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Understanding the Impacts of Drink-Driving for Youth

Contributing Factors, Behavioral Trends, Public Sentiments, and Preventative Interventions

A meta-analysis and machine learning (AI) approach.

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General disclaimers

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A META-ANALYSIS AND MACHINE LEARNING (AI) APPROACH

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A-CRA	Adolescent Community Reinforcement Approach
AI	Artificial intelligence
AI/AN	American Indian / Alaska Native
API	Application Programming
AR	Argentina
ASTP	Alcohol Skills Training Programme
BAC	Blood Alcohol Concentration
BASICS	Brief Alcohol Screening and Intervention for College Students
BSFT	Brief Strategic Family Therapy
CA	Canada
CAPAS	Criando con Amor: Promoviendo Armonía y Superación
CL	Chile
CO	Colombia
CoT	Chain of Thought
DE	Deutschland/Germany
DSPy	Declarative Self-improving Python
DUI	Driving Under the Influence
ES	Spain
EBAC	Estimated Blood Alcohol Concentration
FCU	Family Check-Up
FFT-G	Functional Family Therapy-Gangs
FPNG	Family Preparing a New Generation
FR	France
FSTP	Family Skills Training Programme
GB	Great Britain
HDBSCAN	Hierarchical Density-Based Spatial Clustering of Applications with Noise
ID	Identity Document
IQR	Interquartile Range
IT	Italy
LDA	Latent Dirichlet Allocation
LLM	Large Language Modelling
LMC	Lifestyle Management Class
MADD	Mothers Against Drink-driving

MI	Motivational Interviewing
MLDA	Minimum Legal Drinking Age
MX	Mexico
NIAAA	National Institute on Alcohol Abuse and Alcoholism
NLP	Natural Language Processing
NOS	Newcastle-Ottawa Scale
PAN	Perception of Alcohol Norms
PE	Peru
PLI	Peer-Led Intervention
PMI	Peer-implemented Minimal Intervention
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
PST	Parenting Skills Training
PTSD	Post-Traumatic Stress Disorder
PW	Parenting Wisely
RAG	Retrieval-Augmented Generation
RBS	Responsible Beverage Service
RQ	Research Question
SA	Sentiment Analysis
SIDS	Small Island Developing States
SLP	Saving Lives programme
TF-IDF	Term Frequency-Inverse Document Frequency
TM	Topic Modelling in this list
TND	Towards No Drug Abuse
TRA	Theory of Reasoned Action
UK	United Kingdom
UMAP	Uniform Manifold Approximation and Projection
UN	United Nations
UNITAR	United Nations Institute for Training and Research
URL	Uniform Resource Locator
USA	United States of America
VR	Virtual Reality
WHO	World Health Organization

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Dr. Ali Asgary is a professor of disaster and emergency management at the School of Administrative Studies, York University, Toronto, Canada, with research interests spanning post-disaster recovery and reconstruction, business continuity, risk assessment, decision-making under uncertainty, economic valuation, disaster simulations and modeling, AI, VR, AR, MR, geomatics, and cost-benefit analysis. He has extensively studied urban emergencies, including fires and traffic incidents, and has served as Principal or Co-Principal Investigator on projects funded by NSERC, GEOIDE Geosystems, SSHRC, Pre Carn, CIHR, NFRF, ORF, IDRC, and DRDC. Dr. Asgary was a founding faculty member of Canada's first university program in Disaster & Emergency Management at Brandon University in 2003 and later helped establish the program at York University. Since 2015, he has served as executive director of York University's Advanced Disaster, Emergency and Rapid-response Simulation (ADERSIM) and, since 2021, as inaugural Director of CIFAL York.

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Mr. Sharuka Thirimanne is a software engineering and artificial intelligence practitioner, complemented with a master's degree in computer science from York University. His passion lies in research and development, particularly in the areas of software engineering, NLP, machine learning, and generative AI. Sharuka is excellent at developing innovative solutions that address societal challenges such as drink-driving through the integration of software engineering and AI. What excites him most about AI research and development is its ability to solve real-world challenges and create meaningful solutions. Sharuka finds great fulfilment in building AI applications that streamline processes and deliver significant results. Additionally, the rapid advancements in AI technologies continuously fuel his passion and commitment to staying at the forefront of this field.

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About

This study is the result of a joint effort between the **United Nations Institute for Training and Research (UNITAR)** and York University.

Established in 1965, the United Nations Institute for Training and Research (UNITAR) is the dedicated training arm of the United Nations system. It works to enhance the effectiveness of the United Nations through training and research, developing the capacities of individuals, organizations and institutions to advance global decision-making and sustainable development.

UNITAR delivers accessible, high-impact learning and related services to support achievement of the 2030 Agenda and the United Nations Sustainable Development Goals. Providing training and capacity development activities to assist mainly developing countries with special attention to Least Developed Countries (LDCs), Small Island Developing States (SIDS) and other groups and communities who are most vulnerable, including those in conflict situations.

York University is a top international teaching and research university recognized as Canada's leading comprehensive university in advancing understanding of artificial intelligence in publications and ranks first in Ontario for global collaborative research publications (SciVal 2020–2024). Named as one of the world's leading universities in the 2025 Times Higher Education Impact Rankings. In Canada, York is number one for SDG 4: Quality education, and second for SDG 5: Gender equality, SDG 10: Reduced inequities and SDG 12: Responsible consumption and production. The University scored in the top 10 across the country for 12 out of 17 SDGs.

Executive Summary

Overview

Harmful alcohol consumption, particularly driving under the influence (DUI), poses significant public health and safety risks worldwide. Between 5 per cent and 35 per cent of road fatalities globally are attributed to drink-driving. International frameworks, such as the UN Decade of Action for Road Safety 2021-2030 and The Global Plan for the Decade of Action for Road Safety, aim to reduce traffic deaths by 50 per cent by 2030 through various measures.

Young people are disproportionately affected by the immediate and short-term consequences of DUI, and it often leads to long-term repercussions, including legal issues, psychological effects, and challenges in employment. This highlights the need for more targeted interventions.

To address this issue effectively, it is essential to understand the following better:

1. The patterns of drink-driving behaviour among different age groups of youth and variations within those groups.
2. The differences in DUI and their impacts based on geographic location.
3. The factors contributing to youth road traffic crashes involving alcohol.
4. Effective interventions to mitigate these crashes and their evidence-based impacts.
5. Public sentiments and discussion topics related to drink-driving.
6. The potential of machine learning and AI to discover and analyse these patterns and enhance youth awareness of the consequences of drink-driving.

The main goal of this study is to deepen the understanding of youth alcohol consumption and DUI, ultimately informing strategies to reduce alcohol-related incidents and improve road safety.

Methods and Analyses

This study used a mixed-methods approach which combines existing literature insights with social media data. A meta-analysis and systematic review were conducted to synthesize scientific knowledge on crucial research questions. This was followed by applying Machine Learning and Large Language Model (LLM) processing techniques to analyse selected social media data, focusing on public discourse, sentiments, and patterns related to drink-driving.

The meta-analysis and systematic review investigated the impact of alcohol-related incidents on youth, following Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. The research utilized Comprehensive Meta-Analysis (CMA) and conducted a systematic content analysis of selected articles to address research questions. The review included peer-reviewed articles, conference papers, and credible grey literature based on pre-defined inclusion and exclusion criteria. The analysis focused on the prevalence of alcohol-related incidents, contributing factors, and rates of driving under the influence among youth, as well as comparing the effectiveness of various interventions.

The systematic review identified 1,173 studies; 21 unique studies were included after exclusions. Each intervention was analysed separately, focusing on its impact on DUI rates among youth. This dataset informed both the meta-analysis and thematic analysis.

Social media offers a wealth of data on public opinions, which can be analysed through sentiment analysis (SA) and topic modelling to gain insights into drink-driving. Sentiment analysis employs text mining and Natural Language Processing (NLP) to classify sentiments as positive, neutral, or negative. This approach helps policymakers understand public attitudes and emotions surrounding DUI-related issues, leading to better-informed interventions and policies. On the other hand, topic modelling (TM) is used to identify themes within large datasets utilizing techniques like Latent Dirichlet Allocation (LDA). TM helps uncover critical discussions in social media related to DUI.

Reddit posts and YouTube videos were utilized for sentiment analysis (SA) and topic modelling (TM). Reddit, a popular platform with 52 million daily users, was selected for its anonymity and candid discussions. The study collected and filtered 68,065 posts using English, Spanish, and Portuguese keywords related to alcohol and car crashes. After cleaning, this resulted in 3,057 relevant posts. For data analysis, the Google Translate Application Programming Interface (API) was used to identify the languages of the posts. Reddit's pseudonymous nature and diverse discussions make it a valuable source for sentiment analysis on drink-driving.

YouTube also provides significant insights into drink-driving through the videos and comments shared on the platform, making it an essential source for sentiment analysis and topic modelling. Data was collected using the YouTube Data API with 20 English, French, Spanish, German, and Italian queries targeting specific regions. Transcripts and comments from 1,204 videos were cleaned using regular expressions (regex) to remove filler words, tags, and non-emotional emojis. Additionally, a multilingual transformer model was employed to restore punctuation, enhancing the context of the data.

Drink-driving Awareness Tool

For the purpose of this research an AI-based prototype tool was developed using YouTube data for sentiment analysis and topic modelling.

- The tool leverages LLMs (llama3.1-70b, llama3.2-3b) with Retrieval-Augmented Generation (RAG) to provide information based on real-world stories and documentaries about drink-driving. It is currently hosted on a local server with a user interface built using Streamlit, enabling interactive user engagement.
- This tool combines AI reasoning and data retrieval to enhance public awareness of drink-driving risks and consequences. The tool's main purpose is to use AI to extract the most relevant information from social media (in this case, YouTube videos) through large-scale language processing.

- The tool, in its current form, can be used by everyone interested in the Drink-driving topic. This could include the general public, policymakers, educators, organizations, and those looking for relevant information to use for personal or organizational purposes.
- It is possible to make it more relevant to interventions by customizing the tool to extract information about Drink Drive Interventions, their effectiveness, their issues, case studies, and end users' sentiments. It can provide those who are involved in interventions with a text to find out about interventions that work best with some rationale and reasoning behind them.

Findings

Differences in Drink-driving Behaviour Among Youth Age Groups

Based on the studies analysed, it was found that trends in drink-driving among youth aged 15 to 25 vary based on age and social factors:

- Adolescents aged 15 to 17 are more likely to drive under the influence of alcohol due to their inexperience. Adolescents in this age group, who drink despite being under the legal drinking age, experience stronger effects of alcohol on their bodies.
- Despite stricter laws and effective educational efforts aimed at prevention, numbers remain relatively high in this age group compared to others.
- Among young adults aged 18 to 24, there is a noticeable increase in DUI incidents after they reach the legal drinking age.
- Initiatives such as high-visibility enforcement have been effective in reducing these behaviours. These differences highlight the importance of developing targeted prevention strategies for each age group.

Differences in Drink-driving Behaviour by Location and Region

- The research highlighted that urban areas tend to have higher rates of driving under the influence due to easier access to alcohol and a vibrant nightlife. In contrast, rural areas report fewer DUI incidents, but those that occur often result in higher case-fatality rates. This is primarily because of longer emergency response times, lower density of law-enforcement officers, and a cultural acceptance of risky behaviours.

- Regional differences in DUI rates also vary globally, influenced by factors such as college drinking cultures, strict liquor laws, cultural values, urbanization, and lifestyle changes. Home alcohol consumption poses additional risks, especially for young people.
- In urban settings, youth are particularly vulnerable to higher DUI rates due to their access to alcohol, social pressures, and the abundance of drinking venues. Conversely, DUI rates in rural areas tend to be lower, driven by fewer drinking establishments and more conservative social norms.
- High-visibility law-enforcement efforts have successfully reduced DUI rates among urban youth, while stricter regulations in rural areas further discourage drink-driving.

Short-Term Consequences of Drink-driving on Youth

The studies highlighted different short-term consequences of drink-driving for youth such as:

- DUI among youth increases the risk of incidents, injuries, and fatalities, worsened by their inexperience.
- Legal penalties such as fines, license suspension, and criminal records hinder future opportunities at the individual and family levels.
- Emotional trauma, family tensions, financial burdens, and social stigma also significantly impact mental health and relationships.
- Academic performance may decline due to stress and legal complications.
- At the community and national levels, communities face heightened safety concerns and demand stricter enforcement of DUI laws and an increase in emergency response and medical care for traffic crash injuries.

Long-Term Consequences of Drink-driving on Youth

Through the research, it was found that long-term consequences of drink-driving for youth include:

- The harmful use of alcohol can lead to chronic health issues, addiction, and higher recidivism rates.
- Legal records from DUI convictions restrict education, employment, and life opportunities.
- Families endure financial and emotional strain while communities face increased health-care costs and resource demands.

- The economic burden of DUI incidents and fatalities can impede local economic growth and necessitate stricter law-enforcement.

Factors Contributing to Youth Drink-driving

The studies highlighted different factors contributing to youth drink-driving:

- Underage alcohol consumption, peer influence, lack of parental monitoring, inadequate law-enforcement, and poly-drug use are among the main factors contributing to youth drink-driving.
- Early drinking leads to risky behaviours, including DUI, often driven by social acceptability among peers.
- Adolescents sometimes face peer pressure to drink and drive, with group acceptance distorting risk perceptions and increasing the likelihood of DUI.
- Weak parental involvement and communication increase the chances of youth engaging in drink-driving.
- Weak enforcement of drinking laws and inconsistent penalties reduce the deterrent effect of underage DUI.
- Finally, combining alcohol with drugs amplifies impairment, increasing crash risks among inexperienced young drivers.

Interventions to Reduce DUI Among Youth

Based on the 21 unique studies included, the top individual interventions to reduce DUI among youth were found to be:

- Peer-led Educational Programmes (employ relatable peers to shift attitudes).
- Motivational Interventions in Schools (address personal drinking attitudes through focused discussions).
- Brief Emergency Interventions (leverage crisis moments to highlight risks).
- Mobile and Technology-Based Interventions (deliver reminders via smartphones).
- Parental Monitoring Programmes (enforce curfews and oversee activities to deter risky behaviours).

While the top general interventions used to reduce youth drink-driving were found to be:

- Motivational Interventions (Influence attitudes post-DUI incidents or via mobile technology).
- Educational Programmes (Peer-led and family-based initiatives enhance awareness and parental involvement)
- Regulatory Policy-Driven Strategies (enforce minimum drinking age laws and launch prevention campaigns to reduce alcohol access).

Sentiment Analysis (SA) and Topic Modelling (TM)

Sentiment Analysis of Reddit Data

A sentiment analysis (SA) was conducted based on Reddit data collected for 11 South and Central American countries, namely Argentina, Belize, Bolivia, Brazil, Costa Rica, Cuba, Dominican Republic, El Salvador, Honduras, Nicaragua, Panama. Posts were classified into three sentiments:

1. Negative sentiment: Meaning that people were against drinking and driving.
2. Neutral sentiment: Meaning that people had neutral views, neither negative nor positive, on drinking and driving.
3. Positive sentiment: Meaning that people agreed with drinking and driving.

- Results show that posts discussing drink-driving have increased over time in most countries, notably in the Dominican Republic and Costa Rica. However, no significant increases were observed in Cuba and Panama.
- Positive sentiments declined periodically, while neutral sentiments fluctuated. Negative sentiments showed minor variations but remained relatively stable.
- Posts were classified as 1,505 negative, 1,053 neutral, and 499 positive. Argentina and Brazil exhibited the highest negative sentiment intensities, followed by the Dominican Republic, Bolivia, and El Salvador.
- The collected data revealed that Brazil had the most diverse sentiment range, while other countries exhibited less variability.
- These findings highlight the predominance of negative sentiment in drink-driving discussions across social media, with notable country-specific differences and time-based trends.

Topic Modelling Analysis of Reddit Data

Key topics were identified using Term Frequency-Inverse Document Frequency (TF-IDF) and LDA modelling. Reddit posts were categorized into five main topics:

1. Stories featuring personal experiences with alcohol, particularly incidents involving DUI.
2. Law, focusing on DUI laws, legal changes, and alcohol regulations.
3. Politics and economy, addressing broader societal issues relating to DUI.
4. Travel, including positive posts unrelated to DUI, often sharing travel tips or experiences.
5. News, consisting of reports on DUI incidents, including extreme cases such as record breathalyser results.

- Travel-related DUI posts are the most shared across many countries, except in Argentina, where news about DUI incidents is more prevalent.
- Law-related DUI posts exhibit the highest negative sentiment, while travel-related posts show the least negative sentiment.
- The analysis reveals varied perspectives on DUI across different topics and countries, highlighting the need for targeted interventions and awareness strategies.

Sentiment Analysis of YouTube Data

- Most YouTube transcripts (54.4%) expressed negative sentiments, with minimal positive sentiment across all regions and languages.
- Negative sentiments dominated English, German, and Spanish, while French and Italian leaned towards neutral sentiments. The majority of transcripts showed negative or neutral sentiments across regions.
- A Mann-Whitney U test confirmed a statistically significant difference ($p = 0.042$) between negative and neutral sentiments by region. Negative and neutral sentiments correlated strongly (0.96) across regions. Sentiments across languages also showed strong correlations, with 0.96 between negative and neutral and 0.91 between neutral and positive sentiments.
- These findings highlight the predominance of negative sentiments and their consistency across regions and languages, with significant regional and linguistic variations.

Topic Modelling of YouTube Data

- 61 topics were generated and categorized by sentiment.
- 27 topics were negative, 31 were neutral, and only three were positive, highlighting the dominance of neutral and negative sentiments.
- This analysis underscores the prevalence of negative and neutral discussions in YouTube data related to drink-driving.

Interventions

Based on the meta-analysis conducted, it was found that the most effective interventions to prevent youth DUI include:

1. Peer-led programmes;
2. Family engagement; and,
3. School-community partnerships.

These strategies educate youth on the consequences of drink-driving, promote responsible behaviour, and equip them with decision-making skills through collaboration with families, schools, and communities.

1. Peer-Led Interventions (PLI)

These interventions employ trained peers to educate and influence behaviour. Training, education, role modelling, and ongoing engagement are core elements of this approach. Peer-led interventions have been proven effective in leveraging social influence during adolescence.

Peer-led interventions are classified into three main programme types:

a. Educational and Awareness Programmes: include Brief Advice Sessions, the Alcohol Education Programme, Perceptions of Alcohol Norms (PAN), and Peer Theatre. These interventions focus on raising awareness, correcting misconceptions, and promoting healthier behaviours through interactive, relatable, and engaging formats.

b. Cognitive Behavioural Skill-Based Interventions aim to change thoughts and behaviours related to alcohol consumption by combining education and skills training. They develop decision-making, refusal skills, and strategies for navigating social situations involving alcohol. Effective interventions must consider local contexts, cultural influences, and family roles. Tailored strategies, combining education, awareness, and multifaceted support, are essential to address these regional and geographical disparities. Critical Cognitive Behavioural Skill-Based Interventions include Voice of Reason Programme, Alcohol Skills Training Programme (ASTP), Lifestyle Management Class (LMC).

c. Motivational and Feedback-Related Interventions aim to increase accountability, motivation, and self-efficacy through personalized feedback and motivational strategies, encouraging behaviour change and healthier lifestyle choices. Critical Interventions include Brief Alcohol Screening and Intervention for College Students (BASICS) a two-session programme that includes an initial self-assessment and a feedback session with motivational interviewing, followed by providing harm-reduction strategies through reducing alcohol consumption, Blood Alcohol Concentration (BAC), and binge drinking episodes.

Peer-led interventions can become more effective through:

- Engagement and relatability by using interactive and peer-driven elements.
- Personalisation through tailored feedback and skills training to individual behaviours and motivations.

- Emotional impact by evoking strong emotional responses and providing practical and real-life applications.
- Consistency and follow-up by ensuring sustained engagement through follow-up sessions.
- Effective motivational and feedback-based interventions depend on thoughtful design, ensuring relatability, personalisation, and sustained support to reduce youth alcohol misuse and prevent drink-driving.

2. Family-Based Interventions

Family-based interventions aim to enhance communication, strengthen parenting skills, and create supportive environments to reduce risky behaviours like alcohol misuse and drink-driving among youth. These interventions include:

a. Behavioural Skills and Communication Training, such as:

- Family Check-Up (FCU), which enhances parenting through motivational interviewing and positive reinforcement and is delivered in homes, schools, or clinics.
- Parenting Wisely (PW), which uses interactive videos to improve communication and parenting skills, targeting families with younger children.
- Family Skills Training Programme (FSTP) which focuses on joint parent-child sessions to improve communication, reduce conflict, and foster healthy family dynamics.

b. Therapeutic and Counselling-Based Programmes, such as:

- The Adolescent Community Reinforcement Approach (A-CRA) is another type of family-based programme that combines individual and family sessions to address substance use and improve family support systems.
- Functional Family Therapy-Gangs (FFT-G), which targets high-risk youth with intensive therapy to reduce alcohol-related risks, and Brief Strategic Family Therapy (BSFT), which is a short-term, goal-oriented therapy addressing problematic family dynamics to prevent youth risky behaviours.

c. Culturally Tailored Family-Based Interventions

There are also a variety of culturally tailored family-based interventions such as:

- ***Familias Unidas*** designed for Hispanic families in the USA that promotes better communication and parental involvement to prevent alcohol misuse and drink-driving.
- ***We R Native*** that supports Native American families by combining traditional values with modern health information to address substance use and unsafe behaviours.
- Families Preparing a New Generation (FPNG) that empowers parents and youth through education and family cohesion to reduce risky behaviours.

Key features of effective family-based interventions are:

- Communication to encourage open discussions about such as drink-driving.
- Parental monitoring to reinforce positive behaviour through supervision and involvement.
- Cultural relevance to leverage cultural traditions to resonate with families and youth.
- Collaboration to engage parents and children in joint sessions for practical skill-building.

Family-based interventions provide a holistic approach to reducing youth alcohol misuse and preventing drink-driving, fostering healthier behaviours through improved family dynamics and culturally tailored solutions.

3. Community-Based Interventions

Community-based interventions engage local organizations, families, schools, and public services to address youth drinking and driving through education, outreach, and cultural adaptation. These interventions use multi-component approaches to tackle individual, peer, and societal factors, yielding significant and lasting impacts. These interventions can be classified into:

a. **Education and awareness campaigns** such as Know Your Limits, Rethinking Drinking, and Safe Rides Save Lives.
b. **Reality-check simulations** such as Every 15 Minutes and Virtual Reality-based tools
c. **Emotional appeals and social norms** such as Responsible Redlands and Saving Lives Programme.

These community-based interventions leverage education, emotional strategies, and multicomponent approaches to effectively address youth drinking and driving. Their success lies in collaborative efforts, cultural relevance, and sustaining long-term behaviour change.

Research has identified several effective ways to enhance interventions aimed at reducing youth drink-driving. These strategies include:

- Combining emotional appeals with long-term support;
- Incorporating digital and interactive tools;
- Engaging local leaders;
- Focusing on continuous evaluation and improvement ; and,
- Implementing positive reinforcement and rewards.

When combined, they create a comprehensive and adaptable approach that promotes lasting Behavioural change and strengthens community resilience.

Conclusions

This study combined a meta-analysis and a thematic literature review to explore youth driving under the influence (DUI) behaviours, regional differences, contributing factors, and the effectiveness of interventions from families, communities, and governments. The findings highlight the complexity of youth DUI and emphasize the importance of tailored multifaceted prevention efforts. Despite some progress made over the past 20 years through the collaboration of various stakeholders, challenges related to DUI and its disproportionate impacts on youth persist. Continued efforts are necessary to achieve the global goals related to drink-driving fatalities and injuries, particularly among young people.

Addressing the challenges of youth DUI requires customized interventions that incorporate legal, environmental, educational, and communal strategies. Comprehensive approaches, informed by ongoing research and localized insights, can reduce youth-related DUI incidents and mitigate their societal impacts and short-term and long-term consequences.

Each intervention may effectively address one or more aspects of youth DUI challenges. Some programmes may reduce DUI rates in the short term, while others may be more effective in the long run. Policymakers should build on their success stories and learn from successful programmes in other communities, adopting these strategies locally. Interventions must specifically target at-risk groups based on age and geographic location. Combining individual behaviour modification with family involvement, education, comprehensive policy, and law-enforcement is crucial for reducing DUI incidents.

In today's digital transformation era, there are numerous opportunities to enhance interventions. New technologies can be utilized to understand better and analyse patterns, public opinions, and experiences, allowing innovative intervention technologies, methodologies, and policies to be designed. It is essential to consider global digital devices and ensure that these new interventions can benefit more youth, particularly those with limited access to such programmes.

Chapter 1

Introduction and Background

1.1 Global Road Traffic Fatalities and Drink-Driving

Research and statistics from around the world indicate that harmful alcohol consumption is one of the leading public health risks and poses a significant threat to public safety (WHO, 2018; WHO, 2019). Driving under the influence (DUI) of alcohol can lead to mental confusion, impaired vision, slower reaction times, and reduced attention, all of which negatively impact driving behaviour (Culík et al., 2022). The risk of fatal crashes increases exponentially when blood alcohol concentration exceeds 0.05 g/dL (Kassym et al., 2023). Globally, between 5 per cent and 35 per cent of all road fatalities have been attributed to drinking and driving (WHO, 2018), although these figures vary by country. In low-income countries, higher percentages of fatal crashes attributed to alcohol range from 33 per cent to 69 per cent. In contrast, this figure is about 20 per cent for high-income countries (WHO, 2023).

Since the year 2000, significant international efforts have been mobilized to improve road safety, including the following initiatives: the Decade of Action for Road Safety 2011-2020; the United Nations Road Safety Collaboration (2004); the 2030 Agenda for Sustainable Development; the Stockholm Declaration (2020); the UN General Assembly Resolution A/RES/74/299 on Improving Global Road Safety (2020); the Second Decade of Action for Road Safety 2021-2030; and the WHO-led Global Plan for the Decade of Action for Road Safety 2021-2030 (2021). These initiatives reflect a global commitment to enhancing road safety and reducing traffic injuries and fatalities.

The 2030 Agenda for Sustainable Development recognizes that road safety is essential for promoting health and well-being and creating sustainable, inclusive cities. The Stockholm Declaration highlights the disproportionate impact of road traffic crashes on children and youth and advocates for the adoption and enforcement of legislation to address behavioural risks, such as Drink-Driving, exceeding speed limit, non-use of seat belts, and distracted driving. The UN General Assembly Resolution on Improving Global Road Safety emphasizes the importance of international collaboration to enhance safety measures.

The Decade of Action for Road Safety 2021-2030 builds on the successes and lessons learned from previous efforts to save lives. In cooperation with other partners in the UN Road Safety Collaboration, the WHO and the UN regional commissions developed the Global Plan for the Decade of Action, released in October 2021.

This plan aims to reduce alcohol-related traffic crashes by setting a target to halve road traffic injuries and fatalities related to alcohol use by 2030. It underscores the necessity of legislative and enforcement measures to mitigate risks associated with drink-driving. The Decade of Action for Road Safety 2021-2030 seeks to prevent at least 50 per cent of road traffic deaths and injuries by 2030.

Despite some success in reducing drink-driving—indicated by a decline in fatalities per 100,000 people worldwide (Transport and Infrastructure Council, 2018; WHO, 2017; it continues to be a serious issue with significant consequences for individuals and society. The evidence consistently shows that drink-driving contributes to severe incidents, making its prevention a high priority for both research and policy development (Ehsani et al., 2023). Therefore, further research and practical efforts are needed to achieve the established global goals related to drink-driving fatalities and injuries.

1.2 Road Traffic Crashes and Youth

While drink-driving is a major global contributor to road injuries and fatalities, youth is one of the most affected age groups. Data shows that road traffic crashes are a prominent cause of death among youth worldwide.

According to the WHO (2019), alcohol is the leading risk factor for premature mortality and disability with 10 per cent of all deaths attributed to those aged 15 to 49 years (WHO, 2019), many of whom aged between 15 to 24.

According to the WHO global status report on road safety 2023, approximately 10 per cent of road traffic deaths are related to drink-driving. Evidence from various countries shows similar trends regarding drink-driving.

In the United Kingdom, approximately 22.5 per cent of total casualties in drink-driving collisions are among those aged 16 to 24 (UK Government, 2022).

In Canada, impaired driving remains the leading criminal cause of death and injury, with young people disproportionately affected. Individuals aged 16 to 25 accounted for almost 27 per cent of crash deaths involving alcohol (MADD, 2024).

In the USA in 2022, there were 13,524 (32%) fatalities in motor vehicle traffic crashes in which at least one driver was alcohol impaired. Traffic fatalities in alcohol-impaired driving crashes decreased by 0.7 per cent from 2021 to 2022.

The 21- to 24-year-old age group had the highest percentage (29%) of alcohol-impaired drivers involved in fatal traffic crashes compared to other age groups in 2022 (US Department of Transportation, 2024).

Of the 13,524 people who died in alcohol-impaired driving traffic crashes in 2022, there were 8,012 drivers (59%) who were alcohol-impaired.

Out of a total of 60,048 alcohol-impaired drivers in 2022, 48 per cent were between 15 and 24 years of age (US Department of Transportation, 2024).

In Argentina's context, it is documented that younger individuals are, on average, more prone to be involved in risky driving behaviour such as drink-driving. This is reflected in rates of positive breathalyser tests and, consequently, in mortality rates, with nearly 52 per cent of road transportation fatalities related to the age group 15-24 (Ramsco, 2023).

In 2022, Argentina had 4,567 road fatalities, and about 872 (19%) of them were in the age group 15 to 24 (Ramsco, 2023).

Despite ongoing efforts, the rates of drink-driving among young adults remain concerning (Mun et al., 2022). Younger drivers are particularly vulnerable on the road and alcohol impairment consistently contributes to this risk (Freeman et al., 2012; Curry et al., 2015).

Additionally, young drivers from low socioeconomic backgrounds or low-income countries face an even more significant threat, as they often drive older, less safe vehicles. This situation increases their chances of being involved in incidents and related injuries (Metzger et al., 2020). These factors indicate that further research and targeted interventions are necessary to address the disproportionate risk of crashes and injuries among young drivers (Möller et al., 2020).

1.3 Consequences of Drink-Driving for Youth

Harmful use of alcohol can cause different problems; however, compared to other alcohol-related issues, drink-driving is a high-risk behaviour that can cause harm (Mun et al., 2022).

The consequences of DUI go beyond physical health. The social and economic costs of drink-driving are significant and far-reaching, affecting both individuals and society (Mun et al., 2022). According to the WHO, approximately 1.3 million fatal traffic crashes occur each year (WHO, 2022), and a significant percentage of these crashes are caused by drunk drivers. These crashes result in human and economic losses, affecting the vehicles and individuals involved and the countries where they occur.

The adverse outcomes of DUI incidents can be tragic and include both short-term and long-term legal repercussions, such as hefty fines, suspension of driving licence, and potential imprisonment.

These consequences can cast a long shadow over a young adult's life, starting from adolescence and hindering future educational and employment opportunities. Additionally, the psychological effects of being involved in a DUI incident—whether as a driver or a passenger—can lead to long-lasting anxiety and guilt.

Young drivers, particularly those between the ages of 15 and 25, face heightened risks when it comes to driving under the influence (DUI). This age group is more prone to engaging in risky behaviours, including drink-driving, which exacerbates the problem (Nguyen et al., 2013; Möller et al., 2021).

Research shows that DUI drivers often engage in dangerous activities such as speeding, driving at night, neglecting to wear seat belts, having passengers in their vehicles, and driving older cars on two-lane roads in urban areas (Smailović, 2023).

All these evidence and studies highlight the vast consequences that drink-driving has for youth and their communities and that more needs to be done to reduce the consequences through more effective interventions that will require stakeholders' engagement as well as a better understanding of how societies perceive and assess these risks.

To tackle the issue of DUI among young people, various stakeholders—including families, governments, educational institutions, the private sector, and community organizations—need to take on vital roles and responsibilities.

1.4 Public and Youth Sentiments Regarding Drink-Driving

Studying and understanding public sentiment about societal issues is crucial for researchers, policymakers, and public and private sector organizations. Public sentiment provides valuable insights into people's opinions, attitudes, behaviours, and potential reactions to various policies, plans, products, services, laws, regulations, technologies, and initiatives. By grasping public sentiment, stakeholders can create and implement more effective engagement and communication strategies, develop policies that align with community needs, and anticipate societal trends.

Due to its numerous potential benefits and applications, sentiment analysis has gained considerable acceptance in recent years among various stakeholders (Sánchez-Rada & Iglesias, 2019). This trend has been facilitated by the increasing popularity of social media and the vast amounts of data generated about public opinion and reactions concerning a wide range of topics, policies, and products Wankhade et al.,2022.

Sentiment analysis is commonly used to gauge public opinion on various topics, including alcoholic products, health, entertainment, and the effects of new technologies on drink-driving. For instance, Wang et al. (2022) found that public

attitudes toward autonomous vehicles were generally optimistic, as many believe these vehicles could help reduce the consequences of drink-driving in the future. Similarly, Kumari et al. (2018) utilized sentiment analysis of Twitter data to track the occurrence of drinking events. This information can create a "drunk density" estimation, which could assist with safety interventions in specific geographic areas. In another study, Maity et al. (2018) investigated social media data and sentiment analysis to identify drunk texters automatically and accurately.

Sentiment analysis has not been widely applied to the issue of drink-driving; however, when it has been utilized, intriguing results have emerged. For example, Phlicharoenphon and Rober (2024) found that most Facebook posts about drink-driving in Nakhon Pathom Province, Thailand, expressed positive or neutral sentiments. Additionally, the study indicated that as the number of terms related to alcohol consumption increased in Facebook posts, the incidence of drink-driving cases also rose. Given that many young people use social media, the promising findings from sentiment analysis present new opportunities to understand public perceptions and opinions on this critical issue and find the most effective interventions and policies.

This study is an attempt to understand youth sentiments towards drinking and driving to inform the most effective policies and interventions to prevent and reduce drinking and driving among youth.

1.5 Interventions to Minimize Youth Drink-Driving

DUI-related interventions fall under four general categories:

- Support networks;
- Instructional programmes;
- Enforcement tactics; and,
- Preventative measures.

However, creating robust and holistic interventions to reduce DUI among youth needs a better understanding of the efficacy of these interventions and the unique contributions each stakeholder can make (D'Amico et al., 2004; Grossman et al., 2004).

For example, zero-tolerance laws regarding underage drinking and driving create a clear legal threshold that encourages young people to avoid such behaviour. Graduated licensing systems limit driving privileges for young and inexperienced drivers, which can also reduce DUI incidents by providing a structured approach to earning driving experience.

