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Vulnerable Road Users in Zambia: Equity Dimensions of Road Traffic Deaths and Injuries

Trends, Spatial Disparities and Child Equity Gaps, 2017–2024

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Equity · Children · Transport Justice

Background & Study Rationale

Global burden

Road traffic injuries kill 1.19 million people/year — 90% in LMICs. VRUs (pedestrians, cyclists, motorcyclists) account for more than half of all road deaths globally (WHO, 2023).

Rapid motorisation in Zambia

Zambia's vehicle fleet grew steadily 2017–2024. Motorcycle involvement in crashes rose 2.5-fold. VRUs lack structural protection — making motorisation a direct equity threat.

Equity gaps

Children, rural communities, and pedestrians in low-enforcement provinces bear disproportionate road risk. Disaggregated analysis is essential for SDG 3.6 progress monitoring.

The Gap

No comprehensive national analysis has examined the scale, equity dimensions, and spatial distribution of VRU injuries and fatalities in Zambia across multiple severity levels and population groups.

Study Aim

To quantify VRU burden, assess child equity gaps, map spatial disparities, and characterise temporal trends in road traffic casualties in Zambia, 2017–2024.

Five Research Questions

RQ1	What is the national VRU burden and how has it changed?
RQ2	Are children disproportionately affected?
RQ3	Where are VRU casualties most concentrated?
RQ4	Is the urban–rural gap widening or narrowing?
RQ5	What behavioural and vehicle factors drive VRU risk?

Data: RTSA national crash tables 3–12, 2017–2024 · ZamStats mid-year population estimates · OCHA Zambia district shapefile (ADM2, 2020)

Data & Methods

DATA

Police/RTSA Crash Data

Persons killed, seriously & slightly injured by casualty type · 2017–2024

Children <18 years

Child casualties by status and road-user class

ZamStats + Shapefile

Mid-year population denominators · ADM2 boundary file → 10 provinces

METHODS

VRU Extraction

Pedestrians, cyclists & motorcyclists isolated by casualty_type · consistent coding 2017–2024

Trend Analysis

Binomial logistic OR + Poisson RR (sandwich SE) per calendar year · COVID sensitivity (excl. 2020)

Spatial Analysis

Provincial choropleth · Gini & Theil inequality · Global + Local Moran's I

Urban–Rural

Year × location interaction · Firth-penalised logistic regression

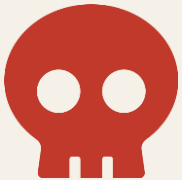
Study period: 2017–2024 · Retrospective descriptive analysis · Secondary data — no patient identifiers · α = 0.05

