

Current substance use and road traffic injury among school-going adolescents in African countries: a multi-country survey-weighted analysis of Global School-based Student Health Survey data, 2003- 2017

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Abstract

Background

Road traffic injuries remain a major cause of preventable death and disability among children and young people, yet multi-country evidence on behavioural correlates among African school-going adolescents is limited. We estimated the prevalence and social patterning of motor-vehicle-related serious injury and examined its association with current alcohol, cigarette, cannabis, and polysubstance use across participating African Global School-based Student Health Survey (GSHS) datasets.

Methods

We harmonised 20 GSHS public-use survey files from 12 African countries. Seventeen surveys from nine countries contained a usable injury-cause outcome, yielding 44,303 adolescents with valid road traffic injury data and 2,520 unweighted cases. Road traffic injury identified motor-vehicle involvement as the major cause of the respondent's most serious injury during the previous 12 months. Pooled prevalence and associations were estimated using within-survey normalised weights, globally unique strata and primary sampling units, and Taylor-linearised variance estimation. Country-specific estimates used original survey weights. Survey-weighted logistic regression adjusted for age, sex, country, and survey period. Prespecified secondary analyses assessed substance-specific associations, polysubstance dose-response, sex interaction, country-specific estimates with random-effects meta-analysis, leave-one-country-out robustness, and restriction to seriously injured adolescents.

Results

The pooled weighted prevalence of road traffic injury was 5.8% (95% CI 5.5 to 6.2%). Prevalence was higher among males than females, and male sex remained independently associated with injury (aOR 1.63, 95% CI 1.47 to 1.80). Any current substance use was associated with higher odds of road traffic injury (aOR 1.78, 95% CI 1.50 to 2.12), as were current alcohol use (1.74, 1.52 to 1.99), cigarette smoking (2.11, 1.80 to 2.47), cannabis use (3.34, 2.63 to 4.24), and polysubstance use (2.36, 1.83 to 3.04). Injury prevalence increased from 4.2% among adolescents using no substance domain to 9.8% among those using all three domains, with an aOR of 1.52 (95% CI 1.36 to 1.69) per additional domain. Country-specific associations were heterogeneous, with a random-effects pooled aOR of 1.82 (95% CI 1.08 to 3.07; $I^2 = 81.8\%$).

Conclusions

Current substance use identifies an important behavioural risk cluster for road traffic injury among school-going adolescents in participating African GSHS surveys. The consistency of the pooled

exposure gradients, alongside substantial country heterogeneity, supports integrated adolescent substance-use and road-safety prevention strategies tailored to local contexts. The cross-sectional design and differing exposure and outcome recall periods preclude causal interpretation.

Background

Road traffic injury remains one of the most consequential and preventable causes of death and disability among children and young people. The World Health Organization estimated approximately 1.19 million road traffic deaths annually and identified road traffic injury as the leading cause of death among people aged 5–29 years [1]. The burden is concentrated in low- and middle-income settings, where rapid motorisation, heterogeneous road infrastructure, large numbers of vulnerable road users, and uneven implementation of proven safety measures intersect with limited trauma-care capacity [1, 2].

The adolescent period is particularly important for injury prevention. Increasing independent mobility, exposure to motorised transport, experimentation with alcohol and other substances, and developmental propensity for risk taking can occur simultaneously. African injury studies have demonstrated substantial road traffic injury burdens among children and adolescents, including recent hospital-based evidence from Ghana and trauma-registry evidence from Malawi [3–5]. However, hospital and registry studies capture treated injuries and may underrepresent less severe events or adolescents who do not reach formal care.

School-based surveillance offers a complementary perspective. The Global School-based Student Health Survey (GSHS) uses standardised sampling and self-administered questionnaires to measure health behaviours and protective factors among students, including violence and unintentional injury, alcohol, tobacco, and drug use [6, 7]. Country-specific GSHS studies have reported motor-vehicle injury as an important mechanism of adolescent injury and have linked behavioural and social exposures, including cannabis use and tobacco-related factors, with serious injury [8, 9]. Yet evidence remains fragmented across individual countries, and few studies have harmonised road traffic injury and current substance-use constructs across multiple African GSHS surveys while preserving the complex sampling design.

This study addresses that gap. We developed a harmonised multi-country road traffic dataset from African GSHS public-use files and used an integrated analytical framework linking contextual factors, current substance-use exposures, motor-vehicle-related serious injury, and policy interpretation. The objectives were to: describe the social, geographic and temporal patterning of road traffic injury; quantify associations with current alcohol, cigarette, cannabis, any-substance and polysubstance use; assess dose-response across the number of current substance-use domains; evaluate country heterogeneity using country-specific models and random-effects synthesis; and assess the numerical validity and internal reliability of the principal models.

Methods

Study design and data source

We conducted a secondary, pooled, cross-sectional analysis of public-use GSHS survey data from participating African countries. The harmonisation release comprised 20 survey files from 12 countries collected between 2003 and 2017. GSHS is conducted primarily among school-going adolescents using a standardised two-stage cluster sampling design in which schools are selected first and classes are selected within participating schools; all students in selected classes are eligible. Country-specific weights account for selection probabilities, non-response, and post-stratification [6, 10].

Study population and sample-size justification

The harmonised source population included 61,241 adolescents from 20 survey files and 12 countries. All records had complete sampling weight, stratum, and PSU fields. The road traffic injury outcome was usable in 17 surveys from nine countries, producing 44,303 adolescents with valid outcome data and 2,520 unweighted road traffic injury cases. Malawi 2009 and Senegal 2005 did not contain a verified injury-cause item, while the Sierra Leone 2017 injury-cause field could not be safely harmonised to the target construct. These surveys were therefore retained in the harmonised resource but excluded from analyses requiring the primary outcome.

No a priori sample-size calculation was undertaken because this was a secondary analysis of all eligible records available in the included public-use datasets. The analytic sample was determined by prespecified outcome validity, module availability, valid survey-design information, and complete-case availability for the covariates required by each model. Model support was assessed using the number of unweighted outcome events and events per estimated parameter. The sample flow is summarised in Fig. 1 and follows STROBE reporting principles for cross-sectional studies [11].

Road traffic injury outcome

The primary outcome, `road_traffic_injury_12m`, was derived from the GSHS Violence and Unintentional Injury module question asking for the major cause of the respondent's most serious injury during the previous 12 months. A response indicating a motor vehicle crash or being hit by a motor vehicle was coded as 1. Another valid cause, including reporting no serious injury, was coded as 0. Missing or unavailable responses remained missing. Thus, the outcome identifies motor-vehicle involvement as the major cause of the most serious injury and does not represent the total number of crashes experienced by a respondent [7].