Alcohol education programmes play a significant role in the lives of youth. Many governments across the globe either support or fund educational programmes related to responsible alcohol consumption in schools and communities. These programmes often include workshops, seminars, and interactive group activities that teach youth about risky behaviours related to alcohol and impaired driving. Discussion educational initiatives led by peers can also be most effective, providing a relevant platform to address these issues (Gill et al., 2020; Linkenbach & Young, 2012).

Other major government interventions include public awareness campaigns. Public awareness, primarily through campaigns led by the government, might be able to educate the youth on the dangers involved with consuming alcohol and driving under its influence. These messages employ multiple media, such as social media, TV, and community events, to effectively send this message to the youth. These messages utilize saliency and framing of real-life consequences that may resonate particularly with young adults and help inculcate a sense of responsibility about driving and drinking.

More effective enforcement is also needed, as increasing patrols and sobriety checks can significantly reduce the number of DUI incidents. Regular enforcement operations, particularly at definite risk times like weekends and public holidays, may deter young persons from drinking and driving. Good enforcement not only aids in arresting offenders but also educates them about the legal implications of DUI (Guimarães et al., 2023; Jomar et al., 2019).

Collaboration with community organizations is also among the effective interventions regarding youth DUI. This involves governments' partnerships with community organizations in implementing activities that reach young drinkers and drivers. These collaborative efforts are implemented under safe ride programmes, designated driver initiatives, and substance abuse prevention workshops. They are conducted at schools, colleges, community centres, and places of worship. By sharing resources and experiences, governments and community organizations can develop multifaceted solutions that may resonate particularly well with young people (Maina et al., 2022; Montero-Zamora et al., 2023; Subica et al., 2022).

Schools and colleges are very critical settings where interventions to reduce the incidence of DUI among the youth can be implemented. Educational institutions can be guided to stem this problem through various methods. The inclusion of alcohol education in school curricula is one way through which schools can pass information related to alcohol use and impaired driving.

Alcohol education can be imparted in health education classes in schools on the dangers involved with alcohol use and impaired driving. Training on the physiological effects of alcohol, its legal implications, and safe driving practices will put the students in a better position to make informed choices (Gohari et al., 2024; Hosseinichimeh et al., 2024).

Running safe driving initiatives at educational institutions is very effective. Educational institutions can collaborate with local law-enforcement to host events that promote safe driving. These events can include workshops on the legal consequences of DUI, demonstrations of impairment simulation, and opportunities for students to sign pledges against drink-driving. Educational institutions can foster a sense of responsibility by engaging students in proactive discussions about safety (Patrick et al., 2020; Walshe et al., 2019).

In addition to family, government, and educational interventions, community organizations play a vital role in addressing youth alcohol consumption and DUI. Community-based strategies can include establishing support groups for youth struggling with alcohol-related issues, providing a safe space for sharing experiences, and seeking guidance. Community organizations can facilitate these groups, fostering a sense of belonging and accountability among participants (Choi et al., 2019).

The effectiveness of different intervention programmes has also been studied. Results show that the most effective programmes have higher social acceptance, public awareness, perceived safety outcomes, stakeholder support and funding, user convenience, availability and accessibility, and lower costs (Fell et al., 2020).

The issue of DUI among youth is complex and requires a multifaceted approach to address it effectively. Interventions must involve families, government agencies, educational institutions, and community organizations to reduce risks and promote safety. Creating a sense of responsibility regarding alcohol consumption and driving is essential.

To reduce DUI incidents among young people, promoting open communication, establishing strong legal frameworks, implementing educational programmes, and encouraging community involvement are essential. All stakeholders can work together towards this goal. Studies indicate that targeted interventions and public awareness campaigns are crucial for effectively combating drink-driving (McLester, 2024). Moreover, existing and emerging digital interventions can be designed and utilized in our digital age to address DUI, potentially reaching new generations highly connected to digital technologies (Gallegos-Jeffrey et al., 2023).

1.6 Current Gaps and Remaining Questions

Many studies have been carried out during the past few decades to understand drink-driving behaviour, its impacts, causes and determining factors, possible solutions, and interventions at different levels (Elvik, 2013; Smailović et al., 2023). However, some critical questions about the youth age group have not been fully answered. Some of these questions are:

1. What are the patterns of drink-driving behaviour among different youth age groups? How do drink-driving behaviours vary among different age groups within the youth category?

2. How do DUI habits and incidents differ by location (urban vs. rural, UN regions)? How do the impacts of drink-driving on youth differ by geographic location (urban vs. rural, different countries or regions)?

3. What factors contribute to youth road traffic crashes involving alcohol? What key factors contribute to road traffic crashes involving youth, with a focus on drink-driving?

4. What are effective interventions known for mitigating these crashes? What interventions exist, and how can they help mitigate the impact of road traffic crashes on youth, based on the evidence gathered?

5. What are the public sentiments and discussion topics regarding drink-driving and its consequences in social media and in different countries?

6. Can we leverage machine learning and AI and develop tools that youth can use to become more informed and self-aware about drink-driving consequences?

This study aims to enhance our understanding of the complexities related to youth, alcohol consumption, and driving under the influence (DUI). The ultimate goal is to inform strategies to reduce alcohol-related incidents and improve public safety. In doing so, we will conduct an extensive meta-analysis and systematic review of the existing literature. Additionally, we will explore the potential of using social media data to gain insights into public perceptions of drink-driving through opinion mining and sentiment analysis.

This research will focus on answering four research questions:

1. What are the patterns of drink-driving behaviour among different age groups of youth?
2. How do the impacts of drink-driving on youth vary by location?
3. What are the primary factors contributing to road traffic crashes among youth, particularly those involving drink-driving?
4. What interventions have been shown to be effective in reducing the incidence and impact of road traffic crashes on youth, and how can they be implemented effectively?

1.7 Study Outline

The remaining sections of this paper are organized as follows: Section 2 presents the Key Findings of the study, covering the results from the meta-analysis, systematic review, sentiment analysis, and topic modelling. Section 3 provides a detailed review of effective youth-focused educational and training-based DUI interventions, categorizing them into peer-led, family-based, and community-based approaches. Section 4 offers a Summary of Key Recommendations derived from the study's findings. Finally, Section 5 provides the overall Conclusions of the research and suggests directions for future work. For a detailed explanation of the methodologies and statistical analyses used, please refer to Appendix 1 and 2. Appendix 3 provides details on the prototype AI-based Drink-driving Awareness Tool developed for this study.

Chapter 2

Key findings

We utilized both meta-analysis and thematic analysis to address our research questions. Our findings suggest that the results can be generalized to alcohol-related crashes resulting in serious injuries or fatalities, particularly in contexts where other confounding factors, such as the use of additional substances, are controlled. For instance:

1. Studies have shown that young drivers who consumed alcohol before driving had significantly higher odds of being involved in collisions, with odds ratios ranging from 1.85 to 6.75 (Borsari et al., 2012; Callaghan et al., 2016).

2. Measures that reduce the rate at which young drivers consume alcohol, such as education and enforcement of drinking laws, have been proven to decrease the rate of DUI incidents and related traffic incidents (Johnson, 2016; Lavoie et al., 2017). This highlights the importance of developing specific strategies to minimize the risks associated with alcohol use while driving, especially among the youth (White et al., 2018; Yockey et al., 2024).

3. The evidence indicates a positive relationship between alcohol use and the risk of motor vehicle collisions, justifying further research and intervention in this field.

To address Research Question 1 (RQ1), we present an analysis of the trends in DUI behaviour among various age groups within the youth demographic. This analysis also compares older age groups, allowing us to explore any differences or continuities in DUI behaviour as individuals transition through different life stages.

In answering Research Question 2 (RQ2), we discuss how different types of locations and geographical differences affect DUI habits among youth.

For Research Question 3 (RQ3), we employ thematic analysis from selected papers to identify additional factors contributing to DUI incidents on the road.

Finally, to address Research Question 4 (RQ4), we use the results from the meta-analysis to determine the most effective interventions. In the following sections, we also combine the analysis of age differences and location types to gain a better understanding of DUI behaviour among youth.

2.1 Drink-Driving Differences Between Youth Age Groups

Critical trends in drink-driving behaviour among youths aged 15 to 25 vary significantly, influenced by age, drinking laws, and social contexts.

Younger adolescents, aged 15 to 17, have a higher rate of alcohol-impaired driving due to their inexperience and the fact that they have recently begun driving. Research shows that this age group is more susceptible to the effects of alcohol, leading to a higher incidence of traffic incidents related to alcohol consumption (Callaghan et al., 2016).

Although more stringent drinking laws and educational efforts have been implemented targeting this demographic, their effectiveness has been limited, mainly depending on local enforcement and cultural attitudes toward drinking (Kypri et al., 2017).

In contrast, the 18 to 24 age group reflects a more complex relationship between alcohol and driving. Young adults often experience an increase in alcohol-related issues upon reaching the legal drinking age, which is evident through sharp spikes in alcohol-impaired driving incidents. However, several countermeasures aimed at those aged 21 to 24, including high-visibility enforcement initiatives, have effectively reduced these behaviours. The variations in drink-driving behaviour across different age groups demonstrate the need for differentiated prevention strategies considering the unique developmental and social factors affecting each cohort.

While the increased independence of young adults often leads to higher risk-taking behaviours, such as driving after drinking, ongoing public health efforts are crucial to mitigating these risks (McCartt et al., 2009) (see Table 1).

Table 1. Drink-Driving Differences Between Age Groups

Age Group	Findings	Citations
15-17	Higher rates of alcohol-impaired driving incidents were observed among this group, particularly influenced by th e drinking age laws.	(Bohman et al., 2004; Callaghan et al., 2016; Kypri et al., 2017; Spirito et al., 2004)
18-19	Significant increases in alcohol-impaired driving incidents were noted after the minimum legal drinking age was lowered. This group showed a marked rise in traffic injuries attributable to alcohol.	(Bohman et al., 2004; Callaghan et al., 2016; Colby et al., 2018; Kypri et al., 2017)
20-21	This age group served as a control in studies, showing a decrease in alcohol-related traffic injuries compared to younger groups.	(Johnson, 2016; Kypri et al., 2017)
21-25	Notable reductions in drinking and driving were observed following enforcement campaigns, but still significant rates of driving under the influence persisted.	(Bohman et al., 2004; Callaghan et al., 2016; Johnson, 2016; Kypri et al., 2017; Spirito et al., 2004)
25+	This group generally showed lower rates of alcohol-impaired driving compared to younger age groups but still faced risks, particularly in social settings.	(Haegerich et al., 2016; Johnson, 2016; Kypri et al., 2017; Teeters et al., 2015)

2.2 Differences in Drink-Driving Behaviour by Location and Regions

Table 2 summarises the geographical disparity in driving under the influence habits and incidents, comparing urban and rural regions and different areas within a country. Relevant in-text citations from the existing literature support our findings in this analysis.

Our examination of DUI incidents reveals a significant difference between urban and rural settings. Urban areas tend to have higher rates of DUI incidents due to better access to alcohol and nighttime entertainment. The presence of bars and other venues for socialising in urban areas leads to increased alcohol consumption, which often results in more cases of drink-driving.

Table 2. Driving under the influence (DUI) habits and incidents based on geographical location

Location Type	DUI Habits	DUI Incidents	Key Findings
Urban Areas	• Higher DUI prevalence due to nightlife access (Burns et al., 2016; Clapp et al., 2005) • Young adults are more likely to drive after drinking (Burns et al., 2016; Cancilliere et al., 2018; Clapp et al., 2005)	• Elevated DUI incident rates (Colby et al., 2018; Fell et al., 2008) • Frequent police checkpoints contribute to higher rates (Borsari et al., 2012; Burns et al., 2016; Martens et al., 2013)	• Resources dedicated to DUI prevention, but population density increases alcohol-related incidents (Borsari et al., 2012; Burns et al., 2016; Clapp et al., 2005; Colby et al., 2018; Martens et al., 2013)
Rural Areas	• Lower DUI prevalence but higher per capita risk • Cultural acceptance of drinking and driving (Colby et al., 2018; Fell et al., 2008; Lavoie et al., 2017; Murphy et al., 2010)	• Fewer incidents but higher case-fatality rates • Longer response times worsen incident outcomes (Colby et al., 2018; Fell et al., 2008; Lavoie et al., 2017; Martens et al., 2013; Murphy et al., 2010)	• Limited DUI prevention resources increase the risk of severe outcomes (Schulte et al., 2024; Spera et al., 2012)

Location Type	DUI Habits	DUI Incidents	Key Findings
North America	• High DUI among college students in urban nightlife areas • Prevention trials reduce DUI (Schulte et al., 2024; Spirito et al., 2004; White et al., 2018)	• Significant DUI incidents, especially among young adults • Minimum Legal Drinking Age (MLDA) laws positively impact DUI rates (Murphy et al., 2010; Spera et al., 2012; Yockey et al., 2024)	• College drinking culture correlates with DUI cases (Martens et al., 2013; Schulte et al., 2024)
Europe	• Varied DUI habits, with some countries showing lower rates due to cultural norms • Stricter DUI laws in many countries	• Lower DUI rates than in North America, but some areas report significant cases (Burns et al., 2016, p. 10; Clapp et al., 2005, p. 2) • Stricter penalties reduce DUI rates (Burns et al., 2016, p. 10; Clapp et al., 2005, p. 2)	• Cultural attitudes influence (DUI) rates across countries (Burns et al., 2016, p. 10; Clapp et al., 2005, p. 2)
Asia	• Emerging drinking culture among youth increases DUI • DUI law-enforcement varies widely (Burns et al., 2016; Clapp et al., 2005)	• Rising DUI incidents, especially in urban nightlife areas • Stricter laws are being implemented in some regions (Burns et al., 2016; Clapp et al., 2005)	• Urbanization and social norms drive an increase in DUI incidents (Callaghan et al., 2016; Cancilliere et al., 2018)
Oceania (Australia and New Zealand)	• New Zealand: Lowering purchase age linked to increased youth DUI • Australia: Alcohol control policies reduce adolescent drinking (Fell et al., 2008; Haegerich et al., 2016; White et al., 2018)	• New Zealand: Long-term rise in DUI-related injuries among young drivers • Australia: Decrease in adolescent drinking and risky drinking (Fell et al., 2008; Haegerich et al., 2016; White et al., 2018)	• Australia's policies decrease youth DUI; New Zealand shows risks with policy changes (White et al., 2018; Yockey et al., 2024)

In contrast, while rural areas report fewer DUI incidents, the fatality rates from these incidents are disproportionately higher. This concerning reality is exacerbated by cultural attitudes that may tacitly accept such behaviour, alongside various challenges that arise in these settings brought about by longer emergency response times in rural areas.

The practice of driving under the influence has a significant regional impact worldwide. For example, the culture of drinking in colleges is one of the main factors contributing to the differences in DUI rates across North America. The environment at colleges often promotes norms of heavy intoxication, which increases the risk of impaired driving.

In contrast, many countries within the European Union have stringent law-enforcement measures and a deeply ingrained cultural value system that discourages DUI, resulting in lower rates of incidents. Meanwhile, in Asia, rapid urbanization and a growing youth population are leading to an increase in DUI cases because lifestyle changes promote behaviours associated with impaired driving.

Research has indicated that in some parts of Africa and Asia, many DUI cases occur without any purchase of alcohol from outside sources. Instead, alcohol may be consumed as part of family traditions or readily available at home, often without adequate restrictions from family members. This situation highlights the dangers of unmonitored alcohol use among youth and the potential consequences for their safety and society.

This nuanced analysis underscores the complexity of DUI behaviours across different contexts, indicating that intervention strategies must be culturally and socially relevant, considering local geographical influences. A uniform approach is likely insufficient to address the unique conditions arising from various environments. Therefore, interventions must be tailored to the specific characteristics of each community.

Local experts should develop case-specific interventions to tackle DUI among youths effectively. The relevance and effectiveness of implemented strategies depend on how well they align with the traits of the target community. A multi-pronged approach is essential, incorporating all available resources and tools, including education, awareness, and support strategies, to minimize the risks associated with alcohol consumption and driving.

Additionally, recognizing the role of families in this process is crucial. Families significantly influence the attitudes and behaviours of young individuals. Fostering a supportive environment that encourages responsible decision-making can significantly reduce DUI incidents among youth. By integrating these elements, we can formulate a more comprehensive and effective strategy to combat this pressing public health issue.

Understanding the differences in drink-driving behaviour by location type and age is also essential for forming effective interventions.

2.3 Differences in Drink-Driving Behaviour by Location Type and Age

The patterns of drink-driving behaviour among youth aged 15 to 25 vary between urban and rural settings (Table 3). In urban areas, individuals aged 15 to 17 face increased access to alcohol and social pressures to drink, leading to a higher rate of alcohol-related driving offenses.

Younger drivers are particularly vulnerable because alcohol elevates their already high risk of traffic crashes. The abundance of bars and social venues in urban settings contributes to a culture where drinking and driving may be more normalized despite legal restrictions.

In contrast, rural areas typically have fewer social establishments and lower rates of alcohol use, resulting in fewer cases of drink-driving among youth. This discrepancy is evident among those aged 18 to 25, with a growing gap in drink-driving behaviour.

Alcohol-related incidents surge in the 18-19 age group immediately after individuals reach the legal drinking age in urban areas, as they gain legal access to alcohol and social events. Specific interventions, such as high-visibility enforcement campaigns, have successfully reduced drinking and driving rates among 21- to 25-year-olds in urban settings. Meanwhile, rural youth in the same age range tend to report lower rates of drinking and driving, which can be attributed to stricter DUI laws and a more conservative social environment.

This highlights the need for tailored prevention strategies considering each location's unique challenges and social contexts.

Table 3. Habits of DUI among youth based on age group and location

Age Group	Findings	Citations
15-17	Higher rates of alcohol-impaired driving incidents, particularly in urban areas where access to alcohol is more prevalent.	(Callaghan et al., 2016; Kypri et al., 2017)
18-19	Significant increases in alcohol-impaired driving incidents were noted in urban settings, especially after the legal drinking age was lowered.	(Callaghan et al., 2016; Johnson, 2016)
20-21	This age group showed a decrease in alcohol-related traffic injuries in rural areas due to stricter enforcement of DUI laws.	(Martens et al., 2013; McCartt et al., 2009)
21-25	Following high-visibility enforcement campaigns, drinking and driving in urban areas significantly reduced, but significant rates persisted.	(Callaghan et al., 2016; Clapp et al., 2005)
25+	Generally, there are lower rates of alcohol-impaired driving compared to younger groups, but urban areas still present higher risks.	(Johnson, 2016; Yockey et al., 2024)

2.4 The Short- and Long-Term Consequences of DUI for Youth

Driving under the influence carries severe short-term and long-term consequences, especially for young drivers who may lack experience and maturity. The immediate risks of DUI can be devastating, including a higher chance of incidents, legal penalties, and emotional and social repercussions. The long-term effects can pose significant challenges, such as chronic health issues and societal burdens that impact entire communities. Understanding these consequences is crucial for effectively addressing the problem and creating comprehensive prevention strategies.

Short-Term Consequences

Increased risk of incidents: One of the most immediate and dangerous outcomes of driving under the influence is the increased risk of incidents. Youth

who already face higher risks on the road due to their inexperience are even more vulnerable when under the influence of alcohol or drugs. Motor vehicle crashes are a leading cause of death among young adults, and the combination of inexperience and impairment from DUI creates catastrophic risks, not only for the driver but also for passengers and other road users.

Legal consequences: Another significant short-term consequence is the potential for legal penalties. Young drivers caught driving under the influence face serious legal repercussions, including fines, license suspension, and even incarceration. These penalties can have lasting effects on their future, making it difficult to obtain employment or access educational opportunities due to the stigma attached to a criminal record (Burns et al., 2016; Colby et al., 2018; Schulte et al., 2024; Spirito et al., 2004; Teeters et al., 2018).

Injuries and fatalities: DUI incidents frequently result in injuries to the driver as well as to others, including severe injuries and fatalities. These incidents can harm not only the intoxicated driver but also innocent bystanders, passengers, and other road users. The physical and emotional consequences of such incidents can lead to long-term health problems and significant psychological trauma, which is often overlooked (Teeters et al., 2015; Teeters et al., 2018).

Emotional consequences: The emotional trauma following a DUI-related incident can be severe, often leading to conditions such as anxiety, depression, and post-traumatic stress disorder (PTSD). These issues can significantly impact an individual's mental health and relationships.

Family consequences: DUI incidents often lead to significant strain within families. This can create tension and conflict, resulting in emotional distress and challenges related to the stigma of DUI offenses. Additionally, family members may encounter financial challenges due to legal fees and increased insurance rates, which can be especially difficult for families already facing economic hardships (Schulte et al., 2024; Spera et al., 2012).

Social consequences: The social stigma associated with DUI offenses can be especially harmful to young people. Those who engage in DUI behaviours may experience ostracism from their peers and community members, which can lead to feelings of isolation. This isolation may worsen risky behaviours, such as increased alcohol or substance use, creating a cycle of poor decision-making.

Financial consequences: Additionally, the financial consequences are significant, as DUI convictions result in higher insurance rates, placing an extra burden on families, particularly those already facing financial instability (Schulte et al., 2024; Spera et al., 2012; Spirito et al., 2004).

Professional consequences: A DUI conviction can affect a young person's professional future. It often leads to a loss of job opportunities, especially in industries where driving is essential. Additionally, even in fields that do not require driving, having a DUI on one's record can restrict access to job opportunities and hinder career advancement (Haegerich et al., 2016; Jewell & Hupp, 2005).

Academic consequences: The stress and legal complications associated with DUI can also negatively impact a youth's academic performance. Legal troubles, coupled with emotional distress, often result in absenteeism and a decline in academic achievement, which can limit future educational and career prospects (Fell et al., 2008).

Community consequences: DUI incidents raise significant concerns about community safety, leading residents to worry about the safety of their streets. This heightened anxiety can result in demands for stricter enforcement of DUI laws, potentially creating a climate of fear and unease within the community (Haegerich et al., 2016).

Long-Term Consequences

The long-term consequences of DUI extend well beyond the immediate legal and physical ramifications.

Health consequences: One of the most concerning long-term impacts is the development of chronic health issues. Prolonged harmful alcohol use can lead to liver disease, addiction, and various mental health disorders, severely impacting an individual's quality of life and longevity (McCartt et al., 2018; McCarty et al., 2019). Moreover, the likelihood of recidivism—the tendency to relapse into impaired driving behaviours—is significantly higher among those who engage in DUI at a young age. This recidivism can perpetuate a cycle of impaired driving, leading to more severe legal consequences and further health deterioration (Meesmann et al., 2015).

Legal consequences: A DUI conviction also carries long-term legal consequences. It can permanently tarnish a youth's criminal record, making it difficult to pursue higher education or secure meaningful employment in the future.

These barriers to success and stability can persist throughout adulthood, severely limiting life opportunities (McGinty et al., 2017; Meesmann et al., 2015).

Family consequences: The strain on families can also be long-lasting. Many families face emotional and financial disruption as a result of a youth's DUI, often due to the costs of legal battles, rehabilitation, and medical expenses. This ongoing strain can erode familial relationships and dismantle essential support systems.

Community consequences: DUI incidents also place a significant burden on community resources. The increased need for emergency services, health-care, and law-enforcement in response to these incidents strains the availability of these resources for other community needs. This strain is compounded by the public health burden that results from alcohol-related incidents, which increase health-care costs and the demand for addiction treatment services, further challenging public health initiatives and funding (McCartt et al., 2009; Murphy et al., 2010; Spera et al., 2012).

Fatalities: The most tragic long-term consequence of DUI is the loss of life. Fatalities resulting from DUI-related crashes have a profound and lasting impact on families and communities, creating a legacy of grief and loss that cannot be quickly healed. These losses also contribute to the shifting of social norms and attitudes within communities, where impaired driving may become normalized, especially among youth, making it increasingly difficult to implement effective prevention strategies (White et al., 2018; Yockey et al., 2024).

Economic consequences: From an economic perspective, the impact of DUI on communities is also significant. Communities often experience economic downturns due to the loss of young lives and the associated costs of incidents, which can impede local growth and development.

Finally, the high rates of DUI among youth can drive policy changes, leading to stricter regulations and enforcement of DUI laws. These policy shifts can have far-reaching consequences for public health and safety, shaping how communities address alcohol consumption and impaired driving (Spera et al., 2012; Spirito et al., 2004; Teeters et al., 2015; Teeters et al., 2018; White et al., 2018).

The effects of Driving Under the Influence among youth extend far beyond the individuals directly involved, impacting families, communities, and broader societal structures. In addition to the immediate risks of incidents and severe legal consequences, the long-term health issues, social stigma, and economic burdens

associated with DUI make it a significant concern. Families can face substantial emotional and financial strain, while communities must deal with increased demands on health-care and law-enforcement resources. In response, governments may enact stricter legislation, although the success of these measures often depends on the level of community involvement.

To effectively address DUI among youth, a comprehensive approach is necessary that includes education, prevention programmes, and community involvement. The broader social implications of DUI suggest that efforts should be holistic. This means combining legal measures with interventions from families, schools, and communities to promote safer driving behaviours and reduce the number of alcohol-related incidents.

2.5 Factors Contributing to Youth Road Traffic Crashes Involving Alcohol

To address the fourth research question (RQ4) and understand key contributing factors to youth-related DUI traffic crashes, we conducted a thematic analysis to identify the factors highlighted in our selected studies. Our findings revealed several key factors associated with these incidents. Understanding these factors is essential to develop effective preventive measures against such incidents. The major contributing factors include underage alcohol consumption, peer influence, insufficient parental supervision, the media's portrayal of alcohol, and inadequate law-enforcement.

Underage Alcohol Consumption

One of the key factors contributing to road traffic crashes among youth is the prevalence of underage alcohol consumption. Statistics indicate that a significant percentage of adolescents engage in drinking, with studies revealing that 39 per cent of eighth graders and 72 per cent of twelfth-graders reported using alcohol in the past year (Bohman et al., 2004; Burns et al., 2016; Cancilliere et al., 2018).

Early alcohol exposure can lead to risky behaviours, including driving under the influence. Research has shown that young people who consume alcohol before the age of 15 are more likely to develop alcohol dependence and engage in dangerous driving behaviours. This issue is often worsened by the social acceptability of drinking among peers, which increases the likelihood of driving while intoxicated among young individuals.

Peer Influence

Peer influence plays a critical role in shaping adolescent behaviour, especially when it comes to alcohol consumption and driving. Adolescents are particularly vulnerable to peer pressure, which can lead them to engage in risky behaviours like drinking and driving (Bohman et al., 2004; Callaghan et al., 2016; Spirito et al., 2004). When peers accept alcohol consumption, it may create a perception that driving under the influence is also acceptable.

This behaviour contributes to distorted risk perceptions among young drivers, causing them to overestimate their ability to handle alcohol compared to their actual capabilities. Furthermore, being in a group of drinking peers significantly increases the likelihood that a young person will drive after consuming alcohol.

Lack of Parental Monitoring

Parental involvement is a significant factor influencing adolescents' drinking and driving behaviour. Research has shown that strong parental influence and effective communication can reduce the likelihood of deviant behaviour among adolescents (Jewell & Hupp, 2005; Haegerich et al., 2016). When parents seem less concerned about their children's activities or fail to communicate the risks associated with alcohol consumption, adolescents may feel less hesitant about their drinking behaviour.

Studies have also found that adolescents whose parents do not monitor their activities or express pride in their achievements are more likely to engage in drink-driving (Spirito et al., 2004; Yockey et al., 2024). A lack of parental monitoring can create an environment where adolescents feel free to experiment with drinking without considering the potential consequences.

Alcohol Advertisement

Media commercial advertisements of alcohol consumption significantly influence the attitudes and behaviours of young people regarding drinking (Smith & Foxcroft, 2009; Finan et al., 2020). Advertisements often depict alcohol as a symbol of social acceptance and fun while downplaying the associated risks (Bohman et al., 2004; Colby et al., 2018). Research indicates that media literacy education can help youth critically analyse these messages, enabling them to make informed decisions about drinking behaviour (Borsari et al., 2012; Cancilliere et al., 2018; Colby et al., 2018).

Inadequate Enforcement of Laws

The enforcement of laws concerning underage DUI is essential for preventing traffic crashes involving young people. Many countries have established minimum legal drinking age laws and zero-tolerance policies to address underage drinking and its consequences, such as driving under the influence of alcohol. However, the compliance and enforcement of these laws can vary widely across different nations (Fell et al., 2008).

In some instances, weak enforcement contributes to a perception among youth that they can consume alcohol and drive without facing severe repercussions. Additionally, the effectiveness of these laws is often weakened by public indifference and inconsistent enforcement in various countries (Clapp et al., 2005; Fell et al., 2008; Schulte et al., 2024). Strengthening the enforcement of existing laws and raising public awareness about the dangers of underage drinking and driving can help reduce the risks associated with these behaviours.

The Amplified Risks of Poly-Drug Use and Impaired Driving Among Youth

The combination of drinking alcohol and using drugs significantly increases the dangers associated with driving under the influence of either substance. Alcohol and drugs can interact in ways that produce impairment much more significant than what might be expected if each were taken individually. This heightened impairment leads to severely reduced motor coordination, slower reaction times, and significantly impaired judgment—all of which are critical for safe vehicle operation.

As a result, there is a high likelihood of traffic incidents involving young drivers, who typically possess lower driving skills. According to McCartt et al (2009), this combination of inexperience and the adverse effects of substances dramatically elevates the risk of motor vehicle incidents.

The prevalence of poly-drug use among adolescents is a significant public health concern, as it is often associated with other risky behaviours, such as driving under the influence. Studies have shown that young drivers who use both alcohol and drugs simultaneously often underestimate the risks associated with impaired driving.

This misjudgement creates a false sense of security, leading them to believe they can operate a vehicle safely despite being severely impaired. Consequently, this false belief increases the number of DUI-related crashes among youth because they fail to recognize the cumulative effects of alcohol and drugs on their ability to drive.

Public health interventions targeting young individuals should concentrate on identifying and addressing the risks associated with poly-drug use. This can be achieved through education about the dangerous consequences of mixing harmful substances. These interventions must emphasize the importance of making responsible choices and understanding the long-term impacts of impaired driving, as noted by Jewell & Hupp (2005), Martens et al. (2013), and McCartt et al. (2009).

Addressing the factors that contribute to youth road traffic crashes involving alcohol requires a comprehensive approach. By focusing on reducing underage alcohol consumption, enhancing parental monitoring, countering negative media portrayals, and improving law-enforcement, communities can create a safer environment for young drivers (Bohman et al., 2004; Borsari et al., 2012; Fell et al., 2008).

2.6 Effective Interventions

This study reviewed multiple and diverse interventions among different studies implemented to reduce driving under the influence among young people, synthesising data from an overall dataset that included 30 individual studies.

The pooled effect size of the interventions represented a statistically significant effect of 0.44 (95% confidence interval: 0.34 to 0.54; $p < 0.001$), indicating a very substantial effect in mitigating DUI behaviours among this demographic. Analysis also showed a high heterogeneity between the individual study effects, the I^2 statistic being 94 per cent, as represented in Table 4.

Table 4. Heterogeneity

Q-value	df (Q)	P-value	I-squared	Q-value
517.3691	29	0	94.39472	517.3691

* The I^2 statistic describes the percentage of variation across studies that is due to heterogeneity rather than chance. $I^2 = 100\% \times (Q-df)/Q$. I^2 is an intuitive and simple expression of the inconsistency of studies' results.

Such high statistical heterogeneity indicates variability in the effectiveness of the diverse interventions applied and the various populations assessed. The random-effects model is, therefore, recommended to estimate more precise summary results further, as shown in Table 5.

Table 5. Fixed vs random-effects models

Model	Number of studies	Point Estimate	Standard Error	Variance	Lower Limit	Upper Limit	Z-value	P-value
Fixed	30	0.318029	1.04E-02	1.08E-04	0.297694	0.338364	30.65287	0.000
Random Effects	30	0.440796	5.22E-02	2.73E-03	0.338456	0.543135	8.441919	0.000

Due to the diverse nature of our study's data, a random-effects model is employed to account for between-study variability. While the fixed-effects model yields a point estimate of 0.318, the random-effects model provides a higher estimate of 0.441.

As part of our meta-analysis, we carefully analysed which interventions stood out as top performers—either unique to individual studies or as general trends across multiple studies. Our systematic and statistically informed selection process enabled us to draw meaningful conclusions from the data.

First, our review focused on evaluating the effect size of each intervention. The effect size, typically expressed in terms of Cohen's d or Hedge's g, indicates the magnitude of the effect produced by the intervention (Figure 1).

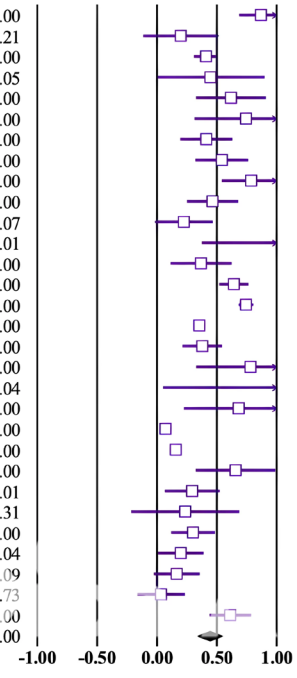
We prioritized interventions with large effect sizes, suggesting stronger and more substantial impacts. We further analysed the Z-values and p-values for each study: a large Z-value signifies a more significant effect, while a small p-value, generally less than 0.05, indicates that a result is statistically significant. This was a crucial measure in selecting studies with robust results, implying that the findings were unlikely to be due to chance.

Confidence intervals surrounding these effect size estimates indicate the range within which the actual effect size may lie. Smaller intervals suggest a more precise estimate, while wider intervals reflect uncertainty regarding the intervention's effectiveness. Given the potential variability among studies, we employed a random effects model in our meta-analysis, assuming that true effect sizes may differ due to variations in populations, interventions, and methodologies. This model enabled us to derive an overall effect size that allows for a more generalized interpretation of the interventions' effectiveness across various contexts.

Next, we conducted a comparative analysis by categorizing interventions, such as distinguishing between individual-level and policy-level interventions. This process helped us identify which interventions were effective across studies and which yielded mixed results. We excluded studies with nonsignificant or small effect sizes, ensuring that the final set included only those interventions that demonstrated a clear potential for positive change.