VRUs Dominate Zambia's Road Traffic Death and Injury Toll

64.1%

of all fatalities

95% CI: 62.2–65.9%



49.5%

of serious injuries

95% CI: 48.3–50.7%

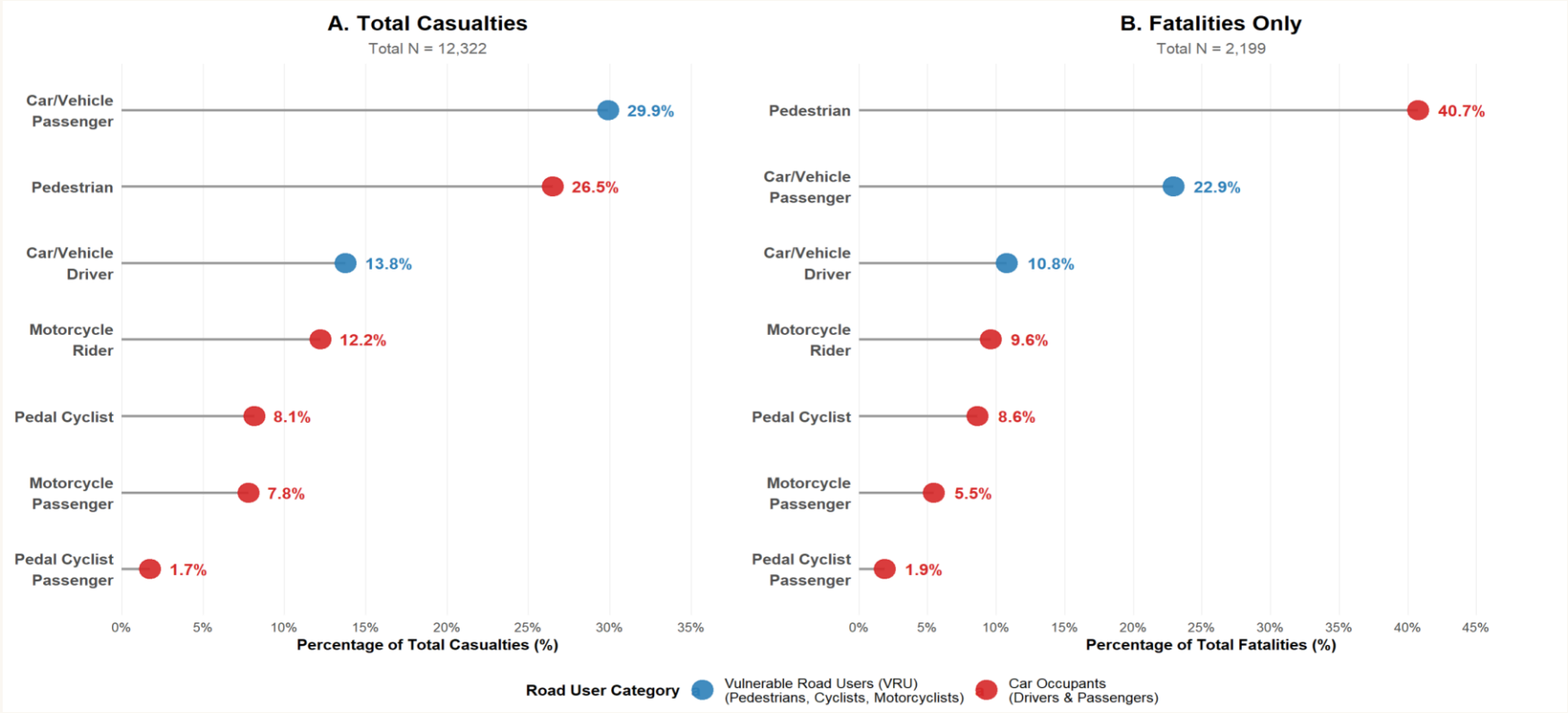
6.84

VRU deaths per 100k

population (2024)

VRU = Pedestrians, Pedal Cyclists, Motorcyclists. Source: RTSA crash data 2017–2024. Rates from ZamStats mid-year population estimates.

Distribution of Road Traffic Casualties by Detailed User Type (2024)



