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Mortality due to unintentional injuries in the population aged 0-14 years, Ecuador 2009-2024

Abstract
Unintentional injuries pose a major challenge to child public health worldwide. Annually, approximately 950,000 children die from these causes, with traffic accidents, drownings, poisonings, burns, and falls being the most significant mechanisms. This study aims to describe the trends and epidemiological characteristics of mortality due to unintentional injuries in the population aged 0 to 14 years in Ecuador during the period 2009–2024. It is a retrospective, descriptive-longitudinal study based on official general death records from INEC. Crude and truncated mortality rates per 100,000 inhabitants were calculated. Temporal trends and the Average Annual Percent Change (AAPC) were analyzed using joinpoint regression models. A total of 4,854 deaths were analyzed. 60.65% were male. A significant reduction in mortality was observed across all subgroups ($p < 0.05$). However, the decline was notably faster in the school-age group of 5 to 14 years (AAPC for males: −5.9%; females: −5.2%) compared to the preschool group of 0 to 4 years (AAPC for males: -1.3%; females: −1.6%). Drowning was the leading cause of external death (31.7% in males, 20.5% in females). Despite the sustained decrease in mortality from unintentional injuries in Ecuador, there remains a concerning stagnation in prevention among early childhood (0 to 4 years) and a persistent gender gap that disadvantages boys. It is urgent to design public policies specifically aimed at preventing drownings and protecting young children in domestic environments.

INTRODUCTION

Unintentional injuries (UI) are a public health challenge affecting the pediatric population. The subset of injuries that includes traffic injuries, drownings, poisonings, burns, and falls accounts for a significant proportion of morbidity, long-term disability, and premature death (Gallagher et al., 2024; Jullien, 2021). Among children under 5 years of age, traffic injuries and drowning are the leading causes of injury-related death (Azarbakhsh et al., 2023; Beaulieu et al., 2024).

The World Report on Child Injury Prevention shows that approximately 950,000 children die each year from such causes; however, 90% of these incidents follow predictable patterns that can be modified through policies promoting safe infrastructure and environments, thereby dispelling the notion that they are purely random (Peden M, Oyegbite K, Ozanne-Smith J, 2008; Shetty et al., 2025).

In Latin America, inadequate urban planning and deep divides between social classes exacerbate this vulnerability. Meanwhile, in high-income countries, there has been a steady decline in infant mortality due to strict regulatory frameworks (Sawe et al., 2022), in Ecuador, respiratory and infectious diseases are the leading cause of death among children under one year of age; infectious diseases likely account for a significant proportion of mortality among children over one year of age (Ministerio de Salud Pública del Ecuador, 2022). This age group requires special epidemiological analysis due to its psychomotor and neurological immaturity; therefore, its safety is intrinsically dependent on adult supervision.

Although this phenomenon is highly significant, the national literature contains a gap regarding the historical development of these rates. Research conducted to date has provided a fragmented analysis, neglecting the epidemiological trends during the 2009–2024 period, a time marked by structural reforms to the general regulations for the approval of the traffic law in 2016 (Decreto Ejecutivo No. 805. Registro Oficial No. 805, 2015).

This study addresses this statistical isolation by jointly analyzing the General Deaths databases of the National Institute of Statistics and Censuses (INEC) for the period 2009–2024. The use of these population-level data, standardized using ICD-10 coding, eliminates the selection biases inherent in standard hospital records. Mapping these patterns is expected to show that road improvements during that period had an asymmetric impact depending on the child's geographic location and age, which will provide an empirical basis for refining current preventive strategies.

The objective of this study is to describe the epidemiological trends and characteristics of injury-related mortality among children under 14 years of age in Ecuador during the period 2009–2024. The interpretation of these historical trends goes beyond simply compiling tables of figures; rather, it provides a fundamental empirical basis for assessing the impact of public policies on the redistributive allocation of health resources to regions with the highest levels of child vulnerability.

MATERIALS AND METHODS

A retrospective study with a descriptive-longitudinal design was conducted. Unit of analysis: the mortality rate from unintentional injuries (UI) among the Ecuadorian population aged ≤ 14 years was analyzed for the period from January 1, 2009, to December 31, 2024. This design allows for the detection of temporal trends in mortality and changes in demographic trends without attributing causality to a specific factor.

