Original Research Article Two

Road Traffic Crashes in Zambia: A Retrospective Descriptive Analysis Using Epidemic Intelligence from Open Sources

Authors: ***Daliso Ngulube[1,2,3], Josphat Bwembya[1], Emmanuel Tembo[1,2], Davie Simwaba[1], Kelvin Mwangilwa[1], Moses Mwale[4], Amos Hamukale[1], Oliver Mweso[1], Doreen Shempela[1], Dabwitso Banda[1,2], Nyuma Mbewe[4], Nyambe Sinyange[1,2]***

Affiliation:

1. Zambia National Public Health Institute, Lusaka, Zambia
2. Zambia Field Epidemiology Training Program, Lusaka, Zambia
3. University of Zambia, School of Public Health, Lusaka, Zambia
4. World Health Organization Country Office, Lusaka, Zambia

Corresponding author: *Daliso Ngulube, dariosteckly@gmail.com*

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Abstract

Background: Road traffic crashes (RTCs) remain a significant public health challenge in Zambia. In the first quarter of 2023 alone, 9,035 crashes and 600 deaths were reported, a 14.3% increase in fatalities from the same period in 2022. However, underreporting is a persistent problem. A local capture-recapture study found that individual data sources captured only 12-19% of fatalities, with combined sources improving completeness to just 37%. To address this gap, the Epidemic Intelligence from Open Sources (EIOS), a web-based platform aggregating media reports for real-time event detection, may offer a valuable complementary data source. This study aimed to describe the epidemiology of RTCs in Zambia using EIOS data and assess their potential to support existing surveillance systems.

Methods: We conducted a retrospective descriptive analysis of RTCs reported through EIOS between January 2023 and April 2025. News articles were identified using tailored search terms for RTCs, injuries, and deaths. Relevant reports were manually reviewed, and key data such as time, location, vehicle type, fatalities, and seasonal patterns were extracted into a structured dataset. Descriptive analysis was performed using Microsoft Excel.

Results: We analysed 51 unique road traffic crashes from 251 identified articles. Most crashes (57%) occurred during the rainy season, with Lusaka accounting for the highest share (27%). Multiple vehicle incidents were predominant (59%). Luano District, although contributing only 2% of crashes, accounted for 26% of total deaths. Crashes peaked during evening hours (31%), followed by the afternoon (27%). Sundays recorded the highest crash frequency (24%). Each crash involved a median of 5 people (IQR 2–9), 1 death (IQR 0–3) and 1 injury (IQR 0–5).

Conclusion: The EIOS data provided novel insights into spatial and temporal patterns of RTCs. While it tends to capture more severe or widely reported events, potentially underrepresenting rural areas with limited media coverage, it still shows promise as a complementary surveillance tool to traditional sources. Integrating open-source intelligence with traditional surveillance systems may strengthen road safety monitoring and inform more targeted interventions.

Key words: seasons, accidents, public health, Zambia, retrospective studies, epidemic intelligence from open sources.

Background

Road traffic injuries (RTIs) and road traffic crashes (RTCs) are a persistent public health challenge worldwide (1–3). The WHO's 2023 report estimates that 1.19 million road traffic deaths occurred globally in 2021, a 5% decline since 2010, yet road injuries remain a major issue, with many resulting in long-term disability (4). The burden of road traffic mortality and morbidity is not evenly distributed. Low and middle-income countries (LMICs) bear a disproportionate share, accounting for over 90% of global road traffic deaths, despite possessing only about 54–60% of the world's registered vehicles (5). Among young people aged 5 to 29 years, RTCs are the leading cause of death, underscoring their devastating impact on the most productive population segments (6).