Figure 1. Forest Plot of Hedges' g

Study name	Intervention	Std diff in means	Lower limit	Upper limit	Z-Value	p-Value
Bohman-2004	Peer-led educational curriculum	0.87	0.69	1.05	9.45	0.00
Borsari et al., 2012	Brief univesrity based motivational intervention.	0.20	-0.11	0.51	1.25	0.21
Burns S.-2016	Multi-strategy approach Motivational for students	0.41	0.31	0.51	8.08	0.00
Callaghan-2016	Government-based drinking age legislation	0.45	-0.00	0.90	1.95	0.05
Cancilliere-2018	Motivational intervention in emergency settings	0.62	0.33	0.91	4.18	0.00
Clapp J.D.-2005	Government-based environmental prevention campaign.	0.74	0.31	1.17	3.39	0.00
Colby SM-2018	3 weeks Motivational University	0.41	0.20	0.63	3.73	0.00
Colby SM-2018	6 months Motivational University	0.54	0.32	0.76	4.86	0.00
Fell J.C.-2008	0.08 law Govenrment Law	0.79	0.54	1.03	6.34	0.00
Fell J.C.-2008	ALR law Govemment Law	0.46	0.25	0.68	4.29	0.00
Fell J.C.-2008	Posession and purchase law Gov. Law	0.23	-0.01	0.47	1.84	0.07
Haegerich-2016	Family-based parental monitoring intervention.	1.94	0.38	3.50	2.43	0.01
Jewell J.-2005	Experiential intervention in university	0.37	0.12	0.62	2.85	0.00
Johnson M-2014	Government-based high-visibility enforcement campaign	0.64	0.52	0.76	10.52	0.00
Kypri K -2017	Government-based minimum purchasing age	0.74	0.69	0.80	24.70	0.00
Lavoie MC -2017	Government-based environmental strategies	0.35	0.31	0.40	15.48	0.00
Martens et al., 2013	motivational interventions college	0.38	0.21	0.54	4.52	0.00
Mccartt A.T.-2009	drinking and driving laws in a college Age 16-20	0.78	0.33	1.23	3.39	0.00
Mccartt A.T.-2009	drinking and driving laws in a college age 21-24	1.26	0.05	2.46	2.05	0.04
Murphy- 2010	Motivation to change college	0.68	0.23	1.14	2.93	0.00
Schulte R -2024	Father's Monitoring Knowledge	0.07	0.03	0.11	3.22	0.00
Schulte R -2024	Mother's Monitoring Knowledge	0.16	0.11	0.20	7.06	0.00
Spera C.-2012	Enforcing Underage Drinking Laws Gov.	0.66	0.33	0.99	3.89	0.00
Spirito A-2004	Brief motivational intervention Emergency department	0.29	0.07	0.52	2.53	0.01
Teeters-2018	Mobile Phone Based Brief Intervention College	0.24	-0.22	0.69	1.03	0.31
white2018	Drink driving policies Gov.	0.30	0.12	0.48	3.25	0.00
white2018	Trading hours Gov.	0.20	0.01	0.39	2.05	0.04
white2018	Youth access policy Gov.	0.17	-0.03	0.36	1.70	0.09
Yockey RA-2024	Parents limit time out on school night	0.03	-0.16	0.23	0.34	0.73
Yockey RA-2024	Parents never/seldom check homework	0.61	0.44	0.78	6.99	0.00
		0.44	0.34	0.54	8.45	0.00



Forest Plot of Hedges' g Effect Sizes and 95% Confidence Intervals, Showing the Direction of Effect for Interventions Targeting Youth DUI (from the Comprehensive Meta-Analysis CMA software Ver3)

We systematically selected interventions that showed the most substantial outcomes in our meta-analysis by applying these statistical evaluations and methodologies. This rigorous approach strengthens the credibility of our findings and provides a solid foundation for informed decision-making regarding intervention strategies.

Initially, we will present individual interventions demonstrating the highest impact in reducing DUI incidents among youth. Following this, we will examine broader, general interventions that exhibit the most substantial cumulative effect in preventing DUI occurrences within this demographic.

Top Individual Interventions

Top individual interventions centre around direct engagement with young people in various contexts:

1. **Peer-led Educational Programmes** offer youth a relatable approach to understanding the dangers of DUI, leveraging social influence to encourage responsible behaviour (Bohman et al., 2004).
2. **Motivational Interventions in Educational Settings** use short, focused discussions to address personal attitudes toward drinking, often in university environments, making them accessible and impactful (Martens et al., 2013).
3. **Brief Interventions in Emergency Settings** utilize the immediacy of an emergency context to deliver motivational content, helping individuals recognize risky behaviours during moments of heightened awareness (Spirito et al., 2004).
4. **Mobile and Technology-Based Interventions** reach youth through smartphones, delivering targeted messages that reinforce safe behaviours and discourage drinking and driving (Teeters et al., 2018).
5. **Parental Monitoring Programmes** involve structured oversight by parents, such as enforcing curfews and monitoring activities, which contributes to a safe environment that deters risky decisions (Haegerich et al., 2016).

Top General Interventions

The systematic review identifies various interventions aimed at reducing DUI incidents among youth. We categorize these interventions into three main subcategories: motivational interventions, educational programmes, and regulatory strategies.

1. **Motivational Interventions** directly influence individuals' attitudes toward drinking and driving. Studies by Borsari et al. (2012), Burns et al. (2016), and Cancilliere et al. (2018) fall into this category as they focus on changing personal behaviour and increasing awareness of risks in settings where individuals may be more open to change, such as universities or emergency rooms. For instance, after a DUI-related incident, a young person may reflect on their drinking behaviour during such moments.

   Mobile and technology-based interventions, as described by Teeters et al. (2018) and Yockey et al. (2024), are also included in this category. These interventions utilize smartphones to maintain continuous contact with individuals, sending timely messages that encourage responsible drinking patterns.

2. **Educational Programmes** aim to increase awareness of the dangers associated with alcohol consumption and the consequences of driving under the influence. Peer-led educational initiatives, like those in the study by Bohman et al., leverage adolescent peer dynamics to change attitudes and lower DUI rates. These programmes highlight peers' vital role in shaping behaviours using relatable and community-driven communication strategies regarding DUI risks. Family-based interventions, as identified by Haegerich et al. (2016), are also educational.

   These programmes promote active parenting through guidance and monitoring. When parents show a genuine interest in their children's activities and set boundaries, such as curfews, the risk of DUI incidents among youth decreases. Programmes like these are crucial for DUI prevention as they focus on educating youths and their families in structured forums.

3. **Regulatory Strategies** encompass broader, policy-driven initiatives to change the social context and regulatory environment to prevent DUI. Government-led policies, as examined by Callaghan et al. (2016) and Clapp et al. (2005), exemplify this category. These policies may include minimum drinking age laws and environmental prevention campaigns designed to restrict access to alcohol and foster safer community environments. Both corrective and regulatory methods aim to alter individual behaviours and shift societal norms regarding alcohol consumption and intoxicated driving.

   Legal restrictions on alcohol access for youth, coupled with awareness campaigns, lay the groundwork for discouraging reckless behaviours. Such interventions are most effective when stringent enforcement mechanisms ensure that laws and policies maintain their impact, even for long-term DUI prevention.

These interventions, ranging from individual to systemic approaches, highlight that DUI prevention among youth must be addressed from multiple angles. Generally, policy-driven interventions tend to be highly effective because of their broad scope and ability to influence societal beliefs. Conversely, individual interventions complement these efforts by impacting personal attitudes and behaviours. Together, they form a comprehensive strategy that tackles the risks of DUI among youths through education, legislation, and community involvement.

2.7 Sentiment Analysis and Topic Modelling

As detailed in the methods section (see Appendix 1), this study conducted two types of analyses: sentiment analysis and topic modelling. The first analysis focuses on Reddit data collected for selected countries in South America and Central America.

Sentiments in the data collected were classified to three classes:

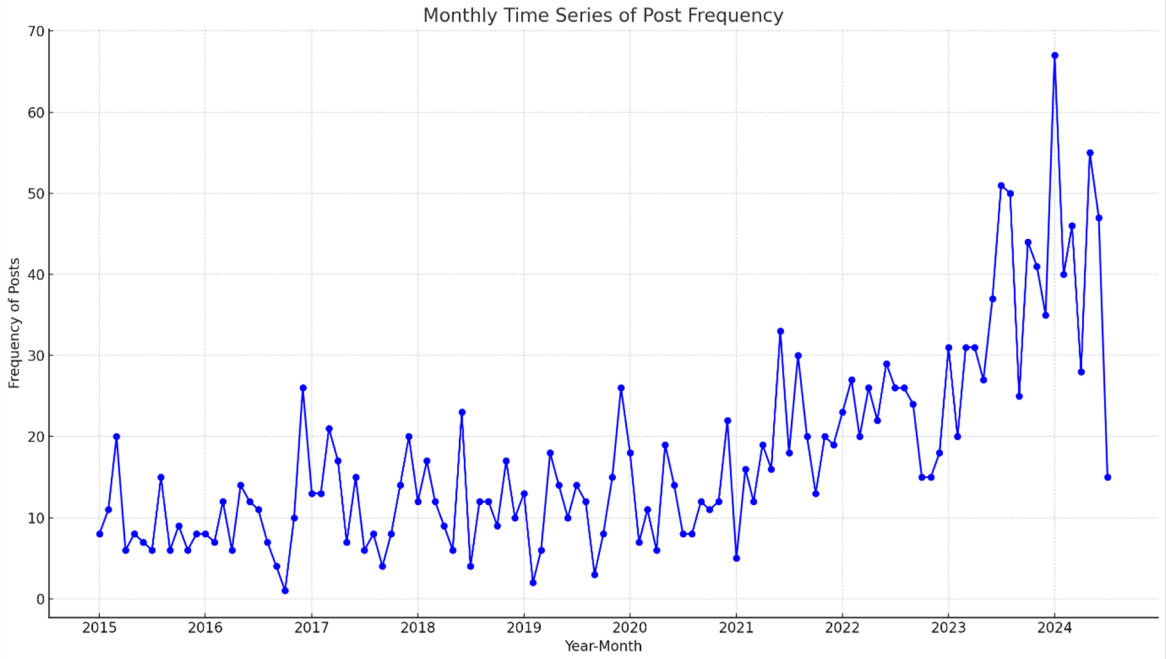
- Negative sentiments, meaning people are against drinking and driving.
- Neutral sentiments, meaning people have neutral views in drinking and driving.
- Positive sentiments, meaning people agree with drinking and driving behaviour.

The second analysis examines YouTube data from selected videos about drink-driving. This section of the paper presents the key findings from sentiment analysis and topic modelling.

2.7.1 Sentiment Analysis of Reddit Data

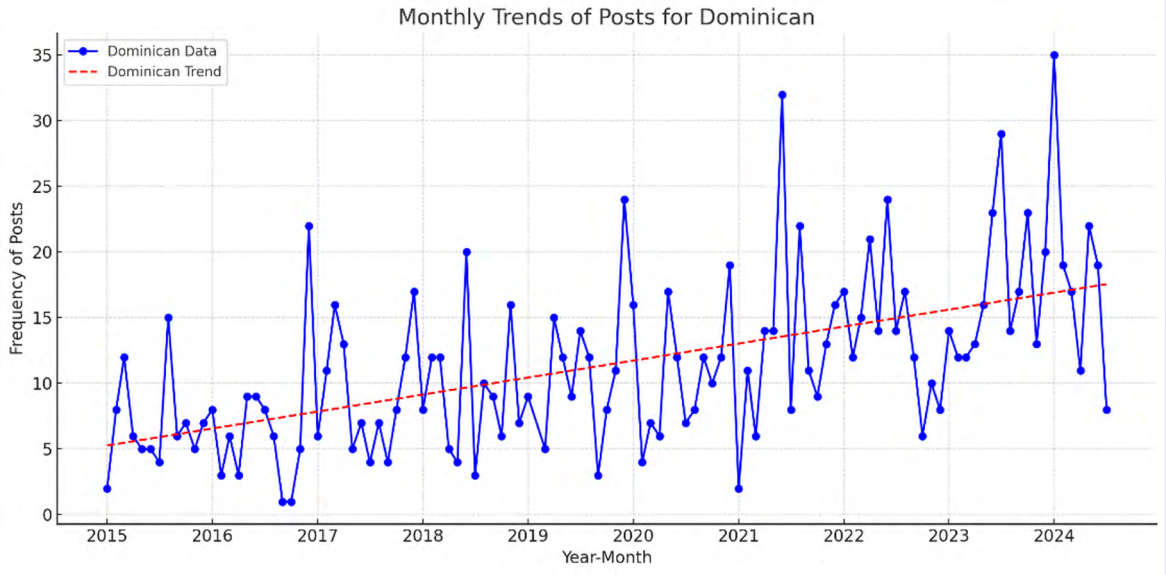
Our data collected from Reddit shows that the overall number of posts using the specified keywords has increased over time (Figure 2). This upward trend may be attributed to a growing number of people joining and actively using these social media platforms, leading to increased discussion engagement. The upward trend is very well observed in most countries, particularly in the Dominican Republic and Costa Rica (Figure 3). Conversely, Cuba and Panama have not followed this trend (Figure 4). The Mann-Kendall test supports the conclusion that the number of posts is not increasing in Cuba or Panama (see Table 26). Acknowledging the low number of posts, it may be inferred that drink-driving is more effectively managed and less of a concern in Cuba and Panama than in previous times.

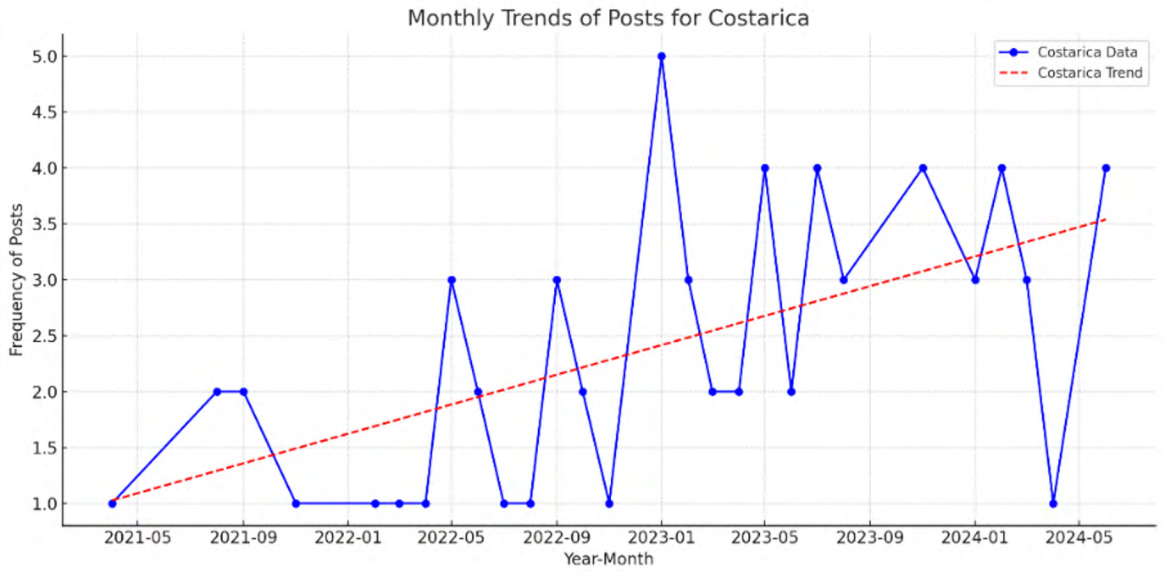
Figure 2. Frequency of Reddit posts over time



Frequency of Reddit posts over time in selected countries between 2015-2024

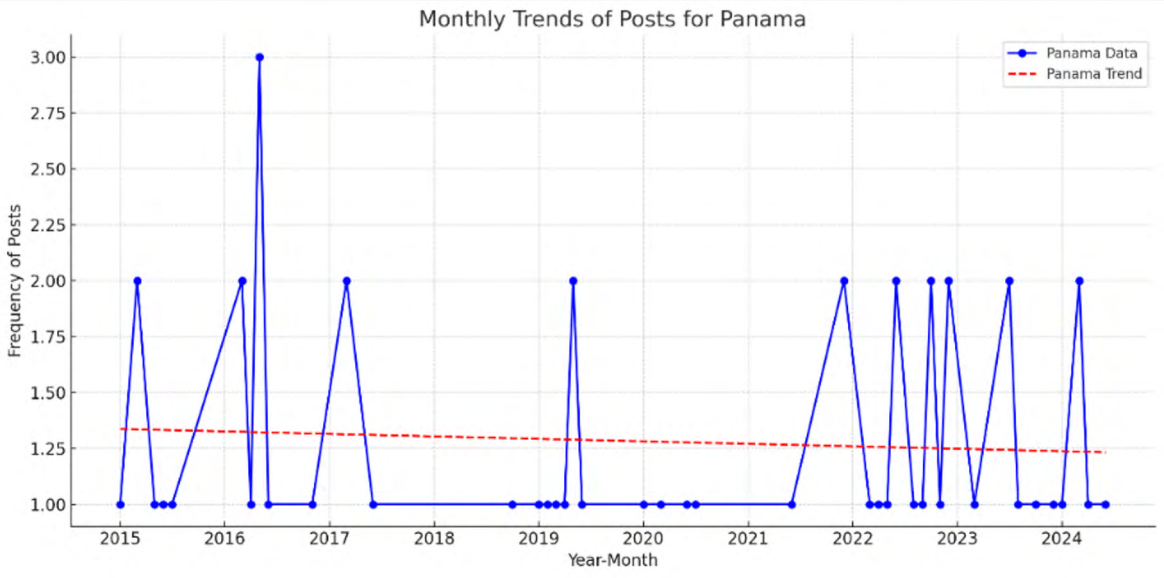
Figure 3. Frequency of Reddit posts over time (Dominican Republic & Costa Rica)

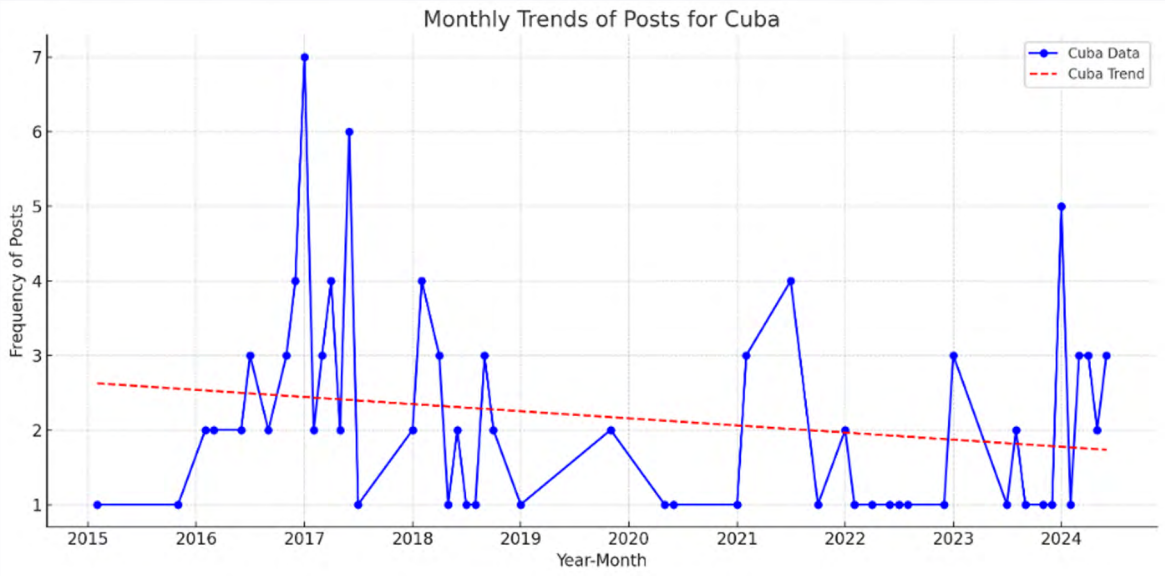




Frequency of Reddit posts over time for Dominican and Costa Rica

Figure 4. Frequency of Reddit Posts over time (Panama & Cuba)





Frequency of Reddit posts over time for Panama and Cuba

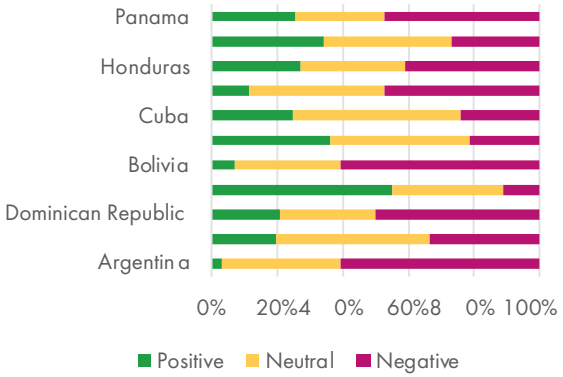
Sentiment analysis for posts in English and Spanish was initially conducted using the Pysentimiento[1] package [Perez et al., 2016]. As anticipated, negative sentiments comprised more than positive and neutral sentiments.

Specifically, 1,505 posts were classified as negative, 1,053 as neutral, and 499 as positive. Table 6 presents the number of posts in each sentiment category for each country. Figure 5 shows the percentage sentiment classes for each country.

Table 6. Number of posts of each country for each sentiment class using Pysentimiento

Country	Positive	Neutral	Negative
Argentina	34	373	631
Brazil	43	101	73
Dominican Republic	271	382	649
Belize	54	33	11
Bolivia	2	9	17
Costa Rica	24	28	14
Cuba	28	57	27
El Salvador	9	32	37
Honduras	6	7	9
Nicaragua	14	16	11
Panama	14	15	26
Total	499	1,053	1,505

Figure 5. Percentage of Sentiment classes by country using Pysentimiento



Percent of sentiment classes for each country based on the Pysentimiento package

To enhance the robustness of the results, we conducted sentiment analysis on English and Spanish posts using the SieBERT[2] and SaBERT[3] models. The analysis revealed 1,474 negative posts, 1,103 neutral posts, and 480 positive posts. Table 7 presents the distribution of posts across each sentiment category for each country using these models. Figure 6 shows the percentage sentiment classes for each country.

1. Pysentimiento: a python AI toolkit for Sentiment Analysis and Social NLP. A transformer-based library for social NLP tasks. Currently supports sentiment analysis and emotion analysis.

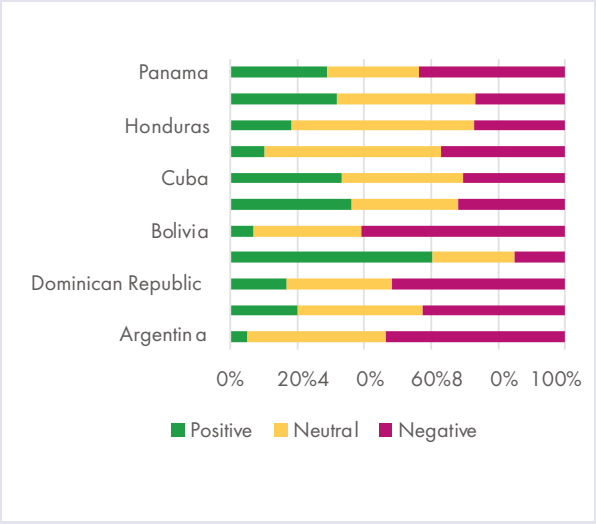
2. SieBERT: a pre-trained AI sentiment analysis model with open-source scripts based on a meta-analysis of 272 datasets and 12 million sentiment-labelled text documents.

3. SaBERT: a pre-trained AI sentiment analysis model designed to detect sentiment analysis in Spanish text. Trained on a dataset of 11,500 Spanish tweets with impressive accuracy rate of 86.47 per cent.

Table 7. Number of posts of each country for each sentiment class using SieBERT and SaBERT

Country	Positive	Neutral	Negative
Argentina	55	429	554
Brazil	44	81	92
Dominican Republic	221	407	674
Belize	59	24	15
Bolivia	2	9	17
Costa Rica	24	21	21
Cuba	34	37	31
El Salvador	8	41	29
Honduras	4	12	6
Nicaragua	13	17	11
Panama	16	15	24
Total	480	1,103	1,474

Figure 6. Percentage of sentiment classes by country using SieBERT and SaBERT



Percent of sentiment classes for each country based on SieBERT and SaBERT

Figure 7 shows the trends of sentiment classes over time. Positive sentiments show trends of decline and peaks, indicating periods of intensified criticisms or concerns.

Neutral sentiments show fluctuations, with some dips and gradual increases in recent years. Negative sentiments remained relatively stable but demonstrated slight increases and decreases, reflecting possible balanced or indifferent opinion shifts.

Figure 7. Trends of sentiment classes over time

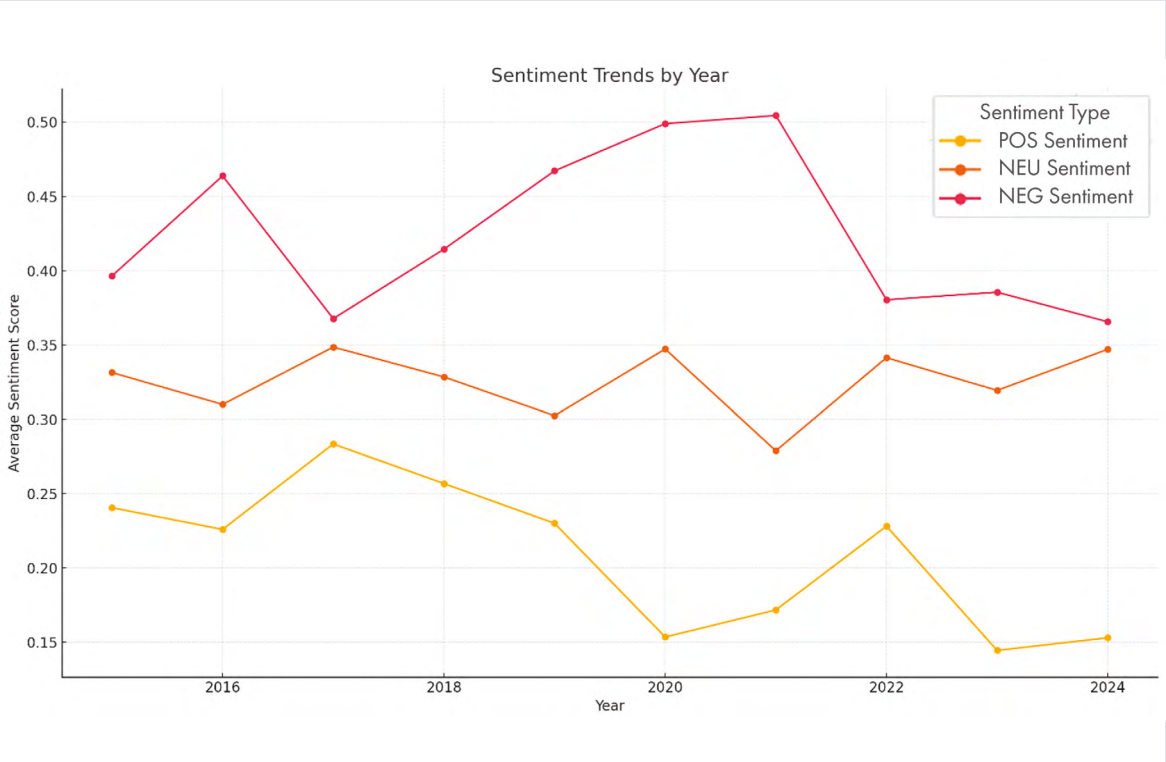
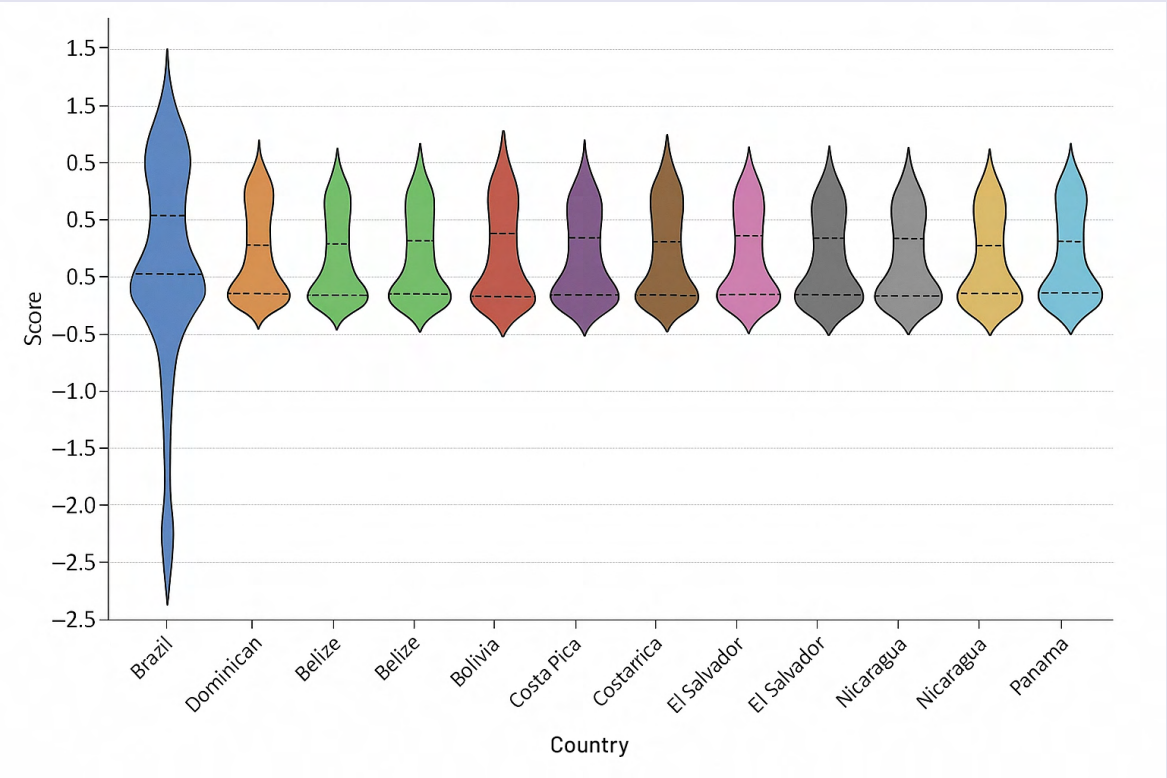


Figure 8 presents the violin plot[4] of sentiment scores for each country. The violin plot depicts the density and spread of sentiment scores. This plot indicates that Brazil exhibits a broader spread, reflecting a more diverse range of sentiment scores.

In contrast, the narrower violins illustrate less variability in sentiment scores. The narrow violin of Dominican Republic indicates a less diverse range of sentiment scores in the country. The dashed line within each violin represents the median sentiment score, while the quartiles are indicated inside the violin.

Figure 8. Violin Plot of sentiment scores by country



The Mann-Whitney U test[5] compared sentiment intensities across different sentiment classes and countries.

Figure 9 compares the sentiments classified by Pysentimiento across different countries, revealing that negative sentiment is significantly stronger than positive sentiment in Argentina, Bolivia, Brazil, the Dominican Republic, and El Salvador.

4. Violin plot: is a statistical graphic to visualise the distributions of numeric data for one or more groups.

5. The Mann-Whitney U test: is a non-parametric statistical test used to test whether there is a difference between two samples or groups.

Figure 9. Comparing the sentiments classified by Pysentimiento for each country

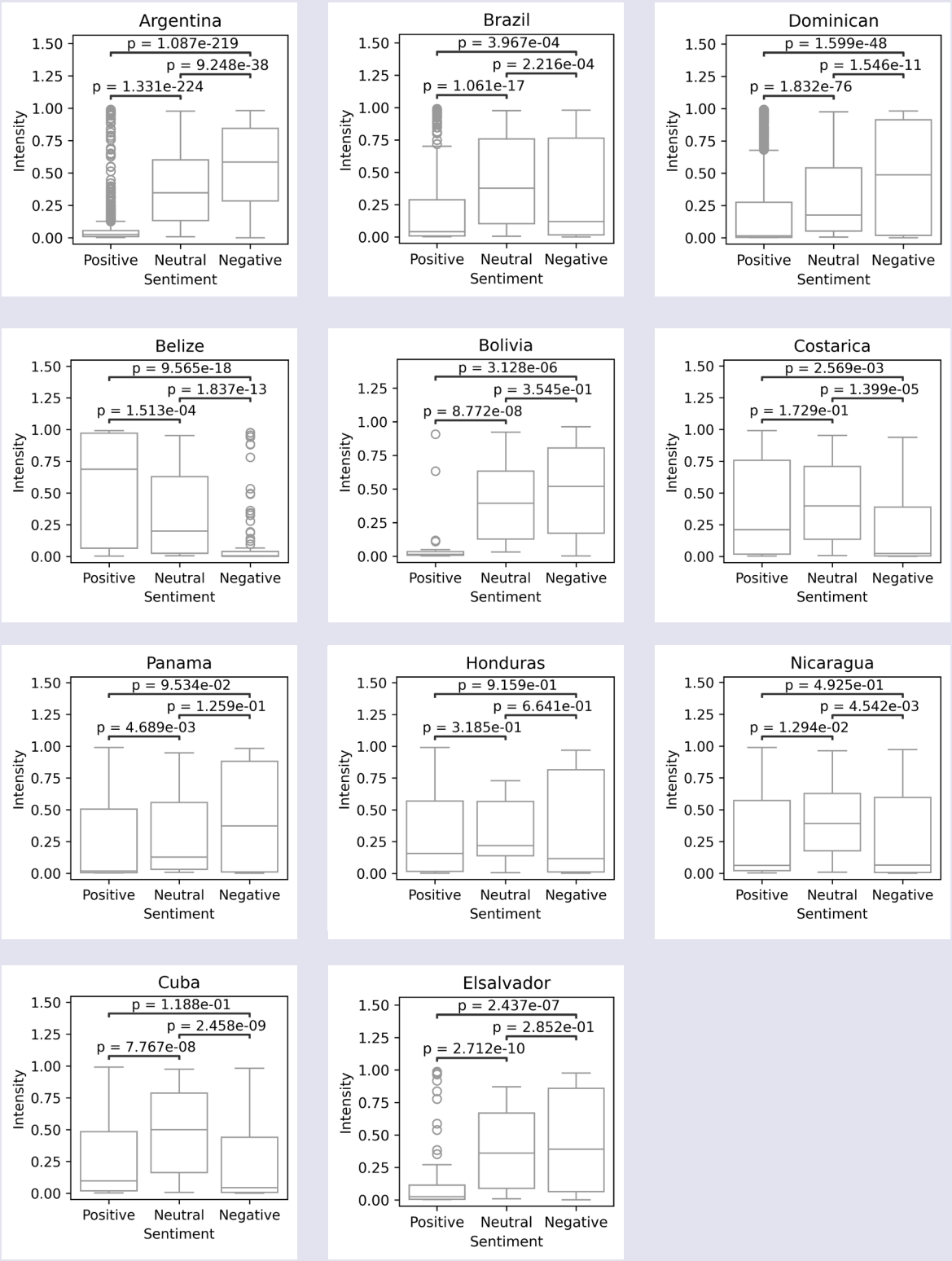


Figure 10 compares the sentiments classified by SaBERT and SieBERT for each country. The graphs show that negative sentiment is significantly more intense than positive sentiment in Argentina, Bolivia, Brazil, Cuba, Dominican Republic, El Salvador, and Panama.

