Targeted Interventions for Dangerous Driving in Low-Middle Income Countries: A Systematic Review

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Abstract

Road traffic injuries are a leading cause of death in low and middle-income countries (LMICs), with over 90% of road fatalities occurring in these settings. Crash statistics are documented, but evidence on which demographics engage in dangerous driving remains fragmented, limiting interventions. This systematic review synthesised evidence on demographic patterns associated with dangerous driving in LMICs and assessed intervention effectiveness. PubMed, Google Scholar, TRID, and OECD iLibrary identified studies published between January 2021 and October 2025 examining dangerous driving and demographic characteristics. Screening followed PRISMA guidelines with narrative synthesis. Twenty-one studies from eighteen countries in South Asia and Sub-Saharan Africa were reviewed. Young adults (18-25 years) were most examined (57.1%), followed by adolescents (<18 years, 19.1%) and adults (26-45 years, 14.2%). Male and middle-income drivers, particularly young adults (18-25 years), were the highest-risk demographics. Aggressive, distracted, speeding, alcohol-impaired, and unlicensed driving were most prevalent. Intervention evidence was scarce: only six

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studies (28.6%) reported interventions, while fifteen (71.4%) reported none. Interventions included multi-component programs (n=2), policy/legislative approaches (n=1), technology-based solutions (n=1), education and training (n=1), and context-specific measures (n=1). However, geographic concentration and socioeconomic underreporting prevent definitive conclusions, leaving policymakers with insufficient evidence for targeted strategies.

Keywords: demographics, young adults, males, traffic safety, risk factors, prevention strategies

INTRODUCTION

Road traffic injuries represent one of the most pressing yet preventable public health challenges of the 21st century. Globally, approximately 1.35 million people die annually from road crashes, with an additional 20 to 50 million suffering non-fatal injuries that often result in long-term disability. (World Health Organisation, 2023). This burden falls disproportionately on LMICs (LMICs), which accounts for over 90% of global road traffic deaths despite having only 60% of the world's registered vehicles. (World Health Organisation, 2023). The human and economic costs are staggering. Road crashes kill and injure predominantly young, economically active individuals, generating ripple effects across families, communities, and national economies. (Anderson *et al.*, 2021; Bačkalić *et al.*, 2025). The World Bank estimates that road traffic injuries cost LMICs between 3% and 5% of gross domestic product (GDP) annually, resources which could otherwise support health, education, and development priorities. (World Bank, 2025).

Unlike infectious or chronic diseases that have achieved major mortality reductions through targeted interventions, road traffic deaths in LMICs have not declined. In some regions, they have even increased. Rapid motorisation, weak enforcement systems,

poor road design, and limited safety culture largely drive this persistence (Bačkalić *et al.*, 2025; Woldu *et al.*, 2020). The United Nations Sustainable Development Goals (SDGs) recognise road safety as a critical target (SDG 3.6), calling for a 50% reduction in road traffic deaths and injuries by 2030. (Sachs *et al.*, 2025). However, achieving this ambitious goal requires moving beyond generic awareness campaigns toward evidence-based, demographically targeted interventions that address the specific populations and behaviours driving crash risk. (Cendales *et al.*, 2023).

This systematic review addresses the fundamental question: Who drives dangerously in low- and middle-income countries? The review synthesises evidence across demographic dimensions, including age, gender, socioeconomic status, education, and occupation, to examine how these characteristics relate to specific dangerous driving behaviours. This review aims to provide a comprehensive demographic risk profile for LMICs. The findings are designed to inform targeted interventions, guide policy and enforcement strategies, and support evidence-based resource allocation in resource-constrained settings. Additionally, the review identifies priority areas for future research and capacity development to strengthen road safety systems. By consolidating fragmented evidence into a coherent synthesis, this review moves beyond anecdotal observations or single-country findings to establish robust patterns that can inform regional and national road safety strategies. The findings are particularly timely given the UN Decade of Action for Road Safety 2021-2030, which calls for evidence-driven approaches to halving road deaths and injuries. (World Health Organisation, 2023). Understanding who drives dangerously and under what circumstances is foundational to

achieving this goal in the world's most vulnerable road environments.

THEORETICAL FRAMEWORK

This review highlights that unsafe acts, errors, and violations arise from systemic conditions rather than isolated driver choices, as proposed by Reason's Theory of Human Error (Cendales *et al.*, 2023). In LMICs, demographic factors intersect with latent issues like weak enforcement, poor road design, and cultural tolerance of risk, leading to predictable behaviours among specific driver groups. (Woldu *et al.*, 2020). Consequently, young male drivers, commercial drivers, low-income drivers, and those with lower education levels often exhibit more dangerous behaviours, not merely due to individual tendencies but because they operate in environments that heighten risky decisions and undermine formal controls. (Bačkalić *et al.*, 2025). Additionally, the Risk Homeostasis Theory elucidates how drivers modify their behaviours based on perceived risk levels, with more experienced or economically pressured groups engaging in compensatory actions like speeding. (Sachs *et al.*, 2025). Furthermore, the Social Norms Theory explains the clustering of behaviours within demographic groups, as individuals tend to conform to the practices of their peers. (Aluja *et al.*, 2023). These theories frame dangerous driving in LMICs as a socially patterned, contextually driven, and systemic phenomenon rather than an isolated behavioural issue. This integrated lens not only underscores the importance of demographic profiling in road safety research, but also provides a conceptual basis for understanding how systemic, cultural, and social factors collectively shape driver behaviour in resource-constrained settings.