Africa has the highest road traffic fatality rate, estimated at 26.6 deaths per 100,000 population, significantly higher than the global average of 17.4 to 18.2 deaths per 100,000 (7). Vulnerable road users (pedestrians, cyclists, and motorcyclists) are particularly affected due to urbanisation, poor road infrastructure, and weak enforcement of traffic laws (6). The Sustainable Development Goals (SDGs) recognised this crisis. Target 3.6 aimed to halve global deaths and injuries by 2020, and Target 11.2 calls for safe, affordable, accessible transport systems by 2030 (8). Despite this, many African countries, including Zambia, face challenges in controlling RTCs due to a lack of reliable, timely, and comprehensive data (9,10). These limitations cause discrepancies between official figures and international estimates. For example, Zambian police recorded 2,163 deaths in 2021 (12), while WHO estimated up to 3,654 deaths (6). In countries like Malawi and Ethiopia, studies show that up to half of all road traffic deaths go unreported (13,14).

Zambia continues to experience a high burden of RTCs. The Road Traffic and Safety Agency (RTSA) reported 32,396 crashes in 2021, leading to 5,307 serious injuries and 2,163 deaths, a 28% increase in fatalities from 2020 (1,690 deaths from 28,484 crashes) (15). Pedestrians accounted for 49% of the 2021 fatalities (12). The RTSA data for the first quarter of 2023 shows 9,035 crashes and 600 deaths, a 14.3% increase in fatalities compared to the same period in 2022, despite fewer crashes (16). Crashes mostly occur in urban areas, but fatalities peak on highways (12). Risk factors include speeding, misjudging clearance, failure to keep to the nearside, and disobeying traffic signs (17). Night travel bans on public service vehicles have reduced deaths, but stronger enforcement and better infrastructure are still needed (12).

Another challenge in Zambia is the fragmentation of data sources. Official crash data rely mainly on police records (15,18), which are underreported due to limited follow-up, definitional inconsistencies, and administrative disincentives (9,19). Other sources like hospitals, civil registration and vital statistics (CRVS), emergency services, insurance companies and local authorities are not routinely integrated, limiting national data accuracy (9). The capture-recapture method has been applied in Zambia and other African countries to estimate the true burden by comparing multiple data sources (9). Findings consistently show that official systems miss many fatalities. To address these gaps, alternative sources are gaining attention.

Social media, news reports, and digital open-source data offer supplementary, real-time surveillance (20–24). In Kenya, Twitter analysis revealed crash patterns not captured in official records (25). The WHO's Epidemic Intelligence from Open Sources (EIOS) platform aggregates digital public information to support real-time surveillance (26).

Originally developed for infectious diseases, EIOS has shown potential for non-communicable events like RTCs (26–28). These platforms can deliver more timely, granular, and cost-effective data than traditional systems, aiding hotspot detection and responsive interventions (26,29,30). However, challenges remain in terms of data validation, representativeness, privacy, and the need for robust analytical frameworks to ensure that open-source data can be reliably used for decision-making (26,29,30).

In Zambia, existing studies on road traffic crashes have predominantly relied on routine data sources such as police and hospital records (9,15,18). While these data are valuable, they are often faced with data quality issues. Despite the growing interest in road safety, the use of media monitoring platforms like EIOS remains underutilized. Given the frequent reporting of severe RTCs in digital media, EIOS is a promising, yet underused tool for supplementing official sources. This study aims to address that gap by determining the epidemiology of road traffic crashes in Zambia using EIOS data.

Methodology

Study design and setting

We conducted a retrospective descriptive analysis of data on road traffic crashes reported through the Epidemic Intelligence from Open Sources (EIOS) platform. The study was conducted in Zambia, a landlocked, middle-income country with an estimated population of 21.7 to 21.9 million people in 2025 (31). Data on RTCs from January 2023 to April 2025 were included in the analysis.

In Zambia, EIOS is integrated into the national public health surveillance system to support real-time epidemic intelligence. Within the platform, two functional boards focusing on human and animal health support epidemic intelligence under the Integrated Disease Surveillance and Response (IDSR) strategy. This framework combines indicator-based surveillance (IBS) and event-based surveillance (EBS) for early outbreak detection. At the national level, data on signals and events are maintained in an Excel log sheet, updated daily by two epidemiologists at the Surveillance and Disease Intelligence Cluster of the Zambia National Public Health Institute (ZNPHI). Monitoring occurs daily from 8:00 am to 5:00 pm, and events are also entered into the Event Management System (EMS tracker) as part of the EBS process.