Figure 10. Comparing the sentiments classified by SaBERT and SieBERT for each country

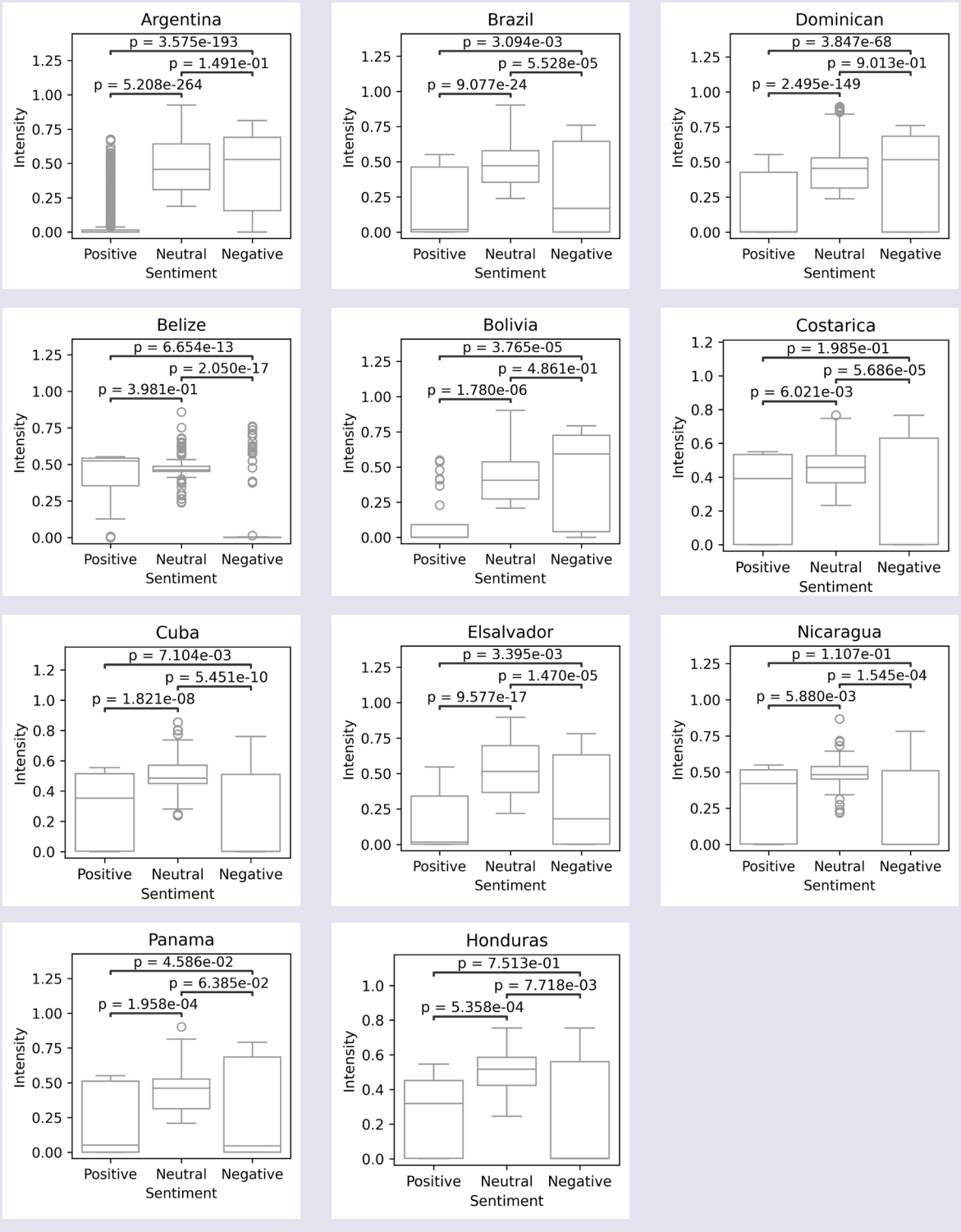
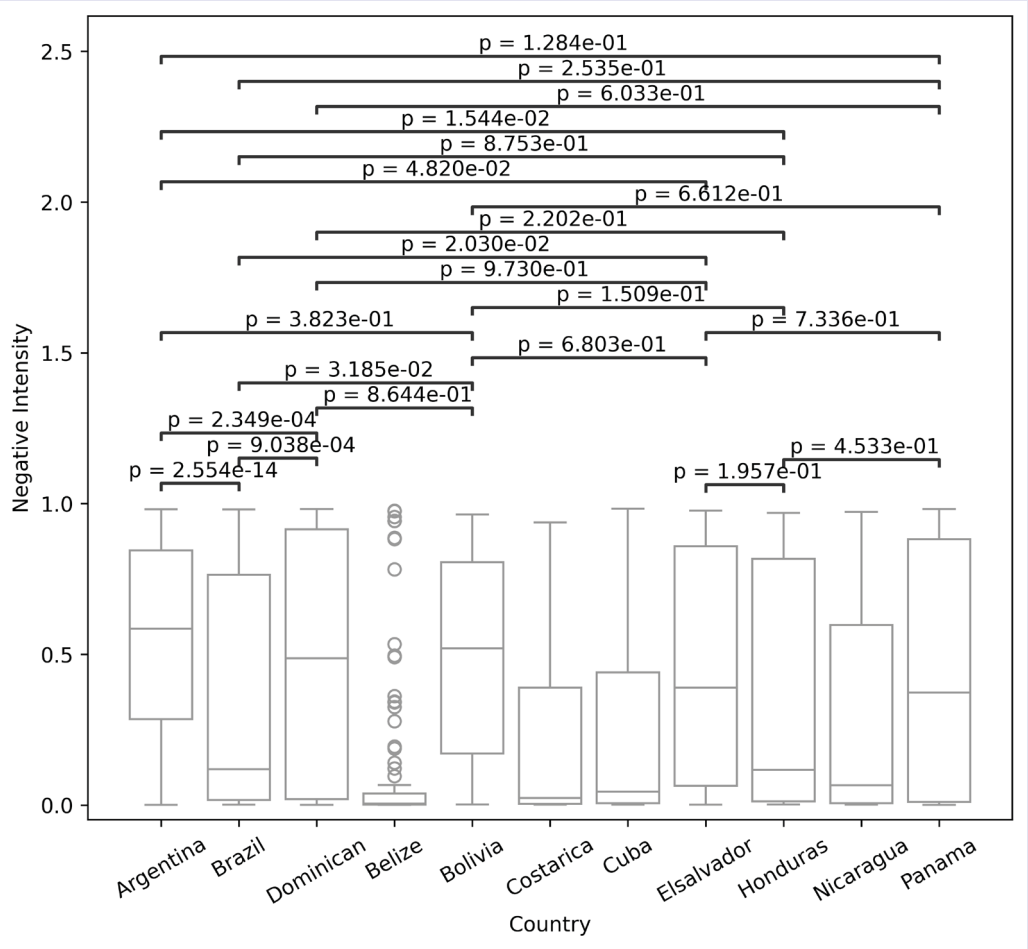
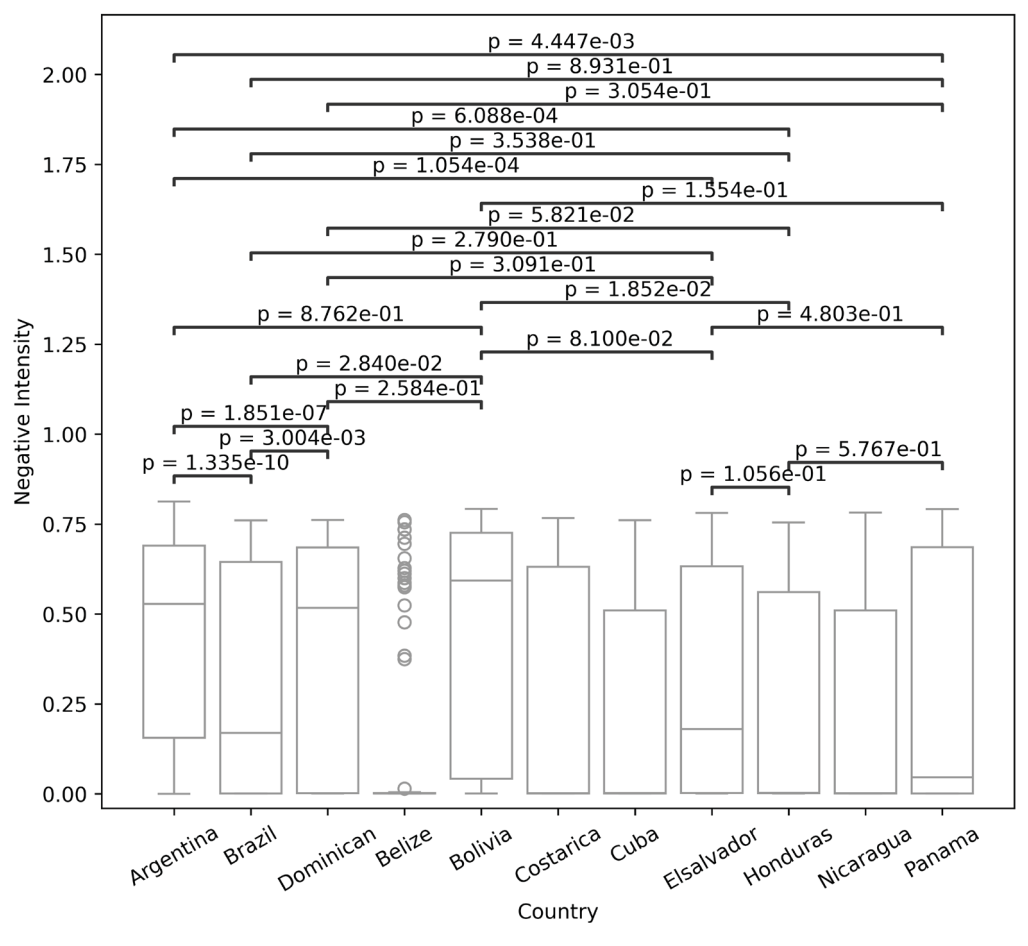


Figure 11 compares the negative sentiment of various countries as classified by Pysentimiento. It shows that Argentina has the highest negative intensity, followed closely by Brazil, which exhibits significantly higher negative sentiment than most other countries. Following these two, the Dominican Republic, Bolivia, El Salvador, Honduras, and Panama demonstrate similarly elevated negative sentiments compared to the remaining countries. Similar results are observed with the sentiment classification models SaBERT and SieBERT, as illustrated previously.

Figure 11. Sentiment intensities comparison by country





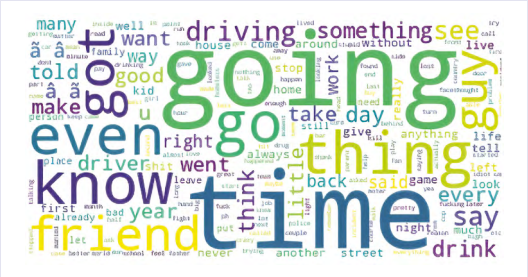
Comparing sentiment intensities of different countries classified by Pysentimiento (left) and SaBERT and SieBERT (right)

2.7.2 Topic Modelling of Reddit Data

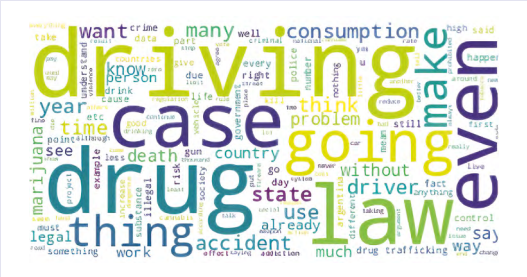
The methods section (see Appendix 1) noted that using the Term Frequency-Inverse Document Frequency (TF-IDF) revealed that five topics would yield maximum coherence. Consequently, the LDA model was employed to categorize the posts into these five topics. Figure 12 shows the word cloud for each topic.

Figure 12. The word clouds of the topics

Topic 1: Stories



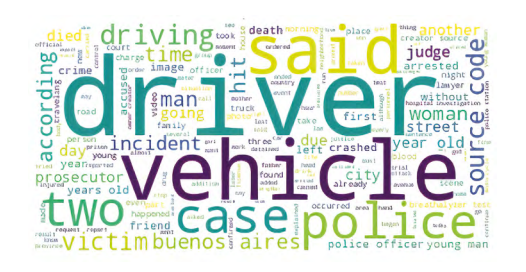
Topic 2: Law



Topic 3: Politics and Economy

Topic 4: Travel

Topic 5: News



We analysed the top 20 posts for each topic and categorized them into five main subjects: Stories, Law, Politics and Economy, Travel, and News. Specifically, discussions about DUI on Reddit can be classified into these five categories. Some posts share personal DUI stories, while others focus on DUI laws and regulations, travel-related issues, or news about DUIs. Table 8 presents the subjects, examples, and the number of posts for each category.

- **Topic 1 on Stories:** The posts under the first category narrate personal stories related to experiences with alcohol. For example, one user shared, "They

caught me in an alcohol test. If it reads 0.50, you receive a ticket. Mine was 0.40. Thank God! A friend criticised me for drinking too much and driving. Tomorrow, we'll see how this story continues."

Some posts, however, don't relate to drink-driving, like this one: "In a somewhat strange incident, I filled my keyboard with dulce de leche, and even after using two kilograms of alcohol gel, it is still sticky. The worst part is that it still works fine, so I can't ask for it to be changed."

- **Topic 2 on Law:** Posts on the second category discuss what should or should not be legal according to the law, particularly regarding drink-driving. For instance, one post states, "Alcohol causes more deaths and accidents than marijuana, yet the former is completely legal." Another suggests, "Raise the tax from 20%, with 19% dedicated to fighting domestic violence and car accidents caused by alcohol." There's also mention of regulatory changes: "If a retailer had a license that previously prohibited the sale of alcohol through a drive-through window, that prohibition is now lifted."

Table 8. Examples of engagements under each topic

No.	Subject	Example	Number of posts
1	Stories	"My second-grade teacher and her husband were killed on 17 by a drunk driver in the 70's."	667
2	Law	"Did you know that speeding laws do nothing to stop drunk drivers! It's like why even have a law if it's not going to stop criminals?!?"	528
3	Politics and Economy	"In a country where young people are increasingly drinking at a younger age, with accidents of traffic that it causes, I find it terrifying that there are programmes showing people drinking excessively."	195
4	Travel	"You could spend the night in Vallejo or Fairfield which isn't that great, but the rooms are much cheaper, but you then have a short drive into Napa Valley where you will spend all your time. The big decision is how to handle a car. In reality a lot of people don't get drunk while wine tasting. Or you can have a designated driver."	1212
5	News	"A drunk driver escaped from the Police and killed a young woman, from Junn, police sources reported."	423

- **Topic 3 on Politics and Economy:** This topic primarily covers politics and economic issues. An example includes, "Openly climate-sceptical, racist, sexist, homophobic behaviour, along with alcohol and drug trafficking, will not influence the upcoming elections in Brazil."

  Another post discusses traffic regulations: "A journalist who gained recognition on social media for her unique way of communicating about traffic warns that you are allowed to go out or return home, but you cannot drink alcohol if you plan to drive."

  However, some posts in this category do not relate to drink-driving. One example is about a cousin in the US who is a truck driver: "He drinks much coffee during work, suffers gastrointestinal issues, and goes to the doctor. They charged him $1,000 just for X-rays and said he needed more tests to diagnose the issue. Upon returning to Cuba, he consulted a doctor who suggested, 'Maybe you should drink less coffee, as this could be the cause of your issues.' The lack of health-care for minimum wage workers is a significant concern, and the health-care system in Cuba could benefit those who are working poor in the US."
- **Topic 4 on Travel:** The posts under this topic primarily discuss activities that people can enjoy while visiting a city or country. For example, one person remarked, "Yes, to both. The community out there is quite hostile. There are a lot of older Mexican and Asian families living in the area. I would say the east side hasn't progressed like the rest of San Jose. King and Story are usually just loud. There are many sideshows and poor driving conditions, plus plenty of drunk drivers at night from those authentic restaurants! If you can, make a trip out here and experience it for yourself. Personally, the area feels too congested for me."

  Another user asked, "From the cities you've visited and the miles you've logged, do you listen to podcasts to keep boredom at bay? What energy drinks or coffee do you consume to stay awake while driving? Lastly, is there a certain number of hours you try to limit your driving to, so you don't start to feel road rage?"

  The sentiments expressed on this topic are overwhelmingly positive and primarily unrelated to drink-driving. For instance, one person suggested, "Most good vineyards are in Maip or Luján de Cuyo, about a 30-minute drive from the city

centre. Check the vineyard websites for reservations. You may also want to have lunch at those places; the food is tasty, and you can sample different wines along the way."

Another commented, "That area is really nice. Most people are friendly. I'm not too keen on the bar scene since I don't drink, but the recovery community is strong! Plus, the nearby beaches like Redondo and Hermosa make for a lovely scenic drive down PV." Lastly, someone recommended, "I would say Santana Row is a safe choice for drinks or coffee. For higher-quality coffee, I recommend Voyager in San Pedro Market or Chromatic Coffee. For nature, grab food at Falafel Drive-In and head to the Rose Garden."

- **Topic 5 on News:** In contrast, the posts under the fifth topic mostly share news events. For example, "Argentina is known for many things, from tango to its passion for football, but you might not know that it also has the world's drunkest drivers. Back in March, Argentinian media reported that a young man in the town of Plottier, Neuquén province, set the world breathalyser record with an astonishing 5.79 grams of alcohol per litre of breath after crashing his car into a ditch. He sustained minor injuries to his face and arms but refused medical assistance and did not cooperate with the police. However, he wouldn't get to brag about his unusual record for long, as a fellow Argentinian broke it just last week."

  This topic is heavily related to incidents of drink-driving, with examples like, "A judicial employee drove drunk, insulted the police, and threatened to relieve herself on public roads," and "A new video complicates the case of the drunk driver who hit a cyclist and crashed into another car." There are also reports such as, "A drunken motorist caused a fatal crash, resulting in two deaths."

Table 9 and Figure 13 present the number and percentage of posts in different countries on different topics, respectively. Except for Argentina, travel-related DUI posts seem to dominate the number of posts in all the countries under study. In Argentina, topic five on news dominated the number of posts followed by topic two on law. While in Brazil and the Dominican Republic, topic four on travel dominated the number of posts followed by topic one on stories.

Table 9. Number of posts for each topic for each country

Country	Topic 1 Stories	Topic 2 Law	Topic 3 Politics Economy	Topic 4 Travel	Topic 5 News	Total
Argentina	172	320	126	95	325	1,038
Brazil	28	13	10	159	7	217
Dominican Republic	407	168	35	600	92	1,519
Belize	3	1	0	92	2	98
Bolivia	5	7	2	12	2	28
Costa Rica	5	4	2	55	0	66
Cuba	12	3	10	86	1	112
El Salvador	10	15	5	41	7	78
Honduras	7	0	2	13	0	22
Nicaragua	4	0	4	33	0	63
Panama	14	7	0	32	2	55
Total	667	538	196	1,218	438	3,057

Figure 13. Percentage of topics by country

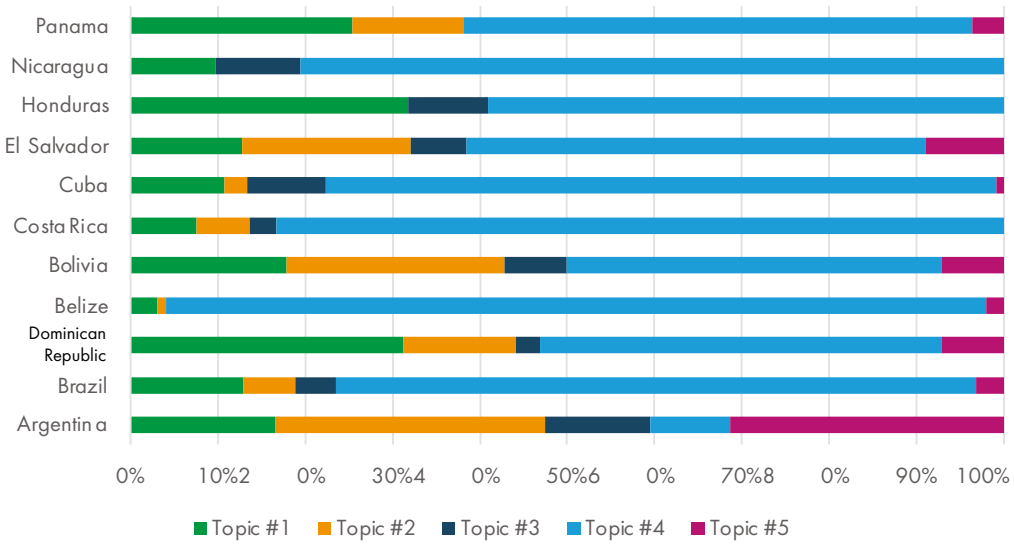


Table 10 presents the count of posts in each sentiment class for every topic. According to Pysentimiento, negative sentiment dominated all the topics except topic three on politics and economy and topic four on travel where neutral sentiment came first. According to SaBERT and SieBERT models, negative sentiment dominated all the topics except topic three on politics and economy where neutral and negative sentiments were equal and topic four on travel where neutral sentiment came first.

Table 10. Number of posts in each sentiment class of each topic

	Pysentimiento			SaBERT and SieBERT		
	Positive	Neutral	Negative	Positive	Neutral	Negative
Topic 1 Stories	57	181	429	41	205	421
Topic 2 Law	4	124	410	6	174	358
Topic 3 Politics & Economy	17	93	86	18	89	89
Topic 4 Travel	419	487	312	408	440	370
Topic 5 News	2	168	268	7	195	236
Total	499	1,053	1,505	480	1,103	1,474

Figures 14 and 15 present a visualisation of the number of posts in each sentiment class for each topic based on Pysentimiento, SaBERT, and SieBERT, respectively.

Figure 14. Number of posts in each sentiment class for each topic based on Pysentimiento

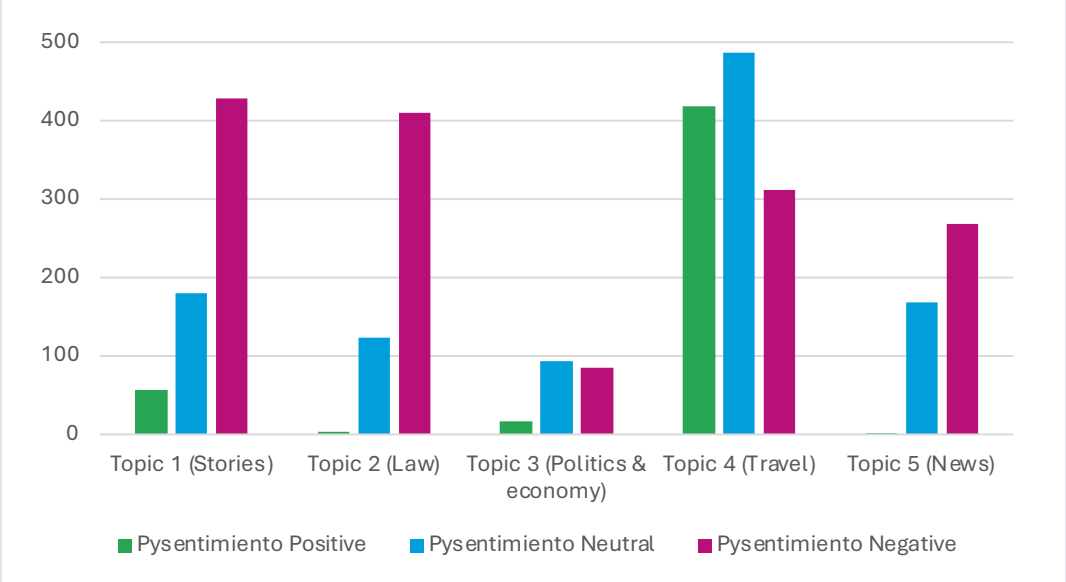


Figure 15. Number of posts in each sentiment class for each topic based on SaBERT and SieBERT

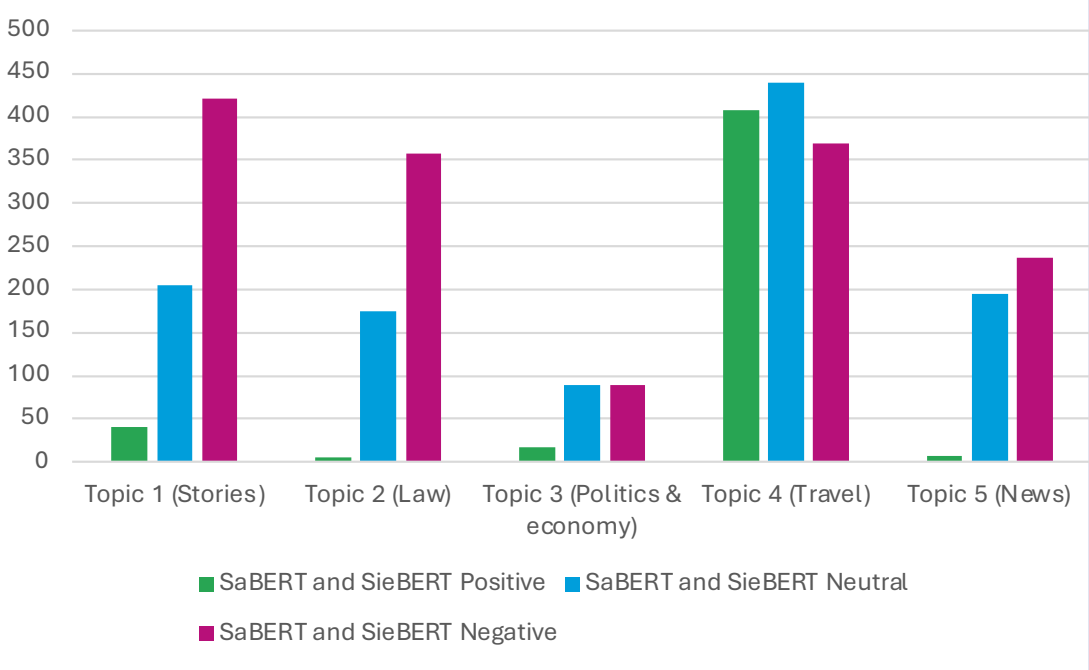
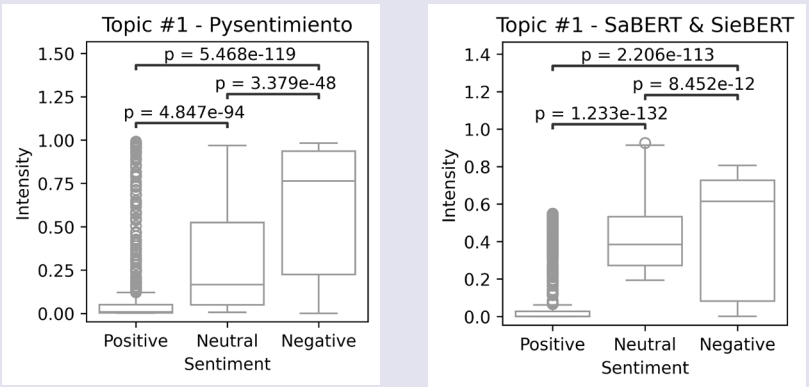
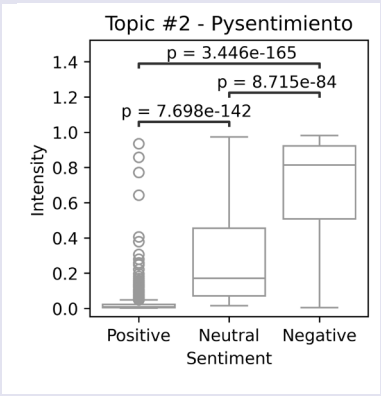
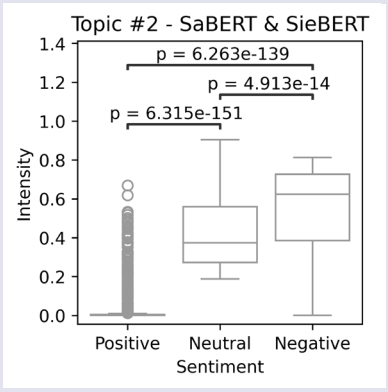


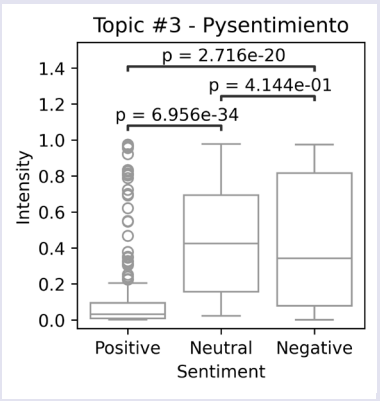
Figure 16 shows that, except for the fourth topic on travel, the negative intensity is significantly higher than the positive and neutral intensities in all other topics.

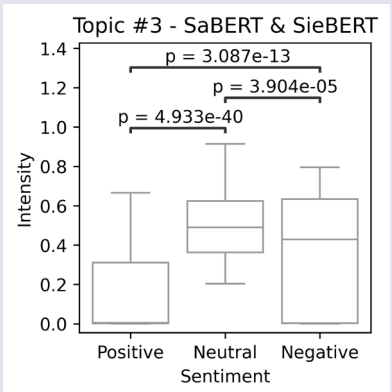
Figure 16. Sentiment scores in each topic

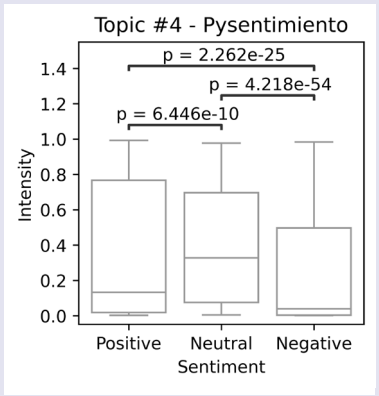


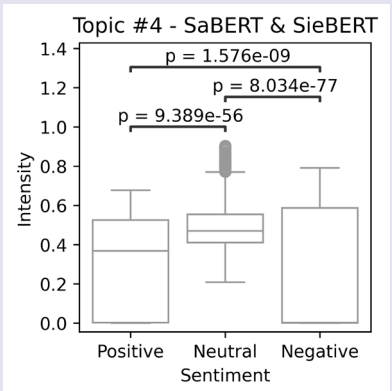

Topic #2 - Pysentimiento
p = 3.446e-165
p = 8.715e-84
p = 7.698e-142
Intensity
Positive
Neutral
Negative
Sentiment

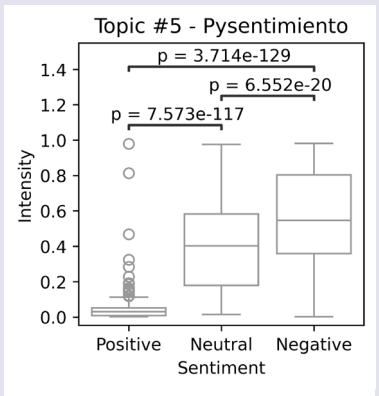

Topic #2 - SaBERT & SieBERT
p = 6.263e-139
p = 4.913e-14
p = 6.315e-151
Intensity
Positive
Neutral
Negative
Sentiment


Topic #3 - Pysentimiento
p = 2.716e-20
p = 4.144e-01
p = 6.956e-34
Intensity
Positive
Neutral
Negative
Sentiment


Topic #3 - SaBERT & SieBERT
p = 3.087e-13
p = 3.904e-05
p = 4.933e-40
Intensity
Positive
Neutral
Negative
Sentiment


Topic #4 - Pysentimiento
p = 2.262e-25
p = 4.218e-54
p = 6.446e-10
Intensity
Positive
Neutral
Negative
Sentiment


Topic #4 - SaBERT & SieBERT
p = 1.576e-09
p = 8.034e-77
p = 9.389e-56
Intensity
Positive
Neutral
Negative
Sentiment


Topic #5 - Pysentimiento
p = 3.714e-129
p = 6.552e-20
p = 7.573e-117
Intensity
Positive
Neutral
Negative
Sentiment

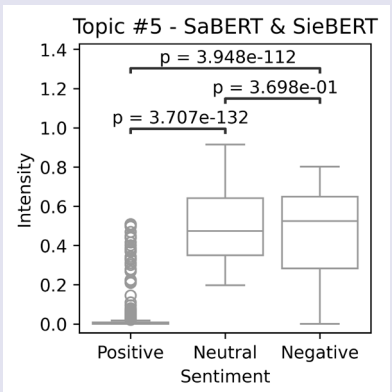
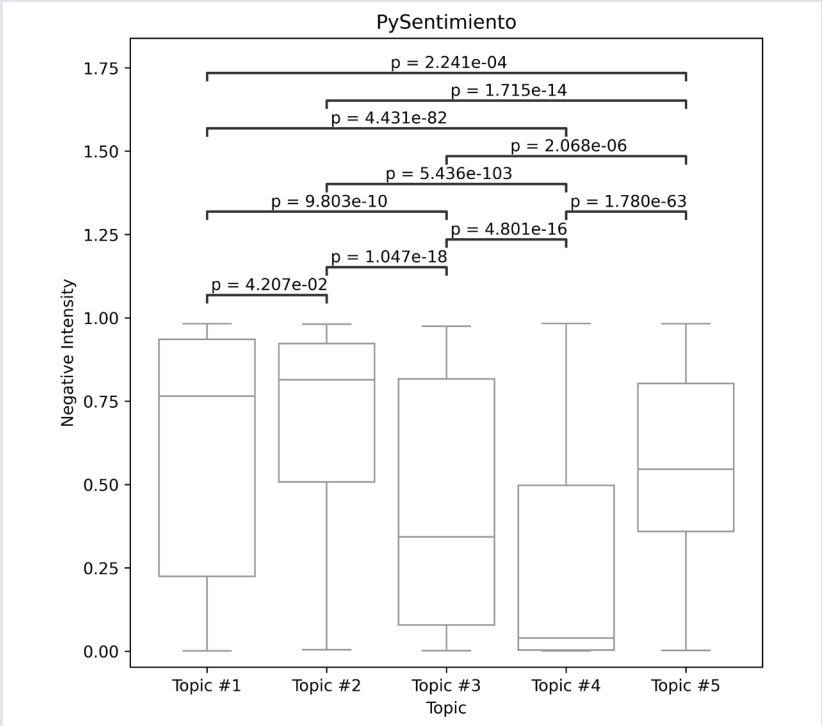
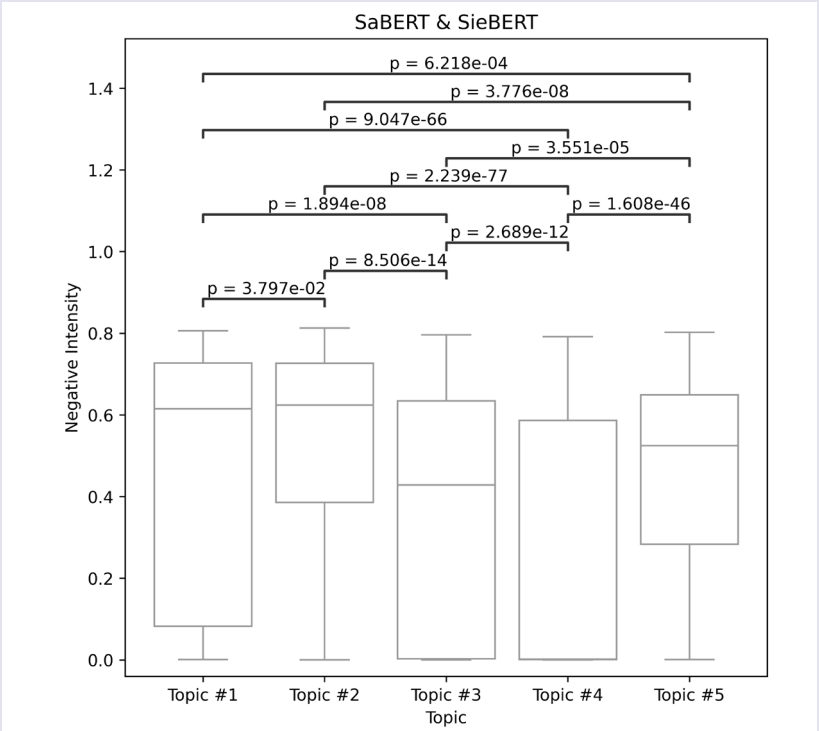

Topic #5 - SaBERT & SieBERT
p = 3.948e-112
p = 3.698e-01
p = 3.707e-132
Intensity
Positive
Neutral
Negative
Sentiment

Figure 17 shows that the topic two on law has a significantly higher negative intensity, while topic four on travel has a significantly lower negative intensity than all the other topics.