LITERATURE REVIEW

Traditional road safety research in LMICs has focused predominantly on crash outcomes, documenting fatality rates, injury severity, victim demographics, and geographic hotspots (World Health Organisation, 2023). This approach reveals the scale of the problem, but offers limited insight into how to prevent crashes. For example, knowing that young men are overrepresented among crash victims does not, by itself, explain why crashes occur or how to intervene effectively. Are young men inherently riskier drivers due to developmental, psychological, or cultural factors? Or do they drive more frequently, over longer distances, and in higher-risk conditions, inflating their apparent risk through exposure rather than behaviour?

To design effective interventions, policymakers require evidence not only on who is injured or killed, but also on who engages in dangerous driving behaviours. Dangerous driving behaviours such as speeding, alcohol-impaired driving, distracted driving, aggressive manoeuvring and failure to use safety equipment, have been consistently linked to crash risk across contexts (Castro *et al.*, 2025). However, the demographic profiles of individuals engaging in these behaviours, and the contextual factors shaping such engagement, vary substantially across settings. (Aleksandra *et al.*, 2024). A 25-year-old male motorcycle taxi driver in Bangkok faces different risk pressures than a 25-year-old male university student in Nairobi, even though both may fall within the "young male driver" category, typically flagged in road safety discourse (Bačkalić *et al.*, 2025).

Demographic profiling, systematic analysis of how dangerous driving behaviours distribute across age, gender, socioeconomic status, education, occupation, and other social characteristics, enables more precise targeting of interventions. Rather than

broad public awareness campaigns that dilute resources across entire populations, demographic profiling supports tailored strategies such as workplace safety programmes for commercial drivers, peer-based social norm interventions for young recreational drivers, enforcement campaigns timed to high-risk groups and locations, and licensing reforms addressing populations most likely to drive without credentials.

Despite the clear need for demographic profiling of dangerous driving in LMICs, the evidence base remains fragmented, inconsistent, and geographically concentrated (Cendales *et al.*, 2023). Studies vary widely in how they define and measure "dangerous driving", ranging from self-reported questionnaires to observational studies to administrative violation records. Demographic variables are inconsistently reported, with many studies omitting critical information on socioeconomic status, education, or occupation. Sample selection often reflects convenience rather than representativeness, with university students and urban populations overrepresented, while rural drivers, elderly drivers, women drivers, and low-income drivers remain understudied (Alrejjal *et al.*, 2022).

Geographically, research capacity and publication output are unevenly distributed across LMICs. Some countries, particularly India, South Africa, and Brazil, have active road safety research communities that produce regular studies. In contrast, vast regions, including Central Asia, the Pacific Islands, and much of the Middle East, remain nearly absent from the published literature (Adeniji *et al.*, 2020). This geographic bias limits generalisability, driving cultures, enforcement systems, vehicle fleets, road infrastructure, and social norms vary dramatically across LMICs, meaning findings from one context may not transfer reliably to another.

RESEARCH DESIGN AND METHODOLOGY

This systematic review synthesised evidence on demographic patterns associated with dangerous driving behaviours and targeted road safety strategies in LMICs, following Preferred Reporting Items for Systematic Reviews and meta-Analyses (PRISMA) guidelines. A comprehensive search was conducted across PubMed, Google Scholar, Transport Research International Documentation (TRID), and OECD iLibrary for studies published between January 2021 and 15 October 2025 Search terms covered four domains, which are dangerous driving behaviours (risky driving, reckless driving, traffic violations), demographic characteristics (age, gender, socioeconomic status, education, occupation), road safety interventions (traffic safety programmes, enforcement strategies, behavioural interventions), and developing country context (LMICs, resource-limited settings, emerging economies). Search strings were adapted to each database's syntax requirements.

Studies were included if they: (i) were conducted in World Bank-classified LMICs; (ii) examined drivers of any type; (iii) reported dangerous driving behaviours in relation to demographic characteristics; (iv) were published in English (2021-2025); and (v) employed observational or intervention study designs with primary empirical data. Studies were excluded if they: (i) focused solely on vehicle technology or infrastructure without examining driver behaviour; (ii) were conducted exclusively in high-income countries; (iii) were editorials, commentaries, or abstracts without full text; (iv) examined only pedestrian or cyclist behaviour; or (v) lacked sufficient demographic information.

Records were imported into Rayyan for duplicate removal and screening. Initial searches yielded 4 358 non-duplicate records (Google Scholar n=3 681; PubMed n=537; TRID n=43; OECD

n=97). Title and abstract screening identified 43 potentially eligible studies for full-text review. After full-text assessment and additional duplicate detection in Zotero, 42 unique studies underwent detailed eligibility assessment. During data extraction, 21 studies were excluded for insufficient demographic data (n=8), geographic ineligibility (n=4), publication year discrepancy (n=1), narrow behavioural focus (n=5), inaccessible full text (n=1), and methodological limitations (n=2). Twenty-one studies met all criteria and were included in the final synthesis (Figure 1).

