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Original Article

Road traffic injury mortality among children and adolescents

Mortalidade de crianças e adolescentes por acidentes de trânsito

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ABSTRACT

Objective: to analyze deaths from road traffic crashes among children and adolescents. **Methods:** an ecological time-series study was conducted using data from the Mortality Information System on road traffic crash deaths among children and adolescents aged 0–19 years from 2003 to 2022. Data were described using relative frequencies and mortality rates per 100,000 population. Trends in mortality rates were estimated over the study period. **Results:** during the study period, 2,065 deaths were recorded. Adolescents aged 15–19 years had the highest mortality rates from land transport accidents, with rates of 18.40 per 100,000 population in 2003 and 14.45 per 100,000 population in 2022. A significant reduction was observed in the mortality rate for the overall group aged 0–19 years (β = -0.195; p=0.006); however, no statistically significant association was found between year and mortality rate among infants younger than 1 year (p=0.775) or adolescents aged 15–19 years (p=0.423). **Conclusion:** the analysis showed a reduction in deaths from road traffic crashes; however, risk remained high among adolescents. **Contributions to practice:** these findings can inform planning and intersectoral decision-making for the prevention and control of road traffic crashes. **Descriptors:** Accidents, Traffic; Infant Mortality; Accident Prevention; Adolescent; Morbidity.

RESUMO

Objetivo: analisar as mortes de crianças e adolescentes por acidentes de trânsito. **Métodos:** estudo ecológico de série temporal, utilizando dados do Sistema de Informação de Mortalidade, referente a óbitos por acidente de trânsito de crianças e adolescentes de 0 a 19 anos ocorridos entre 2003 e 2022. Dados descritos por frequências relativas e taxas de mortalidade (por 100 mil habitantes). Foram estimadas tendências das taxas de mortalidade ao longo da série histórica. **Resultados:** no período analisado, foram contabilizadas 2.065 mortes. Adolescentes (15 a 19 anos) concentraram maiores taxas de mortalidade por acidentes de transporte, sendo em 2003 a taxa de 18,40/100 mil habitantes e em 2022 14,45/100 mil habitantes. Nota-se redução significativa na taxa de mortalidade nas faixas etárias de 0 a 19 anos (β= -0,195; p=0, 006), mas, não foram observadas associações entre o ano e a taxa de mortalidade entre menores de 1 ano (p=0,775) e adolescentes de 15 a 19 anos, (p=0,423). **Conclusão:** a análise evidenciou redução das mortes acidentes de trânsito, porém, mantém elevado risco entre adolescentes. **Contribuições para a prática:** tais achados subsidiam o planejamento, tomada de decisão, inclusive intersetorial para o enfrentamento dos acidentes de trânsito. **Descritores**: Acidentes de Trânsito; Mortalidade Infantil; Prevenção de Acidentes; Adolescente; Morbidade.

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Introduction

Road traffic crashes are a growing global problem[1]. These events are multifactorial phenomena influenced by social, environmental, behavioral, and cultural determinants[2]. Worldwide, approximately 1.35 million deaths occur each year as a result of road traffic crashes, which are the eighth leading cause of death across all ages and the leading cause among individuals aged 5–29 years[3].

In 2020, in Brazil, the Northeast and Southeast regions recorded the highest numbers of deaths from road traffic crashes (1,571 and 1,371, respectively), with events occurring predominantly on weekends. Deaths were more frequent at night, vehicle collisions were the deadliest type of crash (2,955 deaths), and the mortality rate in rural areas was twice that observed in urban areas[4].

It is important to note that children are more susceptible to injuries as pedestrians because of their limited decision-making ability and hazard perception[5-6], as well as their exposure to caregiver negligence and to limited or weak enforcement, legislation, infrastructure, and prevention measures[7]. Adolescents, in turn, face vulnerabilities specific to this life stage, associated with biopsychosocial changes and a greater propensity for risk-taking behavior, contributing to an increased incidence of crashes and violence[2].