The mortality data was obtained from INEC's administrative death records, which are publicly available (https://www.ecuadorencifras.gob.ec). All death records with a underlying cause of death coded according to the 10th Revision of the International Classification of Diseases (CIE-10) for the period 2009–2024 were included.

The population data used as the denominator for calculating rates are derived from the INEC's official population projections, disaggregated by sex, age group, and calendar year, based on the 2010 National Population and Housing Census and updated using the institute's own demographic component methodology. The study period spans 16 years, from January 1, 2009, to December 31, 2024.

The study population consisted of all children and adolescents aged 14 years or younger who died in Ecuador during the study period, with an underlying cause of death due to unintentional injury. The following criteria were defined:

- Inclusion criteria: death records with age at death ranging from 0 to 14 years (age groups 0–4 years and 5–14 years); underlying cause of death coded in CIE-10 within the selected NCI categories; sex recorded as male or female; and usual residence in Ecuador.
- Exclusion criteria: records with unspecified age, unknown sex, residence outside Ecuador, or cause of death coded as intentional injury (self-inflicted, assault, or of undetermined intent), or injuries not listed below.

CIE-10 codes corresponding to unintentional injuries were selected and grouped into four etiological categories, in accordance with the structure of Chapter XX of the ICD-10 (External causes of morbidity and mortality) (Organización Mundial de la Salud (OMS), 1993):

- Transport accidents: codes V01–V79 (including pedestrians, cyclists, motorcyclists, vehicle occupants, and other road users involved in road traffic accidents).
- Accidental falls: codes W00–W19 (including falls on the same level, from stairs, from a height, and other unspecified falls).
- Drowning, asphyxia, and mechanical suffocation: codes W65–W84 (including drowning in bathtubs, swimming pools, and natural bodies of water; foreign bodies in the airways; and accidental suffocation).
- Accidental poisoning: codes X40–X49 (including poisoning from analgesics, antiepileptics, sedatives, narcotics, solvents, pesticides, and other substances).

Annual crude death rates per 100,000 inhabitants were calculated for each age group and sex, using the number of deaths recorded in the corresponding year as the numerator and INEC's annual population projections as the denominator.

The overall truncated mortality rate from LNI was estimated for each subgroup (sex × age group) as a summary measure for the entire 2009–2024 period. The truncated rate was calculated by dividing the total cumulative deaths during the period by the sum of the corresponding annual projected populations.

To estimate the magnitude and direction of the temporal change in mortality rates, joinpoint regression was performed using the Joinpoint Regression Program, version 5.2.0 (National Cancer Institute, Bethesda, MD, USA, available at (https://surveillance.cancer.gov/joinpoint). This procedure detects inflection points (joinpoints) in the time series where the slope of the curve changes significantly, fitting segments with straight lines on the logarithmic scale of the rates.

For each segment and for the total, the model estimated the average annual percentage change (AAPC) along with its corresponding 95% confidence intervals (CI) (obtained using the Monte Carlo permutation method). A negative AAPC indicates a downward trend; a positive AAPC indicates an upward trend. Results with $p < 0.05$ were considered statistically significant.

Software and reproducibility

Data cleaning, processing, and rate calculations were performed using Stata version 17.0 (StataCorp LLC, College Station, TX, USA) and R version 4.3.2 (R Core Team, 2024). Joinpoint regression analysis was performed using the Joinpoint Regression Program v5.2.0 (NCI).

RESULTS

During the 16-year study period (2009–2024), Ecuador recorded 4,854 deaths from NCDs among children under 14. Analysis of the mortality burden by gender revealed marked inequality: 60.65% (n = 2,944) were deaths among males, while 39.35% (n = 1,910) were among females. This excess male mortality, equivalent to six out of every ten recorded deaths, establishes a stable epidemiological pattern over time.

The time-series analysis shows a steady decline in the absolute number of deaths from accidental injuries across all age groups and for both sexes. Among males aged 0 to 4, deaths decreased from 104 in 2009 to 68 in 2024, while in the 5- to 14-year-old group, the decline was from 144 to 63. A similar pattern was observed among females aged 0–4 years, where deaths decreased from 66 in 2009 to 46 in 2024 (a 30.3% reduction), and in the 5–14 age group from 101 to 43 (a 57% reduction) (Table 1).