The final sample of 21 studies, while modest, is considered adequate for several reasons. First, the review focused on a specific intersection of topics (dangerous driving behaviours AND demographic patterns AND LMICs) within a defined timeframe (2021-2025), naturally constraining the available literature. Second, systematic reviews in specialised LMIC health topics frequently include 15-30 studies when addressing focused research questions. (Pati and Lorusso, 2018; Munn *et al.*, 2020). Third, the 21 studies represent 18 different countries across multiple LMIC regions, providing geographic diversity despite the identified concentration in South Asia and Sub-Saharan Africa. Fourth, the included studies collectively examined over 129 536 participants, providing substantial data for pattern identification. However, the fragmentation of the literature, as evidenced by the extensive screening required (4 358 records screened to yield 21 included studies), underscores a critical finding of this review. Research on dangerous driving demographics in LMICs remains sparse and geographically concentrated. This scarcity itself constitutes an important finding, highlighting the urgent need for expanded research in this domain.

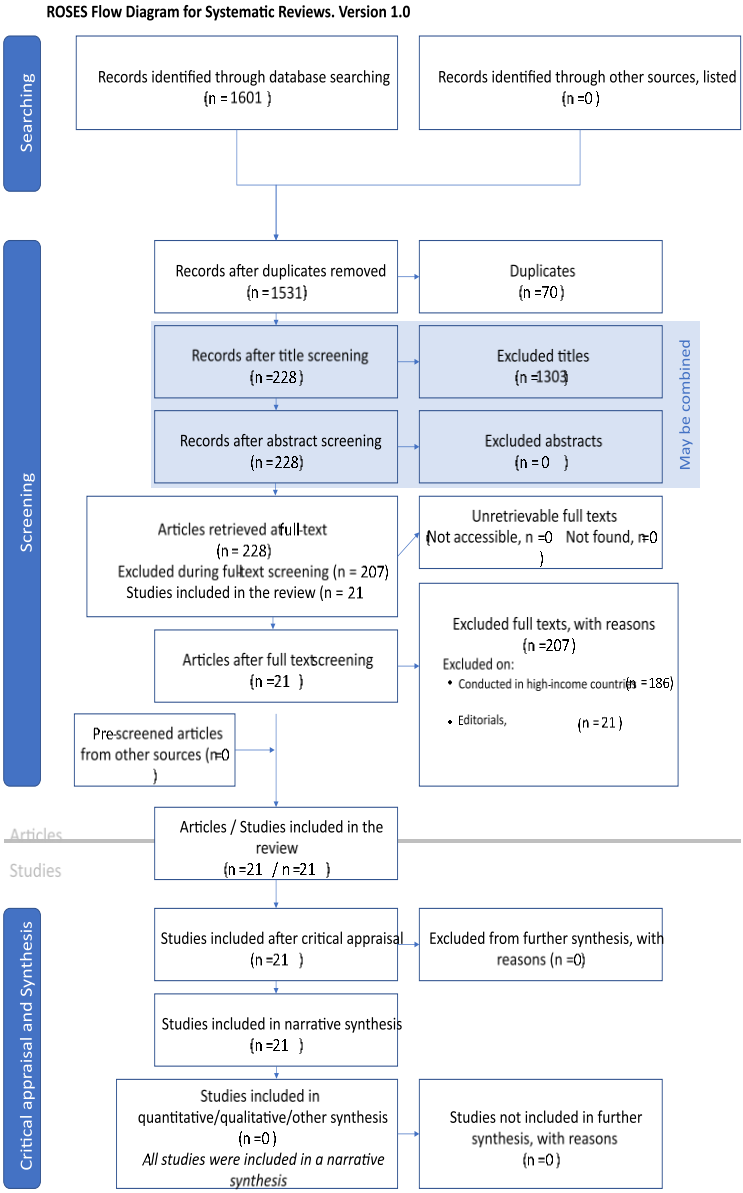

Figure 1: *Roses Flow Diagram for Systematic Review*

Data were extracted using a standardised form, capturing study characteristics (author, year, country, design, sample size, setting), participant demographics (age, gender, socioeconomic status, education, occupation, driving experience), dangerous driving behaviours (speeding, alcohol/drug-impaired driving, distracted driving, aggressive driving, unlicensed driving), measurement methods (self-report, observation, administrative data, validated instruments), interventions (type, target population, outcomes), and key findings (statistical associations, effect sizes). A single researcher performed the extraction, with 25% re-extracted after seven days, showing 95% concordance.

Each study was evaluated for methodological quality using adapted criteria from established appraisal frameworks such as the Joanna Briggs Institute and Critical Appraisal Skills Programme (CASP). The assessment considered five dimensions: clarity and appropriateness of research objectives, sampling methods and adequacy, measurement validity and reliability, appropriateness of statistical analyses, and transparency of reporting. Each dimension was rated on a 0-2 scale, yielding a total quality score out of 10. Studies scoring ≤4 were excluded (n = 2), while those scoring 5-7 were classified as moderate quality and 8-10 as high quality. The 21 included studies demonstrated sufficient methodological rigor (mean = 6.8/10; range = 5-9). Six studies (28.6%) were rated high quality. Fifteen studies (71.4%) were rated moderate quality. Formal validated scoring tools were not applied. However, this adapted framework provided a consistent and transparent approach suitable for the methodological diversity and contextual constraints of LMIC road safety research.