Considering that most of these injuries are preventable, it is important to emphasize that children's and adolescents' behavior and vulnerability conditions differ from those observed in the rest of the population. Their interaction with and experience of the mobility system during childhood and adolescence, whether as pedestrians, cyclists, passengers, or drivers, are often neglected[8].

Road traffic crashes are the leading cause of death among children and young people aged 5–29 years globally[9]. In addition, they cause injuries, disabilities, property damage, and loss of life, affecting not only direct victims but also their communities. They may also trigger psychological disorders, such as depression and anxiety, compromising children's healthy development and impairing caregivers' ability to provide adequate care[5].

Given the increase in road traffic crashes and their substantial economic impact, as reflected in high costs related to health care, social security, and school and work absenteeism[10], coordinated intersectoral and multidisciplinary efforts are essential. In this context, this study is justified by the need to understand the current profile of deaths from road traffic crashes, that is, to convert statistical data into diagnostic indicators that are essential for identifying specific risk factors that compromise children's and adolescents' safety. By characterizing this profile, this research provides the evidence needed to develop targeted interventions and public prevention policies, directly contributing to safer roads and to reducing morbidity and mortality in these age groups.

This study focuses on mortality among children and adolescents due to land transport accidents in the state of Espírito Santo. Accordingly, the investigation analyzes the epidemiological profile and temporal evolution of these deaths over a 20-year time series, seeking to identify not only the magnitude of these events but also variations in mortality rates by age subgroup and type of vehicle or road user involved, to understand the pattern of this mortality outcome in the study setting.

Based on the above, this study aimed to analyze deaths from road traffic crashes among children and adolescents.

Methods

Study design and population

This ecological, descriptive time-series study used data from the Mortality Information System (SIM) for Espírito Santo. The state has 78 municipalities, covers a territorial area of 46,074.448 km^2, and is divided into three health regions: Central-North, Metropolitan, and South. In 2022, the state's estimated population was 3,833,712, and its Human Development Index (HDI) was 0.771 in 2021[11].

The study included deaths of children (0–9 years) and adolescents (10–19 years) living in the state of Espírito Santo. The inclusion criteria were deaths occurring between 2003 and 2022, a 20-year period, with causes classified as land transport accidents according to the International Classification of Diseases, 10th Revision (ICD-10). The 2003–2022 period was selected because it provided the most recent reliable data and completed a 20-year time series, as data for 2023, 2024, and 2025 were available only as preliminary data.

Data collection and analysis

Mortality data for children and adolescents living in Espírito Santo whose deaths were due to external causes classified within the land transport accidents group were extracted by the researchers and compiled from SIM in a Microsoft Excel® spreadsheet. The variables considered also included age group, life stage, and year.

Cause-of-death records were based on the International Classification of Diseases, 10th Revision (ICD-10). In this study, deaths from external causes in the land transport accidents group were considered in the following categories: pedestrian, cyclist, motorcyclist, car occupant, and other land transport accidents.

The age group and life stage categories adopted in this study were based on the criteria recommended by the World Health Organization[12] and used in another study[13]. Classification by life stage segments the population into children (0–9 years) and adolescents (10–19 years), whereas disaggregation into age subgroups (<1 year, 1–4 years, 5–9 years, 10–14 years, and 15–19 years) allows the analysis of vulnerabilities specific to each stage of human development, consistent with public health information systems such as SIM[14].

Data collection consisted of extracting secondary data from official, publicly available sources[14], and the study variables of interest were selected. The information was organized in a Microsoft Excel® spreadsheet and collected between September and October 2024. When records or information were unavailable in SIM, the number of deaths was recorded as zero. Population and census data were obtained from the website of the Brazilian Institute of Geography and Statistics[11].

Data were accessed primarily through the Vital Statistics portal in TABNET, under General Mortality (External Causes), on the website of the Department of Informatics of the Brazilian Unified Health System (DATASUS). In the Health Information (TABNET) menu, Vital Statistics was accessed, and Mortality was selected (available since 1996 under ICD-10), as described above. Espírito Santo was selected as the coverage area, with data tabulated by year of death and external cause group, according to deaths by place of residence.

