of firearms recorded in the city of Guayaquil during the first half of 2024 show how armed violence in Ecuador has prevailed; this type of violence is found throughout Ecuador, especially on

the coast, showing that in Ecuador it is not easy for any government to fight terrorist groups and organized mafias since most of Guayaquil's territory is contaminated by drug-related crime. The Armed Forces and the National Police have tried to mitigate this crime. Still, factors such as the corruption of the justice system in Ecuador make it impossible to achieve better results. It is even worth emphasizing how the increase in armed violence in Ecuador is directly related to the rise in arms trafficking, as stated by the Ecuadorian Observatory of Organized Crime (OECO), which shows with statistical data how arms trafficking and violent deaths in Ecuador have been on the rise since 2021.[34]

According to the article Wound by Firearm as an Independent Predictor of Mortality in Chest Trauma, lung wounds in this type of penetrating trauma require immediate intraoperative evaluation and proper control of the injury, making it possible to compare it with the results obtained from the causes of death by firearm, where hypovolemic shock was one of the leading causes of death, and for which adequate intraoperative care was necessary depending on the type of wound since hypovolemic shock was caused by various factors in this study, including lung wounds from penetrating chest trauma.[35]

According to the results of the present study, there is a large number of deaths with the use of firearms that generate ballistic evidence 1435, during the first semester of 2024 in Guayaquil; the same is comparable to the article Influence of the Integrated Ballistic Identification System in the resolution of deaths caused by firearms in Ecuador, where it mentions that in Ecuador, injuries caused by firearms are one of the leading causes of violent deaths. Between 2010 and July 2021, 10 450 deaths associated with firearm projectiles were reported, according to data from the National Directorate for Information Analysis of the National Police (DNAIPN, 2021). This high number of cases reflects the growing level of violence in the country, with a greater concentration of incidents recorded in the provinces of Guayas, Los Ríos, Esmeraldas, El Oro, Manabí, Pichincha and Sucumbíos, which coincides with the data reflected in this study.[36]

The article "Highways of violent deaths by firearm in the province of Guayas" presents similar results in previous periods on armed violence. According to InSight Crime (2022), a media outlet specializing in security studies, the number of intentional homicides in Ecuador doubled between 2020 and 2021. Data from the Ecuadorian Observatory of Organized Crime (OECO) indicates that this upward trend continued in 2022 and 2023 the figures were even more alarming. During 2022, 1426 intentional homicides were recorded, while in 2023, the figure rose to 2320. According to the Ministry of the Interior, the weapon most used in these crimes was firearms. Among the main factors that have driven this increase in violence are organized crime and the activities of drug cartels and gangs, which are fighting for territorial control. Furthermore, coastal provinces and those with cargo ports have been strategically exploited for drug trafficking, which has intensified the confrontations and insecurity in the country; all these data, when compared with the results of this study, show an increase in armed violence.[37,38,39,40]

This study has been carried out thanks to the collaboration of the Criminalistics and Forensic Sciences Laboratory of Guayaquil. It is worth emphasizing that within the data universe, the typology found included skeletons and anatomical pieces, with which identifying identities is an even more difficult task. For this reason, multidisciplinary work is fundamental, involving forensic dentistry, since teeth play an essential role due to their unique characteristics and relatively high degree of physical and chemical resistance. DNA profiling in forensic dentistry offers a new perspective on human identification. DNA analysis is a new tool used in forensic dentistry and becomes essential when conventional identification methods fail due to the effects of heat, trauma, or autolytic processes, distortions, and difficulties in analysis. There are many biological materials, such as blood, semen, bones, teeth, hair, and saliva, that can be used for DNA typing.[26]

## CONCLUSIONS

We conclude that there is an alarmingly high prevalence of deaths involving the use of firearms in the city of Guayaquil, reflecting a significant increase in armed violence in the first half of 2024. The findings highlight the need to strengthen public health and safety strategies to reduce the incidence of homicides and improve emergency response. The importance of having health personnel trained to care for victims of gunshot wounds is highlighted, as well as the key role of forensic medicine in identifying victims. In addition, the urgency of strengthening gun control and promoting policies that address the structural causes of violence is emphasized to contribute to the construction of a safer and more peaceful society.

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## CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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