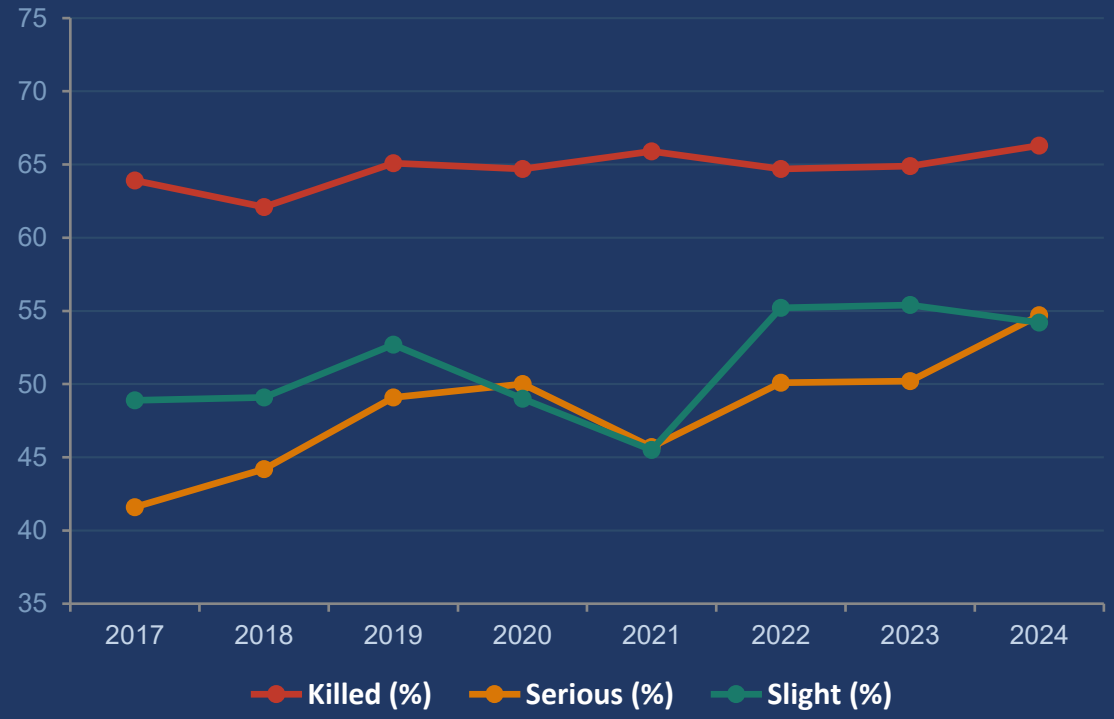
Comparing all casualties vs fatalities only | VRU = Vulnerable Road Users

Trend in Casualty Proportions by Road User Type, 2017-2024

Each panel shows how the proportion of casualties changed over time for each user type

VRU Share Is Rising — Significantly for Serious and Slight Injuries

Annual VRU share of casualties with 95% binomial CI, 2017–2024



Trend: OR per year

Killed

OR = 1.01 (0.997–1.02)

Serious

OR = 1.04 (1.04–1.05)

p < 0.001 ✓

Slight

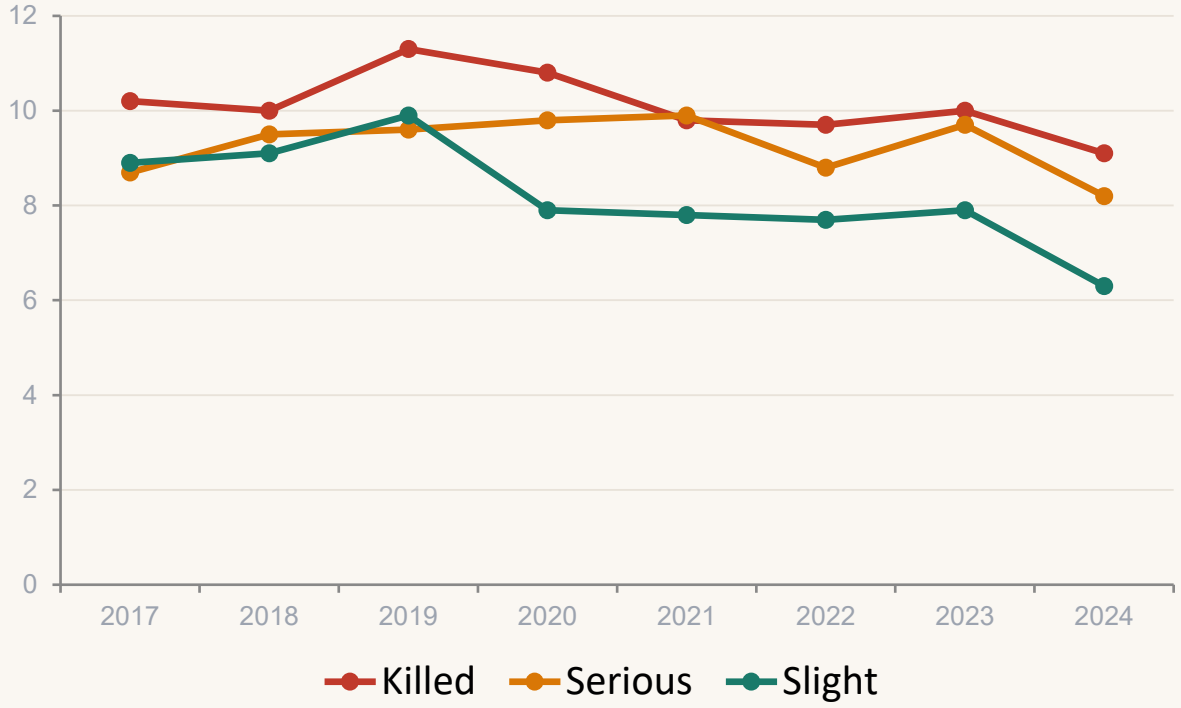
OR = 1.02 (1.01–1.02)