Data analysis

Mortality rates were calculated by dividing the number of deaths from external causes by the estimated resident population for each year in the study period (2003–2022). They were expressed per 100,000 population, both as crude and age-specific rates.

The Shapiro–Wilk test was used to assess variable normality. Temporal trends in mortality rates per 100,000 population were then assessed using simple linear regression. The regression coefficient (β) was interpreted as an estimate of the average annual change in the mortality rate. Statistical significance was set at $p < 0.05$, and 95% confidence intervals were calculated for β coefficients. Statistical analyses were performed using Microsoft Excel® and Stata 14.0.

Ethical considerations

Because this study used only unrestricted publicly available secondary data from the Mortality Information System, approval by a Research Ethics Committee was not required. Data were processed in strict compliance with the Brazilian General Personal Data Protection Law (LGPD), with information used only in aggregated form and with no possibility of individual identification or risk to ethical principles.

Results

During the 2003–2022 period, mortality rates from land transport accidents among children and adolescents aged 0–19 years in the state of Espírito Santo decreased. The highest rate was observed in 2008, with an overall mortality rate of 11.81 per 100,000 population, whereas the lowest was recorded in 2022 at 5.35 per 100,000 population. In 2003, the mortality rate among those aged 0–19 years was 9.45 per 100,000 population, compared with 5.35 per 100,000 in 2022, indicating a substantial reduction in mortality over time across age groups.

The age group analysis showed that adolescents aged 15–19 years had the highest mortality rates from transport accidents, with rates of 18.40/100,000 in 2003 and 14.45/100,000 in 2022 (Table 1).

Table 2 shows that, from 2003 to 2022, the highest mean mortality rates were recorded among motorcyclists in 2011, 2012, 2013, and 2014, followed by deaths involving pedestrians in 2007, 2008, and 2013, and car occupants in 2011, 2012, and 2014. Mortality rates decreased for most crash types, except among motorcyclists and car occupants.

Table 1 – Mortality rates from land transport accidents among children and adolescents, by age group, 2003–2022. Vitória, Espírito Santo, Brazil, 2024

Year	Mortality rate (years/100,000 population)							
	<1	1-4	5-9	0-9	10-14	15-19	10-19	Total
2003	5.09	4.59	4.29	4.98	9.05	18.40	13.84	9.45
2004	1.67	3.70	4.23	4.18	5.35	19.55	12.62	8.46
2005	3.23	3.18	4.41	4.22	5.47	17.55	11.65	7.96
2006	4.76	4.69	3.72	4.67	5.66	16.19	11.05	7.83
2007	–	3.72	6.39	5.19	6.10	24.89	15.84	10.32
2008	5.19	5.57	5.16	5.92	7.72	28.18	18.24	11.81
2009	7.00	6.04	3.77	5.54	5.63	22.67	14.31	9.65
2010	8.16	4.60	4.53	5.43	6.62	24.87	15.73	10.78
2011	1.98	7.13	4.49	5.82	4.92	27.60	16.25	11.21
2012	1.97	6.06	4.08	5.13	3.90	29.97	16.92	11.29
2013	4.08	3.69	3.40	3.93	3.31	28.19	15.73	9.90
2014	8.16	4.50	4.15	5.11	3.64	28.52	16.06	10.59
2015	6.12	2.46	2.64	3.14	3.64	24.21	13.91	8.61
2016	2.04	2.46	3.40	3.14	2.98	16.91	9.94	6.54
2017	–	2.46	2.64	2.55	5.62	21.23	13.41	8.09
2018	–	1.23	2.26	1.77	1.65	24.21	12.92	7.49
2019	2.04	1.23	1.89	1.77	2.31	19.90	11.09	6.54
2020	–	2.05	1.51	1.77	3.97	16.91	10.43	6.20
2021	2.04	3.69	1.89	2.95	2.98	15.92	9.44	6.20
2022	–	2.08	2.36	2.22	3.24	14.45	8.95	5.35
Mean	3.97	3.76	3.56	3.97	3.76	3.76	3.76	3.76