Substance-use exposures

Current alcohol use was defined as at least one day of alcohol use during the previous 30 days. Current cigarette smoking was defined as cigarette use on at least one of the previous 30 days. Current cannabis

use was defined as at least one cannabis-use occasion during the previous 30 days. `any_current_substance_30d` indicated use of at least one of the three domains and was defined only when all three component variables were observed. `polysubstance_use_30d` indicated current use in at least two of the three domains. `substance_domain_count` ranged from 0 to 3 and was calculated only when all component domains were observed. Structural module absence was never recoded as non-use.

Social, demographic, country and temporal variables

The contextual covariates were age group, sex, country, and survey period. Age was grouped as 11–13, 14–16, and 17–18 years while preserving bottom- and top-coded questionnaire responses within the corresponding boundary group. Survey periods were grouped as 2000–2004, 2005–2009, 2010–2014, 2015–2019, and 2020–2024. No eligible survey in the current release was conducted during 2020–2024. Raw grade or class information was retained in the harmonised data but was not forced into a pooled education scale because a validated country-year education crosswalk was not available for this road traffic release.

Integrated analytical framework

The analysis was organised within a four-domain framework. The context domain represented age, sex, country, survey period, and the school-going population. The behavioural domain represented current alcohol, cigarette, cannabis, any-substance, and polysubstance use. The measured injury domain represented motor-vehicle involvement as the major cause of the most serious injury during the preceding 12 months. The policy domain translated convergent behavioural and contextual findings into implications for integrated adolescent substance-use prevention and road-safety strategies. Plausible mechanisms such as acute impairment, risk taking, mobility exposure, and traffic environment were considered conceptual pathways only because they were not measured consistently in the historical survey files.

Survey design and weighting

Original sampling weights, strata, and PSUs were retained for each survey. For pooled analyses, globally unique *survey_sstratum* and *survey_psu* identifiers were constructed by combining the survey identifier with the original stratum and PSU. Country-specific prevalence and regression used the original survey weight. Pooled analyses used a within-survey normalised weight, defined as the original weight divided by the mean weight within each survey, so that each survey retained its within-survey probability structure without being dominated by arbitrary differences in the raw scale of survey weights. Variances and 95% confidence intervals were estimated using Taylor linearisation. There were no singleton PSUs in the full pooled design.

Statistical analysis

We first estimated weighted road traffic injury prevalence overall and by age group, sex, country, and survey period. We then estimated injury prevalence among current users and non-users of each substance exposure. A demographic and contextual survey-weighted logistic regression model included age group, sex, country, and survey period. Separate substance-specific models added current alcohol use, cigarette smoking, cannabis use, any current substance use, or polysubstance use to the protected contextual covariates. The principal behavioural model used any current substance use.

Polysubstance dose-response was assessed by modelling substance-domain count categorically, with zero domains as reference, and continuously to estimate the adjusted odds ratio associated with each additional current-use domain. Prespecified effect modification by sex was evaluated by adding an any-current-substance-by-sex interaction. All odds ratios are reported as associations and are not interpreted as risk ratios or causal effects.

For each country with adequate common-basket substance data, we fitted a country-specific survey-weighted logistic model using original survey weights and adjustment for age and sex, with survey period additionally included when more than one period was observed. Country-specific log odds ratios were pooled using a random-effects model with restricted maximum likelihood and small-sample inference. We report I-squared, tau-squared, Cochran Q, and a prediction interval. A leave-one-country-out analysis evaluated whether the primary pooled estimate was driven by any single country.

Model validity and reliability

Model validity and internal numerical reliability were assessed using convergence, model-matrix rank, condition number, unweighted event count, events per estimated parameter, weighted Brier score, weighted area under the receiver operating characteristic curve, and influential-country analysis. These diagnostics were used to evaluate numerical stability rather than to imply external predictive validation. A sensitivity model restricted the analysis to respondents who reported at least one serious injury, thereby changing the estimand to the odds that the most serious injury was road-traffic-related among seriously injured adolescents.

Missing data and module availability

Complete-case analysis was used for each model after preserving module-level structural missingness. Surveys lacking a substance module were excluded only from analyses requiring that exposure. The 2021 GSHS Core-Expanded catalogue includes seat-belt, helmet, drink-driving, riding-with-a-drinking-driver, and road-safety education questions, but none of the attached historical source files contained a verified version that could be safely harmonised. These optional road-safety fields therefore remained missing and were not analysed [12].

Reporting and ethics

The study is reported in accordance with the STROBE statement [11]. GSHS public-use data are de-identified, and no direct student or school identifiers were included in the harmonised analytical release. The original surveys were implemented under country-specific administrative and ethical procedures. No

new participants were recruited or contacted for this secondary analysis. The authors should confirm whether an additional institutional determination is required by their institutions before submission.

Results

Study sample and participant flow

The harmonised source included 61,241 students from 20 survey files in 12 countries. A valid road traffic injury outcome was available for 44,303 adolescents in 17 surveys from nine countries, including 2,520 unweighted cases. Exposure-specific regression samples were smaller because current alcohol, cigarette, and cannabis modules were not uniformly administered across country-years. The principal common-basket any-substance model included 18,005 adolescents and 878 road traffic injury events across nine eligible surveys from six countries.

Social, demographic, country and temporal patterning

The pooled weighted road traffic injury prevalence was 5.8% (95% CI 5.5 to 6.2%). Prevalence was 7.1% among males and 4.3% among females. In the adjusted demographic model, males had 1.63-fold higher odds of road traffic injury than females (95% CI 1.47 to 1.80, $p < 0.001$). Age-group differences were smaller and were not independently significant after adjustment for country and survey period.

Country-specific weighted prevalence ranged from 2.1% in Mauritius to 8.8% in Ghana. Survey-period prevalence was highest in 2005–2009 at 9.0% and lowest in 2010–2014 at 3.5%. After adjustment for country, the 2010–2014 and 2015–2019 periods had lower odds than 2000–2004, although these comparisons partly reflect changing country composition and should not be interpreted as a continent-wide secular trend.