Table 1. Number of deaths from unintentional injuries by sex and age group. Ecuador, 2009–2024.

	MEN				WOMEN			
	Ages 0-4		Ages 5-14		Ages 0-4		Ages 5-14	
Years	Total	Percentage (%)	Total	Percentage (%)	Total	Percentage (%)	Total	Percentage (%)
2009	104	2.14	144	2.97	66	1.36	101	2.08
2010	89	1.83	135	2.78	59	1.22	62	1.28
2011	99	2.04	127	2.62	67	1.38	64	1.32
2012	92	1.90	114	2.35	72	1.48	76	1.57
2013	92	1.90	107	2.20	58	1.19	74	1.52
2014	100	2.06	145	2.99	72	1.48	102	2.10
2015	88	1.81	134	2.76	65	1.34	97	2.00
2016	81	1.67	91	1.87	57	1.17	55	1.13
2017	72	1.48	74	1.52	52	1.07	48	0.99
2018	76	1.57	104	2.14	57	1.17	45	0.93
2019	82	1.69	71	1.46	48	0.99	37	0.76
2020	78	1.61	68	1.40	49	1.01	52	1.07
2021	79	1.63	94	1.94	43	0.89	55	1.13
2022	70	1.44	64	1.32	43	0.89	47	0.97
2023	76	1.57	63	1.30	59	1.22	39	0.80
2024	68	1.40	63	1.30	46	0.95	43	0.89
TOTAL	1346	27.73	1598	32.92	913	18.81	997	20.54
4854 (100%)								

Note: The overall percentage (100%) refers to the total number of cases during the period covered by the study.

During the 2009–2024 period, the age-standardized mortality rate from unintentional injuries among children under 15 showed a steady downward trend for both

sexes. In 2009, the rate for males was above 10 per 100,000 population, gradually declining to levels close to 6 by 2024. Women maintained rates consistently lower than those of men throughout the entire period, with values ranging from 7 to 4 per 100,000 population. The gender mortality gap remained relatively stable (Figure 1).