Table 2 – Mortality rates from land transport accidents among children and adolescents aged 0–19 years, by vehicle/road user type, 2003–2022. Vitória, Espírito Santo, Brazil, 2024

Year	Pedestrian	Cyclist	Motocyclist	Motorized tricycle	Car occupant	Pickup truck	Heavy transport vehicle	Bus	Other
2003	3.12	0.78	1.41	–	1.87	0.08	–	0.08	2.03
2004	2.00	0.08	1.77	–	2.46	–	0.15	–	2.00
2005	1.94	0.60	1.86	–	1.56	–	0.07	–	1.94
2006	2.27	0.37	2.05	–	1.61	–	0.29	–	1.24
2007	4.13	0.17	2.64	–	2.06	–	0.08	–	1.24
2008	3.25	0.51	3.59	–	3.17	–	0.09	–	1.20
2009	2.41	0.17	2.67	–	2.58	–	0.09	–	1.72
2010	2.52	0.36	3.14	–	3.05	–	0.27	–	1.44
2011	2.40	0.18	4.27	–	3.47	–	0.09	–	0.80
2012	1.94	0.35	4.32	–	3.53	–	–	0.09	1.06
2013	2.07	0.18	4.49	–	1.89	0.09	–	–	1.62
2014	1.44	0.18	4.22	–	3.77	–	–	–	1.44
2015	1.35	0.27	3.68	–	2.07	–	0.18	–	1.44
2016	0.99	0.63	2.61	–	1.62	–	0.18	–	0.81
2017	0.63	0.09	3.86	0.09	1.98	–	0.45	–	1.35
2018	0.72	0.18	3.77	–	1.44	–	–	–	1.71
2019	0.63	0.09	2.16	0.18	1.71	–	–	–	2.07
2020	0.45	0.27	2.52	–	0.63	–	0.09	–	2.52
2021	0.81	0.54	2.25	–	1.62	–	–	–	1.26
2022	0.50	0.40	2.11	–	1.50	–	0.10	–	1.00
Mean	1.78	0.32	2.97	0.01	2.18	0.01	0.11	0.01	1.49

Tables 3 and 4 show that the 15–19-year age group had the highest motorcyclist mortality rates during the study period.

Table 3 – Mortality rates from land transport accidents among children and adolescents, by age group and crash type, 2003–2012. Vitória, Espírito Santo, Brazil, 2024