Table 1
Survey-weighted road traffic injury prevalence by social, demographic, country and temporal characteristics

Characteristic	Category	N	Cases	Weighted prevalence, %	95% CI
Age group	11–13	9,306	481	5.4	4.9 to 5.9
	14–16	27,466	1,520	5.8	5.4 to 6.2
	17–18	7,092	483	6.6	5.8 to 7.6
Sex	Female	21,658	912	4.3	4.0 to 4.7
	Male	22,068	1,552	7.1	6.7 to 7.6
Survey period	2000–2004	6,348	437	8.0	7.1 to 9.0
	2005–2009	9,955	917	9.0	8.3 to 9.7
	2010–2014	19,053	662	3.5	3.1 to 4.0
	2015–2019	8,947	504	5.8	5.0 to 6.7
Country	Algeria	8,002	168	2.3	1.9 to 2.8
	Benin	4,619	289	6.6	5.7 to 7.6
	Ghana	8,696	926	8.8	7.6 to 10.2
	Kenya	2,390	185	8.6	7.0 to 10.5
	Liberia	2,373	217	8.6	6.9 to 10.8
	Mauritania	1,783	67	3.7	2.7 to 5.1
	Mauritius	6,720	139	2.1	1.7 to 2.7
	Mozambique	1,698	123	7.6	5.4 to 10.7
	Namibia	8,022	406	4.8	4.1 to 5.6

Note: pooled age, sex, and survey-period estimates use within-survey normalised weights. Country estimates use original survey weights. Estimates apply only to participating surveys with a usable outcome.

Road traffic injury by current substance use

Road traffic injury prevalence was consistently higher among current substance users than non-users. For alcohol, weighted prevalence was 8.5% among current users compared with 5.3% among non-users. Corresponding contrasts were 8.3% versus 4.2% for cigarette smoking, 12.2% versus 4.0% for cannabis use, and 6.6% versus 4.2% for any current substance use. Polysubstance users had a weighted injury prevalence of 8.7% compared with 4.6% among adolescents using zero or one substance domain.

Adjusted associations with current substance use

After adjustment for age, sex, country, and survey period, any current substance use was associated with higher odds of road traffic injury (aOR 1.78, 95% CI 1.50 to 2.12, $p < 0.001$). All substance-specific models showed the same direction. Current alcohol use had an aOR of 1.74 (95% CI 1.52 to 1.99), cigarette smoking 2.11 (1.80 to 2.47), cannabis use 3.34 (2.63 to 4.24), and polysubstance use 2.36 (1.83 to 3.04). The largest adjusted association was observed for current cannabis use.

Table 2
Road traffic injury prevalence and adjusted associations by current substance exposure

Exposure	No-use prevalence, %	Current-use prevalence, %	Adjusted OR (95% CI)	P value	Model N
Current alcohol use	5.3 (4.9–5.8)	8.5 (7.8–9.3)	1.74 (1.52–1.99)	< 0.001	30,515
Current cigarette smoking	4.2 (3.9–4.6)	8.3 (7.4–9.4)	2.11 (1.80–2.47)	< 0.001	36,881
Current cannabis use	4.0 (3.6–4.3)	12.2 (10.0–14.6)	3.34 (2.63–4.24)	< 0.001	28,813
Any current substance use	4.2 (3.7–4.8)	6.6 (5.8–7.6)	1.78 (1.50–2.12)	< 0.001	18,005
Polysubstance use	4.6 (4.2–5.2)	8.7 (7.0–10.7)	2.36 (1.83–3.04)	< 0.001	18,005
Notes: Adjusted models include age group, sex, country, and survey period. Each exposure is modelled separately because module availability differs across surveys.					

Polysubstance dose-response

A graded pattern was observed across the number of current substance-use domains. Weighted road traffic injury prevalence increased from 4.2% among adolescents using no substance domain to 6.0%, 8.2%, and 9.8% among those using one, two, and three domains, respectively. In the adjusted categorical model, the odds ratios relative to no current substance use were 1.55, 2.53, and 3.07 for one, two, and three domains. Modelled continuously, each additional current-use domain was associated with a 1.52-fold increase in the odds of road traffic injury (95% CI 1.36 to 1.69, $p < 0.001$).

Country heterogeneity and random-effects synthesis

The country-specific adjusted association between any current substance use and road traffic injury varied substantially. Adjusted odds ratios ranged from 0.89 in Namibia to 3.64 in Mauritius. The random-effects pooled estimate was 1.82 (95% CI 1.08 to 3.07), with high heterogeneity ($I^2 = 81.8\%$, tau-squared = 0.203). The 95% prediction interval was 0.51 to 6.49, crossing the null and indicating that the magnitude of the association may differ materially across country contexts.

Table 4
Country-specific adjusted association between any current substance use and road traffic injury

Country	N	Cases	Adjusted OR (95% CI)	P value
Benin	4,061	246	1.72 (1.17–2.53)	0.007
Ghana	2,756	173	2.57 (1.62–4.09)	< 0.001
Liberia	1,788	154	1.94 (1.11–3.37)	0.021
Mauritius	4,356	81	3.64 (2.42–5.49)	< 0.001
Mozambique	1,425	95	1.32 (0.87–2.00)	0.176
Namibia	3,619	129	0.89 (0.56–1.41)	0.603
Random-effects pooled			1.82 (1.08–3.07)	

Model validity, reliability and sensitivity analyses

All principal models converged and had full-rank model matrices. Events per parameter ranged from 73.2 to 162.7, substantially above conventional sparse-model warning ranges. Condition numbers ranged from 6.3 to 8.2, providing no indication of severe numerical collinearity. The principal any-substance model had an AUC of 0.68, a weighted Brier score of 0.046, and 73.2 events per parameter. Discrimination was modest, which is expected for an aetiological behavioural model and was not used as evidence of causal validity.

The primary association was robust to exclusion of individual countries. Leave-one-country-out adjusted odds ratios ranged from 1.63 to 2.06, and all remained above 1.0. Restricting the analysis to respondents who reported at least one serious injury attenuated the any-substance association but it remained positive (aOR 1.43, 95% CI 1.19 to 1.71). There was no evidence that the any-substance association differed by sex (interaction OR 1.02, 95% CI 0.74 to 1.41, $p = 0.894$).