Epidemic intelligence from open sources

The EIOS initiative offers a web-based system that leverages natural language processing and machine learning techniques for public health intelligence (PHI) activities (32). The system scans thousands of articles daily from various sources on the web and processes them through a pipeline that involves language detection, geolocation and entity recognition, tagging, categorization and deduplication. The outputs are displayed as articles and are accessible via a flexible interface that allows individuals and teams to apply custom filters to find information of interest. Many countries have adapted EIOS to their specific surveillance needs, including Zambia, where the system supports both human and animal health monitoring.

Study population and sampling

The study included articles on RTCs in Zambia, captured through the EIOS media monitoring platform. We used purposive sampling to identify articles relevant to the study objectives. Articles were selected based on predefined inclusion criteria and a customized search strategy that was applied to the EIOS data stream. A total of 251 articles met the criteria and were included in the final analysis.

Inclusion and exclusion criteria

The study included news articles on road traffic crashes (RTCs) involving motor vehicles such as cars, buses, trucks, and motorcycles that resulted in at least one reported injury or death (Appendix 1). Articles were sourced from the Zambia human health board, a user-defined workspace or environment that allows users to organize, monitor, and analyse selected content from the EIOS data stream. Reports had to include key details such as the date and location of the incident, type of crash, number of vehicles involved, and the number of individuals injured or killed. Articles that reported on more than one incident were excluded due to missing or aggregated information that could not be disaggregated. Reports capturing other forms of crashes, such as boats, airplanes, and trains, were not included.

Data Collection for Road Traffic Crashes

We customized the date filter by backdating the period from January 1, 2023, and April 30, 2025. The geographic filter was set to Zambia, and we developed a customized search string to identify relevant reports on RTCs. The final search string used was:

(“road traffic accident” | “car crash” | “bus accident” | “truck accident” | “motorcycle crash” | “vehicle collision” | “road accident” | “traffic collision”) + (“injury” | “injuries” | “fatality” | “fatalities” | “death” | “deaths” | “killed” | “accident”) + - (“train” | “plane” | “aircraft” | “helicopter” | “boat”). A total of 251 articles were generated using the customized key search words. We further streamlined our search to four main categories such as Disasters, Outcomes, Populations, and Societal factors. Data on RTCs (Appendix, pg. 16, Fig. 6) were manually reviewed and extracted from the platform and structured into a dataset for subsequent analysis.

Variables

The dataset included key variables related to RTCs, such as the date, time, and location of each incident; the type of incident; the number of vehicles and individuals involved; the number of injuries and fatalities; as well as whether the crash occurred during rush hour and in which season. Rush hour was defined as the peak traffic periods of the day: 7:00 am to 8:00 am and 5:00 pm to 6:00 pm. Time-of-day categories were based on definitions from the Britannica Dictionary (33), with morning defined as 5:00 am to 12:00 pm, afternoon as 12:00 pm to 5:00 pm, evening as 5:00 pm to 9:00 pm, and night as 9:00 pm to 4:00 am. We further defined rainy season as November to April and dry season as May to October.

Data analysis and processing

We cleaned and analysed data using Microsoft Excel version 2019. Pivot tables/charts were used to summarise the dataset, and descriptive statistics: counts, frequencies, and proportions. Median values were used to summarize the number of people involved, injuries and deaths as the data were not normally distributed.

Results

Table 1 presents the descriptive characteristics of RTCs reported through EIOS in Zambia between January 2023 and April 2025. A total of 51 unique road traffic crashes (RTCs) were identified, involving 583 individuals, of whom 237 (40%) were injured and 125 (21%) died. Each crash involved a median of 5 people (IQR 2-9), 1 death (IQR 0-3), and 1 injury (IQR 0-5). Most crashes (57%) occurred during the rainy season, involved multiple vehicles (59%), and occurred outside the peak traffic times (71%).