Year/Age group	Transport accident type				
	Pedestrian	Cyclist	Motocyclist	Car occupant	Other
2003					
< 1	–	–	0.08	0.08	0.08
1–4	0.55	–	–	0.16	0.16
5–9	0.55	–	0.08	0.23	0.16
10–14	1.01	0.39	–	0.55	0.39
15–19	1.01	0.39	1.33	0.86	1.41
2004					
< 1	–	0	–	0.08	0
1–4	0.15	0.08	–	0.08	0.38
5–9	0.38	–	–	0.38	0.23
10–14	0.69	–	0.08	0.31	0.23
15–19	0.77	–	1.69	1.62	1.15
2005					
< 1	0.15	–	–	–	–
1–4	0.3	–	–	0.07	0.22
5–9	0.45	–	–	0.22	0.37
10–14	0.45	0.3	0.15	0.37	0.15
15–19	0.6	0.3	1.71	0.89	1.19
2006					
< 1	–	–	–	0.15	0.07
1–4	0.59	0	–	0.07	0.22
5–9	0.51	0.07	–	0.22	0.07
10–14	0.44	0.07	0.15	0.37	0.29
15–19	0.73	0.22	1.9	0.81	0.59
2007					
< 1	–	–	–	–	–
1–4	0.41	–	–	0.33	–
5–9	1.16	0.08	–	0.33	–
10–14	0.91	0.08	0.17	0	0.33
15–19	1.65	-	2.48	1.4	0.91
2008					
< 1	0.09	–	–	0.17	–
1–4	0.68	0.17	–	0.26	–
5–9	0.68	–	0.09	0.34	0.17
10–14	0.68	0.26	0.34	0.43	0.17
15–19	1.11	0.09	3.17	1.97	0.86
2009					
< 1	0.09	–	–	0.17	0.09
1–4	0.78	–	–	0.43	–
5–9	0.6	–	0.09	0.09	0.17
10–14	0.34	0.17	0.17	0.52	0.17
15–19	0.6	–	2.41	1.38	1.29
2010					
< 1	–	–	–	0.27	0.09
1–4	–	–	–	0.45	0.36
5–9	0.54	0.09	–	0.36	0.09
10–14	0.99	0.18	0.09	0.36	0.09
15–19	0.99	0.09	3.05	1.62	0.81
2011					
< 1	–	–	0.09	–	–
1–4	0.63	–	0.09	0.45	0.09
5–9	0.81	–	–	0.27	–
10–14	0.27	0.09	0.27	0.54	0.18
15–19	0.72	0.09	3.86	2.25	0.54
2012					
< 1	–	–	–	0.09	–
1–4	0.54	–	0.09	0.45	–
5–9	0.45	0.09	–	0.45	–
10–14	0.45	0.18	0.09	0.18	0.09
15–19	0.54	0.09	4.22	2.43	0.99

Table 4 presents the continuation of the analysis for the 2013–2022 period, showing that the previously observed pattern persisted, with higher rates among adolescents, particularly in motorcycles crashes.

Table 4 – Mortality rates from land transport accidents among children and adolescents, by age group and crash type, 2013–2022. Vitória, Espírito Santo, Brazil, 2024

Year/Age group	Transport accident type				
	Pedestrian	Cyclist	Motocyclist	Car occupant	Other
2013					
< 1	0.18	–	–	–	–
1–4	0.45	–	0.09	0.18	0.09
5–9	0.45	0.09	–	0.09	0.18
10–14	0.27	0.09	0.18	0.27	0.09
15–19	0.72	–	4.22	1.35	1.35
2014					
< 1	-	–	0.09	0.18	0.09
1–4	0.18	0.09	0	0.54	0.18
5–9	0.45	0.09	0	0.36	0.09
10–14	0.09	–	0.27	0.54	0.09
15–19	0.72	–	3.86	2.16	0.99
2015					
< 1	0.09	–	–	0.18	–
1–4	0.09	–	0.09	0.27	0.09
5–9	0.36	–	–	0.27	-
10–14	0.45	0.09	0.27	0.09	0.09
15–19	0.36	0.18	3.32	1.26	1.26
2016					
< 1	–	-	–	–	–
1–4	0.36	0.09	–	0.09	–
5–9	0.27	0.09	0.09	0.27	0.09
10–14	0.27	0.09	0.09	0.09	0.18
15–19	0.09	0.36	2.43	1.17	0.54
2017					
< 1	–	–	-	–	–
1–4	–	–	0.18	0.36	–
5–9	0.27	–	-	0.18	0.18
10–14	-	0.09	0.54	0.45	0.36
15–19	0.36	–	3.14	0.99	0.81
2018					
< 1	–	–	-	–	–
1–4	0.09	–	-	0.09	0.09
5–9	0.09	–	-	0.09	0.36
10–14	–	–	0.09	0.18	0.18
15–19	0.54	0.18	3.68	1.08	1.08
2019					
< 1	0.09	–	-	–	–
1–4	–	–	-	0.18	0.09
5–9	0.18	–	-	0.09	0.18
10–14	0.09	–	0.18	0.27	0.09
15–19	0.27	0.09	1.98	1.17	1.71
2020					
< 1	–	–	–	–	–
1–4	–	–	–	0.27	0.18
5–9	0.09	0.18	–	–	0.09
10–14	0.18	0.09	0.09	0.27	0.45
15–19	0.18	–	2.43	0.09	1.80
2021					
< 1	–	–	0.09	–	–
1–4	0.36	–	-	0.27	0.18
5–9	–	0.09	-	0.18	0.18
10–14	0.09	0.36	0.18	–	0.18
15–19	0.36	0.09	1.98	1.17	0.72
2022					
< 1	–	–	–	–	–
1–4	–	–	–	0.30	0.20
5–9	–	0.10	0.10	0.20	0.10
10–14	0.20	0.20	0.10	0.20	0.10
15–19	0.30	0.10	1.90	0.80	0.60