Table 5
Model validity and numerical diagnostics

Model	N	Events	Parameters	EPV	AUC	Brier	Condition no.
Demographic context	43,421	2,440	15	162.7	0.69	0.053	7.0
Alcohol	30,515	1,822	14	130.1	0.67	0.056	6.3
Cigarette	36,881	1,624	16	101.5	0.69	0.043	7.9
Cannabis	28,813	1,202	14	85.9	0.70	0.040	8.2
Any substance	18,005	878	12	73.2	0.68	0.046	6.9
Polysubstance	18,005	878	12	73.2	0.68	0.046	6.8

Framework-based synthesis of findings

The observed results aligned coherently with the prespecified analytical framework. In the context domain, road traffic injury affected 5.8% of adolescents in outcome-eligible surveys, with higher adjusted odds among males and marked country and survey-period variation. In the behavioural exposure domain, any current substance use was associated with 1.78-fold higher adjusted odds, with stronger associations for cigarette smoking, cannabis use, and polysubstance use. The graded increase from 4.2% injury prevalence at zero current-use domains to 9.8% at three domains reinforced the interpretation of behavioural clustering. In the measured injury domain, the outcome captured motor-vehicle involvement in the most serious injury rather than all crash events. Finally, the policy domain is supported by the convergence of contextual and behavioural signals: integrated substance-use prevention and road-safety programming may provide a practical route to identify and protect adolescents at elevated injury risk, while the substantial country heterogeneity argues against a uniform intervention model.

Discussion

In this multi-country analysis of African GSHS data, approximately one in seventeen adolescents with a valid injury-cause response had a motor-vehicle-related cause of their most serious injury in the previous 12 months. The burden was not evenly distributed. Males had substantially higher adjusted odds than females, country prevalence varied approximately fourfold, and the pattern across survey periods was non-monotonic. Most importantly, each current substance-use exposure was associated with higher odds of road traffic injury after adjustment for age, sex, country, and survey period. Cannabis use showed the largest substance-specific association, polysubstance use was strongly associated with injury, and the domain-count analysis demonstrated a clear graded pattern.

These findings extend prior African adolescent injury research in three ways. First, the analysis focuses specifically on motor-vehicle involvement rather than broad serious-injury counts. Second, it harmonises multiple GSHS surveys and explicitly preserves complex survey design. Third, it evaluates current alcohol, cigarette, cannabis, and polysubstance exposures within the same analytical framework while transparently allowing model-specific denominators to vary according to module availability.

The country-specific results provide useful internal face validity. In Liberia, the weighted road traffic injury prevalence was 8.6%, closely matching a previous analysis of the 2017 Liberia GSHS in which motor vehicle crashes accounted for 8.6% of the most serious injuries [8]. That study also found current cannabis use to be associated with serious injury, consistent with the strong cannabis association observed across the broader multi-country sample. Ghanaian GSHS analyses have likewise identified substantial serious injury burden and behavioural correlates among adolescents [9].

The broader injury literature supports the plausibility of a substance-injury relationship but also cautions against simplistic interpretation. Alcohol can impair judgement, reaction time, and risk perception, while cannabis and co-use patterns may mark risk-taking or mobility contexts associated with injury. Studies of fatally injured young drivers have demonstrated frequent alcohol and cannabis detection, although

evidence from high-income driving populations is not directly generalisable to African school-going adolescents [13]. In Malawi, trauma and modelling studies have incorporated alcohol use as an important road traffic injury risk factor and have highlighted the high share of road traffic crashes in the trauma burden [4, 5].

The high I² of 81.8% and the prediction interval crossing 1.0 indicate that the average pooled association should not be treated as universally applicable to every country. Differences in transport modes, adolescent mobility, road infrastructure, enforcement, urbanisation, substance availability, school attendance patterns, and measurement timing may all contribute. The country-specific estimates should therefore be viewed as contextual evidence rather than as a league table. The temporal prevalence pattern similarly should not be interpreted as a continent-wide trend because the set of participating countries changed across periods.

The findings suggest that adolescent substance-use prevention and road-safety prevention should not be designed as entirely separate programmes. School and youth-health systems that identify current substance use may also be reaching a population with elevated road traffic injury burden. Practical responses could include age-appropriate substance-use prevention, road-safety education, enforcement of alcohol-impaired driving laws, safe school-zone design, speed management, helmet and seat-belt promotion, and safer mobility options for young people. A systematic review of adolescent unintentional injury prevention supports the value of multi-component and policy-oriented strategies rather than isolated education alone [14].

However, the current GSHS files do not indicate whether injured adolescents were drivers, passengers, pedestrians, cyclists, or motorcyclists, and they do not provide consistent historical measures of seat-belt use, helmet use, or drink-driving. Policy interpretation must therefore remain at the level of integrated risk prevention rather than attributing the observed associations to a specific crash mechanism.

Strengths and limitations

The study has several strengths. It uses individual-level public-use survey data rather than aggregate country summaries, harmonises the injury outcome by variable labels and labelled response categories rather than assuming identical question numbers across surveys, preserves original survey design fields, distinguishes structural module absence from non-use, and reports model support and stability diagnostics. The dose-response analysis and country-specific random-effects synthesis provide complementary evidence beyond a single pooled odds ratio. The leave-one-country-out analysis also shows that the principal pooled association is not dependent on a single country.

Several limitations are important. First, the outcome identifies the major cause of the most serious injury during the previous 12 months and therefore does not capture all road traffic crashes or injuries. Second, current substance use refers to the previous 30 days, whereas the injury outcome covers 12 months, so temporal ordering cannot be established and reverse or shared-cause explanations remain possible.

Third, the analysis is restricted to adolescents attending school and cannot represent out-of-school adolescents, who may differ in both substance exposure and road risk. Fourth, substance modules and the injury-cause item were not administered uniformly across surveys, producing model-specific analytic samples. Fifth, road-user type, crash circumstances, traffic exposure, vehicle ownership, urban-rural residence, speed, seat-belt use, helmet use, and drink-driving were not consistently available. Sixth, self-reported behaviours and injuries are subject to recall and social-desirability bias. Finally, the survey years span 2003–2017, and pooled estimates should not be interpreted as contemporary Africa-wide prevalence.

Conclusions

Road traffic injury among school-going adolescents in participating African GSHS surveys was socially and geographically patterned and strongly associated with current substance use. Any current substance use was associated with approximately 1.8-fold higher adjusted odds of road traffic injury, while cannabis and polysubstance use showed particularly strong associations. A graded increase across the number of current substance-use domains further suggests that behavioural clustering is relevant to adolescent injury prevention. Substantial country heterogeneity indicates that prevention should combine a common evidence-based road-safety and substance-use framework with country-specific implementation. Longitudinal and transport-specific data are needed to establish temporal pathways and identify the road-user mechanisms that underpin these associations.