Table 1: Characteristics of road traffic crashes in Zambia reported through EIOS (January 2023 to April 2025), n = 51*

Continuous variables	Frequency	Median (IQR)
Number of people involved	583	5(2-9)
Number of deaths	125	1(0-3)
Number of injuries	237	1(0-5)
Categorical Variables	**Frequency**	**Proportion (%)**
Season	-	-
Dry	22	43
Rainy	29	57
Number of vehicles involved	-	-
Multiple vehicles	30	59
Single vehicle	20	39
Unknown	1	2
Rush Hour	-	-
Yes	15	29
No	36	71

** EIOS - Epidemic Intelligence from Open Sources*

Distribution of Road Traffic Crashes by Time of Day

Figure 1 shows the distribution of road traffic crashes (RTCs) across different times of the day. The highest proportion of crashes occurred during the evening (31%), while the night period had the lowest proportion (18%).

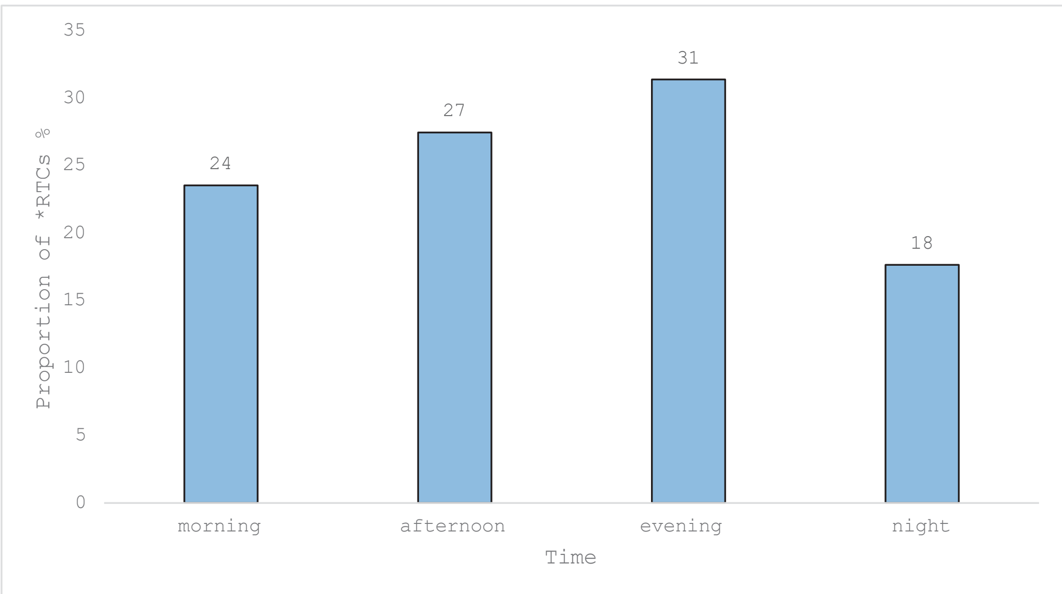

Figure 1: Distribution of road traffic crashes in Zambia by time of occurrence, January 2023 to April 2025 (n = 51)
**RTCs -Road Traffic Crashes*

Proportion of deaths from road traffic crashes by time of day

Figure 2 presents the proportions of deaths from RTCs in Zambia by time of occurrence. The highest number of deaths occurred in the morning (54%) followed by night (21%).