Table 5 shows a statistically significant reduction in mortality rates for the 1–4-year age group (β = 0.159; p = 0.009), 5–9-year age group (β = -0.170; p < 0.001), and 10–14-year age group (β = -0.242; p < 0.001), as well as for the total group of children aged 0–9 years (β = -0.186; p < 0.001). The adolescent category (10–19 years) also showed a downward trend (β = -0.212; p = 0.041), as did the total group aged 0–19 years (β = -0.195; p = 0.006).

No statistically significant associations were observed between year and mortality rate among infants younger than 1 year (p = 0.775) or older adolescents aged 15–19 years (p = 0.423), suggesting stability or variability not explained by time in these subgroups.

Table 5 – Temporal trends in mortality rates from transport accidents (per 100,000 population), by age group, 2003–2022. Vitória, Espírito Santo, Brazil, 2024

Age group (years)	β coefficient (year)	95% CI	p-value
<1	-0.036	-0.31 – 0.23	0.775
1–4	-0.159	-0.27 – -0.05	0.009
5–9	-0.170	-0.23 – -0.11	<0.001
0–9 (children)	-0.186	-0.26 – -0.11	<0.001
10–14	-0.242	-0.34 – -0.14	<0.001
15–19	-0.158	-0.57 – 0.25	0.423
10–19 (adolescents)	-0.212	-0.41 – -0.01	0.041
Total (0–19)	-0.195	-0.33 – -0.06	0.006

CI: Confidence interval

Discussion

The findings provide a detailed overview of child and adolescent mortality from road traffic crashes in Espírito Santo between 2003 and 2022 and may serve as a strategic tool for public health management. The overall reduction in the mortality rate observed in the state is consistent with the downward trend reported in another Brazilian setting, such as the state of São Paulo, where studies have shown gradual decreases associated with stronger road safety policies[15].

However, persistently high rates among adolescents aged 15–19 years in Espírito Santo reflect a global challenge; international statistics indicate that this group remains particularly vulnerable because of greater exposure to risk factors, such as motorcycle use and risk-taking behavior, resembling patterns observed in low- and middle-income countries[16-17]. Thus, although the overall decline indicates progress, the disparity across age groups in Espírito Santo reaffirms the need for targeted interventions that address the profile of deaths identified in other regions of Brazil and worldwide[15].

These findings indicate that, although road traffic crash mortality has declined in Brazil, the country still faces critical challenges in protecting children and adolescents on federal highways, where male sex and adolescence remain the main predictors of death from road traffic crashes[18].

Therefore, combining measures to improve road user behavior with public policies is essential for reducing road traffic crash mortality; when integrated, these measures can enhance preventive outcomes, reduce costs for the health system, and promote strategies for preventing these events, emergency care protocols, and intensive care protocols designed to prevent sequelae[19].

In this context, it is important to highlight changes in traffic legislation regulating child restraint systems, which represented a milestone in child passenger safety and an important advance in the transportation of children in motor vehicles in the country[20]. Therefore, mandatory use of these systems, combined with educational interventions, may have contributed to reductions in deaths resulting from unsafe road traffic.

In addition, most successful intervention studies addressing educational practices aimed at children's safe road behavior have focused on children aged 7–9 years[21]. Key strategies to reduce pedestrian injuries among children tend to involve multifaceted efforts, including increased adult supervision and traffic engineering that prioritizes traffic-calming measures in places where children frequently walk[22].