Abbreviations

AOR

adjusted odds ratio

AUC

area under the receiver operating characteristic curve

CI

confidence interval

GSHS

Global School-based Student Health Survey

PSU

primary sampling unit

REML

restricted maximum likelihood

RTI

road traffic injury

STROBE

Strengthening the Reporting of Observational Studies in Epidemiology.

Declarations

Ethics approval and consent to participate

This secondary analysis used de-identified GSHS public-use data. No new participant recruitment or contact occurred. The original surveys were implemented under country-specific ethical, administrative, and consent procedures. The corresponding author should confirm the institutional determination applicable to this secondary analysis before submission.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Funding

No specific funding was received for this secondary analysis.

Author Contribution

WFN: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Visualization, Writing – original draft, Writing – review & editing, Project administration. SN: Methodology, Validation, Clinical interpretation, Writing – review & editing. MU: Methodology, Validation, Public health and policy interpretation, Supervision, Writing – review & editing. CZ: Conceptualization, Methodology, Supervision, Validation, Writing – review & editing, Correspondence.

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Data Availability

We conducted a secondary, pooled, cross-sectional analysis of public-use GSHS survey data from participating African countries. The harmonisation release comprised 20 survey files from 12 countries collected between 2003 and 2017. GSHS is conducted primarily among school-going adolescents using

a standardised two-stage cluster sampling design in which schools are selected first and classes are selected within participating schools; all students in selected classes are eligible

References

1. World Health Organization. Global status report on road safety 2023. Geneva: World Health Organization; 2023.
2. Vissoci JRN, Shogilev DJ, Krebs E, de Andrade L, Vieira IF, Toomey N, et al. Road traffic injury in sub-Saharan African countries: a systematic review and summary of observational studies. *Traffic Inj Prev*. 2017;18(7):767–73. 10.1080/15389588.2017.1314470.
3. Appiah AB, Wilson ML, Dambach P, MohammadNamdar M, Buunaaim ADB, Alatiiga JA, et al. Epidemiology of pediatric road traffic injuries: a multicenter hospital-based study in Ghana. *Inj Epidemiol*. 2025;12:83. 10.1186/s40621-025-00646-1.
4. Chokotho L, Croke K, Mohammed M, Mulwafu W, Bertfelt J, Karpe S, et al. Epidemiology of adult trauma injuries in Malawi: results from a multisite trauma registry. *Inj Epidemiol*. 2022;9:14. 10.1186/s40621-022-00379-5.
5. Manning Smith R, Cambiano V, Colbourn T, Collins JH, Graham M, Jewell B, et al. Estimating the health burden of road traffic injuries in Malawi using an individual-based model. *Inj Epidemiol*. 2022;9:21. 10.1186/s40621-022-00386-6.
6. World Health Organization. Global School-based Student Health Survey methodology. Geneva: World Health Organization. Available from: <https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey/methodology>. Accessed 5 Sep 2026.
7. World Health Organization. Global School-based Student Health Survey: Core Questionnaire, 2021 version. Geneva: World Health Organization; 2021.
8. Pengpid S, Hinneh JT, Peltzer K. Prevalence and correlates of single and multiple unintentional non-fatal injuries among school-going adolescents in Liberia. *Injury*. 2021;52(4):787–92. 10.1016/j.injury.2020.11.048.
9. Ackah M, Salifu MG, Boakye H. Factors associated with serious injuries among adolescents in Ghana: findings from 2012 Global School Health Survey. *ScientificWorldJournal*. 2021;2021:6622363. 10.1155/2021/6622363.
10. World Health Organization. Malawi Global School-Based Student Health Survey 2009: study description and weighting. WHO NCD Microdata Repository. Available from: <https://extranet.who.int/ncdsmicrodata/>. Accessed 5 Sep 2026.
11. von Elm E, Altman DG, Egger M, Pocock SJ, Gotsche PC, Vandenbroucke JP, STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology statement: guidelines for reporting observational studies. *PLoS Med*. 2007;4(10):e296. 10.1371/journal.pmed.0040296.

12. World Health Organization. Global School-based Student Health Survey: Core-Expanded Questions, 2021 version. Geneva: World Health Organization; 2021.
13. Keyes KM, Brady JE, Li G. Effects of minimum legal drinking age on alcohol and marijuana use: evidence from toxicological testing data for fatally injured drivers aged 16 to 25 years. *Inj Epidemiol*. 2015;2:1. 10.1186/s40621-014-0032-1.
14. Salam RA, Arshad A, Das JK, Khan MN, Mahmood W, Freedman SB, et al. Interventions to prevent unintentional injuries among adolescents: a systematic review and meta-analysis. *J Adolesc Health*. 2016;59(4 Suppl):S76–87. 10.1016/j.jadohealth.2016.07.024.
15. Archer KJ, Lemeshow S. Goodness-of-fit test for a logistic regression model fitted using survey sample data. *Stata J*. 2006;6(1):97–105. 10.1177/1536867X0600600106.
16. Lumley T. Analysis of complex survey samples. *J Stat Softw*. 2004;9(8):1–19. 10.18637/jss.v009.i08.
17. Viechtbauer W. Conducting meta-analyses in R with the metafor package. *J Stat Softw*. 2010;36(3):1–48. 10.18637/jss.v036.i03.
18. Ali MS, D'Elia A, Oxley J, Koppel S. Epidemiology of road traffic injuries and fatalities among children in Ethiopia: a systematic review and meta-analysis. *BMC Public Health*. 2026;26:2236. 10.1186/s12889-026-27952-7.