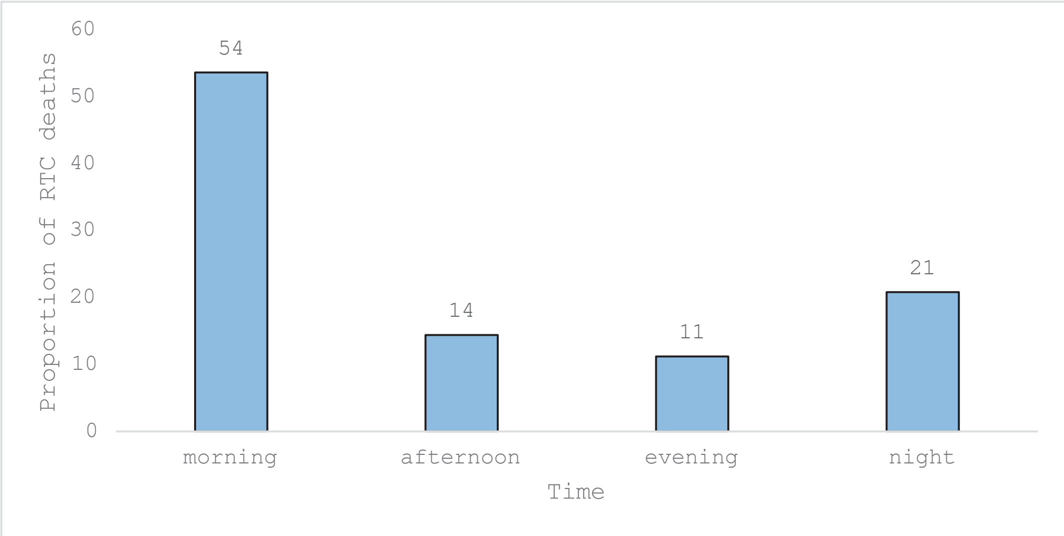

Figure 2: Proportion of deaths from RTCs by time of occurrence, Zambia, January 2023 to April 2025 (n=125)

Distribution of road traffic crashes by day of the week

The highest proportion of RTCs (Fig 3) occurred on Sunday (24%), followed by Thursday (18%). The lowest proportion of RTCs was recorded on Saturday (8%).

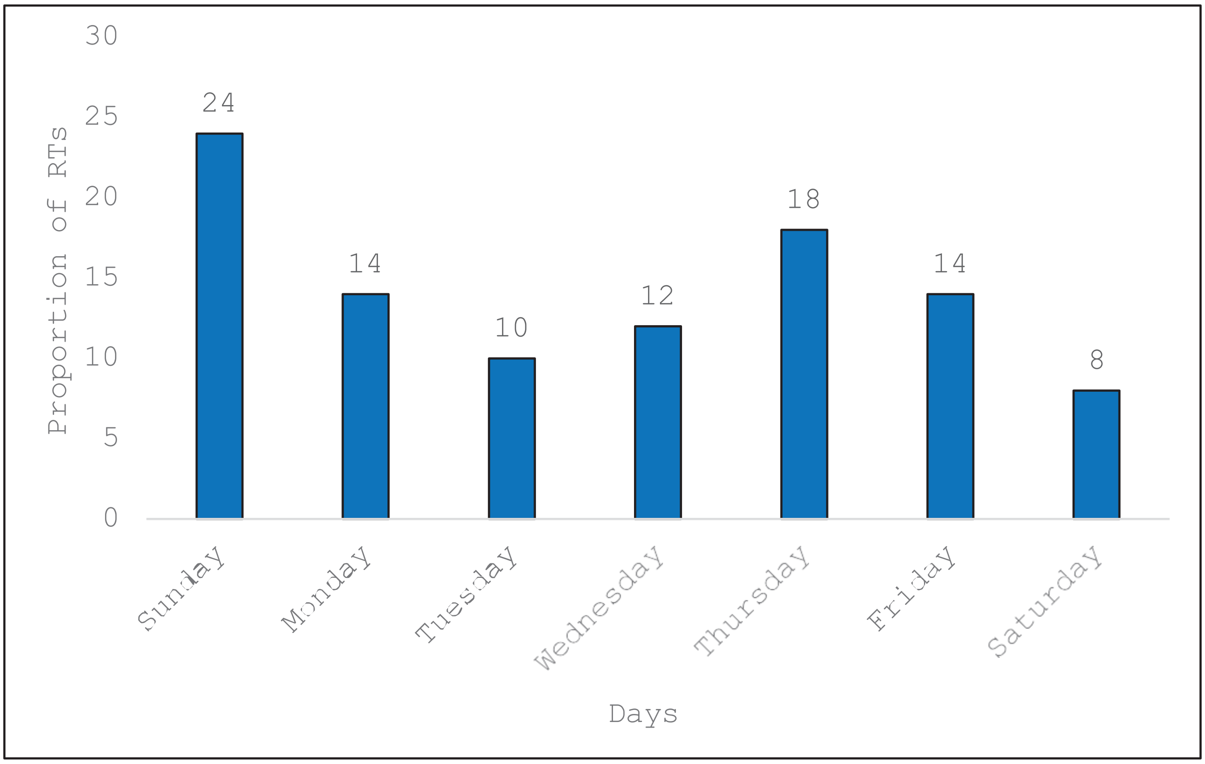

Figure 3: Distribution of road traffic crashes by day of the week, Zambia, January 2023 to April 2025 (n =51)

Distribution of RTCs and deaths by district

Table 2 displays the distribution of RTCs, and fatalities varied across districts. Road traffic crashes (RTCs) were most frequently reported in Lusaka District, which accounted for 27% (14/51) of all crashes. Luano District recorded the highest number of fatalities, contributing 26% (32/125).