p < 0.001 ✓

Binomial logistic regression on aggregate counts. COVID-sensitivity: excluding 2020 yields consistent ORs — results are robust.

Child Road Safety Equity: A Declining but Persistent Burden

Children (<18) as share of all casualties, 2017–2024



Child share declining significantly for slight injuries: OR = 0.948/yr (95% CI: 0.939–0.957, p < 0.001). Child RR (Poisson) = 0.952/yr.

Child Burden (2024)

Fatal injuries

9.1%

of all casualties in this category

Serious injuries

8.2%

of all casualties in this category

Slight injuries

6.3%

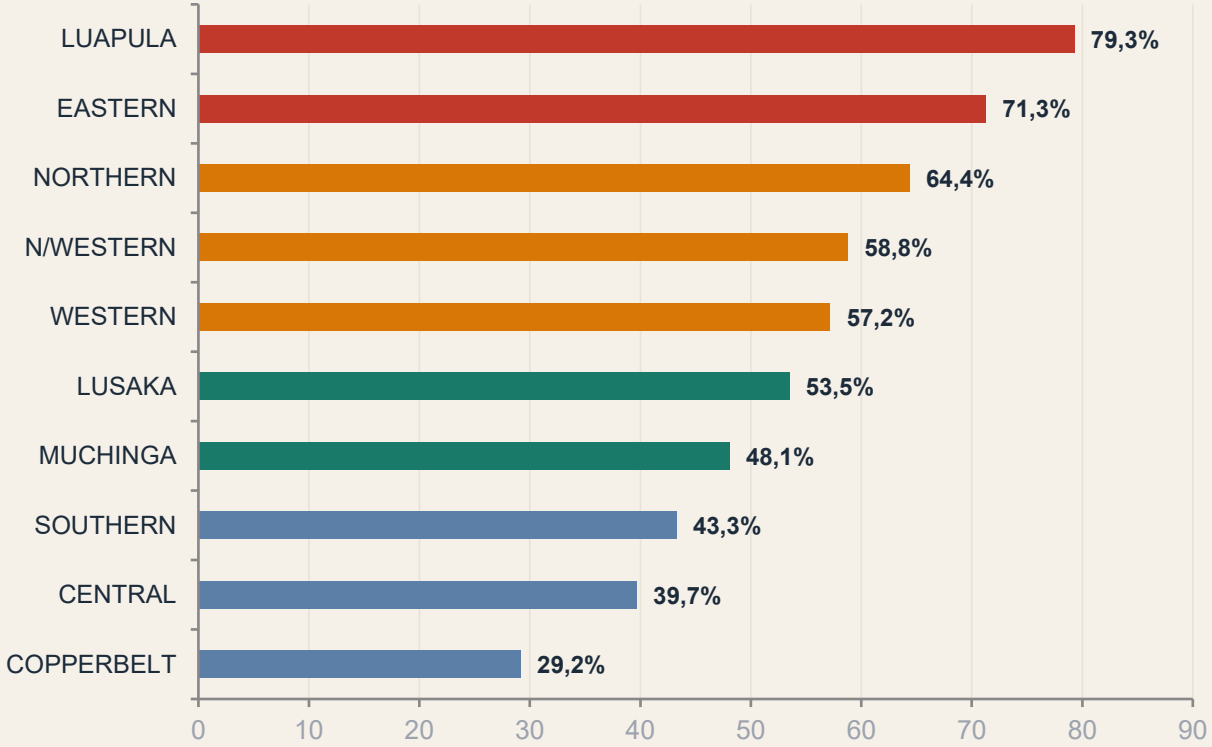
of all casualties in this category