Figure 17. Negative intensity of different topics

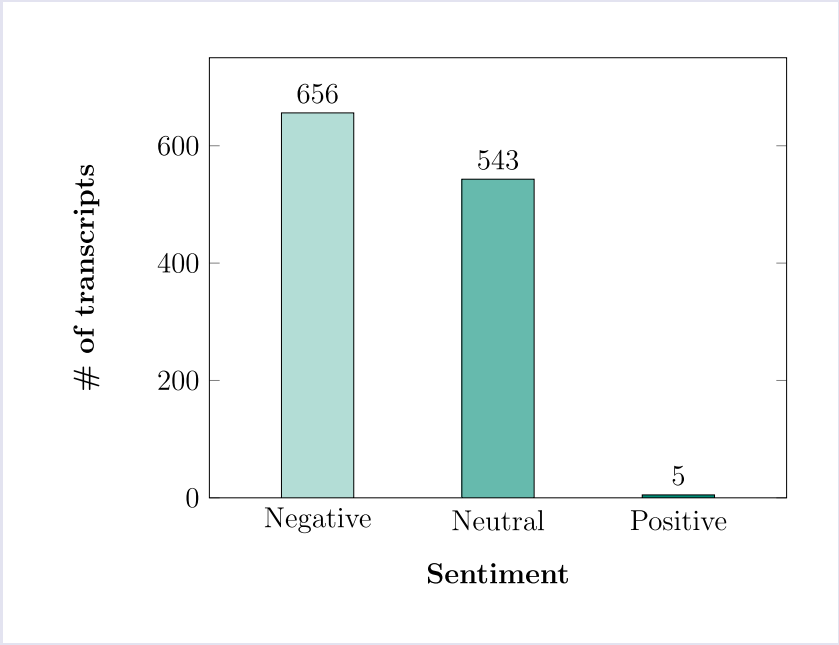




2.7.3 Sentiment Analysis of YouTube Data

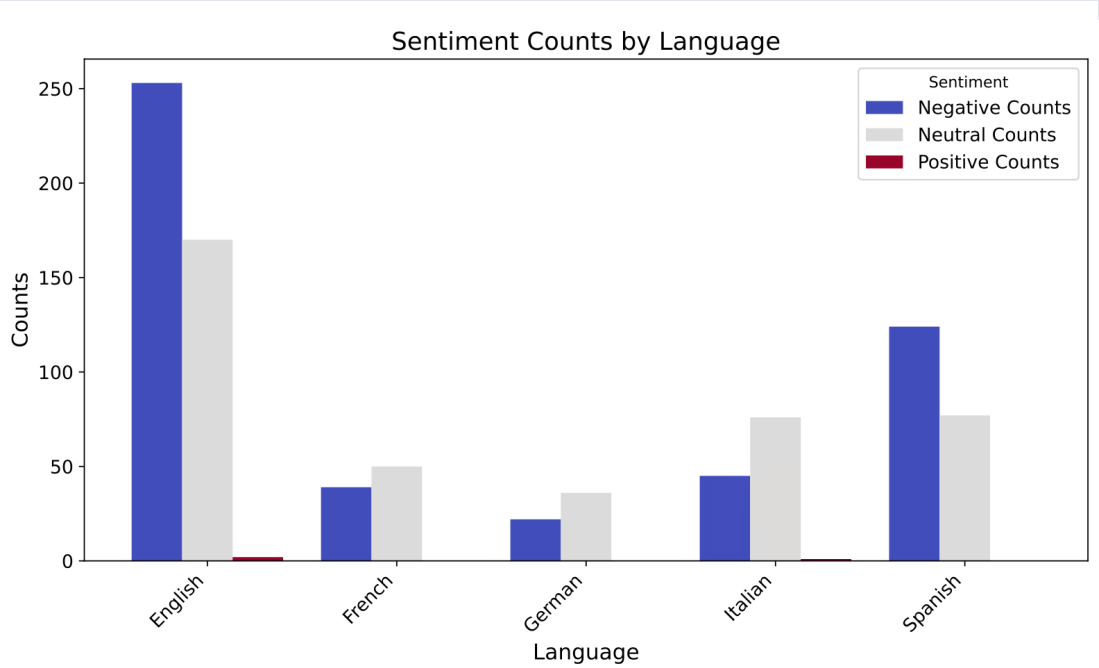
The open-source multilingual Large Language Model (LLM) analysed the transcripts of YouTube videos and assessed the sentiment of each with an average confidence level of 90.1 per cent. The analysis found that most transcripts (54.4%) expressed negative sentiments. Figure 18 presents a bar chart that illustrates the distribution among positive, negative, and neutral sentiments, offering a clear visual representation of the sentiment trends within the dataset.

Figure 18. Sentiment analysis results



Additionally, the grouped bar plot presented in Figure 19 displays the sentiment counts organized by language. It shows that negative sentiment dominates in English and Spanish languages while neutral sentiment dominates in French, German and Italian languages.

Figure 19. Sentiment count by language



To gain additional insights, a contingency table was created to evaluate the relationship between categorical variables as shown in Table 11.

In Canadian English (CA), British English (GB), and the Unites States of America English (US) between 59.32 per cent and 68.42 per cent of sentiments were negative.

While in French (FR) and Italian (IT), 50.77 per cent and 61.74 per cent of sentiments were neutral, respectively.

Negative sentiment dominated Spanish speaking countries where it represented between 54.55 per cent to 68.75 per cent of sentiments.

Table 11. Contingency table

Language	Region	Count			Percentage		
		Positive	Neutral	Negative	Positive	Neutral	Negative
English	CA	13	5	1	68.42	26.32	5.26
	GB	16	8	0	66.67	33.33	0
	Other	14	14	0	50	50	0
	US	210	143	1	59.32	40.4	0.28
	CA	0	11	0	0	100	0
French	FR	32	33	0	49.23	50.77	0
	Other	7	6	0	53.85	46.15	0
German	DE	19	35	0	35.19	64.81	0
	Other	3	1	0	75	25	0
Italian	IT	43	71	1	37.39	61.74	0.87
	Other	2	5	0	28.57	71.43	0
Spanish	AR	7	5	0	58.33	41.67	0
	CL	11	5	0	68.75	31.25	0
	CO	10	7	0	58.82	41.18	0
	ES	14	7	0	66.67	33.33	0
	MX	18	15	0	54.55	45.45	0
	Other	15	11	0	57.69	42.31	0
	PE	12	6	0	66.67	33.33	0
	US	37	21	0	63.79	36.21	0

Figure 20 illustrates the distribution of sentiment percentages by language across various regions. The data shows that the majority of sentiments are negative for English, German, and Spanish, as indicated by higher medians and narrower interquartile ranges (IQR), suggesting consistency in these sentiments. In contrast, the sentiment for French and Italian is predominantly neutral. Additionally, the percentages of positive sentiment for all languages across regions are nearly zero. Notably, French demonstrates a broader range of sentiment percentages across regions, with half of the negative sentiment percentages falling between zero to 50 per cent.

Figure 20. Sentiments percentage by language across regions

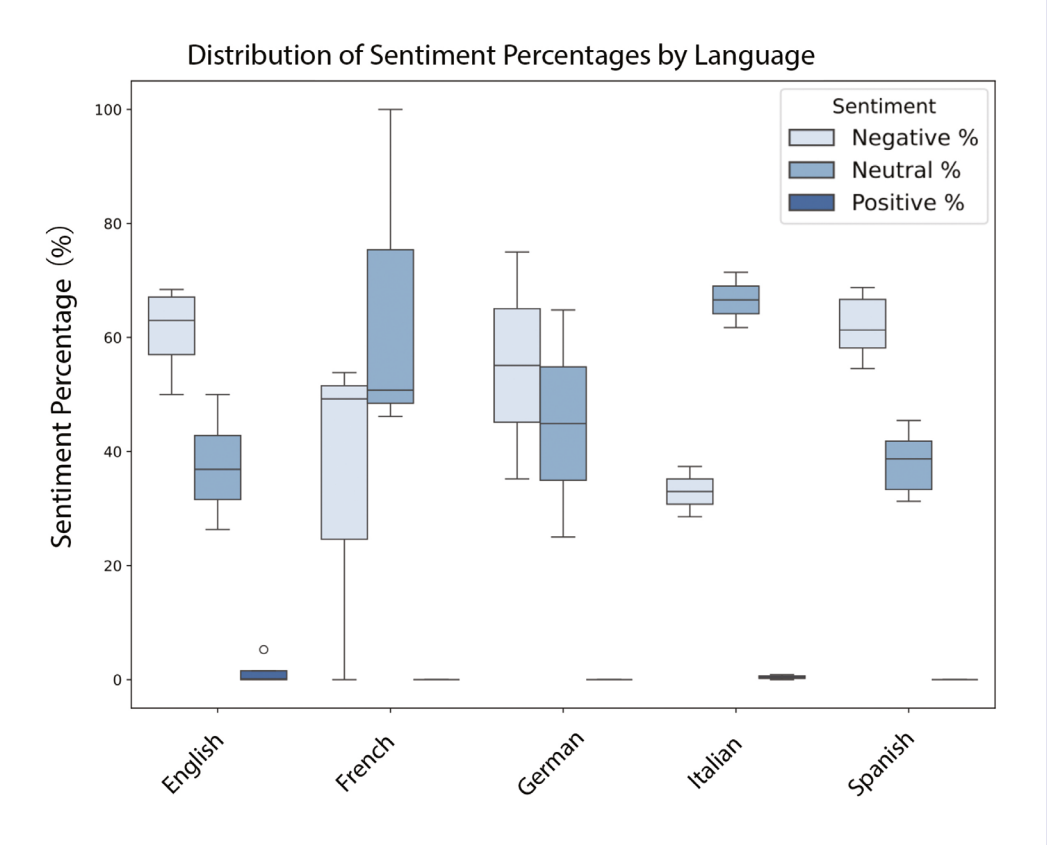


Figure 21 displays the sentiments found in YouTube video transcripts categorized by region. The heatmap demonstrates that most transcripts exhibit either negative or neutral sentiments across these regions.

To investigate this further, a Mann-Whitney U test was conducted to determine if there is a statistically significant difference between negative and neutral sentiments across regions. The test results yielded a p-value of 0.042, which is below the threshold of 0.05. Consequently, we reject the null hypothesis and conclude that there is a statistically significant difference in the percentages of negative and neutral sentiments across regions.

Figure 21. Sentiments percentage across regions

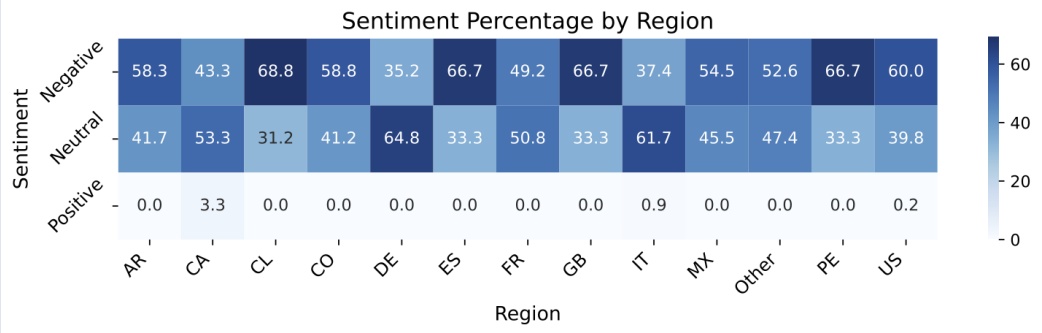


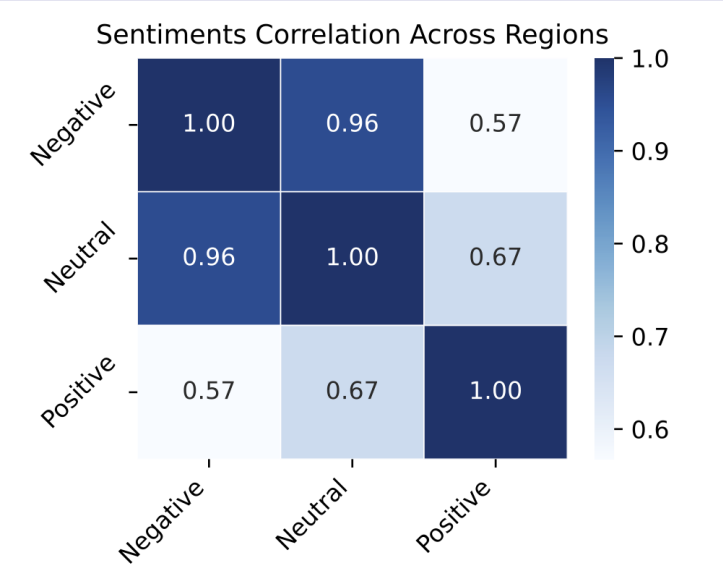
Figure 22 (a) showcases the correlation matrix of sentiments across regions. Remarkably, it reveals a striking correlation of 0.96 between negative and neutral sentiments across these regions. Conversely, the correlations between positive and negative sentiments and those between positive and neutral sentiments are moderate.

Furthermore, Figure 22-(b) illustrates the correlation matrix of sentiments across languages. Notably, this figure uncovers a robust correlation of 0.96 between negative and neutral sentiments and a substantial correlation of 0.91 between neutral and positive sentiments across various languages.

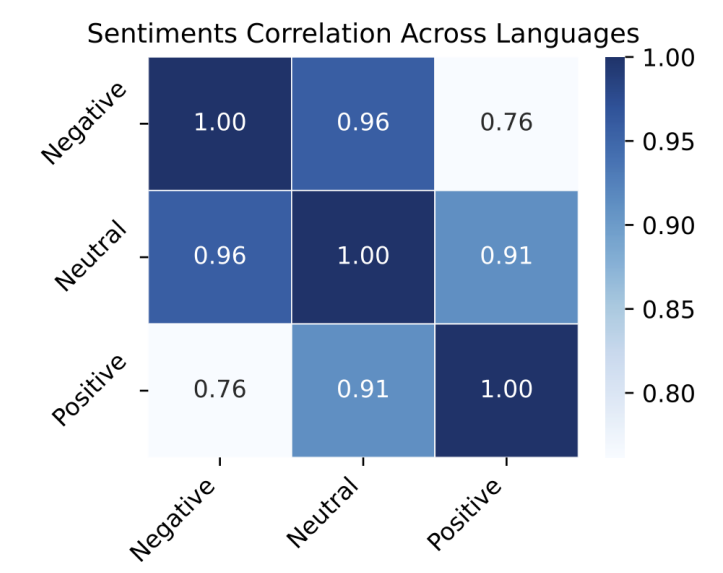
In summary, sentiments exhibit a stronger correlation across languages than regions, highlighting the intricate connections inherent in our analysis.

Figure 22. Sentiments correlations across regions and languages

(a) Sentiment correlations (regions)



(b) Sentiment correlation (languages)



Cramer's V test[6] was conducted to assess the strength of the association between two categorical variables. The degrees of freedom, calculated from the dataset, were determined to be 2. Cramer's V test showed that the association between sentiments and regional attributes had a score of 0.21, indicating a medium association level between sentiments and regions. In contrast, the test examining the relationship between sentiments and language yielded a score of 0.15, which signifies a weak association between sentiment and language.

2.7.4 Topic Modelling of YouTube Data

Zero-shot BERTopic modelling[7], integrating dimensionality reduction using Uniform Manifold Approximation and Projection (UMAP)[8], clustering using Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN)[9], and Class-based TF-IDF[10] were utilized for topic modelling of YouTube data. KeyBERT[10] and LLM representation models were used. English transcript chunks related to drink-driving were used in this topic modelling.

This methodology enables the use of a predefined set of topics. The topic labels were initially created and embedded using the bge-large-en-v1.5 embedding model. The embeddings of the YouTube transcript chunks were then compared to these predefined labels through cosine similarity. If the similarity score exceeded the 0.9 threshold, the corresponding zero-shot topic was assigned to that chunk. The predefined topics (Driving Under the Influence DUI, drink-driving consequences, drink-driving impact on youth, drink-driving consequences on young adults, and drink and drive accidents) were incorporated for zero-shot topic modelling.

Using this approach, we identified 51 topics. Table 12 presents the keywords extracted by the KeyBERT transformer model alongside the topics generated by the LLM based on these keywords.

6. Cramer's V test: is an effect size measurement for the chi-square test of independence. It measures how strongly two categorical fields are associated.
7. Zero-shot BERTopic modelling: is a technique that allows you to find topics in large amounts of documents that were predefined.
8. Uniform Manifold Approximation and Projection (UMAP): is a dimensionality reduction technique that constructs a high dimensional graph representation of the data then creates a low-dimensional graph.
9. Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN): is a clustering algorithm used in unsupervised learning to identify groups of similar data points, also known as clusters, within a dataset.
10. KeyBERT: is a minimal and easy-to-use keyword extraction technique that leverages BERT embeddings to create keywords and key phrases that are most similar to a document.

Table 12. Zero-shot BERTopic topic modelling results

1	['dui', 'sober', 'driving', 'accident', 'impaired', 'happened', 'drive', 'arrested', 'drunk', 'drinking']	Consequences of drunk driving
2	['dui', crime', 'Killing, 'murder, 'drunk, 'driving', 'comment', 'justice', 'guilty', 'killed']	Harsh penalties for drunk driving offenses
3	['dui', 'dwi', 'breathalyzer', 'driving', 'drive', "fines', 'comment', 'plead', 'alcohol', 'jail']	Driving Under the Influence (DUI)
4	['sentenced', 'victim', 'comment', 'justice, 'drunk', 'victims','killing', 'arrest', 'killed', 'jail']	Drunk Driving Sentencing Controversies
5	['comment', 'driving', 'dui', 'drive', 'drunk', 'drink', 'fail', 'sober', 'drivers', 'drinking']	Dangers of drunk driving
6	['cops', 'dui', 'police', 'arrest', 'officer', 'arrested', 'drunk', 'cop', "comment', 'drinking']	Public reaction to a woman being arrested for DUI after blowing a 0.06 BAC
7	['drunk' 'funny', 'riving', 'sober', 'drive, drinking', 'fluffy', 'comment', 'drink', 'lol']	Drunk driving and related incidents
8	['breathalyzers', 'dui', 'police', 'check', 'intoxicated','breathalizers', 'breath', 'sample', 'use', 'ask']	Breathalyzer use and DUI testing procedures
9	['driving', 'drunk', 'drinking', 'alcohol', 'drive', 'comment', 'drink', 'drove', 'banned', 'dangerous']	Drink Driving Laws and Penalties in the UK
10	['cops', 'police', 'officer', 'dwi', 'arrested', 'cop', 'asked', 'trooper', 'drunk', 'comment']	Corruption and misconduct by law enforcement officers
11	['talk', 'resisting', 'warrant', 'arrest', 'officer', 'handcuff' 'police','ask', 'hear', 'listen']	Arrest and Police Interaction
12	['accident', 'crash', 'drunk', 'happened', 'driving', 'trauma', 'drive', 'drinking', 'woke', 'affected']	Consequences of drunk driving accidents
13	['walk', 'steps', 'instructions', 'ask', 'instructions', 'ask', 'test', 'demonstrate', 'tests', 'tip', 'counting', 'touch']	Field sobriety tests
14	['died', 'oprah', 'tragi", comment, 'death, 'victims', suffering,'accident', 'sad', 'lady']	Life and Death of Jacqui Saburido
15	['driving', 'vehicle', 'car', 'hey', 'talk', 'intoxicated', 'ask', 'wait', 'stop', 'hello']	Traffic Stop Incident

15	[‘driving’, vehicle, ‘car’, ‘hey’, ‘talk’, ‘intoxicated’, ‘ask, ‘wait’, ‘stop’, ‘hello’]	Traffic Stop Incident
16	[‘duis’, ‘dui’, ‘damages’, ‘plaintiff’, ‘punitive’, ‘accident’, ‘accidents’, ‘defendant’, ‘claims’, ‘intoxicated’]	Drunk Driving Lawsuits and Civil Cases
17	[‘bartender’, ‘intoxicated’, ‘bartenders’, ‘drunk’, ‘bar’, ‘hooters’, ‘alcohol’, ‘shots’, ‘comment’, ‘suspect’]	Drunk Driving Lawsuit and Accountability
18	'accident', 'driving', 'murderer', 'happened', 'drinking', 'drive', 'killed', 'parents', 'died', 'memories'	Consequences of drunk driving accidents on families and individuals
19	['manslaughter', 'dui', 'accident', 'driving', 'victim', 'killed', 'intoxication', 'drunk', 'crash', 'happened']	Drunk driving accidents and fatalities
20	['advert', 'driving', 'adverts', 'drive', 'crash', 'message', 'traffic', 'funny', 'drunk', 'comment']	Public Service Announcements (PSAs) for Drink Driving Prevention
21	['dui', 'drunk', 'accident', 'driving', 'seatbelts', 'comment', 'drinking', 'alcohol', 'happened', 'drink']	Consequences of drunk driving accidents
22	['breathalyzers', 'breathalyzer', 'cops', 'dui', 'police', 'arrest', 'arrested', 'arrests', 'crime', 'officers']	False DUI Arrests in Tennessee
23	['accident', 'grief', 'crying', 'comment', 'tears', 'prayers', 'praying', 'tragedy', 'emotionally', 'loss']	Grief and Loss Support
24	['condolences', 'prayers', 'praying', 'comment', 'pray', 'driving', 'hugs', 'grief', 'crying', 'heartbreaking']	Loss and Grief Following a Tragic Event
25	['driving', 'weekend', 'celebrating', 'saturday', 'drive', 'drinking', 'holiday', 'monday', 'rideshare', 'friday']	Holiday season and drunk driving prevention
26	['finalmente', 'licencia', 'gente', 'policía', 'también', 'puede', 'donde', 'mucho', 'años', 'sobre']	Consequences of driving under the influence of alcohol or drugs
27	['intoxication', 'alcohol', 'driving', 'drinking', 'drink', 'sober', 'drunk', 'impaired', 'speeding', 'drive']	Risks and consequences of driving under the influence of alcohol
28	['plea', 'plead', 'restitution', 'court', 'adjudication', 'guilty', 'judge', 'damages', 'felony', 'probation']	Legal proceedings in a US court
29	['duis', 'dui', 'driving', 'rideshare', 'traffic', 'fatalities', 'impaired', 'uber', 'accidents', 'driven']	Impact of Uber on Drunk Driving in Houston

30	['driving', 'drunk', 'drove', 'drive', 'drinking', 'waking', 'blacked', 'car', 'parked', 'speeding']	Drunk Driving Stories and Experiences
31	['driving', 'momma', 'comment', 'crash', 'drive', 'mom', 'parents', 'drunk', 'prayers', 'recovered']	Consequences of drunk driving accidents
32	['officer', 'police', 'arrested', 'trooper', 'cop', 'impounded', 'condolences', 'comment', 'negligent', 'charged']	Accountability of Law Enforcement in Handling Impaired Drivers
33	['accident', 'driving', 'drunk', 'talk', 'drinking', 'drive', 'died', 'drink', 'happened', 'comment']	Dangers of drunk driving
34	['dui', 'comment', 'intoxicated', 'driving', 'impaired', 'drunk', 'drink', 'alcohol', 'drive', 'laws']	[DUI and Drunk Driving Laws]
35	['bakersfield', 'drunk', 'impaired', 'madd', 'walk', 'madd', 'mothers', 'happening', 'changed']	DUI Awareness and Prevention
36	['drank', 'alchohol', 'police', 'jail', 'alcohol', 'comment', 'victim', 'update', 'prison', 'cop']	DUI and its consequences
37	['accident', 'survivors', 'victims', 'crash', 'comment', 'tragedy', 'driving', 'died', 'trip', 'memories']	Carrollton bus crash and its aftermath
38	['alcoholic', 'driving', 'alcohol', 'drunk', 'drinking', 'alcohol', 'drink', 'drive', 'comment', 'smoking']	Dangers of drunk driving and alcohol consumption
39	['dui', 'californians', 'drunk', 'seatbelts', 'communist', 'comment', 'driving', 'californian', 'drinking', 'communism']	Public perception of drunk driving laws in the United States
40	['parents', 'driving', 'talk', 'conversation', 'drinking', 'drive', 'mentality', 'shaming', 'drunk', 'drink']	Deterrents to impaired driving among teenagers
41	['driving', 'arrest', 'accident', 'resisting', 'drink', 'police', 'alcohol', 'asked', 'officer', 'test']	Drunk Driving Cases and Field Sobriety Tests
42	['drunk', 'police', 'comment', 'idiots', 'alcohol', 'drivers', 'drive', 'motorcycle', 'riding', 'ride']	Drunk driving accidents and consequences
43	['comment', 'testimony', 'daughter', 'drunk', 'prayers', 'pray', 'tragic', 'amen', 'dad', 'praying']	Death of a Pregnant Woman due to Drunk Driving Accident
44	['accident', 'sentenced', 'victim', 'crashed', 'sentencing', 'crash', 'driving', 'drive', 'guilty', 'killed']	DUI cases and consequences

45	['driving', 'available', 'irresponsible', 'drunk', 'drive', 'concerned', 'potentially', 'able', 'vehicle', 'license']	Driving under the influence
46	['jackie', 'jacqueline', 'crash', 'fateful', 'engulfed', 'trapped', 'flames', 'tell', 'told', 'gone']	Consequences of Drunk Driving Accidents
47	['duis', 'dui', 'penalties', 'driving', 'consequences', 'fines', 'offenses', 'impaired', 'felony', 'conviction']	Drunk Driving Consequences and Penalties
48	['accident', 'driving', 'incident', 'swerving', 'crash', 'stumbled', 'witness', 'stopped', 'happened', 'cyclist']	DUI Traffic Accident Investigation
49	['comment', 'drunk', 'drinking', 'drive', 'died', 'stopped', 'remember', 'prayers', 'driver', 'suicide']	Consequences of drunk driving
50	['driving', 'comment', 'accident', 'drunk', 'speeding', 'fatalities', '65mph', 'drive', 'accidents', 'drinking']	Consequences of drunk driving and reckless behaviour behind the wheel
51	['daughter', 'mourning', 'daughters', 'parent', 'mothers', 'mother', 'experiencing', 'sentence', 'reversal', 'affected']	Impaired Driving Laws and Victim Support

The topics identified through topic modelling were categorized according to their sentiments to enhance the analysis. Table 13 shows the distribution of negative, neutral, and positive topics. The results indicate that 27 topics fall under the negative category, 31 under neutral, and only three under positive, revealing a significant predominance of neutral and negative sentiments in the data.

The sentiment analysis correlates with findings on drink-driving differences between youth age groups that shows notable reductions in drink-driving in the 21-25 age groups. With these reductions come different sentiments that view the topic as neutral or positive, as well as other contributing factors such as culture, social norms, and perceptions in some regions that could contribute to the positive sentiments.

Table 13. Sentiment vs. topic modelling generated topics

Sentiment	Topic	Sentiment	Topic
Negative	Drink-Driving accidents and fatalities	Neutral	Traffic Stop Incident
Negative	Consequences of drunk driving accidents on families and individuals	Neutral	Deterrents to impaired driving among teenagers
Negative	Traffic Stop Incident	Neutral	Drunk Driving Lawsuits and Civil Cases
Negative	Holiday season and drunk driving prevention	Neutral	Field sobriety tests
Negative	Risks and consequences of driving under the influence of alcohol	Neutral	Risks and consequences of driving under the influence of alcohol
Negative	Consequences of drunk driving	Neutral	Consequences of drunk driving accidents
Negative	Consequences of Drink-Driving Accidents	Neutral	Impact of Uber on Drunk Driving in Houston
Negative	DUI cases and consequences	Neutral	Arrest and Police Interaction
Negative	Drunk Driving Consequences and Penalties	Neutral	Consequences of drunk driving accidents on families and individuals
Negative	Grief and Loss Support	Neutral	Holiday season and drunk driving prevention
Negative	Breathalyser use and DUI testing procedures	Neutral	Consequences of drunk driving
Negative	Legal proceedings in a US court	Neutral	Carrollton bus crash and its aftermath
Negative	Drink-Driving Stories and Experiences	Neutral	Legal proceedings in a US court
Negative	Drink-Driving and related incidents	Neutral	Grief and Loss Support

Sentiment	Topic	Sentiment	Topic
Negative	Driving Under the Influence (DUI)	Neutral	DUI Awareness and Prevention
Negative	Impact of Uber on Drunk Driving in Houston	Neutral	Breathalyser use and DUI testing procedures
Negative	Drink-Driving Laws and Penalties in the UK	Neutral	Drunk Driving Cases and Field Sobriety Tests
Negative	DUI Awareness and Prevention	Neutral	Public Service Announcements (PSAs) for Drink Driving Prevention
Negative	Impaired Driving Laws and Victim Support	Neutral	Drink-Driving accidents and fatalities
Negative	Deterrents to impaired driving among teenagers	Neutral	Dangers of Drink-Driving
Negative	Public perception of drunk driving laws in the United States	Neutral	Drunk Driving Stories and Experiences
Negative	Dangers of drunk driving	Neutral	Drunk driving and related incidents
Negative	DUI Traffic Accident Investigation	Neutral	Impaired Driving Laws and Victim Support
Negative	Arrest and Police Interaction	Neutral	Drunk Driving Consequences and Penalties
Negative	Drink-Driving Cases and Field Sobriety Tests	Neutral	Public perception of drunk driving laws in the United States
Negative	Consequences of driving under the influence of alcohol or drugs	Neutral	Consequences of driving under the influence of alcohol or drugs
Positive	Consequences of drunk driving accidents on families and individuals	Neutral	Drink-Driving Laws and Penalties in the UK
Positive	Risks and consequences of driving under the influence of alcohol	Neutral	DUI cases and consequences
Positive	Consequences of driving under the influence of alcohol or drugs	Neutral	Corruption and misconduct by law enforcement officers
		Neutral	Driving Under the Influence (DUI)

2.8 Summary of Key Findings

- **Younger adolescents, aged 15 to 19**, have a higher rate of alcohol-impaired driving due to their lesser experience in driving. Research shows that this age group is more susceptible to the effects of alcohol, leading to a higher incidence of traffic incidents related to alcohol consumption (Callaghan et al., 2016). In contrast, the 21 to 25 age group shows notable reductions in drinking and driving behaviour.
- **Urban areas** have elevated DUI incident rates with resources dedicated to DUI prevention and population density contributing to this rate while in **rural areas** there are lower incident rates but higher case-fatality rates mainly because of the longer response time and limited DUI prevention resources worsening the outcomes.
- The culture of drinking in colleges is one of the main factors contributing to the differences in DUI rates across **North America**. In contrast, many countries within **European Union** have stringent law-enforcement measures and a deeply ingrained cultural value system that discourages DUI, resulting in lower rates of incidents.
- Meanwhile, in **Asia**, rapid urbanization and a growing youth population are leading to an increase in DUI cases as lifestyle changes promote behaviours associated with impaired driving. However, in some parts of **Africa and Asia**, many DUI cases occur without purchasing alcohol. Instead, alcohol is readily available at home, often without adequate restrictions from family members, as part of family traditions and gatherings.
- **The short-term consequences** of driving under the influence (DUI) include increasing the risk of incidents, especially for inexperienced youth drivers, resulting in severe injuries or fatalities for drivers, passengers, and bystanders. They suffer legal consequences such as penalties, license suspension and incarceration. DUI creates tension and emotional distress within families. DUI offenders face ostracism, isolation, and worsening risky behaviours.
- **The long-term consequences** of DUI include convictions that permanently damage criminal records, restricting higher education and employment opportunities. Long-term physical and emotional impacts include PTSD, anxiety, and depression. DUI incidents increase demand for emergency services, health-care, and law-enforcement, straining resources. Communities face economic losses from the death of young individuals and incident-related costs.
- **Key factors contributing to youth road traffic crashes involving alcohol** are underage alcohol consumption, peer influence, lack of parental monitoring, alcohol advertisement, inadequate enforcement of laws, and the amplified risks of poly-drug use and impaired driving among youth.