Table 2: Distribution of RTCs and deaths by district, Zambia, January 2023 to April 2025 (n for RTCs = 51; n for deaths =125)

District	RTCs* n=51 (%)	Deaths n=125 (%)	District	RTCs* n=51 (%)	Deaths n=125 (%)
Chama	1 (2)	0 (0)	Mpika	1 (2)	4 (3)
Chilanga	1 (2)	1 (1)	Mpongwe	1 (2)	2 (2)
Chipangali	1 (2)	1 (1)	Namwala	1 (2)	4 (3)
Chirundu	3 (6)	10 (8)	Ndola	2 (4)	0 (0)
Chisamba	1 (2)	2 (2)	Nyimba	1 (2)	0 (0)
Kabwe	1 (2)	1 (1)	Petauke	1 (2)	0 (0)
Kafue	1 (2)	4 (3)	Rufunsa	1 (2)	0 (0)
Kalomo	2 (4)	0 (0)	Serenje	1 (2)	12 (10)
Kalulushi	1 (2)	4 (3)	Lusaka	14 (27)	11 (9)
Kapiri Mposhi	3 (6)	10 (8)	Luano	1 (2)	32 (26)
Kitwe	1 (2)	2 (2)	Lundazi	1 (2)	1 (1)
Liteta	1 (2)	3 (2)	Luwingu	1 (2)	0 (0)
Livingstone	1 (2)	0 (0)	Masaiti	1 (2)	1 (1)
Mazabuka	2 (4)	5 (4)	Mumbwa	1 (2)	1 (1)
Mkushi	3 (6)	12 (10)	Monze	1 (2)	3 (2)

**RTCs - Road Traffic Crashes*

Discussion

This study analysed the epidemiology of road traffic crashes (RTCs) in Zambia using EIOS data. While many of the studies cited for comparison utilized routine data sources such as hospital and police records (19,34–36), our analysis relied on open-source media monitoring through the EIOS platform. Compared to official RTSA statistics (16), EIOS identified fewer crashes but provided more granular detail. This is especially useful in Zambia, where routine data may be incomplete or delayed. Our results show clear seasonal variation in road traffic crashes (RTCs), with most incidents occurring during the rainy season. A hospital-based study in Monze, Zambia, also found that 43.4% of road traffic fatalities occurred during the rainy season (19). While that study focused on fatalities, our findings align with broader research showing that rainfall increases crash risk. For example, U.S. data show a 34% higher risk of fatal crashes during the rainy season (35,36). In contrast, a Ugandan study found nearly equal crash rates between rainy and dry seasons (37). These patterns suggest that targeted rainy-season interventions such as improved road maintenance, public awareness campaigns, and stricter speed enforcement are critical for reducing RTCs.

A study in Nigeria reported that single-vehicle (SV) crashes made up 61.7% of incidents, while multiple-vehicle (MV) crashes accounted for 38.3% (38). SV crashes were more frequent, but MV crashes caused more severe injuries and fatalities (38). Our study contrasts this finding. The MV crashes were more common than SV in Zambia. This difference likely reflects local traffic patterns and road use. Given the higher harm potential of MV crashes, efforts should prioritize enforcing traffic laws, promoting safe driving, and improving infrastructure in busy areas.