Given substantial heterogeneity in study designs, measurement methods, and outcome measures, narrative synthesis was employed. The narrative synthesis was organised around six thematic domains derived deductively from the research

objectives and inductively from recurring patterns identified during data extraction. The first domain examined demographic risk profiles, capturing variations in age, gender, socioeconomic status, education, and occupation across studies. Attention was given to both consistent and contradictory findings. The second domain addressed geographic distribution and research gaps, highlighting represented and underrepresented LMIC regions and populations. The third domain focused on the prevalence of dangerous driving behaviours such as speeding, alcohol impairment, distraction, and aggression, examined across demographic groups. The fourth domain explored contextual and cultural factors influencing driving patterns. These included infrastructure quality, enforcement capacity, social norms, and economic pressures. The fifth domain reviewed intervention approaches and effectiveness, examining implemented strategies, target populations, and reported outcomes. The sixth domain assessed methodological quality and evidence gaps. It involved evaluating study rigor, measurement consistency, and areas with insufficient or conflicting evidence.

Findings within each domain were synthesised narratively, emphasising recurring patterns, areas of divergence, and knowledge gaps, warranting further research. Quantitative data, where available, were summarised using descriptive statistics such as frequencies and percentages. In cases of conflicting results, such as inconsistent gender-related findings, both perspectives were reported.

Research that reports significant results (for example, showing that young male drivers are more likely to drive dangerously) tends to get published more often than studies that find no such relationship. This can create a false impression that

certain patterns are stronger or more common than they really are. To reduce this risk, the review searched multiple databases and included grey literature sources such as the OECD iLibrary, without excluding studies based on their findings. However, a formal test for publication bias (like a funnel plot) was not possible because the synthesis was narrative and the outcome measures varied widely across studies.

Restricting searches to English-language publications may have excluded relevant research published in other languages, particularly from non-Anglophone LMICs such as China, Brazil, or Francophone Africa. This limitation may contribute to the observed geographic concentration of included studies.

The overrepresentation of studies from South Asia (28.6%) and Sub-Saharan Africa (28.6%), with the complete absence of research from major LMICs such as China, limits generalisability. This concentration may reflect genuine research capacity differences or database indexing biases. Findings should be interpreted as most applicable to South Asian and African LMIC contexts, rather than universally applicable across all LMICs.

RESULTS

A total of 21 studies met the inclusion criteria and were analysed in this systematic review. The studies were obtained from Transport Research International Documentation (TRID) (n = 1), PubMed (n = 7), OECD (n = 2), and Google Scholar (n = 11). All studies originated from LMICs LMICs. Four primary study designs were identified across the included research: cross-sectional, case-control, observational, and other mixed designs. Cross-sectional studies were the most prevalent, accounting for

57.1% of the total, while case-control designs were the least frequent (4.8%).

An analysis of publication trends across the five years (2021-2025) revealed a fluctuating but generally upward trajectory. The proportion of studies increased from 14.3% in 2021 to 30% in 2022, reaching its peak in 2023 (33%). A notable decline occurred in 2024 (10%), followed by a slight recovery to 14.3% in 2025. It is important to note that this trend represents the frequency of publications rather than behavioural incidence. Figure 1 illustrates this temporal distribution.

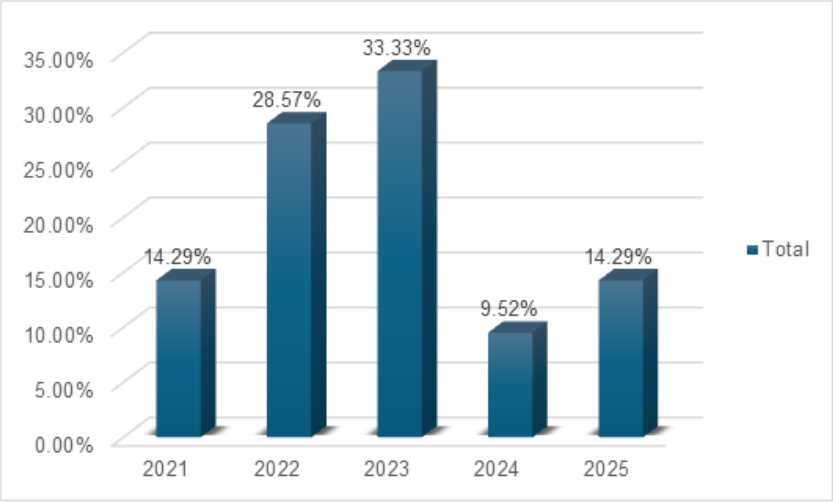

Figure 2: *Analysis of publication years*

Note: 2025 data represent publications through October 2025.