- **The top individual interventions** implemented to reduce driving under the influence among young people centre around direct engagement. These interventions include Peer-led Educational Programmes, Motivational Interventions in Educational Settings, Brief interventions in Emergency Settings, Mobile and Technology-Based Interventions and Parental Monitoring Programmes.
- **The top general interventions** implemented to reduce driving under the influence among young people are categorized into three main categories: Motivational Interventions, Educational Programmes and Regulatory Policy-led strategies.
- **An analysis of Reddit posts** from 2015-2024 reveals a statistically significant increase in discussions related to drink-driving, particularly in the Dominican Republic and Costa Rica. This trend, confirmed by a Mann-Kendall test, suggests growing public engagement. Conversely, Cuba and Panama did not exhibit a similar increase, potentially indicating that drink-driving is a less prominent topic of public concern in these nations.
- **AI-powered sentiment analysis** of 3,057 relevant Reddit posts showed a strong negative bias. The posts were classified as 49.2% negative (1,505 posts), 34.4% neutral (1,053 posts), and only 16.3% positive (499 posts). The intensity of this negative sentiment was significantly more pronounced in countries such as Argentina, Brazil, Bolivia, the Dominican Republic, and El Salvador.
- **Topic modelling** of the 3,057 posts identified five primary themes: Travel (1,218 posts), Stories (667 posts), Law (538 posts), News (438 posts), and Politics & Economy (195 posts). While travel-related content was the most frequent overall, discussions in Argentina were uniquely dominated by news reports on DUI incidents. The "Law" topic was associated with the highest intensity of negative sentiment, indicating that public discourse is most critical when discussing legal regulations and consequences.
- **A sentiment analysis of 1,204 YouTube video transcripts** indicated that 54.4% expressed negative sentiments towards drink-driving, with minimal positive content across all regions. Negative viewpoints were most prevalent in English, German, and Spanish-language content, whereas French and Italian content tended towards more neutral, factual reporting.
- **Topic modelling of the YouTube data** generated 51 distinct topics, which were then categorized by sentiment. The results showed that 27 topics were negative, 31 were neutral, and only 3 were positive. This distribution underscores that YouTube content overwhelmingly focuses on the dangers, consequences, and legal aspects of drink-driving, rather than its promotion.

Chapter 3

Youth-Focused Educational and Training-Based DUI Interventions

In the previous section, we found that Motivational Interventions and Educational Programmes are among the most effective and top interventions for youth DUI challenges. Building on these findings, this section will introduce some critical educational and training-based interventions and examine their effectiveness.

The prevention of youth drink-driving has become a crucial priority for communities and governments worldwide due to its significant personal, social, economic, and legal consequences. As discussed before, drink-driving remains one of the leading causes of road fatalities, especially among young drivers, who are more likely to engage in risky behaviours like consuming alcohol before driving. The devastating effects impact the individuals involved and their families, communities, and society.

In response to these challenges, various educational interventions have been designed, developed, and implemented to raise awareness among young drivers about the adverse outcomes associated with drink-driving, including injury, death, legal penalties, and emotional trauma. These prevention programmes play a vital role in educating youth on the dangers of drink-driving by fostering collaborative efforts among families, schools, law-enforcement, and local organizations. These interventions promote responsible behaviour and equip young individuals with the skills to make informed decisions.

Research indicates that effectively preventing harmful alcohol use among youth requires three essential skills:

1. An understanding of adolescent development and the principles of youth-adult partnerships;
2. The ability to integrate this knowledge into the design and execution of programmes; and
3. The use of relational practices that empower young people by involving them in decision-making processes (Ballard et al., 2023).

By incorporating the insights of young people, we can promote responsible alcohol consumption more effectively.

Three types of interventions—peer-led, family engagement, and school-community partnerships—have proven effective in reducing risky behaviours related to alcohol consumption before driving. By involving multiple stakeholders, these initiatives create a comprehensive support network that promotes positive behaviours and helps prevent drink-driving incidents among youth.

The interventions are categorized into three groups: peer-led interventions, which emphasize the influence of peers in reducing alcohol consumption and risky driving behaviours; family-based interventions, which focus on the importance of family involvement in promoting safer driving habits; and community-based interventions, which highlight the significance of community initiatives in educating adolescents and young adults about the dangers of drinking and driving.

This section explores various educational and training methods and tools used in diverse prevention strategies to enhance young people's awareness of the physical, mental, social, and legal consequences of drink-driving. By examining existing programmes, case studies, and evidence-based approaches, this section aims to provide a deeper understanding of how these initiatives contribute to reducing the incidence of drink-driving and promoting safer communities.

3.1 Peer-led Interventions (PLI)

Peer-led interventions are educational and preventive strategies where individuals of similar age, social background, or experience lead activities, share information and support their peers. In a typical PLI programme, individuals who share demographics or experiences with the target audience are trained as peer educators or leaders. These peer leaders then deliver programme content, offer support, or facilitate discussions among their peers. PLIs are commonly utilized in fields such as health promotion, mental health awareness, substance abuse prevention, and educational development. These interventions leverage peer influence to encourage behaviour change by training young individuals to lead discussions and activities that raise awareness about the dangers of drink-driving. Peer-led programmes often utilize social influence within youth groups, making the message more relatable and impactful.

The significant elements of PLI programmes include:

1. **Training Peer Leaders**: Participants undergo training to learn about the topic, develop communication and leadership skills, and learn methods for promoting positive behaviour change.
2. **Education and Support:** Peer leaders conduct sessions, discussions, or activities on a targeted topic in a relatable and informal manner. They may share personal stories, moderate group discussions, or lead educational workshops.
3. **Role Modelling and Influence:** Peer leaders act as role models, encouraging their peers to adopt healthier behaviours and demonstrating a relatable example of positive change.

4. **Ongoing Engagement:** Many PLI programmes include follow-up sessions or ongoing support from peer leaders to reinforce behaviour change over time.

Peer leaders are valuable because they significantly influence individual attitudes and behaviours, particularly during adolescence and young adulthood. Peer leaders' relatability fosters trust, which makes individuals more open to receiving information and messages about behaviour change. Research has demonstrated that people are more likely to listen to and be influenced by someone they view as a peer, especially on topics such as responsible alcohol consumption, substance use, mental health, and social behaviour.

Many studies have examined and reviewed PLI programmes (Gersh et al., 2019; Lavilla-Gracia et al., 2022; Wade et al., 2022; Pueyo-Garrigues et al., 2023). Research indicates that peers may influence the initiation and escalation of alcohol use and misuse more than parents during early adolescence (Beal, Ausiello, and Perrin, 2001; Crawford and Novak, 2002; Windle, 2000). Cross-sectional studies have shown that peer social influence is the only factor independently linked to abstaining from alcohol misuse (Beal, Ausiello, and Perrin, 2001).

To illustrate the diversity and effectiveness of PLI programmes, we examine several notable cases worldwide. These programmes highlighted the range of approaches taken in different cultural and regional contexts to encourage positive behavioural change through peer influence.

Each case demonstrates unique ways in which peer-led structures can foster trust, motivate engagement, and promote sustained participation, leveraging the power of shared experiences among individuals of similar ages or backgrounds.

Given that these interventions consist of multiple components, the classification is a valuable framework for understanding various aspects of the programmes rather than a definitive categorical model. This approach recognizes the complexity of the interventions and allows for flexibility in interpreting their different elements and impacts. Ultimately, it facilitates a more nuanced understanding of their effectiveness in promoting healthier and more responsible behaviours related to alcohol consumption among youth.

3.1.1 Educational and Awareness Raising Programmes

These peer-led interventions focused on educating individuals about alcohol's physiological effects, highlighting potential consequences of consumption, such as

health risks and financial burdens. They also addressed social norms surrounding drinking behaviours, encouraged protective strategies to mitigate associated risks, and provided foundational knowledge on defining a standard drink, understanding blood alcohol concentration levels, and recognizing individual alcohol tolerance.

a) Brief Advice Sessions

The Brief Advice Sessions lasted 15 minutes and utilized a minimal intervention approach. They aimed to address potential risks associated with alcohol use and provided practical strategies for reducing alcohol consumption. This intervention was information-based, primarily focusing on raising awareness and improving understanding of alcohol-related issues. It emphasized increasing participants' knowledge about the health effects of alcohol, the social and financial consequences of excessive drinking, and the importance of responsible consumption (Borsari et al., 2012).

b) Alcohol Education Programme

The Alcohol Education Programme is a two-hour session that includes an interactive component. Participants receive detailed information about the effects of alcohol on the body. The programme covers key concepts, such as defining a standard drink, calculating maximum estimated blood alcohol concentration (peak eBAC), and understanding individual tolerance levels. This engaging format aims to enhance participants' awareness and understanding of these factors, helping them make informed decisions about alcohol use (Cimini et al., 2009).

During this programme, peer counsellors discuss various aspects of college drinking culture. They focus on its prevalence on campus, the potential negative consequences of alcohol consumption, and strategies for reducing risks through protective behaviours. This dialogue aims to promote a more informed perspective on drinking habits and encourage safer practices among students.

c) Perceptions of Alcohol Norms Intervention

The (PAN) intervention lasts approximately 45 minutes and primarily consists of interactive presentations led by peers. These presentations focus on value clarification, the risks associated with alcohol consumption, its potential consequences, social norms regarding drinking, and students' perceptions of peer drinking behaviours. The goal of this approach is to actively engage participants while providing them with essential information to help them make informed decisions about alcohol use.

The PAN intervention employs normative re-education and value clarification strategies to address and correct misconceptions about alcohol use among peers, particularly among youth populations. This strategy is designed to give students accurate insights into their peers' alcohol consumption patterns and the associated consequences. Additionally, it seeks to shift students' attitudes toward the acceptability of excessive drinking, promoting a more critical perspective on such behaviours. By fostering awareness and reflection, the initiative aims to encourage healthier choices regarding alcohol among students. (Stamper et al., 2004).

d) Peer Theatre

The Peer Theatre intervention helped students evaluate their values and goals. It encouraged them to incorporate responsible decision-making about alcohol consumption into their overall value system. This reflective process aimed to empower students to align their choices regarding alcohol use with their broader life objectives, foster a culture of accountability, and promote healthier behaviours within their social circles (Environmental Health Perspectives, 2019).

The Peer Theatre intervention is a two-hour event with an interactive theatrical presentation highlighting various norms, attitudes, and behaviours associated with alcohol consumption. This engaging format encourages discussion and reflection among participants by dramatizing the complexities of alcohol use in social situations. The intervention seeks to raise awareness and challenge common perceptions surrounding drinking behaviours (Cimini et al., 2009).

3.1.2 Cognitive Behavioural Skill-based Interventions

These interventions are designed to bring about changes in both thoughts and behaviours related to alcohol consumption. By combining two primary strategies—alcohol education and skills training—these programmes aim to improve participants' understanding of the risks associated with drinking while also equipping them with practical skills for making responsible choices.

While education and awareness programmes provide essential information about the physiological effects of alcohol, social norms, and the potential consequences of excessive drinking, cognitive behavioural interventions focus on skills training. These interventions help develop decision-making abilities, refusal skills, and strategies for navigating social situations where alcohol is present.

a) Voice of Reason Programme

The Voice of Reason intervention consists of five interactive sessions, each lasting one hour, aimed at modifying alcohol-related behaviours. The programme focused on developing effective communication skills while promoting alcohol awareness and protective strategies.

Participants engaged in practice conversations with their peers, which allowed them to apply the skills they learned in a supportive environment. This hands-on approach not only facilitated learning but also encouraged the adoption of healthier drinking behaviours through peer interaction and feedback (Abadi et al., 2020).

b) Alcohol Skills Training Programme (ASTP)

The Alcohol Skills Training Programme is a cognitive-behavioural approach aimed at the secondary prevention of alcohol-related problems. This comprehensive initiative targets students who are at risk of developing issues with alcohol. The programme includes multiple components that provide essential information about addiction and various exercises and training sessions.

These activities are designed to help students identify their triggers for drinking, improve their refusal skills regarding alcohol, and develop effective stress management techniques. The ASTP consists of two 90-minute sessions. During these sessions, peer leaders present brief informational segments, followed by discussions in smaller groups. The programme's primary goal is to change participants' drinking behaviours and associated lifestyle patterns.

c) Lifestyle Management Class (LMC)

The Lifestyle Management Class is a structured, peer-led intervention programme designed to address alcohol misuse among college students. It is designed for both voluntary and mandated participants and focuses on lifestyle choices and behaviours that contribute to alcohol-related issues. The LMC has been evaluated for its effectiveness in reducing risky behaviours like drinking and driving.

The programme consists of two peer-led sessions, each lasting two hours. These sessions aim to develop skills for effective lifestyle management in a college environment. Various topics are covered during these sessions, including health behaviour change, the importance of moderate drinking, safety considerations while drinking, academic responsibilities, stress management, time management, and goal setting.

3.1.3 Motivational and Feedback-related Interventions

These interventions aim to promote personal accountability, increase motivation, and build participants' self-efficacy to reduce resistance to change. To accomplish this, the programmes utilize motivational strategies and personalized feedback mechanisms. By emphasizing these elements, the interventions encourage participants to actively reassess their behaviours, supporting a transition towards healthier lifestyle choices through enhanced self-awareness and greater confidence in their ability to make changes.

a) Brief Alcohol Screening and Intervention for College Students Programme

One influential intervention that has proven effective when delivered by peers is the BASICS programme. BASICS is an evidence-based programme designed to reduce risky drinking behaviours among college students, particularly those in the youth demographic. It adopts a harm-reduction approach rather than being strictly abstinence-based and aims to help students understand the risks associated with their drinking and make safer choices.

BASICS typically consists of two structured sessions:

1. **Initial Assessment**: In this session, students complete a self-assessment regarding their alcohol use, motivations, and related risks. This assessment includes peer comparisons to illustrate discrepancies between perceived and actual drinking norms.

2. **Feedback Session**: During the follow-up session, a trained counsellor reviews the assessment with the student. They discuss the student's drinking patterns, potential risks, and strategies for reducing harm. This session employs motivational interviewing techniques to encourage students to set realistic goals for safer alcohol consumption.

Research indicates that when peers deliver BASICS, it leads to reductions in the amount and frequency of alcohol consumption, estimated peak blood alcohol concentration, and the number of binge drinking episodes among college students (Lavilla-Gracia et al., 2022). University students perceive peer facilitators as skilled, competent, and well trained (Mastroleo et al., 2014; Pueyo-Garrigues et al. 2023).

b) Peer-implemented Minimal Interventions (PMI)

Peer-implemented minimal Interventions using motivational interviewing techniques have gained popularity as a method to address risky behaviours among youth, especially about alcohol use and drink-driving prevention. The PMIs are brief and focused interventions conducted by peers instead of professionals. Their goal is to promote positive behavioural changes with minimal intervention time. These interventions are designed to be accessible, requiring little training and resources, yet their effectiveness is enhanced by the relatability and trust that peers naturally share.

Motivational interviewing is a counselling technique that seeks to inspire intrinsic motivation for change by engaging individuals in discussions about their ambivalence toward specific behaviours. It is particularly effective in PMIs because it enables peers to encourage self-reflection and goal setting without passing judgment.

3.1.4 Effectiveness of Peer-led Initiatives

Peer-led initiatives build leadership skills and capacity among youth, making them effective advocates for driving behaviour change, especially in contexts where youth are more receptive to messages delivered by their peers (Kennedy et al., 2022). In addition, more recent studies highlight the effectiveness of these programmes in fostering leadership and responsibility among participants (Ballard et al., 2023).

The primary outcomes assessed in these studies included the quantity and frequency of drinking, peak eBAC, the number of heavy drinking episodes, and alcohol-related consequences. Nearly all studies evaluated the quantity and frequency of drinking, with the Daily Drinking Questionnaire being the most commonly used tool.

Many studies recognize the positive effects of peer-led interventions; however, some research highlights the potential negative impacts of peer mentoring. For example, Valente and colleagues aimed to evaluate whether a substance abuse prevention programme tailored for social networks could reduce substance use among high-risk adolescents without inadvertently encouraging deviant behaviour. They conducted a randomized classroom trial to compare control classes with those participating in the evidence-based substance use prevention programme (Valente et al., 2007).

The results of their study showed that the Towards No Drug Abuse (TND) Network was effective in reducing substance use. However, the programme effect interacted with peer influence and was effective mainly for students who had peer networks that did not use substances. Students with classroom friends who use substances were more likely to increase their use (Valente et al., 2007). This highlights the dual potential of peer groups to either positively or negatively impact an individual's decision regarding drug and alcohol use.

What is more, an essential caution regarding peer-led interventions emerged from a study in Ireland, which found that first-year high school students who participated in such an intervention reported higher alcohol consumption compared to those who did not (Botvin and Griffin, 2007). As a result, the design and execution of peer-led alcohol interventions and youth empowerment should be carefully considered to account for this potential unintended effect.

The effectiveness of PLIs largely depends on their ability to engage youth meaningfully and relatable. The interventions that stand out in terms of impact on drink-driving prevention—such as the PAN, Peer Theatre, and BASICS—share a few critical characteristics:

1. **Engagement and Relatability**: PLIs incorporating interactive elements and peer connections, like Peer Theatre and PAN, are typically more engaging and relatable to youth. Using real-life scenarios and corrective feedback on social norms creates a sense of immediacy and relevance.

2. **Personalisation**: Interventions like BASICS and ASTP that offer personalized feedback or skills training are more likely to resonate with youth because they address their unique behaviours and motivations. Personalized approaches also encourage self-reflection, fostering longer-term commitment to behaviour change.

3. **Emotional Impact and Real-Life Application**: Programmes that evoke emotional responses or provide practical skills, such as Peer Theatre and ASTP, demonstrate a higher impact. Real-life applications of the intervention content make it easier for youth to understand and internalize the risks of drink-driving.

4. **Consistency and Follow-Up**: Interventions incorporating follow-up sessions or ongoing support yield better outcomes. For instance, programmes like LMC encouraging sustained engagement show higher long-term effectiveness, especially when youth commit to lifestyle changes.

Table 14. Effectiveness, key strength, and limitations of educational and awareness-raising programmes

Educational and Awareness Raising Programmes			
Interventions	Effectiveness	Key Strength	Limitation
Brief Advice Sessions	• BAS has shown moderate effectiveness in increasing awareness but often lacks depth due to its short duration. • Youth who engage in risky drinking behaviours may require more intensive, continued support to foster lasting Behavioural change.	• Accessible • Low-cost • Time-efficient • Easily scalable	• Limited in impact without follow-up or reinforcement.
Alcohol Education Programme	• AEP has shown effectiveness in enhancing knowledge but may be less impactful in driving long-term Behavioural change due to its educational, rather than experiential, nature.	• Provides foundational knowledge.	• May not sufficiently engage youth or lead to sustained behaviour change if delivered in a traditional, lecture-based format.
Perceptions of Alcohol Norms Intervention	• PAN is highly effective as it addresses common misperceptions about peer drinking norms, revealing that most peers consume less alcohol than individuals often assume. • PAN interventions that use real-time feedback show notable success in reducing drinking behaviours among youth by reshaping their understanding of social norms.	• Corrects misperceptions, a known driver of risky drinking behaviour	• Requires accurate data and continuous updates to remain relevant to the peer group.
Peer Theatre (Environmental Health Perspectives)	• Particularly influential for its high engagement level, fostering empathy by showcasing the real-world consequences of drink-driving. • Has shown success in reducing drink-driving intentions by allowing youth to connect emotionally to the risks involved.	• High engagement • Emotional impact • Relatability	• Resource-intensive • Effectiveness may vary depending on the quality of peer actors and scenario relevance.

Table 15. Effectiveness, key strength and limitation of cognitive Behavioural skill-based Interventions

Cognitive Behavioural skill-based interventions			
Interventions	Effectiveness	Key Strength	Limitation
Voice of Reason Programme	• Moderately effective • Most effective for youth who may respond positively to group discussions with peers. • Requires supplementary content • Its impacts may diminish over time.	• Peer-led discussions are relatable, encouraging introspection.	• Effectiveness varies depending on the skills and credibility of peer educators.
Alcohol Skills Training programme	• Highly effective for reducing binge drinking and risky behaviours among youth. • Its focus on moderation rather than abstinence might limit its direct impact on drink-driving behaviours.	• Provides practical skills that are directly applicable.	• Not explicitly focused on the risks of driving under the influence, which may reduce its effectiveness in preventing drink-driving.
Lifestyle Management Class	• Effective in reducing risky alcohol behaviours by helping youth set personal goals and understand the broad consequences of drink-driving. • Requires more commitment but is impactful for participants ready to make changes.	• Holistic approach to lifestyle and behaviour change.	• Limited accessibility due to its length and structure which may deter some youth from participating.

3.1.5 Building Effective PLI Programmes for Youth Drink-Driving Prevention

To enhance the effectiveness of PLI programmes aimed at preventing drink-driving, the following recommendations can be considered:

1. **Integrate Corrective Norms Messaging**: Since young people often misjudge their peers' drinking behaviours, incorporating real-time, data-backed social norms can correct these misconceptions and help reduce risky behaviours.
2. **Incorporate Interactive and Relatable Elements**: Storytelling, role-playing, and real-life testimonials should be included to make the risks of drink-driving more relatable. Interactive workshops that utilize real peer experiences can significantly increase engagement.
3. **Utilize a Personalized, Skill-Building Approach**: Skill-building sessions should be tailored to individual participants, such as those focused on refusal skills and pacing techniques. Programmes that prompt self-reflection on personal behaviours, like BASICS, can provide stronger reinforcement.
4. **Commit to Long-Term Engagement**: To achieve sustained impact, implement a follow-up structure. Continued contact, support groups, or periodic refresher sessions will reinforce learned behaviours and help discourage relapses.

In conclusion, combining educational and practical components fosters a holistic approach in PLIs. This encourages individuals to rethink their attitudes towards alcohol and to apply this knowledge in real-life contexts, ultimately promoting healthier lifestyle choices and reducing the prevalence of risky drinking behaviours.

3.2 Family-based Interventions

Family-based interventions involve parents or guardians and children in activities that promote positive behaviours and reduce risks. These programmes primarily focus on enhancing family communication, parenting skills, and support structures to help family members, especially youth, make healthier and safer decisions.

Family-based interventions can include parent training, family therapy sessions, and workshops. These interventions aim to strengthen family bonds and create supportive environments that help prevent harmful behaviours.

These programmes emphasize the importance of fostering an environment where young family members can openly discuss the consequences of behaviours such as drink-driving, ultimately aiming to reduce risky activities. They also highlight actions' personal, social, and legal ramifications, reinforcing the idea of responsible behaviour.

While family influence may decrease during adolescence, it remains a significant factor in young people's participation in risky behaviours. For example, parental actions such as monitoring their children and expressing disapproval of heavy drinking are strongly associated with lower levels of alcohol consumption among adolescents, even when taking peer influence into account (Wills et al., 2004)

We categorized family-based interventions according to specific aspects of family dynamics, such as communication, behaviour modification, and family support systems. These aspects are integral to addressing risk behaviours like alcohol misuse and drink-driving.

3.2.1 Behavioural Skills and Communication Training

These programmes aim to enhance family communication and behavioural skills, helping young people make informed decisions, reduce risky behaviours, and cultivate supportive relationships. In the context of preventing drink-driving, these interventions provide families with the tools to engage in open and constructive discussions about the dangers of alcohol and driving. Additionally, they assist parents in guiding their children toward safer choices. Several types of interventions have been implemented in this area, including:

a) Family Check-Up (FCU)

The FCU is an intervention to enhance parenting skills through motivational interviewing techniques. Its primary goals are to assess parenting practices, establish boundaries, and improve overall family dynamics. The FCU aims to strengthen family management practices while addressing behavioural adjustment challenges in children and adolescents.

The FCU encourages positive parenting approaches by reducing coercive and negative parenting behaviours. It is suitable for families with children aged 2 to 17 and can be utilized for both preventive and therapeutic purposes. The intervention can be delivered in a brief, focused format over two to three sessions, making it an effective component of a health promotion strategy.

When implemented successfully, the FCU can help mitigate youth-related issues such as harmful alcohol consumption and risky behaviours, including drink-driving. The model consists of two main phases: (1) an initial assessment and feedback session; and, (2) a parent management training component emphasizing positive behaviour reinforcement, setting healthy limits, and building solid relationships.

The FCU is customizable to meet the unique needs of each child and family and can be conducted in various settings, including homes, public schools, community centres, community health centres, and clinics. In this section, we briefly list and describe some cases of FCU programmes.

b) Parenting Wisely (PW)

This programme combines digital tools with interactive video scenarios to teach parenting skills and effective communication. The primary goal of PW is to strengthen families and enhance the development and well-being of children. Over the long-term, PW aims to promote healthy child development. By providing accessible, evidence-based guidance, PW can help reduce the risk of substance use and encourage safer choices among youth. The programme is in a group setting and includes an interactive online learning component. The PW programme is designed for families with children aged 7 to 18 years. The primary topics in PW programmes encompass child development, parent-child interactions and bonding, parenting techniques, conflict resolution, problem-solving, and effective communication.

c) Family Skills Training Programme (FSTP)

The FSTP is a family-based intervention that enhances parenting skills, improves communication, and fosters family cohesion. Its goal is to prevent youth from engaging in risky behaviours, such as substance use and, indirectly, drinking and driving.

The FSTP typically includes structured sessions for both parents and children. These sessions focus on developing skills that promote healthy family dynamics, reduce conflict, and support youth development. Key components of the FSTP involve parent training, skills development for children, and joint family sessions where parents and children practice the skills they learn together. This collaborative approach helps improve communication and strengthen family bonds (Allen et al., 2013).

d) Criando con Amor: Promoviendo Armonía y Superación (CAPAS)

The CAPAS parent-training programme is tailored for Latino immigrant parents with children who exhibit mild to moderate behavioural issues. Its five key objectives are: 1) promoting positive parent-child interactions; 2) encouraging the development of prosocial skills in children; 3) reducing problematic behaviours through effective discipline; 4) enhancing parental supervision; and, 5) facilitating family problem-solving through negotiation and agreements (Parra-Cardona et al., 2023; (UNICEF, 2021). By addressing cultural aspects and family dynamics, CAPAS assists parents in guiding their children away from risky behaviours, including alcohol misuse, thereby reducing the likelihood of drink-driving.

3.2.2 Therapeutic and Family Counselling-Based Interventions

These interventions include therapeutic approaches that target family conflict and the underlying issues contributing to risky behaviours. By strengthening family support and addressing behavioural challenges, these programmes aim to prevent youth from engaging in drink-driving. Below, some of the programmes in this category are briefly introduced:

a) Adolescent Community Reinforcement Approach (A-CRA)

The A-CRA is a behavioural treatment designed for youth and young adults aged 12 to 24 who are dealing with substance use disorders, particularly alcohol use. A-CRA aims to enhance family, social, and educational or vocational support systems to facilitate recovery. This intervention can be delivered in various settings, including outpatient, intensive outpatient, and residential treatment programmes.

A-CRA consists of guidelines for three types of sessions: individual sessions with the youth, sessions with parents or caregivers, and joint sessions that include both the youth and their parents or caregivers.

Clinicians select from a range of A-CRA procedures based on the individual's needs and self-assessment of happiness in different areas of life. These may include enhancing problem-solving skills to navigate daily stressors, improving

communication skills, and encouraging active participation in positive social and recreational activities. The ultimate goal is to boost life satisfaction while reducing alcohol and substance use issues (Office of Justice Programs, 2025).

Practicing new skills during therapy sessions is a crucial part of the skills training involved in A-CRA. Each session concludes with a homework assignment that the therapist and the client agree upon, aimed at practicing the skills learned during that session. These assignments often involve participating in pro-social activities. Additionally, every session begins with a review of the homework from the previous session.

b) Functional Family Therapy-Gangs (FFT-G)

The FFT-G is an intensive, home-based therapeutic intervention lasting three to five months. The primary goal of FFT-G is to enhance the safety, stability, and overall well-being of children and their families while reducing risky behaviours such as drinking and driving.

An adaptation of Functional Family Therapy, FFT-G specifically targets high-risk youth involved in gang-related or delinquent activities. By improving family communication and problem-solving skills, FFT-G indirectly addresses issues related to alcohol misuse and the risks associated with drinking and driving.

Developed by FFT LLC and implemented by Family Psychology Mutual (FPM), FFT-G focuses on youth aged 10 to 17 who are at risk of becoming involved in county lines drug trafficking or engaging in drink-driving. In the programme's initial phases, families receive multiple contacts per week, with each home visit lasting between 60 and 90 minutes. As the intervention progresses, the frequency of contact shifts to a weekly schedule ("Functional Family Therapy Gangs (FFT-G)" 2024).

c) Brief Strategic Family Therapy (BSFT)

The BSFT is a short-term, goal-oriented intervention designed to change problematic interaction patterns within families. Sessions typically last 60 to 90 minutes, and a total of 12 to 15 sessions are conducted over the course of three months.

The approach is based on the understanding that each family has unique interaction dynamics that emerge during their interactions. These dynamics, viewed as a family "system," influence the behaviour of all family members. Therefore, the family is treated as a cohesive unit. Repetitive behaviours in family interactions can either be constructive or problematic. The BSFT specifically targets these patterns, especially

those linked to the behavioural issues of young people. The goal is to develop a practical plan that promotes healthier and more effective family interactions ("Brief Strategic Family Therapy | National Gang Centre" 2024).

BSFT addresses problematic family dynamics and substance use behaviours related to alcohol. Through a focused, therapeutic approach, BSFT helps prevent risky behaviours, such as driving under the influence, by strengthening family relationships and improving youth decision-making.

3.2.3 Culturally Tailored Programmes

These programmes are customized for specific cultural or community groups and work well in addressing drink-driving within culturally relevant frameworks. They are particularly effective in areas where cultural values shape behaviour and can be leveraged to discourage drink-driving. As Gersh and colleagues argue, these programmes focus on enhancing parental skills such as clear communication, establishing rules, and monitoring their children's behaviour (Gersh et al., 2019).

a) Familias Unidas for Alcohol and Substance Use Prevention

Familias Unidas is a culturally tailored, family-based intervention aimed at preventing issues such as conduct disorders, drink-driving, and risky sexual behaviours among Hispanic youth. The programme enhances family functioning by promoting better communication between parents and adolescents, increasing family support, and strengthening parental involvement in their children's lives, including their interactions with peers and school activities (Cordova et al., 2012).

Familias Unidas focuses on creating supportive networks for Hispanic immigrant parents, helping to reduce social isolation and integrate them into the wider community. By providing parents with essential knowledge and resources, Familias Unidas aims to promote healthier behaviours and minimize risk factors for both boys and girls (Rojas et al., 2023).

Familias Unidas incorporates elements from culturally adapted frameworks explicitly designed for Hispanic communities in the U.S. The programme is primarily delivered through multi-parent groups to enhance effective parenting skills and through family visits where parents can practice these skills during interactions with their adolescent children.

A trained facilitator leads the multi-parent groups, which consist of eight to nine weekly sessions, each lasting two hours and involving ten to 15 parents, with at least one parent from each family participating. These sessions include interactive exercises and discussions that promote problem-solving and encourage parents to understand and actively engage in protecting their adolescents. Additionally, the programme includes four to ten family visits, each lasting about an hour, allowing parents to reinforce the skills they have developed in the group sessions.

b) We R Native - Family Communication for American Indian/Alaska Native Youth

This programme is an innovative and culturally tailored initiative designed to support American Indian and Alaska Native (AI/AN) families in fostering open and healthy communication about sensitive topics, such as substance use and risky behaviours like driving under the influence. It is part of the We R Native network, a comprehensive health resource created by the Northwest Portland Area Indian Health Board to empower Native youth to make safe and healthy choices.

The programme integrates traditional cultural values with modern health information to facilitate discussions between parents and youth. Its goal is to strengthen family bonds and create an environment of mutual respect and understanding. By leveraging Native traditions and storytelling, We R Native provides resources that resonate with parents and youth in AI/AN communities. The programme addresses issues such as alcohol use, peer pressure, and the consequences of unsafe behaviours in meaningful ways within their cultural context.

c) Families Preparing a New Generation (FPNG)

The FPNG is a family-based prevention programme aimed at reducing risky behaviours in youth, particularly substance abuse, including alcohol misuse and drink-driving. This programme strengthens family dynamics to promote positive behaviour changes and resilience in children and adolescents. The FPNG emphasizes developing communication skills, parental monitoring, and family cohesion, all essential in preventing risky behaviours such as drink-driving among young people (Williams et al., 2016).

The FPNG provides culturally sensitive, family-based prevention by empowering parents to effectively communicate with their children about alcohol and other risky behaviours. The programme strengthens family bonds and promotes positive youth development, which indirectly helps discourage risky behaviours like drink-driving.

Typically, the programme includes components such as parental involvement, youth education, and family sessions. These structured sessions involve parents and youth,

aiming to improve overall family functioning and reinforce the content learned during individual sessions (Marsiglia et al., 2016).

3.2.4 Parenting Skills and Monitoring Programmes

These programmes aim to equip parents with skills to effectively monitor and guide their children's behaviour, providing practical strategies for managing youth risk factors related to drink-driving.

a) Parenting Skills Training (PST)

This type of training educates parents on how to set boundaries, monitor their children's activities, and maintain consistent discipline. Parents who undergo this training are better equipped to recognize the signs of substance use and intervene early, which can reduce the risk of their children engaging in drink-driving.

The programme also teaches parents effective communication strategies that foster open and honest discussions with their children. This aspect is crucial for addressing sensitive topics like alcohol use, as it enables parents to convey their values and expectations in a non-confrontational manner. Additionally, parents learn how to establish consistent rules and boundaries. This includes setting clear expectations regarding behaviour, such as avoiding alcohol use, never drinking, and driving, which helps youth internalize these boundaries as non-negotiable.

b) Positive Parenting Programme (Triple P)

The Positive Parenting Programme, called Triple P, is an evidence-based intervention designed to enhance parenting skills, improve family relationships, and reduce behavioural issues in children and adolescents. The programme employs a tiered approach, starting with broad informational resources and progressing to intensive one-on-one sessions tailored to each family's needs.

Triple P can play a vital role in preventing drink-driving by equipping parents with practical strategies for monitoring, communicating, and guiding their children through challenging situations that may involve risky behaviours, such as drinking and driving. The programme emphasizes the importance of parental supervision and setting clear behavioural expectations, which are crucial for preventing youth from engaging in drink-driving. Parents learn to actively monitor their teens' whereabouts, peer groups, and social activities, reducing the likelihood of their children encountering risky situations involving alcohol and driving.

3.2.5 Effectiveness

Family-based interventions can reduce risky behaviours through enhanced family cohesion, communication, and parental monitoring.

Programmes like Family Check-Up, FSTP, and BSFT have demonstrated exceptionally high efficacy due to their adaptability and focus on communication and problem-solving skills. Studies suggest that family intervention programmes have been notably effective in decreasing the initiation of alcohol use among the youth group. However, the level of effectiveness varies. Notably, the most influential family interventions sustained their impact on reducing alcohol initiation rates at a follow-up period of 48 months (Smith et al., 2009).

Culturally adapted programmes like Familias Unidas and We R Native showcase the importance of cultural relevance in engaging participants. Programmes prioritizing communication and monitoring skills, like Parenting Wisely and BSFT, have a substantial impact as they directly address key predictors of risky behaviour. Programmes like Parenting Wisely and FPNG, which offer flexibility in delivery and are accessible digitally, tend to have higher engagement rates and effectiveness.