While road traffic crashes (RTCs) in high-income settings like the United States often peak during morning and afternoon rush hours (19), our analysis reveals a distinct pattern. In this study, the highest number of RTCs occurred during the evening period, with the night period accounting for the most fatal crashes. These findings are consistent with RTSA reports from 2020 and 2021, which showed that the highest number of crashes occurred between 18:00 and 20:00 hours (15). The elevated crash frequency during evening hours may be attributed to increased traffic volume, reduced visibility, and the onset of driver fatigue (39). Meanwhile, the higher fatality burden during night hours is likely driven by a combination of high-speed travel on less congested roads, impaired driving, particularly alcohol use, poor street lighting, and the absence of road markings (39). These findings suggest that while crash prevention strategies must address evening traffic risks, reducing fatalities will require targeted nighttime interventions, including improved road lighting, stricter enforcement against impaired driving, and community-level awareness on nighttime travel risks.

Temporal patterns of road traffic crashes (RTCs) vary across regions, influenced by travel behaviour, infrastructure, and enforcement practices. Several studies across Africa report varied temporal patterns of RTCs related to weekdays and weekends. For example, higher crash rates over weekends have been observed in Congo and South Africa, often linked to more open traffic flow and different travel behaviours (40–42). In contrast, Ethiopia reported most fatal RTCs during weekdays, influenced by work and school travel patterns (43). In our study, we found that most RTCs occurred on Sundays, unlike RTSA official data, which shows higher crashes on Fridays and Saturdays (15). This reflects the influence of local socio-cultural factors and media reporting patterns.

Another key finding from our analysis is the disproportionately high fatality burden observed in Luano, a rural district, despite a higher number of crashes being reported in Lusaka, an urban area. This rural-urban disparity mirrors broader national trends reported by the RTSA, which show that while 76% of crashes occur on urban roads, a greater proportion of fatalities 58% are recorded on rural or inter-district roads (15). The higher death toll in rural areas like Luano may be attributed to high-speed impacts, delayed emergency response, and limited access to quality post-crash care. In contrast, although Lusaka experiences more frequent crashes, the severity is often lower due to factors such as reduced average vehicle speeds and quicker access to emergency services (44). This contrast is further supported by findings from Monze district, where over 90% of road traffic deaths occurred before reaching a health facility, underscoring the critical gaps in rural emergency response systems (19). In Tanzania, a study found high injury rates on rural roads, exacerbated by poor infrastructure and limited emergency response (34). These findings underscore the urgent need for tailored interventions in rural settings, including improved road infrastructure, strengthened emergency care systems, and targeted road safety education, to address the substantial burden of road traffic injuries outside urban centers.

This study is not without limitations. As with other forms of social media monitoring, EIOS relies on unstructured data from media houses, which may vary in accuracy, completeness, and geographic coverage. Manual abstraction of reports increases the potential for duplication or omission of incidents. In addition, media sources often capture only the initial reports; outcomes such as hospital deaths or long-term disabilities are rarely followed up. The relatively low number of reports identified may also underestimate the actual scale of road traffic crashes, particularly in rural or low-media coverage areas. We also recognize that EIOS may disproportionately capture severe or dramatic crashes that are more likely to be reported in the media. This introduces a selection bias, limiting the generalizability of our findings to all road traffic crashes occurring in Zambia. Nonetheless, the level of detail in these media reports, such as timing, location, and number of people involved, highlights the platform's value as a complementary data source, especially where routine surveillance is delayed or incomplete. Despite these limitations, open-source platforms like EIOS show considerable promise for enhancing road traffic injury surveillance and informing targeted interventions.

Conclusion

This analysis demonstrated that social media monitoring platforms such as EIOS can serve as useful complementary tools for RTC surveillance in Zambia. While the total number of reported incidents in this study likely underestimates the national burden, the captured data is novel and provides unique, location-specific insights, including patterns not easily observed in traditional data sources. By capturing timely and incident-specific information, EIOS offers a valuable, real-time perspective on road traffic risks, particularly in settings where traditional reporting systems are limited or delayed. There is a need to strengthen Zambia's road traffic surveillance by integrating social media monitoring with traditional data systems. This would enhance real-time monitoring and support more informed decision-making. Given the higher risk of fatalities in rural districts, targeted investments in emergency response infrastructure and trauma care are critical. Interventions should also focus on evening and weekend risk periods, including improved road infrastructure, increased enforcement, and behavioural campaigns addressing fatigue and alcohol-related driving