The 21 studies represented 18 individual countries and two multi-country analyses. Table 2 presents the geographic distribution. South Asia contributed 6 studies (28.6%), with India (n=3, 14.3%) being the most represented single country,

followed by Pakistan (n=2, 9.5%) and Bangladesh (n=1, 4.8%). Sub-Saharan Africa accounted for six studies (28.6%), including one multi-country study covering eight African nations. The Middle East and North Africa region contributed four studies (19.0%). Latin America was represented by three studies (14.3%) from Brazil, Colombia, and Ecuador. Southeast Asia contributed two studies (9.5%) from Cambodia and Thailand. Eastern Europe was represented by a single study from Serbia (4.8%). One study analysed data from 32 countries across multiple regions.

Table 1: *Geographic Distribution of Studies*

Region	Countries	Number of Studies	% of Studies
South Asia	India, Pakistan, Bangladesh	6	28.6%
Sub-Saharan Africa	Nigeria, Madagascar, Tanzania, The Gambia, Zimbabwe, + multi-country study	6	28.6%
Middle East/North Africa	Saudi Arabia, Egypt, Iran, + African multi-country	4	19.0%
Latin America	Brazil, Colombia, Ecuador	3	14.3%
Southeast Asia	Cambodia, Thailand	2	9.5%
Eastern Europe	Serbia	1	4.8%
Multi-regional	32-country study	1	4.8%

Gender emerged as a dominant demographic variable in the reviewed studies. Sixteen studies (76.2%) reported that men were the most likely to engage in dangerous driving, reflecting a consistently higher risk appetite compared to women. Three studies (14.3%) indicated that women were equally prone to dangerous driving behaviours, while two studies (9.5%) found no significant gender differences. Figure 2 illustrates the gender distribution across studies.

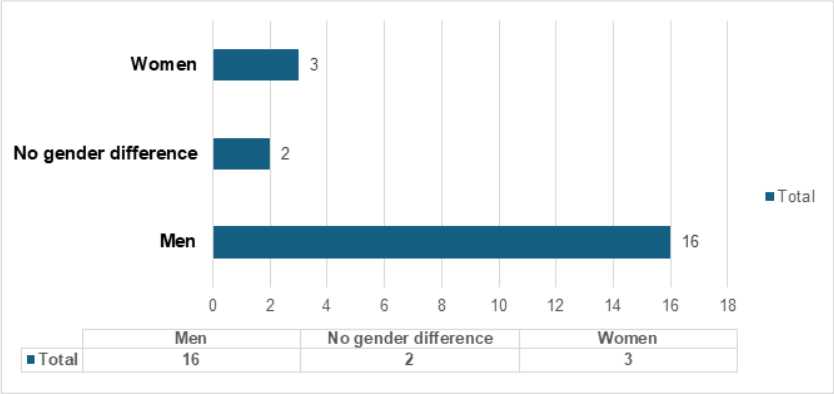

Figure 3: *Gender distribution in dangerous driving behaviour studies*

DANGEROUS DRIVING BEHAVIOURS

Across the 21 studies, multiple dangerous driving behaviours were identified. These included speeding, alcohol-impaired driving, drug-impaired driving, aggressive driving, distracted driving (phone/texting), failure to use seatbelts, illegal overtaking, reckless lane changing, driving without a license, and fatigue or drowsy driving. Table 2 illustrates the behaviours.

Table 2: *Dangerous driving behaviours*

Dangerous Driving Behaviour	Sum of No. of Studies Reporting	% of No. of Studies Reporting
Aggressive driving	14	13.9%
Distracted driving (phone/texting)	12	11.9%
Speeding	12	11.9%
Alcohol-impaired driving	11	10.9%
Driving without a license	9	8.9%
Reckless lane changing	9	8.9%
Drug-impaired driving	9	8.9%
Illegal overtaking	8	7.9%
Not using seatbelts	7	6.9%

Running red lights	5	5.0%
Fatigue/Drowsy driving	5	5.0%
Grand Total	**101**	**100.00%**

Multiple dangerous driving behaviours were reported within individual studies. The 101 total instances represent all behaviours documented across the 21 studies, with studies reporting an average of 4.8 behaviours each. When disaggregated by gender, male drivers accounted for 76.2% of all reported dangerous driving incidents across the 21 studies, while female drivers contributed 14.3%. The remaining 9.5% of studies found no gender-based differences. Male drivers were particularly dominant in speeding, alcohol-impaired driving, and aggressive driving behaviours.

Analysis of age distribution across the 21 included studies reveal that young adults (18-25 years) were the most frequently examined age group, accounting for 57.1% (12 of 21) of the studies. Adolescents (<18 years) represented 19.1% (n=4), followed by adults (26-45 years) at 14.2% (n=3). A single study (4.8%) focused on elderly drivers (>65 years). One study (4.8%) did not specify participants' age ranges. Young adults were consistently identified across studies as engaging in dangerous driving behaviours more frequently than other age groups examined.

Table 3: *Age group and dangerous driving*

Primary Age Groups	Count	% of Studies
Young adults (18-25)	12	57.1%
Adolescents (<18)	4	19.1%
Adults (26-45)	3	14.2%
Elderly (>65)	1	4.8%
Not specified	1	4.8%
Grand Total	**21**	**100.00%**

Of the 21 studies, 13 (61.9%) did not report the socioeconomic status of participants. Among those that did, four studies (19.0%) identified participants as middle income, three studies (14.3%) involved mixed socioeconomic groups, and only one study (4.8%) focused on low-income participants. The top five dangerous driving behaviours (aggressive driving, distracted driving, speeding, alcohol-impaired driving, and driving without a license) were predominantly reported among middle-income drivers, representing 19.1% of the total reviewed studies. Table 4 clearly illustrates this narrative.