Family-based programmes also have some limitations (see Table 16). Programmes like FSTP are resource-intensive and may face accessibility barriers. Sustainability can also become an issue for these programmes. While shorter programmes may be effective in the short term, they may require additional support to maintain long-term behavioural change. Finally, family-based programmes tailored to specific cultural groups may be less applicable to the broader populations.

Table 16. Strengths and limitations of family-based interventions

Intervention	Strengths	Limitations
Family Check-Up (FCU)	• Strengths-based approach tailored to family needs • Increases parental engagement and adaptability	• Relies on parents' willingness to self-assess • Effectiveness reduced with non-committed families
Parenting Wisely	• Interactive and computer-based • Flexible and accessible for parents unable to attend in-person sessions	• Challenges for parents struggling with digital formats • May not address complex family issues comprehensively

Intervention	Strengths	Limitations
Family Skills Training Programme (FSTP)	• Separate and joint sessions for parents and children • Builds skills before joint application	• Long duration which may cause participants to drop out • Resource-intensive, limiting accessibility
Criando con Amor: CAPAS	• Culturally adapted content boosts relevance and engagement	• Limited to Latino communities • Requires culturally competent facilitators
Adolescent Community Reinforcement Approach (A-CRA)	• Replace substance-related activities with positive alternatives • Benefits high-risk youth	• Requires ongoing support for Behavioural change • Less effective with weak social support networks
Functional Family Therapy-Gangs (FFT-G)	• Focused on high-risk youth with antisocial behaviour • Addresses root causes of risky behaviour	• Primarily targets gang-related issues • Limited direct impact on drink-driving behaviours
Brief Strategic Family Therapy (BSFT)	• Short-term structure is practical and accessible • Emphasizes communication to address drink-driving behaviours	• Limited depth of change for severe cases • Families may need more intensive or ongoing support
Familias Unidas	• Culturally relevant design aligns with Hispanic family values • Boosts engagement and effectiveness	• Limited applicability to non-Hispanic families • Requires culturally competent facilitators
We R Native	• Culturally specific for AI/AN families • Promotes connection and sustainability	• Only applicable to AI/AN populations • Effectiveness depends on alignment with traditional practices
Families Preparing a New Generation (FPNG)	• Focuses on parental monitoring and communication • Equips parents to prevent risky behaviours	• Limited access without trained facilitators • Requires ongoing parental commitment
Parenting Skills Training (PST)	• Enhances parental monitoring and involvement • Focuses on positive reinforcement and discipline • Discourages risky behaviours	• Dependent on parental engagement • Resource-intensive structure limits accessibility
Positive Parenting Programme (Triple P)	• Flexible and adaptable to family needs • Offers online and community-based resources	• Requires parental commitment • Tiered structure may be time-intensive

Increasing accessibility, incorporating digital components, using hybrid delivery, engaging schools and community centres, and emphasizing long-term engagement are recommended as ways to enhance and improve the effectiveness of family-based interventions:

1. **Incorporating Digital Components**: Leveraging digital platforms can bring these programmes directly into the homes of families who may otherwise find it challenging to attend in-person sessions. For instance, programmes like Parenting Wisely, which deliver parenting guidance through interactive, digital content, allow parents to complete sessions at their own pace. Digital tools such as mobile apps, webinars, or online modules make learning convenient and can accommodate families' busy schedules.

2. **Using Hybrid Delivery Models**: Offering a mix of in-person and digital resources allows families to choose a format that best suits their lifestyle. This hybrid approach can include online workshops paired with optional in-person group meetings or individual family sessions, creating flexibility while providing some level of personal interaction.

3. **Engaging Schools and Community Centres**: Partnering with schools and local community centres to deliver these programmes can also increase access. By using spaces familiar to families, programmes can help reduce transportation barriers and encourage participation through trusted community settings.

4. **Emphasizing Long-Term Engagement**: To maintain the advantages of family-based programmes, it is crucial to keep families engaged even after the initial intervention period. Without ongoing support, families may find it challenging to retain the skills and habits they developed during the programme significantly as their children grow older and encounter new challenges related to drink-driving.

3.3 Community-based Interventions

Community-based prevention strategies play a crucial role in reducing youth drinking and driving behaviour. These approaches emphasize the importance of collaborative efforts among local organizations, families, schools, and public services. By addressing multiple factors—such as individual choices, community dynamics, and peer influences—community-based interventions provide an effective way to tackle various challenges related to this issue (D'Amico et al., 2009).

In this section, we define community-based interventions as initiatives by entire communities to benefit everyone within that community. Community-level programmes often blend education with environmental strategies to reduce alcohol misuse and its associated consequences, such as drink-driving.

These programmes utilize various tools, including school-based curricula, social media campaigns, and outreach efforts designed to engage youth in active learning about the personal, social, and legal repercussions of drink-driving.

Studies indicate that social and cultural contexts significantly shape health behaviours, such as alcohol consumption, within societies (Anderson et al., 2018). For example, Greene and colleagues examined how various aspects of rural America's landscape and culture promote and deter drinking and driving among young people (Greene et al., 2018).

Their findings emphasize the importance of exploring the underlying and broader factors contributing to drinking and driving. Additionally, they suggest that future research and interventions consider the complex interplay between cultural values and environmental influences in shaping the risky health behaviours observed in rural communities.

Furthermore, evidence from community interventions demonstrates their effectiveness in changing youth attitudes and behaviours. These initiatives often utilize tools like parental involvement and media outreach to reinforce anti-drinking and driving messages (Imm et al., 2018).

3.3.1 Education and Awareness Campaigns

The goal of these interventions is to raise awareness about the dangers of drinking and driving while educating the public on how to make safe choices. These programmes provide educational materials, workshops, and outreach initiatives in schools that highlight the risks associated with drink-driving and its effects on health, families, and communities. Additionally, the programmes emphasize developing decision-making skills in young people. Some examples include:

a) Know your limits

This initiative, launched by the Canadian Centre on Substance Use and Addiction, offers tips and guidance for individuals who are thinking about reducing their alcohol consumption to a lower-risk level. This self-help resource can be used

independently or with the support of a health-care provider (Canadian Centre on Substance Abuse and Addiction, 2023).

b) Rethinking Drinking

The National Institute on Alcohol Abuse and Alcoholism (NIAAA) in the USA has launched a public health initiative that offers evidence-based information about alcohol and its effects on health. This initiative provides tips, tools, and resources for individuals who want to reduce their alcohol consumption or quit drinking altogether (National Institute on Alcohol Abuse and Alcoholism, 2025). This programme offers various resources aimed at helping individuals evaluate and, if necessary, modify their drinking habits. While it mainly focuses on adults, its educational structure and tools can also be advantageous for campaigns that target youth, especially in encouraging safe and informed choices about alcohol consumption.

c) Safe Rides Save Lives

This Australian-based organization encourages people to plan for safe transportation options, such as designating a sober driver, using ride-share services, or participating in community-organized ride programmes. This campaign typically involves community advertisements, social media engagement, and incentives for responsible behaviours.

d) Host educational strategies

Host-based approaches have been the most widely adopted in community-based prevention efforts. These strategies focus on influencing the decision-making of drinkers or drug users or on delaying the initiation of alcohol and drug use. The underlying idea behind educational strategies targeting the host is that, with adequate information or personal support, individuals will make more informed and responsible decisions regarding alcohol use.

Host educational strategies typically fall into two categories: (1) public education campaigns that utilize mass media, printed resources, and verbal communication, such as information shared by health professionals, and (2) targeted communication aimed at specific groups, such as school children drink-driving, or pregnant women drink-driving (Pentz et al., 1989; Hansen, 1993).

The other advantage of Host educational strategies is that they are generally well-accepted and can be implemented without resistance. They tend to be "non-confrontational," except in cases where the information provided contradicts the community's cultural values and norms.

3.3.2 Reality-Check simulations

Some communities implement programmes where realistic simulations of crash scenes are staged in high schools to demonstrate the life-threatening consequences of drink-driving. These emotional events, often involving local law-enforcement, health-care workers, and student actors, aim to leave a lasting impact on participants. Examples of simulations include:

a) Every 15 Minutes

"Every 15 Minutes" is a uniquely impactful programme designed to highlight the severe consequences of impaired driving through immersive, emotional simulations. Staged to mimic real-life incident scenarios, this initiative brings visceral, lasting awareness to teenagers and their families about the dangers of driving under the influence (City of Santa Rosa, 2025).

Although the crash scenes are dramatized, their emotional responses are genuine, enhancing the programme's effectiveness in fostering a deep, personal understanding of road safety risks. The programme is supported by a central information hub that serves communities worldwide and facilitates the global sharing of resources and insights related to the initiative.

b) Virtual Reality-Based Drink-driving Educational Tool

A recent study describes the development of a virtual reality (VR) app that mimics the effects of alcohol on a driver. By applying graphical filters and time delays, this study created a simulation that allowed participants to experience the effects of alcohol impairment.

Twenty volunteers, aged between 18 and 60 years (mean age 25.5 ± 11.6), participated in the evaluation. Data collection focused on concentration times, reaction speed, and object observation during both alcohol-simulated (impaired) and non-simulated (unimpaired) conditions (Masterton and Wilson, 2024).

c) Mothers Against Drink-driving (MADD)

This programme allows offenders to hear from families impacted by drink-driving tragedies. These panels use firsthand stories to make a profound emotional impression, showing offenders the devastating effects of their actions on others.

3.3.3 Empowering Communities Through Working on Social Norms and Behaviour Change Theories

These initiatives use social modelling based on behaviour change theories to shift community norms around drink-driving. These Community-based interventions that used behaviour change theories as their theoretical background to address drink-driving found a positive impact of using these theories to teach young drivers about the perils associated with drink-driving.

Yousef and colleagues assessed Emotional Appeals Effectiveness in anti-drink-driving advertisements. They argued that the Theory of Reasoned Action (TRA) has a solid predictive utility in explaining drink-driving intentions. Also, they found that the combination of both positive and negative emotional appeals was more effective in changing drink-driving attitudes among communities, norms, and intentions of young adults (Yousef, Dietrich, and Torrisi, 2021).

Their assertion suggests that community-based interventions should integrate these emotional strategies into their campaigns. For positive appeals, community programmes should share success stories of individuals who made safe choices, creating aspirational messages. Also, for negative appeals, community outreach programmes should use storytelling or visual media (e.g., videos and posters) to evoke strong emotional responses and convey the seriousness of the issue. Some examples of community-based interventions include:

a) Responsible Redlands

This is an initiative that implements several measures, including the adoption of a social host and deemed-approved local ordinance, conducting minor-decoy and shoulder-tap operations, increasing sobriety checkpoints and saturation patrols, providing responsible beverage service (RBS) training, utilizing identification scanners to detect fraudulent identification, and launching a publicity campaign encouraging community members to report noisy drinking gatherings (Fell et al., 2018).

b) Saving Lives Programme (SLP)

The SLP established community task forces in six mid-sized towns in Massachusetts to address drink-driving and enhance traffic safety. These task forces, composed of private citizens and representatives from various city departments (such

as schools, police, health, and recreation), were coordinated by a full-time municipal-based leader.

Rather than state or federal agencies, the communities designed most of the programme's initiatives. The task forces implemented a range of interventions, including media advocacy campaigns, business outreach programmes, awareness days focused on speeding and drink-driving, speed watch hotlines, peer-led education in high schools, alcohol-free prom nights, college prevention efforts, increased police enforcement, responsible beverage service training, alcohol outlet monitoring, and keg registration.

3.3.4 Effectiveness

The findings highlight the relative differences in rates between the intervention sites and the matched comparison sites, specifically for nighttime injury crashes, DUI related crashes, daytime crashes, hospitalized assault cases, and the proportion of violent assaults reported.

The results also indicate reductions in both the amount of alcohol consumed and the variability in drinking patterns, as well as a decrease in self-reported instances of driving under the influence or over the legal limit. While there was a statistically significant rise in the percentage of respondents who reported drinking in the intervention sites compared to the comparison sites (from 65% to 66%), this was coupled with notable reductions in the average amount of alcohol consumed per occasion and the variability in those amounts' factors linked to heavy drinking.

The critical point about community interventions is that they ought to be considered multicomponent programmes if we aim to achieve the highest level of influence. Thus, these programmes must simultaneously tackle various protective and risk factors, including those at the individual, peer, family, school, community, and societal levels.

Comprehensive programmes generally produce more significant and lasting effects compared to other approaches. This may be due to the ability of multicomponent community programmes to address multiple influences on youth drug use (such as peer, family, school, and societal norms) simultaneously and to offer more sustained programme exposure than single-component interventions.
Building effective community-based youth drink-driving prevention programmes

requires a comprehensive approach integrating multiple strategies. Based on the strengths and limitations of the interventions we reviewed, here are some key recommendations:

a) Combining Emotional Appeals with Long-Term Support

Community programmes can integrate emotional appeals with sustained engagement. Programmes like Every 15 Minutes use high-impact, emotional simulations that create a powerful initial impression. However, these need to be followed by regular, less intense engagements to reinforce the message over time. For example, running yearly simulations or campaigns, coupled with monthly or quarterly workshops, support groups, or discussion sessions where youth can reflect on and discuss what they have learned, can be an influential combination.

b) Incorporating digital and interactive tools

Another effective method is using digital tools, such as online resources from Rethinking Drinking and VR-based tools, to provide accessible, immersive learning experiences. While entertaining, digital resources make information readily available and provide constant reminders and educational reinforcements. An example can be developing a mobile app or website that includes self-assessment tools, local resources for ride-sharing or sober-driving programmes, or creating a VR-based drink-driving simulation for an immersive experience.

c) Engaging Local Leaders

As seen in programmes like MADD and Responsible Redlands, community support can be impactful for young adults. These programmes can foster a supportive environment that promotes responsible behaviour by involving local leaders, influencers, and peers. To this end, one example can be recruiting community influencers (e.g., student leaders and local youth icons) to promote drink-driving prevention messages. Organizing community events where these leaders speak about the importance of safe driving and share personal stories has the potential to build positive behaviours.

d) Continuous Evaluation and Improvement

Programmes can incorporate ongoing evaluations to measure effectiveness and make necessary adjustments. This approach ensures that the programme adapts to

emerging trends and challenges. To this end, conducting regular surveys for focus groups or interviews with participants and stakeholders to assess the programme's impact can be impactful. Then, feedback can be used to refine the approach, add new components, or focus on areas where improvement is needed.

e) Incorporating Positive Reinforcement and Rewards

Another powerful method is to encourage responsible behaviour by rewarding positive choices, similar to programmes that provide incentives for responsible decisions. Rewards and recognition can reinforce safe behaviour, especially among youth. For instance, implement a reward system where youth receive discounts, vouchers, or recognition for making safe transportation choices. Partner with local businesses to offer these incentives, including restaurant discounts, event tickets, or merchandise.

Table 17. Effectiveness, strengths, and limitations of community-based programmes

Intervention	Strengths	Strengths	Limitations
Know Your Limits	• Helps understand alcohol tolerance. • Reduces the likelihood of impaired driving.	• Promotes self-awareness and responsibility. • Accessible and personal.	• Misjudgement of limits in high-stress or social settings. • Peer pressure affects decisions.
Rethinking Drinking	• Provides self-assessment tools. • Educates on healthy drinking habits.	• Interactive online tools for reflection. • Private and easily accessible.	• Low engagement for non-help seekers. • Limited for those without internet access.
Safe Rides Save Lives	• Emphasizes the importance of safe rides home. • Reduces drink-driving incidents.	• Offers practical solutions (e.g., ride-shares). • Raises awareness about planning.	• Dependent on transportation availability. • Cost barriers in rural areas.

Intervention	Strengths	Strengths	Limitations
Host Educational Strategies	• Encourages safer social gatherings. • Reduces drink-driving by providing alternatives.	• Shifts responsibility to hosts. • Builds a communal prevention approach.	• Relies heavily on hosts' cooperation. • May fail if guests resist suggestions.
Every 15 Minutes	• Discourages drink-driving among teens. • Simulates real-life crash impacts.	• Visually impactful and memorable. • Highlights real-life consequences effectively.	• High cost and time-intensive. • Emotional impact fades over time.
VR-Based Drink-driving Educational Tool	• Demonstrates impaired driving dangers. • Allows risk-free experience of outcomes.	• Highly engaging and interactive. • Effective for younger audiences.	• High cost of VR technology. • Less effective without broader education.
Mothers Against Drink-driving (MADD)	• Advocates for strict policies. • Raises awareness and supports victims.	• Reputable organization with broad reach. • Compelling victim stories inspire action.	• Regional effectiveness varies. • Limited by funding and volunteer dependency.
Emotional Appeals	• Alters attitudes through ads and campaigns. • Uses fear, humour, or empathy to engage.	• Creates lasting impressions. • Engages youth effectively.	• Fear-based content may desensitize audiences. • Humour might not be taken seriously.
Responsible Redlands	• Reduces alcohol-related harm. • Focuses on education, policy, and community involvement.	• Strong community accountability. • Incorporates multiple prevention strategies (e.g., checkpoints).	• Depends on community participation. • Challenging to scale beyond local regions.
Saving Lives Programme (SLP)	• Combines education, law-enforcement, and activism. • Reduces drink-driving incidents.	• Comprehensive integration of prevention strategies. • Combines personal awareness and policy initiatives.	• Resource-intensive. • Dependent on local collaboration.

Chapter 4

Summary of Key Recommendations

Research indicates that effectively preventing harmful alcohol use among youth requires three essential skills: 1) an understanding of adolescent development and the principles of youth-adult partnerships; 2) the ability to integrate this knowledge into the design and execution of programmes; and 3) the use of relational practices that empower young people by involving them in decision-making processes (Ballard et al., 2023).

Three types of interventions—peer-led, family engagement, and school-community partnerships—have proven effective in reducing risky behaviours related to alcohol consumption before driving. By involving multiple stakeholders, these initiatives create a comprehensive support network that promotes positive behaviours and helps prevent drink-driving incidents among youth.

To enhance the effectiveness of **Peer-Led Interventions** programmes aimed at preventing drink-driving, the following recommendations can be considered:

- Integrate Corrective Norms Messaging: Since young people often misjudge their peers' drinking behaviours, incorporating real-time, data-backed social norms can correct these misconceptions and help reduce risky behaviours.
- Incorporate Interactive and Relatable Elements: Storytelling, role-playing, and real-life testimonials should be included to make the risks of drink-driving more relatable. Interactive workshops that utilize real peer experiences can significantly increase engagement.
- Utilize a Personalized, Skill-Building Approach: Skill-building sessions should be tailored to individual participants, such as those focused on refusal skills and pacing techniques. Programmes that prompt self-reflection on personal behaviours, like BASICS, can provide stronger reinforcement.
- Commit to Long-Term Engagement: To achieve sustained impact, implement a follow-up structure. Continued contact, support groups, or periodic refresher sessions will reinforce learned behaviours and help discourage relapses.

To enhance the effectiveness of **Family-Based Interventions** programmes aimed at preventing drink-driving, the following recommendations can be considered:

- Incorporating Digital Components: Leveraging digital platforms can bring these programmes directly into the homes of families who may otherwise find it challenging to attend in-person sessions. For instance, programmes like Parenting Wisely, which deliver parenting guidance through interactive, digital content, allow parents to complete sessions at their own pace. Digital tools such as mobile apps, webinars, or online modules make learning convenient and can accommodate families' busy schedules.

- Using Hybrid Delivery Models: Offering a mix of in-person and digital resources allows families to choose a format that best suits their lifestyle. This hybrid approach can include online workshops paired with optional in-person group meetings or individual family sessions, creating flexibility while providing some level of personal interaction.
- Engaging Schools and Community Centres: Partnering with schools and local community centres to deliver these programmes can also increase access. By using spaces familiar to families, programmes can help reduce transportation barriers and encourage participation through trusted community settings.
- Emphasizing Long-Term Engagement: To maintain the advantages of family-based programmes, it is crucial to keep families engaged even after the initial intervention period. Without ongoing support, families may find it challenging to retain the skills and habits they developed during the programme significantly as their children grow older and encounter new challenges related to drink-driving.

To enhance the effectiveness of **Community-Based Interventions** programmes aimed at preventing drink-driving, the following recommendations can be considered:

- Combining Emotional Appeals with Long-Term Support: Community programmes can integrate emotional appeals with sustained engagement. Programmes like Every 15 Minutes use high-impact, emotional simulations that create a powerful initial impression. However, these need to be followed by regular, less intense engagements to reinforce the message over time. For example, running yearly simulations or campaigns, coupled with monthly or quarterly workshops, support groups, or discussion sessions where youth can reflect on and discuss what they have learned, can be an influential combination.
- Incorporating Digital and Interactive Tools: Another effective method is using digital tools, such as online resources from Rethinking Drinking and VR-based tools, to provide accessible, immersive learning experiences. While entertaining, digital resources make information readily available and provide constant reminders and educational reinforcements. An example can be developing a mobile app or website that includes self-assessment tools, local resources for ride-sharing or sober-driving programmes, or creating a VR-based drink-driving simulation for an immersive experience.
- Engaging Local Leaders: As seen in programmes like MADD and Responsible Redlands, community support can be impactful for young adults. These programmes can foster a supportive environment that promotes responsible behaviour by involving local leaders, influencers, and peers. To this end, one example can be recruiting community influencers (e.g., student leaders and local youth icons) to

promote drink-driving prevention messages. Organizing community events where these leaders speak about the importance of safe driving and share personal stories has the potential to build positive behaviours.

- Continuous Evaluation and Improvement: Programmes can incorporate ongoing evaluations to measure effectiveness and make necessary adjustments. This approach ensures that the programme adapts to emerging trends and challenges. To this end, conducting regular surveys for focus groups or interviews with participants and stakeholders to assess the programme's impact can be impactful. Then, feedback can be used to refine the approach, add new components, or focus on areas where improvement is needed.
- Incorporating Positive Reinforcement and Rewards: Another powerful method is to encourage responsible behaviour by rewarding positive choices, similar to programmes that provide incentives for responsible decisions. Rewards and recognition can reinforce safe behaviour, especially among youth. For instance, implement a reward system where youth receive discounts, vouchers, or recognition for making safe transportation choices. Partner with local businesses to offer these incentives, including restaurant discounts, event tickets, or merchandise.

Conclusions

This meta-analysis and thematic review sought to examine critical patterns in the consumption of alcohol among youth and how it relates to DUI, aiming at understanding age-related behaviours and regional differences, factors that may contribute to alcohol-related crashes, and the effectiveness of various interventions that were made by families, community or government. It combined a meta-analysis with a thematic review to show depth in the complexity of youth DUI and provide an overall understanding of individual and societal factors influencing these behaviours.

Results indicated apparent variations between age groups and across different geographic regions. Rates of DUI were higher in urban areas compared to rural areas. Predictably, the youngest drivers, primarily aged 15 to 19, showed increased DUI shortly after reaching the legal drinking age.

Interventions to reduce these behaviours have varied success levels. Whereas some educational programmes and strict law-enforcement and policy measures were successful in immediately bringing down DUI rates, motivational interventions were small but yielded long-term results. Community strategies focusing on enforcement have successfully lowered the rates over time.

These findings suggest that the differential targeting of at-risk youth is a function of age and geographic location. The overall study shows complex interactions between the social context, access to alcohol, and enforcement; these suggest that targeted prevention efforts must be equally multifaceted. Individual behaviour modification, family participation, education, and policy enforcement are fundamental aspects in reducing the incidence of events concerning DUIs involving young drivers.

Several strengths can be discerned from this study, which has collected extended data to comprehensively understand youth behaviour regarding DUI with more robust statistical methods, such as random-effects modelling. Accordingly, this methodology addressed the heterogeneity among the reviewed studies.

These findings compare to the existing literature and further strengthen the effectiveness of stringent legal measures in place that help in curbing the DUI behaviour of youths. The study builds on the work of previous studies by underlining how the level of success varies across regions and different age groups.

The findings justify the need for more localized and contextually appropriate community-based interventions since one-size-fits-all interventions might have a minimal scope.

The implications for policy and practice are significant. Policymakers may consider focusing law-enforcement efforts in urban areas, where DUI rates tend to be higher, while rural areas have more significant needs for educational outreach and motivational programmes.

These might be embedded in new technology-based interventions, such as mobile apps providing real-time feedback for young drivers, which can further improve the effectiveness of these strategies in preventing impaired driving.
Future research should also be directed to the less-researched area of poly-drug use and its interaction with alcohol in contributing to impaired driving. Managing long-term follow-ups of various interventions is a must and is especially needed in rural areas with minimal resources for DUI prevention.

Investigation into psychological and cultural factors (which are remarkably diverse in this matter in different countries) in shaping youth behaviour regarding alcohol and driving would yield more profound insights into the crafting of effective prevention strategies.

Finally, this study puts the needed emphasis on tailored, multifaceted interventions to comprehend youth DUI better. Incidents of driving under the influence among young drivers will be reduced through a combination of legal, educational, and community-based strategies that address the causes and risks of driving while intoxicated. Young drivers should be protected by diverse, context-specific approaches, with the need to minimize the broader impacts of DUI in society.

While this study yields crucial insights into intervention approaches targeting DUI incidents among youth, recognizing the study's limitations is essential for accurate interpretation and meaningful future research directions (Appendix 2).

Future research should address these limitations by adopting more standardized definitions, developing consistent measurement tools, enhancing methodological rigor, and analysing interventions over the long-term across varied cultural

and geographic settings. Such approaches would strengthen the reliability and applicability of findings for guiding future DUI prevention efforts among youth.

Moving forward, continuous evaluation and refinement of DUI prevention programmes will be necessary to adapt to emerging trends and challenges. Incorporating real-time data collection, user feedback, and policy adjustments will enhance the effectiveness of interventions. Strengthening collaborations among governments, educational institutions, health-care providers, and community organizations will further bolster efforts to curb alcohol-impaired driving among youth. By sustaining commitment and innovation in DUI prevention, societies can work towards creating safer roads and healthier communities for future generations.

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Appendices

Appendix 1. Methodology

This study used a mixed-methods approach that combines existing literature insights with social media data. A meta-analysis and systematic review were conducted to synthesize the current scientific knowledge on crucial research questions. Following this, machine learning techniques and extensive LLM were employed to analyse selected social media data, focusing on public discourse, sentiments, and patterns related to drink-driving. This section provides a brief overview of the methodologies utilized in the study.

1.1 Meta-Analysis and Systematic Review

A meta-analysis and systematic review were conducted to examine the impacts of alcohol-related incidents on youth, following the guidelines outlined in PRISMA. Comprehensive Meta-Analysis (CMA) version 3 was utilized, as it is considered the most appropriate software for performing the required analyses. The outcomes and the final sample for the meta-analysis and thematic analysis were employed to address the relevant research questions. A systematic content analysis was conducted by thoroughly reviewing the texts of the selected articles after the selection process was completed to explore these questions further.

1.1.1 Search Strategy

English articles published between 2004 and 2024 in PubMed, Scopus, and ISI Web of Science were searched. The search terms used included: “adolescents” OR “youth,” OR “underage” OR “young,” OR “DUI” OR “driving under the influence” OR “impaired driving” OR “drink-driving” OR “driving while intoxicated” OR “alcohol” OR “ethanol” OR “alcoholic beverages” OR “spirits” OR “liquor” OR “alcohol consumption” OR “alcohol intake” OR “drinking behaviour” OR “alcohol use” OR “alcohol ingestion” OR “alcohol-impaired driving” OR “underage drinking” OR “drink-driving behaviour by age” AND “policy” OR “intervention.” The searches were conducted in October 2024, and terms were tailored for each database to ensure comprehensive retrieval of all relevant articles. In addition to the electronic searches, we cross-checked with prior meta-analyses on alcohol-

related incidents involving youth to identify eligible studies that might have been missed. Table 18 presents the databases, search queries, and the number of papers extracted from each.

Table 18. Summary of database searches for studies on youth alcohol use and impaired driving, including policy and intervention focus

Database	number
PubMed/Medline: ("adolescents" OR "youth" OR "underage" OR "young" OR "DUI" OR "driving under the influence" OR "impaired driving" OR "drink-driving" OR "driving while intoxicated" OR "alcohol" OR "ethanol" OR "alcoholic beverages" OR "spirits" OR "liquor" OR "alcohol consumption" OR "alcohol intake" OR "drinking behaviour" OR "alcohol use" OR "alcohol ingestion" OR "alcohol-impaired driving" OR "underage drinking" OR "drink-driving behaviour by age") AND ((("Policy"[Mesh]) OR "Public Policy"[Mesh]) OR "Drug and Narcotic Control"[Mesh]) AND ("Early Intervention, Educational"[Mesh] OR "Clinical Trial" [Publication Type]))	998
Scopus: (TITLE-ABS-KEY (((policy OR intervention) AND ("adolescents" OR "youth" OR "underage"))) AND TITLE-ABS-KEY (("DUI" OR "driving under the influence" OR "impaired driving" OR "drink-driving" OR "driving while intoxicated" "alcohol consumption" OR "alcohol intake" OR "drinking behaviour" OR "alcohol use" OR "alcohol ingestion" OR "alcohol-impaired driving" OR "underage drinking" OR "drink-driving behaviour by age")))	245
ISI Web of Science: TI= ((policy OR intervention) AND ("adolescents" OR "youth" OR "underage")) AND TS= ("DUI" OR "driving under the influence" OR "impaired driving" OR "drink-driving" OR "driving while intoxicated" "alcohol consumption" OR "alcohol intake" OR "drinking behaviour" OR "alcohol use" OR "alcohol ingestion" OR "alcohol-impaired driving" OR "underage drinking" OR "drink-driving behaviour by age")	357
National Library of Medicine Clinical Trials	1

1.1.2 Eligibility Criteria and Data Collection

Studies were deemed eligible for inclusion in our study if they met the following criteria: (1) the participants were classified as youth, typically aged between 15 and 25; (2) the studies specifically addressed behaviours related to drink-driving or the impacts of such behaviours on road traffic crashes; (3) both quantitative and qualitative research designs were accepted, provided they yielded numerical outcomes for the meta-analysis phase; (4) the studies were published as peer-reviewed journal articles, conference papers, or credible grey literature; and (5) research conducted in various geographical locations was included to capture the differential impacts across diverse contexts.

Studies were excluded if they met at least one of the following criteria: (1) the focus was not on youth; (2) the research did not specifically investigate drink-driving behaviours or their consequences; (3) the studies were published in a language other than English; and (4) full-text articles were not accessible online or through requests to the corresponding authors or local library document delivery services.

Data was extracted using standardized data extraction forms for the selected studies. Extracted information encompassed relevant study details, including authorship, publication year, geographical location, study design, and sample size. Additionally, population characteristics such as mean age, gender distribution, and study setting were recorded. Furthermore, the incidence of outcomes related to DUI among youth was noted for each study population.

1.1.3 Synthesis of Results

In this study on patterns and interventions to reduce DUI among youth, data from various studies were standardized to enable comparisons and produce a final effect measure. The reviewed data included independent groups (mean values and standard deviations), cohort 2x2 tables with rates, cohort 2x2 tables with events, correlations with standard errors, and p-values for correlations. Due to the diverse nature of the original studies, different formats were required for analysis. Specifically, the data formats included independent group data from seven studies, cohort data with rates from nine studies, and cohort data with events from nine studies. Additionally, correlation and standard error data were available from three studies, while a single study provided a p-value for correlation. The reviewers, extracted or calculated odds ratios when they were not explicitly provided. When necessary, they also contacted the authors of related studies for further information. This comprehensive approach allowed a thorough analysis of how study design, quality, and outcome variables influenced the final risk estimates.

The CMA software was utilized to estimate individual and overall effect sizes through meta-analyses using random-effects modelling. Hedges's g was chosen to measure effect size due to its alignment with best practices in humanities research and its ability to facilitate comparison with future studies. The analysis aimed to determine whether the interventions significantly impacted the rates of DUI among youth while also allowing for a comparative assessment of the relative effectiveness of these interventions across different settings.

1.2 Sentiment Analysis and Topic Modelling

Social media users' opinions, comments, and reviews regarding policies, subjects, news, products, and services generate a vast amount of data. Sentiment analysis can process this data, providing valuable insights into public perceptions, opinions, thoughts, and impressions (Wankhade et al., 2022). Machine learning and large language model (LLM) processing methods, such as sentiment analysis and topic modelling, can examine drink-driving behaviour and patterns by analysing social media data.

1.2.1 Sentiment Analysis

Sentiment Analysis leverages advanced text mining and NLP techniques to identify and extract subjective information from textual data (Wankhade et al., 2022). SA is widely utilized by businesses, governments, and private organizations for applications such as reputation management, market research, competitor analysis, service and product evaluation, and capturing customer feedback. The SA can be conducted at multiple levels, including document, sentence, phrase, and aspect (Wankhade et al., 2022).

Data for SA is often sourced from websites, social media platforms, and news outlets. The primary objective of SA is to classify public sentiments about a phenomenon into categories such as positive, neutral, and negative. Positive emotions are typically associated with joy, happiness, satisfaction, and love, while negative emotions reflect sadness, depression, and anger. Once data is collected, sentiment classification is performed to analyse natural language outputs, identify essential claims or opinions, and classify them based on emotional attitudes (Wankhade et al., 2022). There are three main approaches to conducting SA: the Lexicon-Based Approach, the Machine Learning Approach, and the Hybrid Approach.

Sentiment in a document can be quantified using the following formula:

$$S = \frac{\text{neg} - \text{pos}}{\text{neg} + \text{pos} + \text{neu}}$$

Where neg is the number of negative keywords, pos is the number of positive keywords, and neu is the number of neutral keywords in the document (Spinczyk et al., 2018).

SA is a highly effective tool for addressing issues related to DUI. DUI-related news, behaviours, services, policies, and interventions are frequently discussed on social media. SA enables policymakers at various levels to gauge public sentiment toward these topics. It provides valuable insights into the attitudes and emotions, both positive and negative, expressed by the public, particularly among youth. Additionally, SA helps policymakers understand the polarity of sentiments, the subjects of discussion, and the individuals or groups expressing specific opinions or emotions. This information can inform more effective interventions and policy decisions regarding DUI matters.

The following steps are often followed in conducting a sentiment analysis: 1) data source or platform representing the domain is chosen, i.e., Reddit or YouTube; 2) data is scraped from the source using data scraper tools to gather content from the platform source; 3) collected data is pre-processed and cleaned for analysis; 4) one or a mix of methods including corpus-based, machine learning-based, dictionary-based are used to analyse the data; 5) sentiment analysis is undertaken to extract insights the emotional tones in the data (Meghana, 2024).