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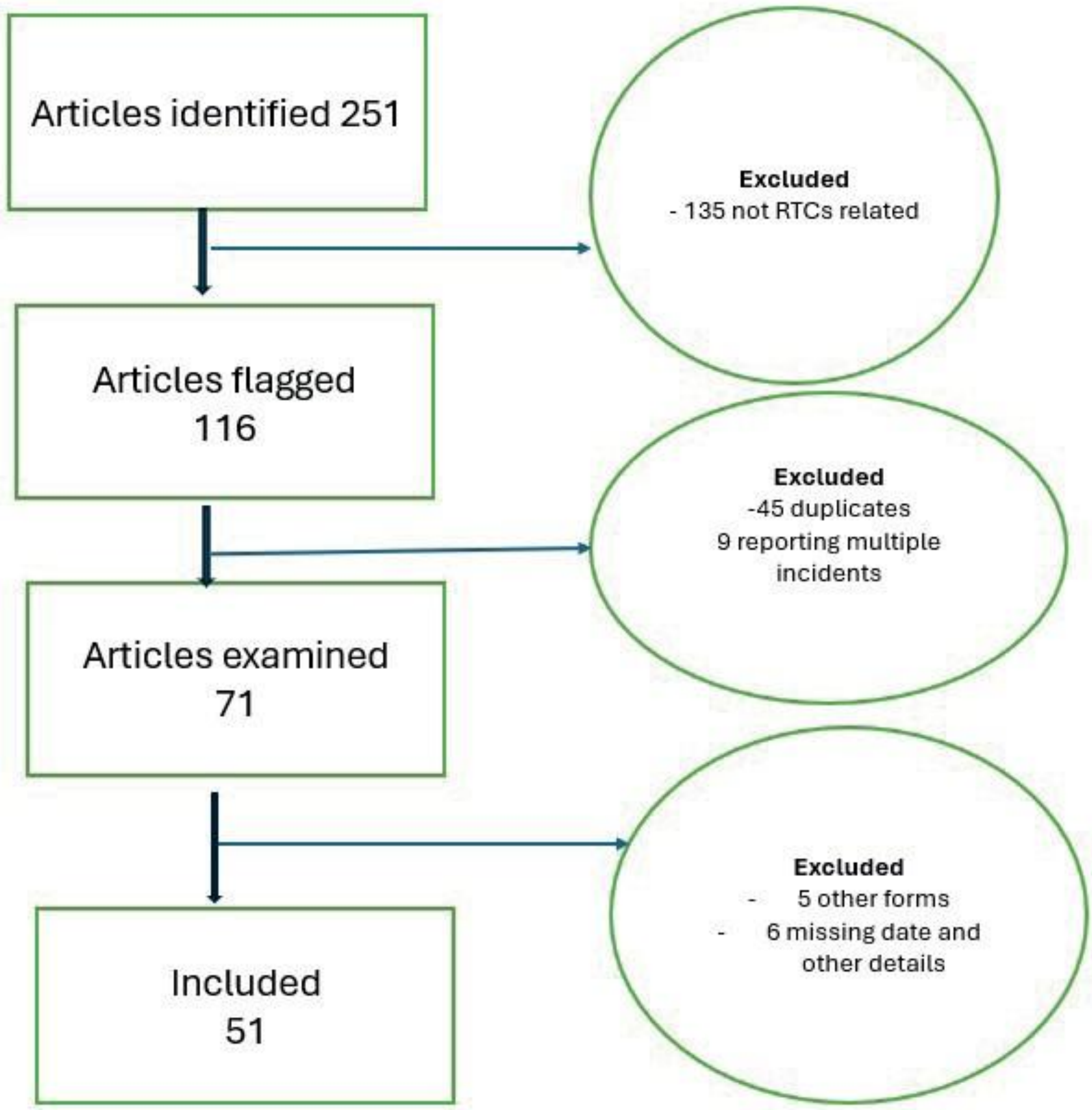
Appendix



Appendix 1: Identification and selection of road traffic crash articles through EIOS, 2023 to 2025, Zambia