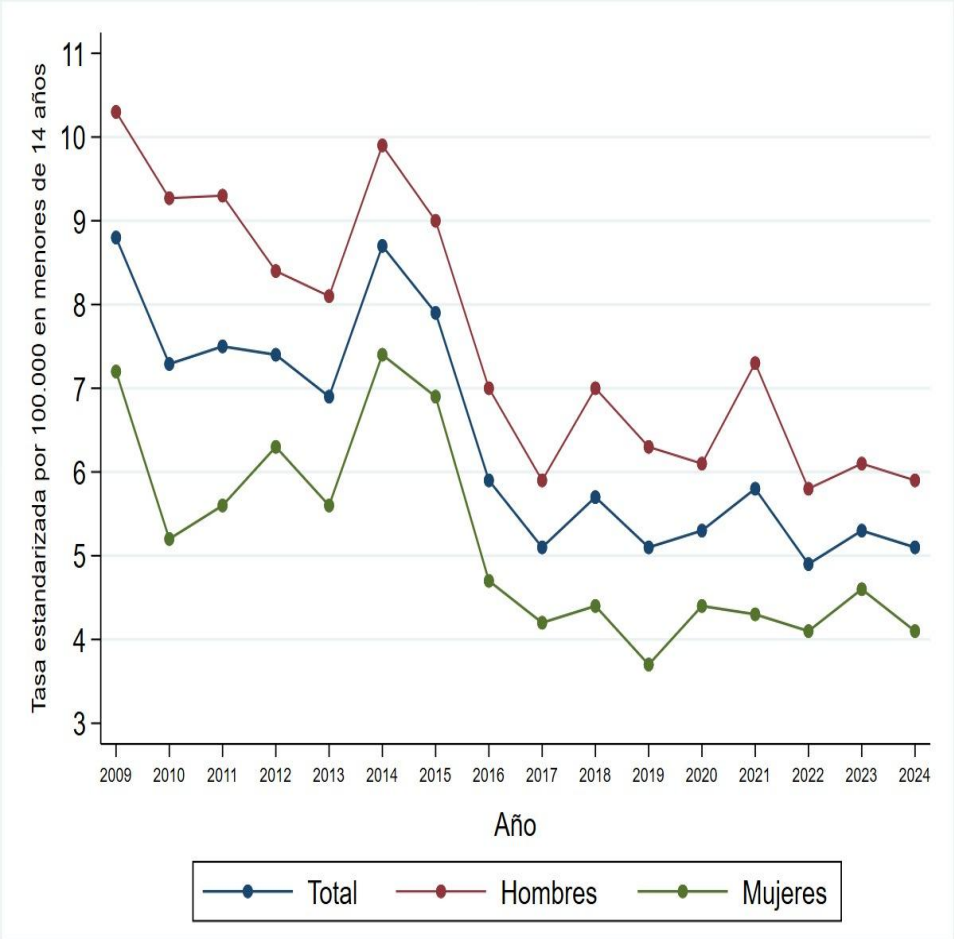

Figure 1. Time trend in the age-standardized mortality rate from unintentional injuries among children aged ≤ 14, by sex (per 100,000 population). Ecuador, 2009–2024.

Figure 1. Time trend in the age-standardized mortality rate from unintentional injuries among children aged ≤ 14, by sex (per 100,000 population). Ecuador, 2009–2024.

Of the cohort's total 4,854 deaths, drowning was the leading cause of death, accounting for 31.7% (among men) and 20.5% (among women) of the overall burden, followed by traffic accidents (21.5% and 13.4%, respectively). Accidental falls and poisonings accounted for smaller proportions, although with a similar distribution between the sexes. For all types of injury, a higher mortality burden was observed among males (Figure 2).

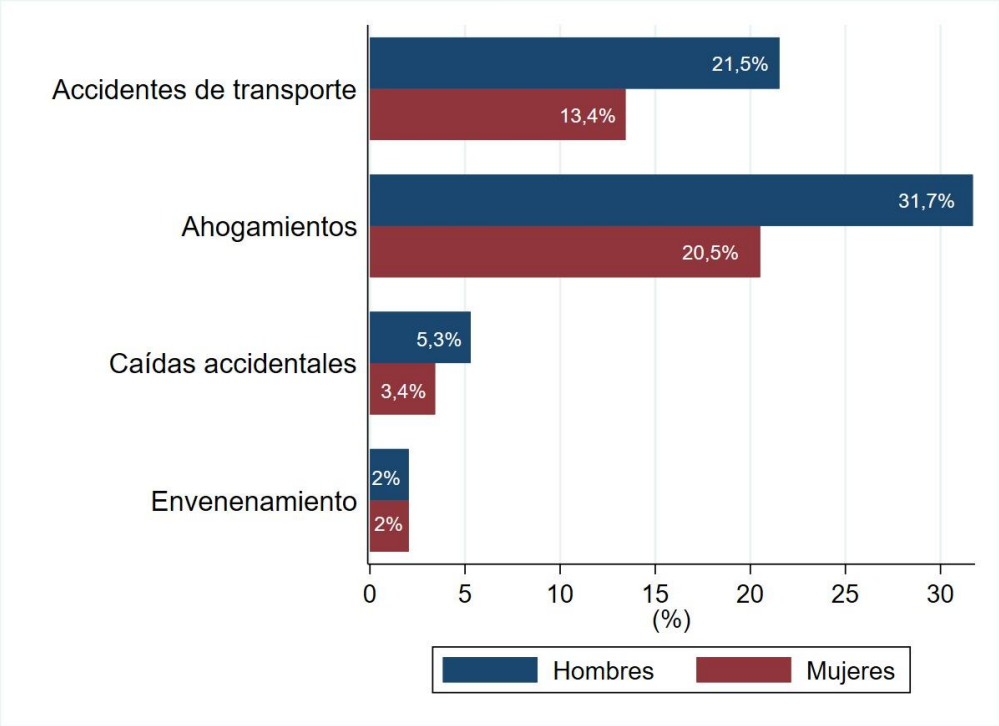

Figure 2. Percentage distribution of types of unintentional injuries by sex among children and adolescents under 15 years of age. Ecuador, 2009–2024.

Note: The figures represent the percentage of each type of unintentional injury out of the total number of deaths recorded during the study period, broken down by sex.