VRUs Dominate Zambia's Road Traffic Death and Injury Toll

VRU = Pedestrians, Pedal Cyclists, Motorcyclists. Source: RTSA crash data 2017–2024. Rates from ZamStats mid-year population estimates.

A 50-Percentage-Point Divide: From Copperbelt (29%) to Luapula (79%)

VRU share of all casualties by province, 2024/25



Inequality metrics

Gini coefficient (2024)

0.122

Theil index (2024)

0.025

Range (max – min)

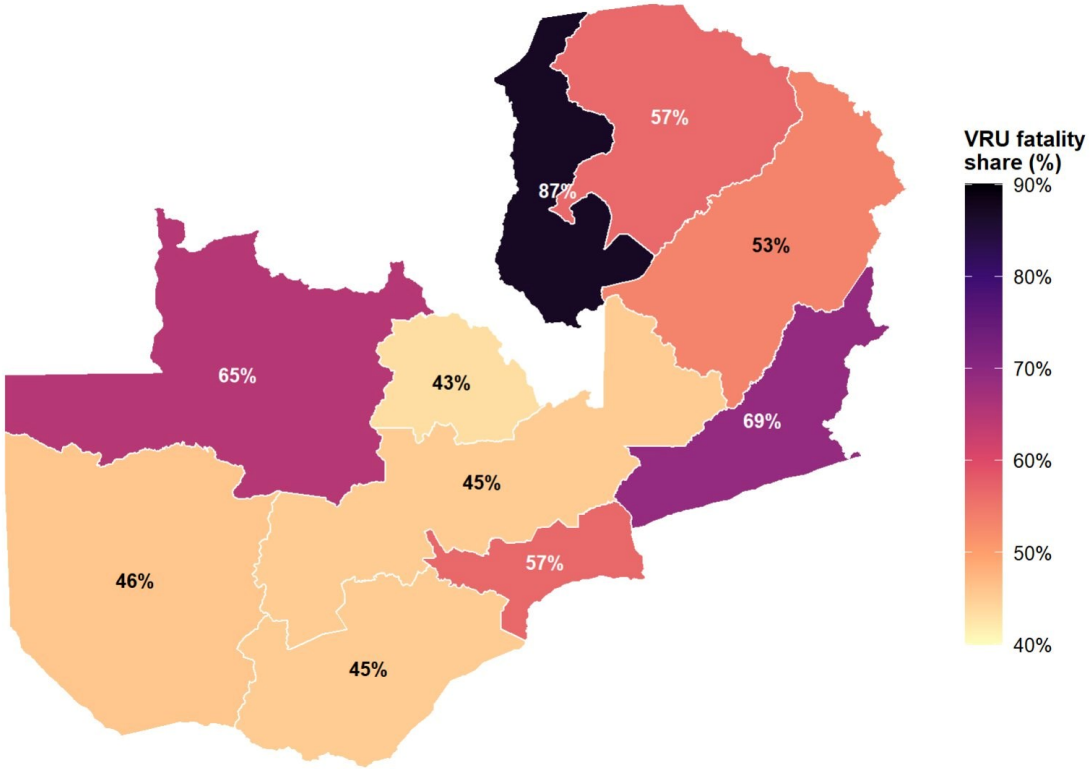
50.1 pp

Moran's I (2024)

−0.031 (p = 0.34)

No significant spatial clustering — rural burden is province-specific, not geographically contiguous