Another relevant finding of this study is the predominance of mortality among motorcyclists, followed by car occupants and pedestrians. This scenar-

io is consistent with national literature identifying motorcycles as the vehicle associated with the highest fatality among young people[23]. While deaths among pedestrians and occupants of four-wheeled vehicles show a downward trend, motorcyclist mortality in Espírito Santo shows stability or growth[24], a pattern also observed in states such as São Paulo, where fleet expansion and weak enforcement contribute to persistently high death rates[15].

Internationally, this trend is also observed in low- and middle-income countries, where motorcycles are used as a low-cost means of transportation and as a work tool, resulting in severe injury profiles and high hospitalization rates among young people, as shown in global studies[17,25]. Such evidence reinforces the view that the stability of this mortality, in contrast to the decline in other modes of transportation, calls for stricter, more targeted enforcement policies and educational interventions for this population.

The proportion of children injured in road traffic crashes increases with age and with changes in the type of restraint used; this may be related to adolescents' greater autonomy and their use of two-wheeled motor vehicles, which are known to carry a high crash risk[26].

This alarming finding may be related to the multiple vulnerabilities specific to adolescence. These changes make adolescents more susceptible to risk-taking behavior[16], such as alcohol and drug experimentation, driving without a license, and low adherence to protective measures such as seat belt and helmet use.

In this context, nonuse or incorrect use of helmets increases the risk of fatal traumatic brain injuries in young people almost tenfold, reinforcing the need for targeted enforcement in this group[17]. Helmet use is associated with fewer head injuries across all age groups[27]. It is worth noting that for young people, passive protection is insufficient unless accompanied by structural changes to urban infrastructure and strict controls on the sale and operation of vehicles by minors and operation of vehicles by minors[15].

Regarding car occupants, the findings of this study indicate that this group accounted for the secondhighest mean mortality rate from road traffic crashes in Espírito Santo from 2003 to 2022. This finding is consistent with the high occurrence of deaths from the same cause among Brazilian children younger than 10 years between 2000 and 2021, with the highest proportion of victims observed among vehicle occupants[17]. This pattern points to a downward trend in mortality among car occupants[15]. Previous studies also highlight the severe impact of these crashes on the pediatric population because of physical vulnerability and nonuse or improper use of restraint systems[15,23]. Internationally, the mortality profile of child passengers in four-wheeled vehicles remains a central public health concern and is often associated with high-impact collisions, a pattern that reinforces the need to maintain and strictly enforce road safety laws to protect this specific group[16,25].

Deaths from land transport accidents in early childhood, concentrated mostly in events involving cars and pedestrian crashes, may suggest children's limited risk perception, difficulty making safe traffic decisions, and caregiver negligence[8]. This finding is relevant and draws attention to the importance of child road safety, whether inside vehicles or on public roads, and highlights the importance of child restraint systems[20].

Although pedestrian deaths declined substantially, experts disagree on the age at which typically developing children can safely cross streets without intensive, targeted training. The transition from childhood to adolescence is marked by progressive autonomy and greater exposure to urban space; this behavioral change, combined with the shift to higher-risk modes of transportation, significantly increases this group's vulnerability[9].

This pattern of pedestrian vulnerability among children and adolescents is supported by national statistics that identify pedestrian crashes as one of the main causes of death in high-density urban areas, such as São Paulo, where reductions in these rates have been associated with traffic engineering interventions and road safety education[15].

Internationally, pedestrian crash patterns in low- and middle-income countries still show disproportionate rates compared with those in high-income countries, indicating that pedestrian safety depends not only on individual behavior but also on intersectoral policies to protect the most vulnerable road users[16-17]. Overall, there was a statistically significant reduction in the mortality rate among individuals aged 0–19 years; however, no associations were observed between year and mortality rate among infants younger than 1 year or adolescents aged 15–19 years.