The overall age-standardized mortality rate from unintentional injuries was higher among men than among women, both in the 0–4 age group (3.58 vs. 2.54 per 100,000 population) and in the 5–14 age group (4.08 vs. 2.66 per 100,000 population). The PCAM was negative and statistically significant in all age groups, confirming a sustained downward trend during the 2009–2024 period. The decline was most pronounced in the school-age group (5–14 years) for both sexes, with an AHR of −5.9% (95% CI: −7.6 to −4.1) in males and −5.2% (95% CI: −7.7 to −2.6) in females. In the preschool age group (0–4 years), the annual reduction was more moderate (−1.3% in boys; −1.6% in girls) (Table 2).

Table 2. Overall crude rate and average annual percentage change (AAPC) in mortality from unintentional injuries by sex and age group. Ecuador, 2009–2024.

Sex	Age group	Total number of deaths (2009-2024)	General Truncated Rate	PCAM (IC 95%)
Men	0 a 4 años	1.346	3.58	-1.3 (-2.1 a -0.4)*
	5 a 14 años	1.598	4.08	-5.9 (-7.6 a -4.1)*
Women	0 a 4 años	913	2.54	-1.6 (-2.9 a -0.3)*
	5 a 14 años	997	2.66	-5.2 (-7.7 a -2.6)*

*p < 0,05. PCAM: Porcentaje de Cambio Anual Medio estimado mediante regresión joinpoint. IC 95%: Intervalo de confianza al 95%. LNI: Lesiones No Intencionales.

DISCUSSION

This study presents the most extensive longitudinal analysis to date on mortality from unintentional injuries among Ecuadorian children, covering a 16-year period (2009–2024) and 4,854 deaths among children under 14 years of age. The main results can be summarized into three epidemiological patterns with high clinical and public health impact: (i) a stable and statistically significant downward trend in each and every age group considered; (ii) excess male mortality, which is structural and persistent (60.65% of total deaths); and (iii) a variable rate of decline across age groups, approximately four times higher among school-age children (5–14 years; PCAM ≈ −5.5%) than among preschoolers (0–4 years; PCAM ≈ −1.5%), reflecting that advances in child safety were not uniform and that early childhood constitutes the most urgent preventive gap in the system.

The gradual decline in mortality from unintentional injuries observed in Ecuador is consistent with international evidence. The Global Burden of Disease

analysis for the period 1990–2021 shows that, globally, mortality from unintentional injuries among people under 20 has followed a downward trend, with projections indicating that this decline will continue through 2035 (Wei et al., 2025). In Latin America, there were declines of nearly 40% in mortality among children under 5 years of age between 2000 and 2019 at the municipal level, with the largest reductions observed in post-neonatal deaths and deaths among children aged 1–4 years (Chivardi et al., 2023; Moncayo et al., 2024).

The present data provide a contribution that goes beyond confirming this regional trend: when stratified by age group, it becomes evident that the rate of decline in the Ecuadorian preschool group — with a PCAM of just −1.3% in males and −1.6% in females — is substantially lower than that recorded in the school-age group, and also lower than the declines documented in comparable developing countries using similar methodologies. Studies on transport injuries in children under 14 in China, which employed joinpoint regression, reported significantly faster annual declines in mortality in the 0–4-year-old group. (Chen et al., 2024), which places Ecuadorian preschoolers as a group with insufficient preventive performance in a comparative perspective.

Regarding male excess mortality, Ecuadorian data, with a mortality ratio of approximately 1.54 between men and women, exceeds the reported global averages. Worldwide, the sex mortality ratio was 1.13 for the 0–4 age group and 1.16 for the 5–14 age group in 2021, with progressive increases as age advances. (Chen et al., 2024). However, this excess is not unexpected in the Latin American context: Latin America and the Caribbean have one of the highest male mortality ratios in the world among those under 25, with 64.8% of all deaths in 2021 being males, partly driven by greater exposure to external causes (Fondo de Población de las Naciones Unidas, 2024).

The stability of the gender gap over the 16-year period—with no evidence of convergence—suggests that the interventions implemented have failed to have a differential impact on the factors that explain greater vulnerability among males, including differential supervision patterns, gender socialization norms that encourage risky behaviors, and greater exposure to uncontrolled environments (Chen et al., 2024).