Figures

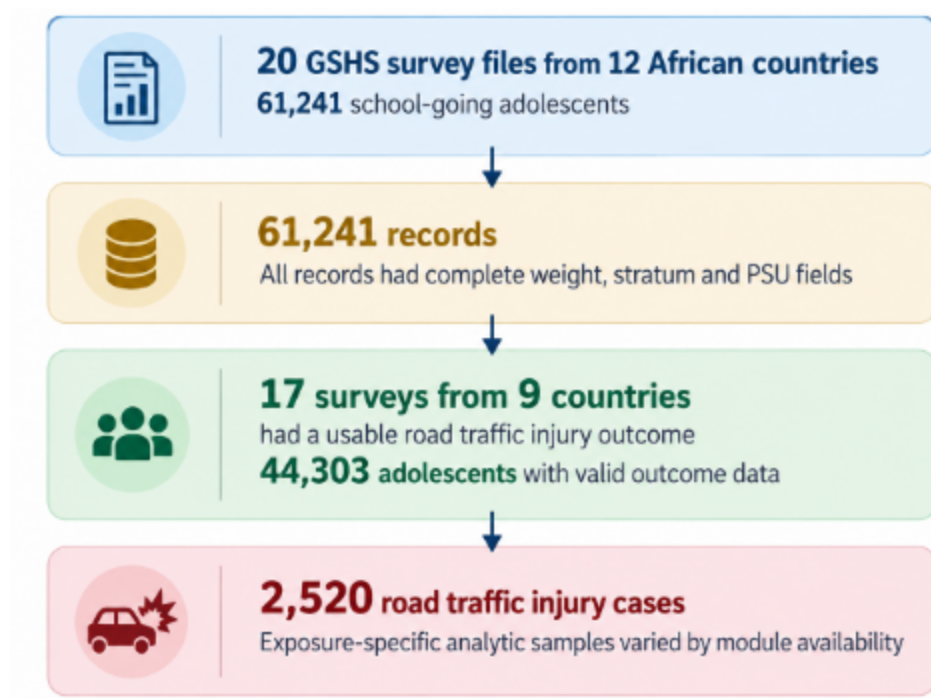


Figure 1

STROBE-style analytic sample flow. Exposure-specific regression sample sizes vary because the substance-use modules were not uniformly available across surveys.

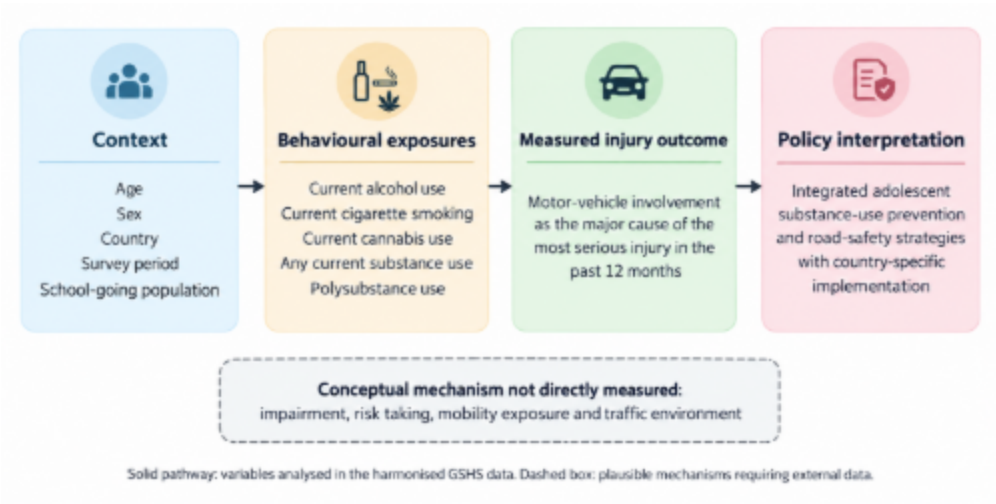


Figure 2

Integrated analytical framework linking measured context, behavioural exposures, the harmonised road traffic injury outcome, and policy interpretation. The dashed mechanism box identifies plausible pathways that were not directly measured.

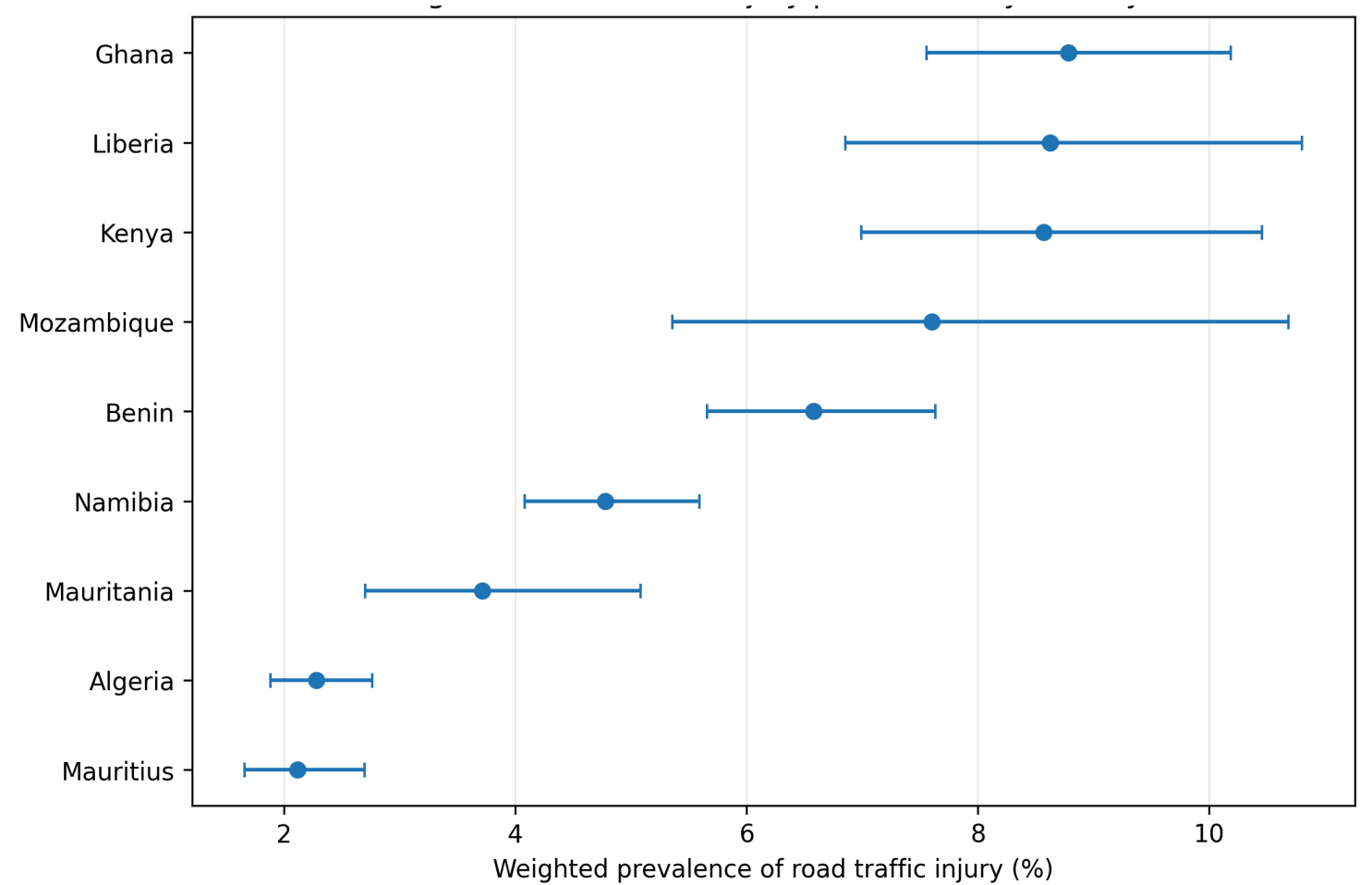


Figure 3

Survey-weighted road traffic injury prevalence by country with 95% confidence intervals.