Table 4: *Socio-economic, educational, and occupational factors*

Socio-economic Status	Count	% of Studies
Not reported	13	61.9%
Middle	4	19.0%
Mixed	3	14.3%
Low	1	4.8%
Grand Total	**21**	**100.0%**

Similarly, educational status was underreported. Thirteen (13) studies (61.9%) omitted this variable. Among the remaining studies, 19.0% reported tertiary-level participants, while another 19.0% included mixed education levels.

Regarding occupational background, 52.4% of studies did not report participants' employment status. Of those that did, 19.0% involved employed drivers, 19.0% focused on students, and 9.5% examined mixed groups. Both employed and student drivers showed engagement in the most frequent dangerous driving behaviours.

Only six studies (28.6%) reported interventions aimed at reducing dangerous driving behaviours, while 15 studies (71.4%) made no mention of any intervention measures. Among the identified interventions, multi-component programmes (n=2)

were the most common, followed by policy/legislative approaches (n=1), technology-based solutions (n=1), education and training programs (n=1), and other context-specific measures (n=1).

Table 5: *Targeted interventions*

Socio-economic Status	Count	% of Study
N/A	15	71.4%
Multi-component	2	9.5%
Policy/Legislation	1	4.8%
Technology-based	1	4.8%
Education/Training	1	4.8%
Other	1	4.8%
Grand Total	**21**	**100.0%**

Only two studies assessed the effectiveness of interventions, and both reported partial effectiveness. The six intervention studies focused primarily on urban settings within their respective countries.

The analysis of the 21 studies reveals the following patterns: Male drivers were reported as the most likely to engage in dangerous driving behaviours in 76.2% of studies. Young adults (18-25 years) were the most frequently studied age group (57.1%) and were consistently identified as engaging in dangerous driving behaviours. The five most common dangerous driving behaviours were aggressive driving (13.9%), distracted driving (11.9%), speeding (11.9%), alcohol-impaired driving (10.9%), and driving without a license (8.9%). Among studies reporting socioeconomic status, middle-income participants were most frequently represented (19.0%). Socio-economic status and educational background were not reported in 61.9% of studies. Intervention studies accounted for 28.6% of the total, with multi-component programmes being most

common (n=2). Two studies assessed intervention effectiveness, both reporting partial effectiveness.

DISCUSSION

This systematic review of 21 studies identified male drivers (76.2%) and young adults aged 18-25 years (57.1%) as most frequently engaging in dangerous driving behaviours in LMICs. The most reported behaviours were aggressive driving, distracted driving, speeding, alcohol-impaired driving, and unlicensed driving. Research concentrated in South Asia (28.6%) and Sub-Saharan Africa (28.6%), with critical gaps in East Asia, Central Asia, and the Pacific. Most studies failed to report socioeconomic status (61.9%) or education (61.9%), and only 28.6% included interventions, highlighting both clear demographic patterns and substantial methodological limitations.

The geographic concentration in South Asia and Sub-Saharan Africa reflects broader global health research patterns. India contributed three studies (14.3%), suggesting active research infrastructure and awareness of road safety as a public health priority. However, China's complete absence represents a critical gap, given its status as the world's largest LMIC experiencing rapid motorisation. Central Asian republics, Pacific nations, and several Southeast Asian countries remain unrepresented.

This imbalance limits generalisability, as dangerous driving patterns vary substantially by regional culture, infrastructure quality, and enforcement capacity. It may also reflect language bias, where non-English publications are systematically excluded, and uneven research capacity across LMICs. Future systematic reviews should actively seek multilingual sources and regional databases.

Male driver predominance (76.2%) aligns with global research demonstrating consistent gender disparities in road traffic risk. However, interpretation requires considering both behavioural and structural factors. While evolutionary psychology links males to sensation-seeking and risk-taking, structural explanations offer critical nuance. In many LMICs, vehicle ownership and regular driving remain predominantly male activities due to economic, cultural, and religious norms limiting women's mobility.

The observed male dominance may partially reflect a denominator problem. Men simply drive more frequently and for longer distances, increasing exposure. Male drivers are more likely to drive commercially, work night shifts, and use highways, all higher-risk contexts. Women typically make shorter, daytime trips within familiar areas, inherently carrying lower risk.

Critically, no studies reported exposure-adjusted risk rates (dangerous behaviours per kilometre driven). Without such data, it remains unclear whether men are inherently more dangerous or simply more exposed drivers. This distinction is important for intervention design. If the gender gap arises mainly from greater exposure rather than inherent differences, interventions should prioritise situational risk factors like night driving and commercial pressures, instead of focusing solely on modifying male behaviour.