Spatial Inequity: A 44-Percentage-Point Divide Across Zambia's Provinces



Key findings

1 Luapula
87% · near-total VRU dominance

2 Eastern
69% · high rural exposure

3 N-Western
65% · remote, low enforcement

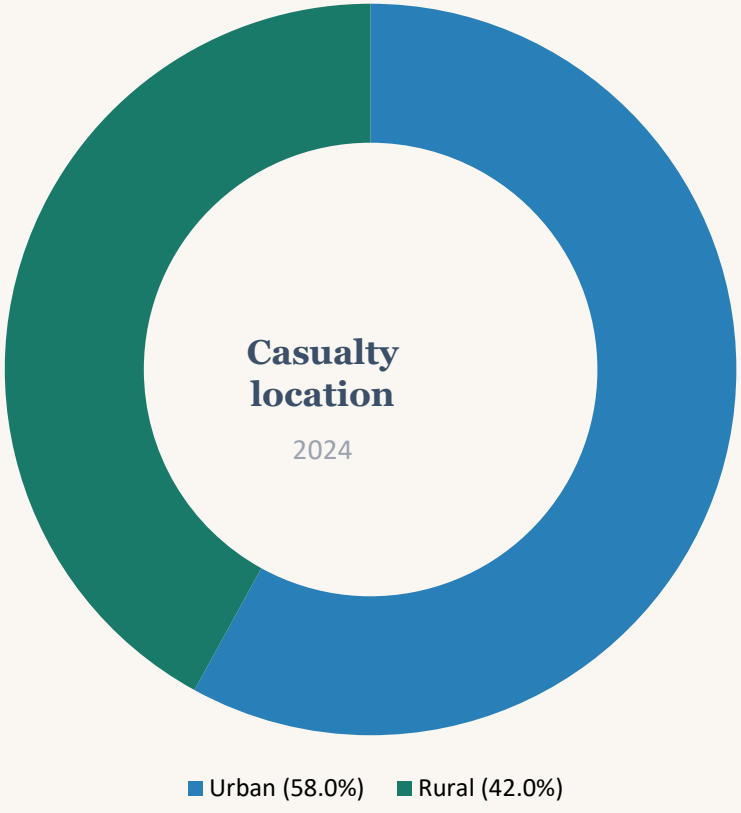
4 Central (min)
43% · lowest — more urban mix

Dark = higher VRU share. Lightest provinces still exceed 40% — no province is safe. Burden is province-specific, not geographically contiguous → targeted responses needed.

44 pp range · Gini = 0.122
No significant spatial clustering (Moran's I, p > 0.05)

Figure 3. VRU fatality share by province. Source: RTSA crash data · ZamStats · Zambia district shapefile (OCHA ADM2, 2020)

Urban–Rural Convergence: VRU Burden Rising Faster in Rural Areas



Key findings

VRU share rising in both settings

Rural: 44.7% (2017) → 55.0% (2024)
Urban: 50.7% (2017) → 56.4% (2024)

Urban–rural gap narrowing

Interaction term year × Urban: OR coefficient = −0.028 ($p < 0.001$) — rural VRU burden growing faster