Young age, particularly adolescence, remains one of the main predictors of death from road traffic crashes[18], corroborating the findings of this study. While child mortality is predominantly linked to biological and preventable prenatal causes, the mortality peak in late adolescence is driven by homicide, road traffic crashes, and suicide[23]. Younger children had higher rates of traumatic brain injury and lower helmet use compared with older children.

It should be noted that, in addition to deaths, crashes cause numerous injuries with lifelong consequences. Accordingly, engineering measures—such as speed-reduction strategies, roads designed to accommodate different road users, child restraint systems, safe vehicle design, and safer design of other modes of transportation—can help prevent these events[27].

Finally, road traffic crashes are complex and multifactorial phenomena whose causes are largely preventable. Effective prevention of road traffic crash mortality among children and adolescents requires integration across sectors, including health, education, public safety, and infrastructure, as well as broader societal engagement through actions that raise awareness and foster shared responsibility[9].

In this regard, the results show substantial progress in reducing mortality; however, persistently high rates in specific subgroups in Espírito Santo are consistent with the national reality, in which reducing child and adolescent mortality from external causes still depends on further strengthening protective measures[23]. Active community participation and stronger protection networks are essential for reducing this population's vulnerability in low- and middle-income countries[16-17].

Within this intersectoral framework, nursing plays a central role in linking health surveillance and direct care for victims. Nurses, as health educators in primary health care and as care managers in urgent and emergency care settings, can coordinate multidisciplinary actions to implement prevention protocols and raise families' awareness about the use of safety devices, translating epidemiological data into care interventions designed to preserve life and mitigate biopsychosocial sequelae among young people.

In addition, road traffic crashes should be understood as a form of social violence, often resulting from structural omissions, enforcement failures, and institutional negligence[24]. This unsafe road environment, especially for motorcyclists and pedestrians, reflects inequalities that directly affect young people's quality of life and healthy development[15]. Such evidence reinforces the urgent need for coordinated efforts to ensure safe streets and comprehensive protection of children's and adolescents' rights[10,25].

Study limitations

Despite the robustness of the 20-year time series, this study has limitations that should be considered when interpreting the results. In terms of internal validity, the use of secondary data from the Mortality Information System is subject to underreporting and errors in death certificate completion, which may mask the true magnitude of specific crash-related causes.

In terms of external validity, the findings are specific to the socioeconomic and demographic context of Espírito Santo, a state in Brazil's Southeast region. They may differ from those of other regions of Brazil, which have distinct road infrastructure, vehicle fleets, and enforcement patterns. Therefore, although the data provide a detailed local assessment of Espírito Santo, the results should be generalized to the national level with caution and are best used as a comparative model for states with similar epidemiological profiles.

Contributions to practice

The findings can inform the development of intersectoral preventive measures that link health and public safety to reduce road traffic crashes among children and adolescents. In addition, the data can support health professional training and continuing professional development, helping tailor care to the specific profile of children and adolescents receiving care.

In this regard, nurses contribute to health education, especially in primary health care, by coordinating strategies to prevent and mitigate the impacts of road traffic crashes during childhood and adolescence. In hospital and emergency care settings, nurses are also responsible for immediate management and rehabilitation and play an essential role in identifying vulnerabilities and strengthening protection networks to reduce morbidity, mortality, and biopsychosocial sequelae in these age groups.

Conclusion

A reduction in road traffic crash mortality among children and adolescents was observed over the study period; however, risk remained high among adolescents, with a predominance of fatalities associated with motorcycle crashes. These findings highlight the need to strengthen prevention and control strategies for this population, considering the specific characteristics of different age groups and crash mechanisms.

Author contributions

Conceptualization, analysis, and interpretation; drafting the article and critically revising it for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the manuscript, ensuring that questions related to the accuracy or integrity of any part are appropriately investigated and resolved: **Kosanke e Silva A, Leite FMC, Santana NMT, Pinto IBA, Camboin FF**.

Data availability

The authors declare that the data are available within the article and are publicly available, having been extracted from the Mortality Information System. They can be accessed at https://datasus.saude.gov.br/mortalidade-desde-1996-pela-cid-10/.

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