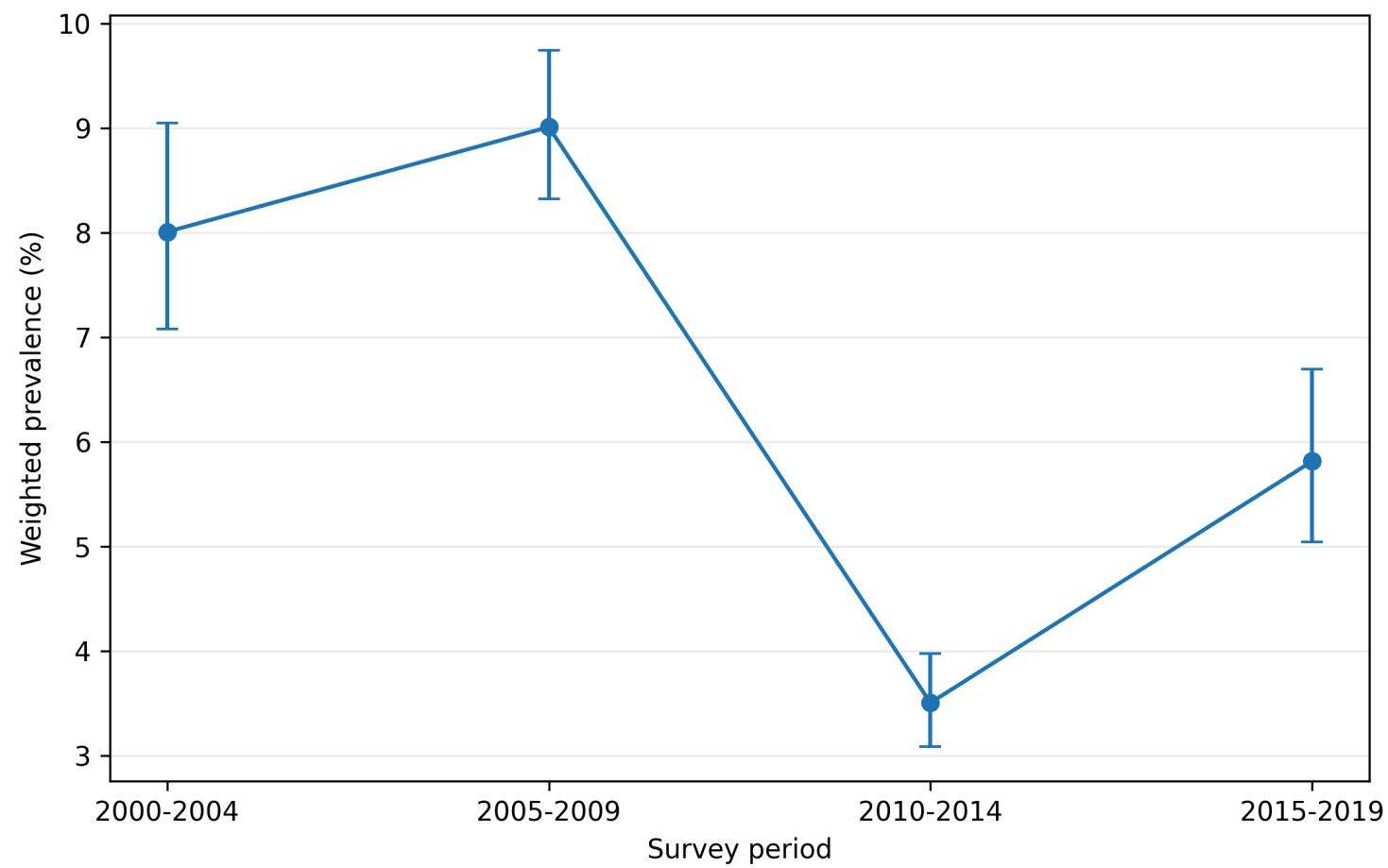


Figure 4

Survey-weighted road traffic injury prevalence by grouped survey period. No eligible survey was available for 2020-2024.