The three studies (14.3%) finding no gender differences suggest heterogeneity warranting investigation, possibly reflecting contexts where women's driving participation is higher or enforcement is gender neutral. Young adults (18-25 years) dominated both study samples (57.1%) and identified risk profiles. While this aligns with global literature identifying young drivers as high-risk, the methodological design raises an

important question: Are young adults truly the most dangerous, or simply the most studied? The concentration of young adult samples (57.1% of studies) creates confirmation bias. Researchers recruiting university students or newly licensed drivers for convenience produce data that inevitably identify this age group as high-risk. Without proportional sampling of elderly drivers (only 4.8% of studies) and middle-aged adults (14.2%), the review cannot determine whether young adults are genuinely more dangerous or simply more studied. Exposure-adjusted, age-representative studies are required to resolve this fundamental question.

Developmental psychology provides plausible explanations for elevated youth risk. The prefrontal cortex, responsible for impulse control, matures until the mid-20s (Aluja *et al.*, 2023). Combined with peer influence, sensation-seeking, inexperience, and social pressures, young adults may genuinely exhibit riskier patterns. In LMICs, inadequate driver education, inconsistent enforcement, economic pressures toward commercial driving, and social norms around alcohol compound these risks. However, the virtual absence of elderly driver research (4.8%) represents a significant blind spot. As life expectancy increases in LMICs, older driver populations will grow substantially. Age-related cognitive decline reduced reaction times, and vision impairment may create distinct risk profiles that current research overlooks. Future research must employ age-representative sampling to disentangle whether observed patterns reflect true differences or methodological artefacts.

Among studies reporting socioeconomic status (38.1%), middle-income drivers were most frequently associated with dangerous driving, a counterintuitive finding. Several explanations emerge. First, middle-income populations are experiencing rapid motorisation. As incomes rise above subsistence levels, vehicle

ownership becomes attainable, often for the first time, coinciding with inadequate driver training, weak enforcement, and nascent safety cultures.

Second, middle-income drivers likely have higher road exposure than low-income populations, affording regular vehicle use for commuting, recreation, and social activities. Third, they may experience a unique psychological state possessing sufficient resources for vehicle ownership but insufficient resources to absorb crash consequences, potentially fostering invulnerability or status performance through aggressive driving.

Fourth, enforcement patterns may inadvertently overlook middle-income drivers, with police focusing on commercial (often low-income) or elite (high-income) drivers. The near-complete absence of low-income driver studies (4.8%), prevents definitive comparisons. Low-income drivers may engage in different dangerous behaviours, such as driving unroadworthy vehicles and overloading passengers, less visible to research focused on speeding or phone use. This socioeconomic reporting gap represents a critical limitation for effective intervention targeting.

This paradox is noteworthy because it challenges the common assumption that dangerous driving is primarily concentrated among low-income or young, risk-prone groups. It highlights a neglected but increasingly significant demographic, middle-income motorists whose growing mobility and behavioural patterns may be reshaping road safety risks in developing economies. Recognising this dynamic is crucial for designing equitable and targeted interventions that address emerging risk groups within rapidly motorising societies.

The widespread omission of educational data (61.9% of studies) and occupational information (52.4% of studies) limits the

ability to assess whether these variables predict dangerous driving in LMIC contexts. Among the studies that did report these factors, findings suggest that neither education nor employment status serves as a strong discriminator of driving risk. Educational background showed no clear protective effect. Among the eight studies reporting education, four studies (19.0%) examined tertiary-level participants, while another four studies (19.0%) included mixed education levels. Both groups exhibited dangerous driving behaviours at comparable rates. This contrasts with assumptions that formal education, which often includes greater exposure to public health messaging and risk literacy, would translate into safer driving behaviour. The lack of educational protection suggests that road safety outcomes are governed more by enforcement consistency, cultural norms around driving, and perceived impunity than by individual knowledge or reasoning capacity. This finding has important implications for intervention design. Traditional driver education programmes that rely primarily on information transmission, teaching rules, showing crash statistics, and explaining collision physics may have a limited impact in LMIC contexts, where behavioural norms are shaped by peer modelling, absent enforcement, and social identity performance. More effective approaches may involve social norm campaigns, peer influence interventions, and visible enforcement that shift perceptions of acceptable behaviour.

Similarly, employed drivers (19.0% of studies) and students (19.0% of studies) exhibited comparable rates of dangerous driving, though likely for different reasons. Employed drivers, particularly those in commercial transport, face time pressures, economic incentives to maximise trips, and extended hours on the road, all risk factors for speeding, fatigue, and aggressive driving. In contrast, students often drive for recreational purposes under peer influence and social performance pressures, with higher exposure to distracted and alcohol-

impaired driving scenarios. The equivalence between these groups suggests that dangerous driving arises from diverse situational contexts, rather than a single occupational or demographic profile. Interventions must, therefore, be context-specific. Workplace safety programs for commercial drivers, social norm campaigns for youth, and enforcement strategies tailored to the temporal and spatial patterns of different driver groups may be effective ways of reducing dangerous driving.

The five most common behaviours, aggressive driving (13.9%), distracted driving (11.9%), speeding (11.9%), alcohol-impaired driving (10.9%), and unlicensed driving (8.9%), reflect both universal risk factors and LMIC-specific contexts. Aggressive driving may be amplified by road congestion in rapidly growing urban areas, weak enforcement with minimal consequences, cultural norms around masculinity valorising assertive driving, and mixed traffic environments requiring constant negotiation. Distracted driving, particularly phone use, is problematic where hands-free technology is less accessible and enforcement is minimal. Speeding takes on particular meaning where road infrastructure is inadequate for vehicle speeds, poorly maintained roads, absent lane markings, and inadequate lighting mean that moderate speeding dramatically increases crash severity.