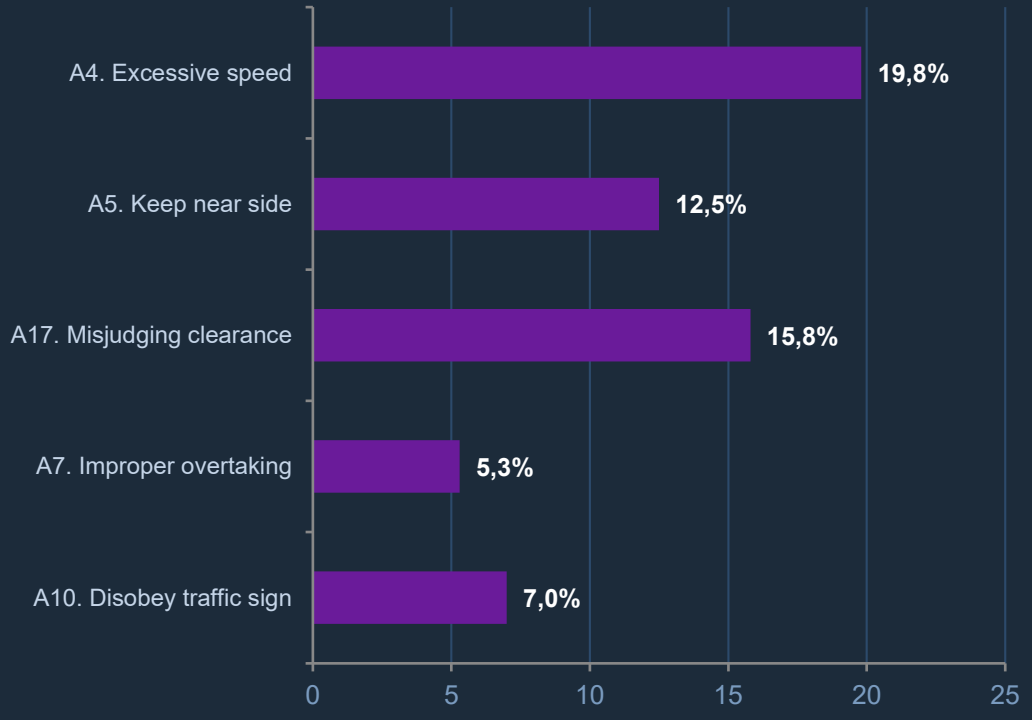
Policy implication

Rural intervention cannot wait — pedestrian infrastructure and enforcement must extend beyond cities

Urban/rural VRU split estimated via proportional reallocation (disclosed approximation). Interaction: Firth-penalised logistic regression.

Speed and Lane Indiscipline Drive VRU Exposure — and Both Are Worsening

Top crash causes: share change from 2017–2019 to 2022–2024



Biggest shifts (first vs last 3 years)

A4. Excessive speed

15.4% → 19.8% (++4.3pp)

A10. Disobey traffic sign

2.9% → 7.0% (++4.1pp)

A5. Keep to near side

13.8% → 12.5% (−1.3pp)

Motorcycles in fleet (vehicle)

2.6% → 6.4% (++3.8pp)

Cause categories not VRU-exclusive. Motorcycle vehicle share from x9_types_of_motor_vehicles, 2017–2024.

Robust Results: Four Sensitivity Tests Confirm the Core Findings

COVID sensitivity (excl. 2020)

Excluding 2020 yields near-identical ORs for all three severities. Results are not an artefact of pandemic-year mobility restrictions.

Narrow VRU definition

Restricting VRU to pedestrians + cyclists only (excluding motorcyclists) gives identical ORs — findings hold regardless of VRU definition used.

Data quality — 0% missingness

All 10 source tables show 0% missing in key classification variables. Data completeness = 100% for each year 2017–2024.

Trimmed series (excl. 2025)

Excluding the potentially incomplete 2025 year strengthens ORs: Killed 1.02*, Serious 1.06***, Slight 1.04***. Results become more conservative with full data.

Data-quality-weighted sensitivity (weighting by completeness score) produces identical ORs — confirming 100% completeness across all years.

Conclusions & Policy Implications

Dominant burden

VRUs account for 64% of all fatalities — 2 in every 3 road deaths in Zambia. This is not a marginal group.

Rising trend

Serious and slight injury shares rising significantly (OR = 1.04 and 1.02/yr). Fatal share stable — but at an already alarming level.

Children improving

Child share declining — especially slight injuries (OR = 0.948/yr, $p < 0.001$). Progress exists but absolute numbers remain high.

Spatial inequity

Luapula–Copperbelt gap of 50 percentage points. Rural VRU burden growing faster than urban — convergence from the wrong direction.

Policy Priorities

Pedestrian infrastructure first — pavements, crossings, lighting in rural districts

Speed management targeting (now 19.8% of all crashes) as the #1 cause

Provincial equity action plans for Luapula, Eastern, Northern (≥64% VRU share)

Institutionalise annual VRU equity monitoring as part of Road safety strategy

Thank you · mwalem@who.int · WHO Zambia Country Office