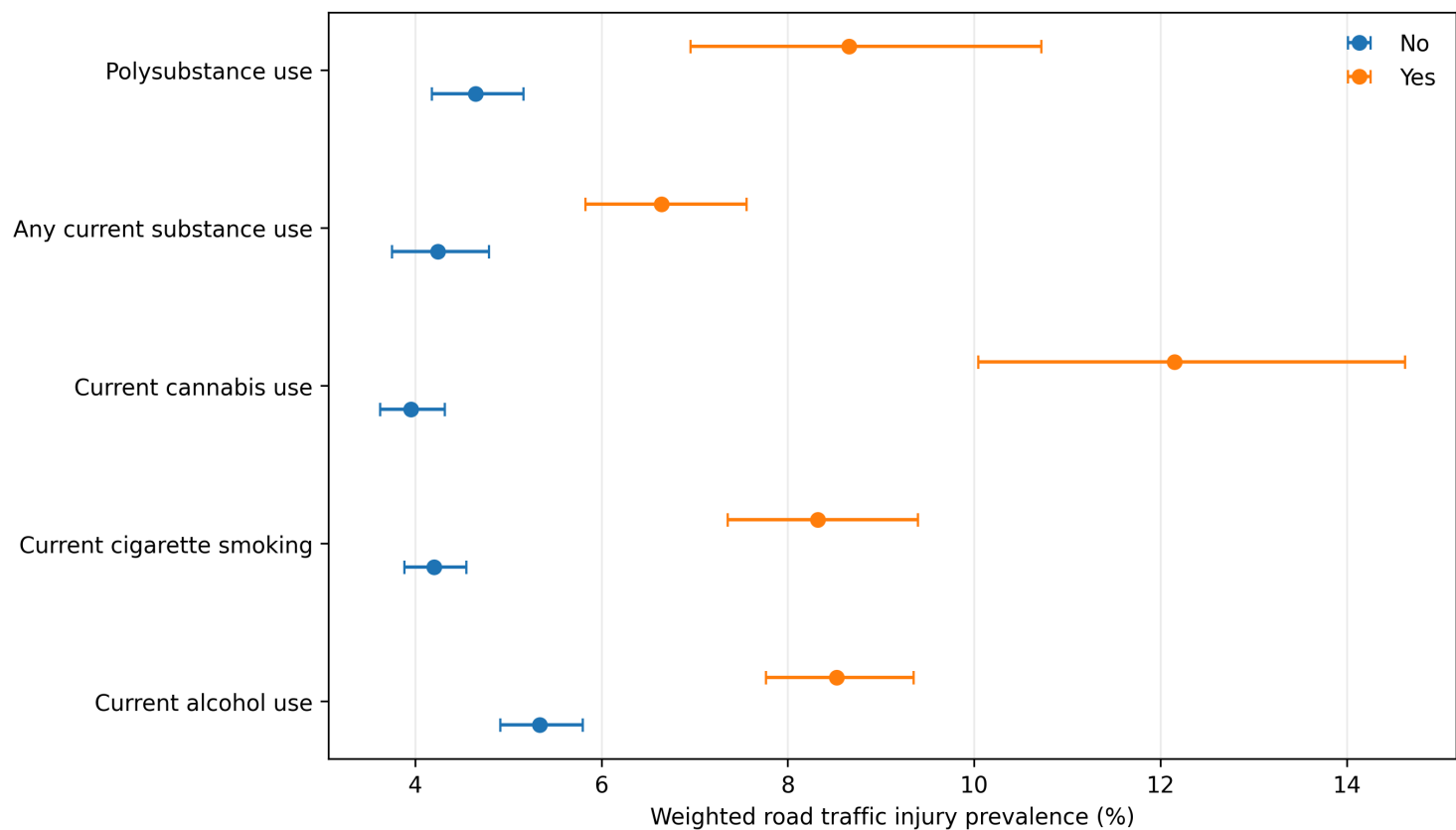


Figure 5

Survey-weighted road traffic injury prevalence among current users and non-users of each substance exposure. Denominators vary because modules were not uniformly available.

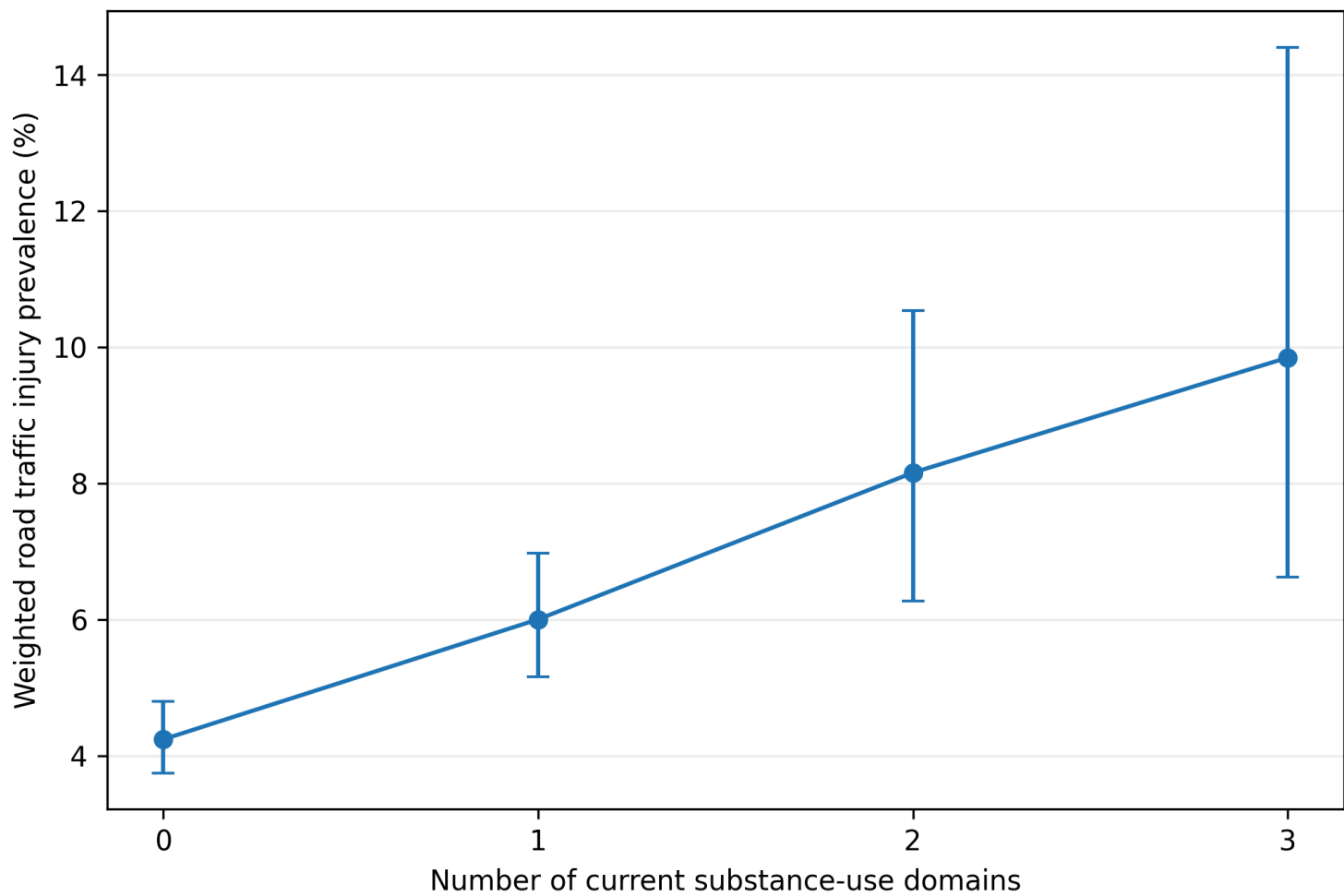


Figure 6

Survey-weighted road traffic injury prevalence by the number of current substance-use domains, with 95% confidence intervals.