With regard to the etiological distribution, the prevalence of drowning as the leading cause of death from NID—accounting for 31.7% of deaths among men and 20.5% among women—is a finding that demands priority attention. The international literature identifies male gender, age under 5 years, rural areas, and lack of adult supervision as the main risk factors for drowning in low- and middle-income countries (Fortuin et al., 2022; Peden & Işın, 2021; Xie et al., 2025).

The fact that this mechanism has remained the leading cause of death for 16 consecutive years, despite the overall decline in mortality, suggests that the preventive strategies implemented in Ecuador have been more effective in addressing causes with more direct structural solutions—such as traffic accidents, which can be mitigated through traffic regulations—than in addressing drowning (Oviedo-Bayas et al., 2025), whose prevention requires sustained community-based interventions, swimming instruction with universal coverage, and modifications to the physical environment surrounding natural and artificial bodies of water.

The findings of this study point to three high-priority areas for research and intervention. First, the variation in the rate of decline across age groups calls for studies with a higher level of geographic and socioeconomic detail to identify the areas and household conditions that exacerbate stagnation among preschoolers. Ecuador has deep territorial inequalities between the Amazon region, the rural highlands, and the coast, which this analysis—based on consolidated national data—is unable to reveal. A small-area design, or analysis at the provincial level, would be the next step in the methodology.

Second, the stability of the gender mortality gap over 16 years suggests that universal interventions have not been sufficient to address the social and gender determinants underlying higher male mortality. Future studies should investigate whether gender-specific programs for the prevention of drowning and traffic accidents—similar to those documented in successful interventions in middle-income countries—can reduce this gap in a sustainable manner.

Third, the timing of the introduction of traffic-related regulatory reforms in Ecuador during the first part of the analysis period and the accelerated decline in school-age traffic fatalities—particularly starting in 2016—suggests a causal hypothesis that must be tested using quasi-experimental designs, such as interrupted time series or differences-in-differences, where one objective would be to quantify the impact attributable to specific regulatory interventions. Having this evidence of effectiveness would be a decisive factor in directing resource investment toward actions with the highest return on preventive performance per unit of effort.

This study has limitations that must be taken into account when interpreting its results. Because this is a retrospective descriptive study using administrative data, it is not possible to link the observed trends to specific exposure or intervention factors. The quality and completeness of the death registry may have varied during the analysis period, particularly in the early years when the National Health Information System was undergoing changes; however, the use of INEC population microdata standardized according to ICD-10 minimizes selection biases typical of traditional hospital registries.

CONCLUSION

Over the 16-year study period, the mortality rate from accidental injuries among Ecuadorian children showed a sustained and statistically significant decline across all age groups and both genders, which can be considered evidence of a real improvement in child safety during that period. This progress was uneven: the decline was considerably more pronounced in the school-age group (5–14 years; PCAM ≈ −5.5% on average) than in the preschool group (0–4 years; PCAM ≈ −1.5%), indicating that the preschool group remains the group with the greatest inertia in risk reduction and, therefore, the most urgent preventive priority.

The excess mortality among males—with approximately 6 out of every 10 deaths occurring among boys—

remained constant throughout the period and is consistent with patterns reported for Latin America and the Caribbean. This finding should not be attributed solely to biological differences but is the result of interactions between gender norms, differential supervision models, and greater environmental exposure to risk, thereby opening up opportunities for gender-sensitive interventions in the prevention of pediatric injuries.

Drowning, along with traffic accidents, accounted for the highest number of NID-related deaths throughout the entire period. The fact that drowning remains the leading cause of preventable death among children under 15 in Ecuador, despite 16 years of available data, underscores the urgent need to implement specific water safety policies: universal swimming instruction programs, signage, physical barriers at publicly accessible bodies of water, and active supervision campaigns, particularly in rural and coastal areas.

Ethical considerations

This study was conducted using secondary data, which is publicly available, had been anonymized by the INEC at the source, and made it impossible to identify any individual. In accordance with current legislation in Ecuador (Organic Health Law and Regulations for Health Research) and the principles contained in the Declaration of Helsinki, the protocol was not reviewed by an ethics committee since there is no intervention in human subjects or use of personally identifiable data.

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