Alcohol-impaired driving reflects both global cultural patterns and LMIC-specific enforcement gaps. Breath testing and sobriety checkpoints are rare or inconsistently applied. Unlicensed driving, largely absent from high-income country discussions but prevalent in LMICs, reflects inadequate testing infrastructure, bribery-based license acquisition, and limited enforcement capacity, signalling broader governance failures. These patterns underscore that dangerous driving in LMICs cannot be addressed through isolated interventions but requires

comprehensive approaches addressing enforcement capacity, infrastructure quality, licensing integrity, and cultural norms.

Only 28.6% of studies reported interventions, with merely two assessing effectiveness (both reporting "partial effectiveness"). This implementation gap represents one of the most critical findings, suggesting road safety in LMICs remains predominantly descriptive rather than solution-focused, contrasting sharply with high-income countries, where intervention trials constitute substantial research.

Several explanations merit consideration. Research capacity and funding limitations may constrain complex intervention trials requiring extended follow-up and large samples. Institutional barriers may prevent policy-level or enforcement-based interventions requiring government cooperation. The six identified interventions included multi-component programmes (n=2), policy/legislative approaches (n=1), technology-based solutions (n=1), education/training (n=1), and other (n=1).

The vague "partial effectiveness" assessments, without clear success definitions, measurable outcomes, or comparison groups, reflect broader weaknesses in intervention evaluation culture. This evidence vacuum has serious policy implications. Governments and development agencies lack rigorous evidence to guide decision-making, often importing interventions from high-income contexts without adaptation, which may fail or produce unintended consequences. Closing this gap requires targeted investment in intervention research capacity, researcher-agency partnerships, long-term evaluation funding, and academic reforms valuing applied research.

Several limitations constrain interpretation and generalisability. First, only 21 studies spanning five years across all LMICs, limit the evidence base. Geographic concentration in South Asia and

Sub-Saharan Africa means findings may not generalise to underrepresented regions, particularly East Asia. Second, restricting searches to English-language databases likely excluded relevant research in other languages. Third, young adult overrepresentation (57.1%) creates potential confirmation bias, while elderly driver absence (4.8%) prevents meaningful age-comparative analysis.

Fourth, no studies reported exposure-adjusted risk rates, preventing a distinction between true behavioural differences and differential exposure. Fifth, socioeconomic and educational underreporting (61.9%) severely limits the assessment of these factors' correlations with dangerous driving. Despite these limitations, the review provides valuable insights into demographic patterns and research gaps, offering a foundation for targeted future research.

The findings carry several important implications. First, while young men represent high-risk demographics, interventions should not focus exclusively on this group. Evidence of dangerous driving across multiple categories suggests that comprehensive approaches are needed. Second, distinct risk profiles across occupational and social groups necessitate context-specific intervention design, commercial drivers require workplace safety programmes, young recreational drivers need social norm campaigns, and urban commuters require infrastructure improvements.

Third, the high prevalence of directly deterrable behaviours suggests that strengthening traffic policing capacity is foundational, including breath testing equipment, speed detection technology, and routine patrol presence. Fourth, unlicensed driving prevalence (8.91%) points to governance failures; reforming licensing systems to ensure rigorous testing, eliminating corruption, and improving accessibility should be

prioritised. Fifth, geographic concentration reflects uneven research infrastructure. International partnerships and capacity-building initiatives should strengthen research in underrepresented regions. Finally, effective interventions require multi-sectoral coordination across police, health, education, urban planning, and justice sectors.

CONCLUSION AND FUTURE DIRECTION

This systematic review identifies young adult male drivers (18-25 years) as the demographic group most frequently engaging in dangerous driving in LMICs, with aggressive driving, distracted driving, and speeding most prevalent. However, critical limitations, such as geographic concentration, young-adult oversampling (57.1%), underreporting of socioeconomic status (61.9%), and the absence of exposure-adjusted risk rates, prevent definitive conclusions about who drives most dangerously versus who drive most frequently. The scarcity of intervention research present in only 28.6% of studies represents the review's most concerning finding. Road safety in LMICs remains predominantly descriptive, documenting problems rather than testing solutions, leaving policymakers without evidence-based strategies. Future research must prioritise rigorous intervention trials, standardised demographic reporting, age-representative sampling, and geographic expansion. For policy, findings support comprehensive approaches addressing enforcement capacity, licensing integrity, infrastructure quality, and context-specific behavioural interventions rather than a narrow focus on young male drivers alone. With road traffic injuries ranking among the leading causes of death in LMICs, translating descriptive knowledge into effective interventions is urgent. Critical directions include age-representative sampling, recruiting proportional samples across all age groups; exposure-adjusted risk assessment, collecting driving exposure data to calculate risk rates; targeted research in underrepresented regions, particularly East Asia; elderly driver research addressing age-

related cognitive decline and adaptation strategies as populations age; and rigorous intervention trials using randomised controlled or quasi-experimental designs with cost-effectiveness analysis.

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