1.2.2 Topic Modelling

Topic Modelling is a powerful technique developed to analyse and extract meaningful insights from large textual datasets. TM is a statistical method that helps identify events, concepts, or topics discussed in texts. Its goal is to uncover underlying variables in large datasets (Blei, 2012). Topic modelling focuses on three key elements: constructs (essential components of texts such as words), collections (groups of related words), and topics (clusters of constructs that form a coherent semantic meaning). By observing the co-occurrence of constructs within a collection, topic models can reveal hidden structures in the data. The major categories of TM

techniques include algebraic, fuzzy, probabilistic, and neural approaches. In recent years, the rise of social media has spurred the development of numerous tools and methods to organize, interpret, and summarize large volumes of textual information. Among these, the LDA has emerged as one of the most widely used and practical approaches for topic modelling (Vayansky & Kumar, 2020). LDA models identify various topics in a text collection and determine the proportion of each topic within an individual document.

Topic modelling techniques are evaluated using several criteria: diversity, coherence, stability, efficiency, and flexibility. Diversity refers to the semantic variety of the generated topics. Coherence describes the logical consistency of words within topics. Stability measures the reliability of topic rankings across multiple model iterations. Efficiency is related to the computational complexity of the model. Finally, flexibility refers to the ability to handle diverse data types and varying levels of preprocessing.

Topic modelling is invaluable in analysing DUI-related data on social media. It enables researchers to identify and understand the critical discussions and themes emerging from public discourse. The following steps were undertaken in conducting the topic modelling study: 1) Spanish posts were translated into English using the Google Translate API; 2) the posts were pre-processed by lemmatizing and tokenizing the text and removing stop words; 3) The TF-IDF method was applied to weigh the importance of terms; 4) It was determined that setting the number of topics to five maximized coherence; and finally, 5) the LDA model, implemented using the Sci-Kit Learn Python package, was to group the posts into five distinct topics.

1.3 Data Collection

1.3.1 Reddit Data

Reddit data examined public opinions, concerns, and fears surrounding drink-driving. Reddit is one of the most prominent social platforms, boasting 52 million daily active users (Reddit.com, 2020a) and over 138,000 active topical communities known as subreddits (Marotti, 2018). Due to its widespread influence and high user engagement, Reddit has increasingly become a valuable data source for researchers (Choudhury and De, 2014; Proferes et al., 2021). Reddit data has been used in many previous studies, but its use on drink-driving is minimal.

This exploratory study selected the Reddit platform primarily because it provides significant anonymity. This anonymity and its permissive content policies encourage users to share their thoughts openly, often resulting in sensitive and candid discussions. Most discussions on Reddit are public and accessible to anyone—except for private subreddits. User-generated content, including original posts and comments, is governed by a voting system. The visibility of content is determined based on these Reddit community votes with posts garnering higher votes reflected in the top-most section of the site.

Demographic data on Reddit users is inherently limited due to the pseudonymous nature of participation. However, according to Reddit's site administrators (Reddit.com, 2021), most users (58%) are between 18 and 34 years old, and 57 per cent are male. Researchers can access Reddit posts, comments, and metadata directly via the platform or its official API. The API is publicly available, free to use, and offers various functions to facilitate data collection and analysis.

Reddit platform has been widely used for sentiment analysis across various domains, including education, health, geopolitics, cyber security, stock market, and emerging technologies (He et al., 2020; Nandurkar et al., 2023; Upadhyay et al., 2023; Savela et al., 2024). For example, Reddit data has been used to analyse sentiment to understand educators' and learners' perspectives regarding online classes (Li et al.,2023). Similarly, Melton et al. (2021) used Reddit data to analyse sentiments and discussion topics about COVID-19 vaccines. Guerra and Karakuș (2023) used sentiment analysis to measure emotions such as hope and fear during the Russia-Ukrainian conflict. Savela et al. (2024) explored people's discussions on Reddit about emerging robotic technologies. Reddit data has also been used to analyse sentiments toward stock trends, demonstrating its predictive potential (Lindskog & Serur, 2020).

In this exploratory study, we focused on South American countries. The following steps were used to collect Reddit data: 1) using the PullPush API [1], 68065 posts were retrieved using various relevant keywords (Table 23). The keywords were in three languages, English, Spanish, and Portuguese, and either hashtags or related to two topics: drinking alcohol and car accidents or crashes; 2) the dataset was filtered to extract the posts directly related to DUI. Only the posts that had keywords from either the hashtags group or both the "drinking alcohol" topic and "car accident" topic were considered valid; 3) posts were cleaned, for example, URLs and mentions were removed; 4) null records were dropped, and 3057 number of valuable posts were left; 5) the language of the posts was identified using the Google Translate API (Google Trans, 2024)]. Table 19 presents the distribution of the remaining posts by country and language.

Table 19. Number of posts of each country for each language

Country	English	Spanish
Argentina	148	890
Brazil	217	0
Dominican Republic	1302	0
Belize	98	0
Bolivia	17	11
Costa Rica	65	1
Cuba	112	0
El Salvador	59	19
Honduras	16	6
Nicaragua	37	4
Panama	43	12
Total	2114	943

1.3.2 Youtube Data

YouTube hosts millions of videos highlighting risky driving behaviours and their serious consequences, such as injuries and fatalities. A subset of those videos focuses on drink-driving incidents, sharing personal stories or witness accounts. This makes YouTube a valuable platform for gathering insights into real-world drink-driving incidents, their consequences, and public reactions and sentiments toward them.

Many researchers have used YouTube data for sentiment analysis and topic modelling in various domains (Drus & Khalid, 2019; Chalkias et al., 2023; Meghana, 2024). Transcripts of YouTube videos and comments made on them offer invaluable insights about the subject matter. YouTube data has been very effective in science communication and public education. In health care, sentiment analysis based on YouTube data has been instrumental in dissecting patient testimonials

and revealing valuable insights into the sentiment dynamics surrounding medical procedures and patient satisfaction (Meghana, 2024).

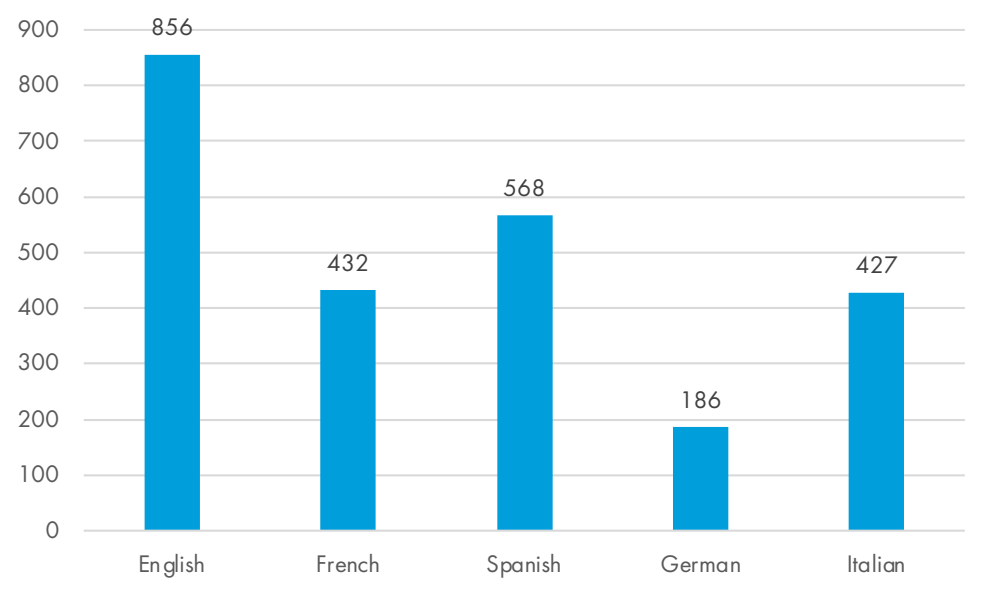
YouTube provides a data API that enables searching for videos using a query while targeting a specific region through the region code parameter. To retrieve videos related to drink-driving in English, French, Spanish, German, and Italian, we used 20 queries (Table 20). When retrieving videos in French, Spanish, German, and Italian, these queries were translated into the corresponding languages, and the region code was set to FR, ES, DE, and IT, respectively.

Table 20. Search queries used for YouTube video retrieval on drink-driving

Query	
Drink-driving the personal story.	Why not to drink and drive
Personal experience with drink-driving	Dangers of drink-driving stories
Survivor story drink-driving	Drink-driving prevention story
My story drink-driving	Teen drink-driving consequences
Drink-driving accident survivor story	Young adult drink-driving story
Consequences of drink-driving	Drink-driving survivors' documentary
Impact of drink-driving	Police interview drunk driver
Drink-driving accident consequences	Stories from drink-driving offenders
Drink-driving life impact	Lost loved one drink-driving story
Drink-driving awareness	Drink-driving impact on youth

Subsequently, the YouTube transcript API Python package and the YouTube Data API's comment Threads endpoint were utilized to retrieve video transcripts and their associated comments using video IDs. This process successfully retrieved 2,610 YouTube videos. Figure 23 provides an overview of the retrieved videos categorized by language.

Figure 23. Number of YouTube videos by language



Number of YouTube videos retrieved by language

The search results retrieved using the YouTube Data API occasionally include unrelated videos, such as those featuring streaming of driving games, despite containing keywords related to drink-driving. To ensure the dataset is free from such irrelevant content, a multilingual opensource Large LLM, Llama3.1-70b in Ollama (https://ollama.com/library/llama3.1:70b), is used as a binary classifier to categorize videos as either "related" or "not related" based on their transcripts. The Llama3.1-70b model was selected due to its superior multilingual performance compared to open-source models of similar scale. Furthermore, to enhance the model's inference speed, we leveraged its 2-bit quantized version, which significantly improved processing efficiency without substantially compromising accuracy. We applied LangChain (https://python.langchain.com/docs/introduction/), an open-source framework for developing applications powered by LLMs. This framework created a processing chain that seamlessly integrates the prompt, the LLM, and a JSON output parser, ensuring that all results are consistently formatted in JSON. Based on their transcripts, the classification process identified 1,204 YouTube videos as relevant to drink-driving. Table 21 provides an overview of these videos, categorized by language.

Table 21. YouTube video transcript classification results

Language	English	French	Spanish	German	Italian
Count	605	116	252	71	160

1.3.3 Data Preprocessing

YouTube video transcripts often contain tags such as [Music] and [Applause], as well as filler words like "um," "uh," and "hmm," which do not provide meaningful information. Additionally, these transcripts frequently lack proper punctuation. Several preprocessing steps were performed on 1,204 YouTube video transcripts and their associated comments to prepare the data for use in the Drink-driving Awareness Tool developed for the purpose of this research paper.

First, the regular expressions (regex) Python package was used to remove filler words and tags like [Music] and [Applause] across all five target languages—English, French, Spanish, German, and Italian. Regex were also used to eliminate emojis from the comments while retaining only emotion-related emojis, as they can help identify the sentiment of the comments.

Next, a multilingual transformer model called "full-stop-punctuation-multilang-large" was used to address the punctuation issues in the transcripts, which is available on Hugging Face. This model, fine-tuned for punctuation restoration, was chosen for its robust performance, achieving a macro-average accuracy of approximately 76 per cent across various punctuation types, including full stops, commas, question marks, colons, and dashes. These preprocessing steps resulted in a refined dataset of 1,204 YouTube video transcripts and comments optimized for contextual information in the LLM prompts.

1.3.4 Retrieval Of Video Region

To finalize the dataset, we retrieved the country where each video was uploaded on YouTube. Since the metadata for individual videos does not directly include the upload country, we adopted a two-step approach. First, we used the YouTube Data API's videos endpoint to fetch the metadata of each video using its video ID, which

provided the associated channel ID. Then, we utilized the channels API endpoint to obtain the upload country based on the channel. Table 22 presents the number of videos categorized by their upload country.

Table 22. YouTube videos uploaded countries and the count

Country	US	IT	FR	DE	MX	CA	GB	ES	PE	CO
Count	415	115	66	55	33	30	24	21	18	17
Country	CL	AR	AU	BE	EC	SV	PY	GT	HK	Other
Count	16	12	9	7	5	5	4	4	3	36

US-United State, IT-Italy, FR-France, DE-Germany, MX-Mexico, CA-Canada, GB-Great Britain, ES-Spain, PE-Peru, CO-Colombia, CL-Chile, AR-Argentina, AU-Australia, BE-Belgium, EC-Ecuador, SV-El Salvador, PY-Paraguay, GT-Guatemala, HK-Hong Kong

1.3.5 Topic Modelling On Youtube Transcripts

Real-world drink-driving incidents featured on YouTube, whether as stories or documentaries, highlight various aspects such as consequences, impacts, behaviours, underlying causes, and prevention strategies. Identifying these key areas is crucial for conducting in-depth investigations to raise public awareness, shape evidence-based policies, and foster a safer driving culture. Consequently, topic modelling was performed using the BERTopic technique. This neural topic modelling approach employs vector clustering techniques and a class-based variation of TF-IDF to generate coherent topic representations.

Semantic chunking was applied to all transcripts categorized to identify textual segments that directly address drink-driving. The semantic chunking technique utilizes embedding similarity to dynamically determine breaks between sentences, ensuring that each chunk comprises semantically coherent sentences. Specifically, LangChain's semantic chunker was used to divide each video's transcript into semantically similar sections by analysing embedding distances between consecutive sentences. A distance exceeding the 95th percentile threshold (the default value in LangChain) signified the start of a new semantic section.

BERTopic leverages sentence embeddings, allowing it to capture the semantics of text more effectively than conventional topic modelling techniques, which often fail to account for semantic meaning. Additionally, BERTopic supports the use of multiple representational models. For this study, KeyBERT, a keyword extraction technique that harnesses BERT embeddings to generate keywords and critical phrases, was utilized alongside an LLM that was instructed to generate meaningful topics based on the keywords identified through the topic modelling process.

The workflow began by encoding all English chunks into embeddings using the bge-large-en-v1.5 pre-trained embedding model from Hugging Face. BERTopic then applied dimensionality reduction using the UMAP technique and clustering with HDBSCAN. Subsequently, the data was fitted into the topic model, and KeyBERT generated topics represented by keywords and their likelihood of occurrence within each topic. These keywords were then passed to the LLM (Llama-3.1-8B-Instruct), which synthesized them into coherent and meaningful topics.

A novel zero-shot topic modelling approach was employed to identify topics using a predefined set while simultaneously uncovering new topics that did not align with the predefined categories. This method provided flexibility in discovering emerging or unforeseen topics. The predefined topics DUI, drink-driving consequences, drink-driving impact on youth, drink-driving consequences on young adults, and drink and drive accidents) were the foundation for zero-shot topic modelling.

1.3.6 Sentiments of The Youtube Transcripts

Conducting sentiment analysis on YouTube video transcripts provides valuable insights into the emotional tone and underlying sentiments expressed in stories and documentaries about drink-driving. This analysis helps us understand how these narratives resonate with audiences.

The previously collected dataset of 1,204 YouTube videos on drink-driving was used to gain a deeper understanding. For this analysis, the 2-bit quantized multilingual LLaMA 3.1:70B model provided by Ollama was utilized. A Declarative Self-improving Python (DSPy) framework was used, which allows the construction of modular AI systems by defining input-output behaviour through signatures and prompting techniques. The DSPy then expands these signatures into detailed prompts.

In this sentiment analysis, a DSPy's class-based signature with "Positive," "Negative," and "Neutral" as sentiment options was used, combined with chain-of-thought (CoT) prompting. CoT was specifically chosen to enhance the language model's reasoning capabilities, thereby improving the accuracy and confidence of the sentiment classification. This approach enabled the researchers to evaluate the sentiment of each YouTube transcript, along with the reasoning behind the sentiment classification and the associated confidence score.

Appendix 2. Analyses

2.1 Meta-Analysis

2.1.1 Selection of Studies

The literature search identified 1,173 studies from databases including PubMed (571), Web of Science (357), and Scopus (245) and one from the registry of clinical trials (registry of clinical trials). After removing 71 duplicate records, 1,102 studies were screened, excluding 1,020 based on relevance. Overall, 82 reports were retrieved and assessed for eligibility. Of these, 60 were excluded, leaving 22 studies included in the final review. This revised version integrates the specific numbers and details from the PRISMA flowchart. Additionally, another study was excluded after data extraction because it contained duplicate data from a previous paper, with a final number of 21 unique studies. Some of the studies presented more than one intervention. Since we focus on interventions and their impact on DUI among youth, we put each intervention in a different row in the meta-analysis. We used this sample for the meta-analysis and the thematic analysis to answer the research questions (Figure 24).

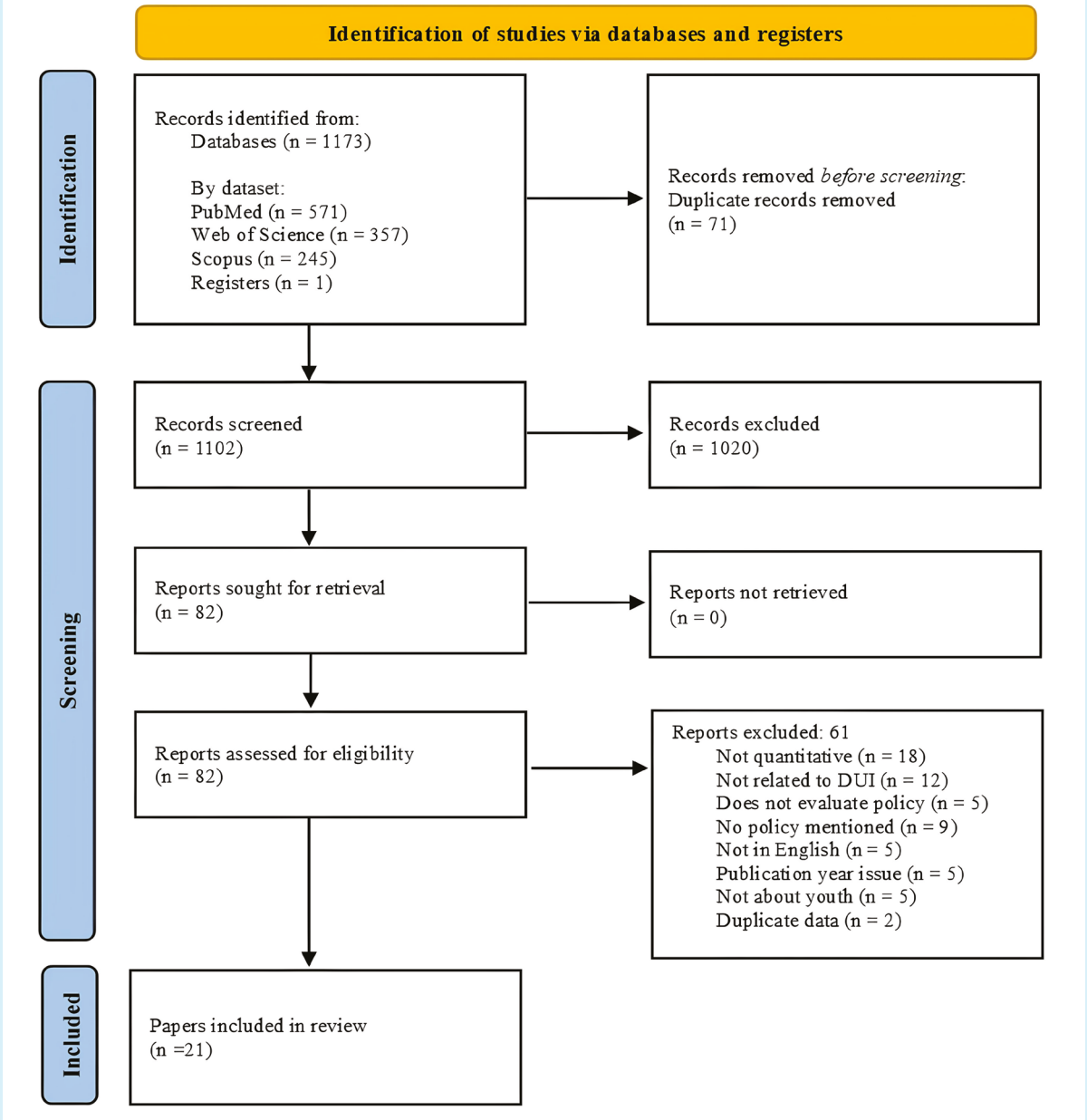
2.1.2 Quality and Characteristics of Included Studies

Each study scored seven or higher on the nine-point Newcastle-Ottawa Scale, indicating high methodological quality (Table 25). Our analysis revealed some variability among the studies we addressed using random effects models in the meta-analyses (Table 5). These results can be generalized to youth-focused DUI patterns and prevention efforts.

The meta-analysis focused on studies examining youth (typically aged 15-25) involved in road traffic crashes due to DUI of alcohol. Only studies that assessed interventions aimed at preventing or reducing DUI behaviour among youth, with quantified effects of alcohol consumption on driving performance, were included. Studies that evaluated the effects of DUI from both alcohol and other substances, such as cannabis, or those lacking quantifiable DUI effects were excluded. The analysis utilized data specifically related to changes in DUI behaviour among youth from various articles.

The studies included in this review employed diverse methodologies, encompassing case-control designs and randomized clinical trials. Interventions studied ranged

Figure 24. PRISMA Flow Diagram



PRISMA Flow Diagram Illustrating Study Selection Process for Systematic Review on DUI Interventions Targeting Youth based on (Page et al., 2021)

from educational programmes and public policies targeting youth drink-driving to law-enforcement initiatives and community-based efforts, all aimed at reducing DUI-related crashes among young drivers. The studies were conducted across multiple countries and utilized various data sources, including police reports, hospital records, self-reports, and official government data related to DUI incidents. All selected studies directly measured the impact of alcohol-related interventions on youth driving behaviour and the incidence of traffic incidents.

Across the studies, DUI rates among youth varied significantly, ranging from 5 per cent to 30 per cent, influenced by location and type of intervention. The review aimed to analyse the effectiveness of these interventions by comparing DUI rates before and after the implementation of preventive measures and contrasting rates in regions with interventions against control regions without targeted measures.

A recurring limitation in the studies was the potential for participants to have used other drugs in combination with alcohol and not being reported in the context. Although every study reported on alcohol consumption, some lacked sufficient details about the use of other substances like cannabis or prescription medications. This lack of evidence, in some cases, made it challenging to pinpoint the specific effect of alcohol on DUI incidents. In order to address this issue, our meta-analysis focused exclusively on cases where alcohol was the only substance that led to DUI incidents, excluding any instances where drivers tested positive for multiple substances (Cancilliere et al., 2018; Colby et al., 2018; Kypri et al., 2017; Spirito et al., 2004; Teeters et al., 2015; Teeters et al., 2018; White et al., 2018; Yockey et al., 2024).

Of the 21 studies included, 15 showed a statistically significant effect of interventions on reducing DUI-related road traffic crashes among youth who had consumed alcohol before driving. The effect sizes of interventions included in the study (which were in some cases more than one intervention ranged from 0.09 (95% CI [0.07, 0.11]) to 0.87 (95% CI [0.68, 1.05]), underscoring the interventions' potential effectiveness in lowering DUI-associated risks within this demographic.

The interventions analysed varied in effectiveness. Educational programmes among high school and early university age groups effectively lowered DUI rates after the programme was completed, though long-term rates were not presented. Public policies that pursued increased severity in penalizing underage DUI, including zero-

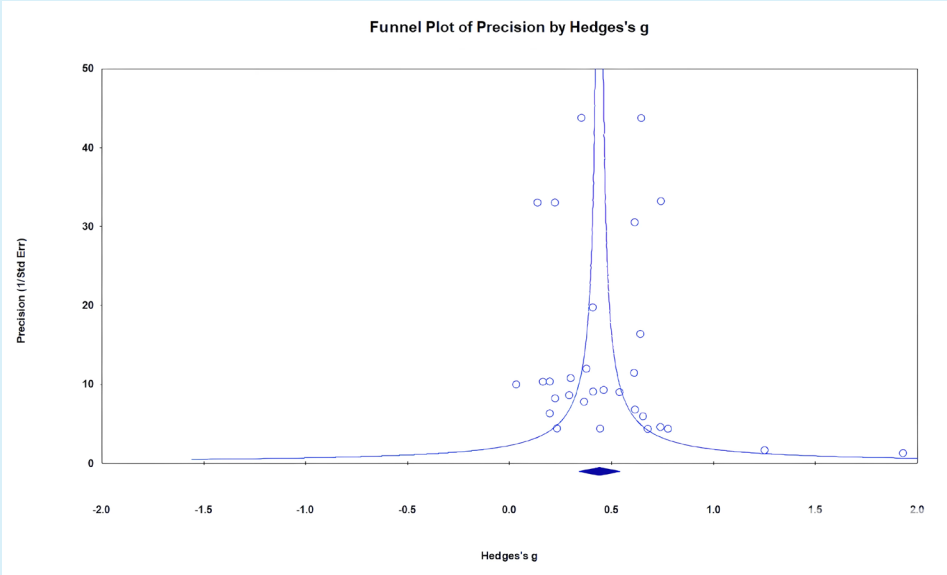
tolerance laws for blood alcohol concentration, were more clearly sustained in their effectiveness in lowering DUI rates and overall traffic crashes in locations where such policies were imposed. Other measures that turned out effective included increased numbers of roadside sobriety checks and random breath testing by the police, for which media campaigns were particularly effective in raising young people's awareness of the risks of driving under the influence.

Therefore, interventions to minimize DUI among youth can be categorized into three distinct groups; (1): Motivational Interventions which focus on enhancing motivation to modify the drinking behaviours of youth through various counselling techniques and feedback mechanisms among youth; (2): Educational Programmes which are designed to inform both youth and their parents about the associated risks of alcohol consumption while promoting healthy behavioural choices; and finally, (3): Environmental Strategies involves broader community initiatives that can be enforced by authorities and strengthened through governmental policies, such as changes in law-enforcement practices and new policies designed to make alcohol less accessible. These efforts aim to discourage behaviours linked to drinking and driving. Notably, if a parental intervention aims to boost motivation, it would fall under the first group, but if it is more about education, it would fit into the second.

2.1.3 Publication Bias

Figure 25 displays a funnel plot illustrating the relationship between precision—measured as the inverse of the standard error—and the effect size, represented by Hedges's g. Studies typically cluster symmetrically around the combined effect size in a well-distributed meta-analysis with minimal publication bias, creating a funnel-shaped plot. This symmetry indicates that effect sizes are not significantly influenced by selective reporting or other forms of publication bias.The current review covers various interventions to prevent DUI among youth, drawing from various methodological and contextual backgrounds. As a result, we expect some degree of heterogeneity, which may lead to asymmetry in the plot due to genuine differences in intervention types rather than bias. The few outlier studies likely reflect this inherent heterogeneity rather than any publication bias. Our review's potential for publication bias is low, suggesting that the results likely represent the actual effects.

Figure 25. Funnel Plot of Precision by Hedges's g



The funnel plot illustrates the relationship between precision (inverse of standard error) and Hedges's g (effect size). Without publication bias, studies would be expected to be distributed symmetrically around the combined effect size. Given the diverse nature of our study, which encompassed multiple interventions rather than focusing on a single one, a low publication bias is anticipated. The outlier articles likely reflect variability in the interventions employed.

2.1.4 Risk of Bias Assessment

The Newcastle-Ottawa Quality Assessment Scale scores (see Table 25) for the studies we reviewed indicated apparent differences in the rigor of the research, especially between high-quality and moderate-quality studies. The higher-quality studies, such as those by Bohman et al. (2004) and Callaghan et al. (2016), demonstrated strong methodological robustness. These studies carefully selected participants, completed thorough outcome measurements, and maintained adequate follow-up periods, all of which enhanced the reliability of their findings. Additionally, they effectively controlled for confounding variables.

In contrast, moderate-quality studies, exemplified by those conducted by Burns et al. (2016) and Martens et al. (2013), exhibited less methodological rigor. Their group comparisons were weakened due to insufficient control of confounding factors, raising concerns about potential biases in follow-up assessments. Furthermore, some studies in this category did not include non-exposed groups, limiting their results' generalizability.

One consistent limitation in the studies is related to how exposure is measured. Most relied on self-reported measures or subjective criteria, which can introduce bias. For example, Burns et al. (2016) used self-reported data that was not objectively verified, leading to potential inaccuracies. In contrast, other studies, like Mukamal et al. (2005), employed structured assessments, which enhanced their reliability. The follow-up periods were generally appropriate, although a few studies had lower response rates that indicated non-response bias, potentially affecting their findings. High-quality studies demonstrated substantial evidence of methodological robustness and reliability, making their findings trustworthy. While moderate-quality studies can still provide valuable data, their limitations warrant caution in interpretation, particularly regarding external validity and the potential for bias.

2.1.5 Limitation of the Study

The high heterogeneity across the studies included in this meta-analysis represents a limitation. For example, cultural context differences might significantly affect intervention efficacy across various regions, a factor that the current analysis could not fully encompass.

While the random-effects model aims to address variability, these underlying differences present challenges for confidently applying the results across diverse geographic or cultural landscapes. Additionally, while most of the included studies had rigorous methodological methods, the studies varied in methodological quality, as evidenced by their Newcastle-Ottawa Quality Assessment Scale scores (Table 25).

Another significant limitation arises from inconsistencies in definitions and measurement methods across the reviewed studies. The studies defined key variables differently—terms such as “youth” and “driving under the influence” lacked standardization, and methods for assessing alcohol consumption and DUI incidents varied substantially.

Data limitations further constrained the analysis. Several studies provided incomplete datasets, restricting the scope and depth of analysis possible.

Notably, some studies did not include data on poly-drug use alongside alcohol consumption, complicating efforts to isolate alcohol’s specific impact on impaired driving. Another generalizability issue stems from the regional specificity of many interventions analysed.

For instance, the impact of community-based or policy-driven interventions may vary significantly between urban and rural settings. A future research priority should be to analyse these geographic and contextual differences to clarify how intervention efficacy might vary across diverse environments.

Furthermore, although the review attempted to control for various confounding factors, not all studies adequately accounted for critical influences, such as socioeconomic status, access to public transportation, peer networks, and non-documented production and use of alcohol in some local communities, especially in Africa and Asia.

The "file drawer effect" also warrants mention as a limitation. Despite exhaustive literature searches, it remains possible that unpublished studies were not included in this analysis.

Finally, the diversity of intervention types, study designs, and outcome measures in the included studies introduces interpretive complexity. While the random-effects model addresses some variation, caution is essential when generalizing these results across settings or populations.

Table 23. Keywords

Language	English	Spanish	Portuguese
Drinking Alcohol	drunk, drink*, alcohol, beer,	ebria, ebrio, cerveza, alcohol	bêbada, bêbado, álcool, cerveja
Car Accidents	driv*, crash, "road rule violation"*, "car accident"*, "road accident"*, "traffic accident"*, "car incident"*, "road incident"*, "traffic incident"*,"road safety", "road rage"*, "ghost rid"*, "traffic safety", collision, police*, motor*, traffic*	conducir, tráfico, "accidente automovilistico", chocar, "carretera segura", "accidente de tráfico", motora, "incidente automovilistico", "incidente en la carretera"	colidir, dirigi, tráfego, "acidente de carro", "segurança na Estrada", "incidente rodoviário"
Hashtags	dontdrinkanddrive, donotdrinkanddrive, nodrinkinganddriving, desigdriver, drivesober, arrivealive, drivedry, matesmatter		

Table 24. Number of posts by country

Country	Subreddits	Number of Posts
Argentine	r/argentina, r/ArgentinaBenderStyle, r/BuenosAires, r/BuenosAiresProvincia, r/Chubut, r/Cordoba, r/CordobaArgentina, r/Corrientes, r/RepublicaArgentina, r/EntreRios, r/Formosalibre, r/RioNegroARG, r/salta, r/SanJuan, r/sanjuanislands, r/SanLuisObispo, r/SanLuisPotosi, r/SanLuisRioColorado, r/santacruz, r/santacruzlocals, r/SantaCruzFriends, r/Santacruzbikes, r/SantaFe, r/santafelocals, r/SantaFeAR, r/Misiones, r/ComisionesArgentina, r/Neuquen, r/jujuy, r/lapampa, r/LaRioja, r/Mendoza, r/SantiagodelEstero, r/Tucuman, r/tierradelfuego	1038
Brazil	r/Brazil, r/acre, r/Manaus, r/bahia, r/NewsBahia, r/EspiritoSanto, r/Maranhao, r/MatoGrosso, r/MinasGerais, r/Paraiba, r/Parana, r/Piaui, r/rondonia, r/Roraima, r/SantaCatarina, r/riodejaneiro, r/RioDeJaneiroBrazil, r/RioGrandeDoNorte, r/riograndedosul, r/saopaulo, r/SaoPauloFC, r/Sergipe, r/Palmas, r/Aracaju, r/Joinville, r/BoavistaFC, r/PortoVelho, r/portoalegre, r/Natal, r/teresina, r/Recife, r/curitiba, r/joaopessoa, r/BeloHorizonte, r/CampoGrande, r/StockCarBrazil, r/cuiaba, r/SaoLuis, r/goiania, r/vitoriaES, r/Serra, r/brasilia, r/Fortaleza, r/Salvador, r/Macapa, r/maceio, r/riobrancoes	7421
Dominican Republic	r/Dominican, r/SantoDomingo, r/Santiago, r/SanPedro, r/SanJuan, r/NorthSanJuan, r/SanJose, r/SanJoseSUCKS, r/r4rSanJose, r/SanJoseFood, r/SanJoseSharks, r/Samana, r/PuertoPlata	43780
Belize	r/Belize	1313
Bolivia	r/BOLIVIA, r/BoliviaDemocratica	1492
Costa Rica	r/costarica, r/AlajuelaYa	1420
Cuba	r/cuba, r/RealCuba, r/Guantanamo, r/SantaClaraCounty, r/santaclara	4206
El-Salvador	r/ElSalvador, r/elsalvador4k	1690
Honduras	r/Honduras	1300
Nicaragua	r/Nicaragua	1236
Panama	r/Panama, r/panamacity	4207
Total		69103

Table 25. Newcastle-Ottawa Scale (NOS) Scores

Authors	Study Design	Focus	Sample Size	Sample Characteristics	Interventions	Location	Funding Source	Comparison Groups	NOS score
Spirito et al. (2004)	Randomized Clinical Trial	Brief motivational intervention for alcohol-positive adolescents treated in an emergency department	152	Adolescents aged 13 to 17 years with positive blood alcohol concentration (BAC)	Motivational Interviewing (MI) vs. Standard Care (SC)	Northeast United States	National Institute on Alcohol Abuse and Alcoholism (Grant AA09892)	MI vs. SC	8
Bohman et al. (2004)	Quasi-experimental	Evaluating the "Protecting You/ Protecting Me" curriculum for alcohol use prevention and vehicle safety skills	259	Third, fourth, and fifth graders taught by high school peer leaders	Protecting You/ Protecting Me curriculum	Texas, USA	Grant ED-01-J20-1559-01 from the Criminal Justice Division of the Texas Governor's Office	Intervention vs. Comparison classrooms	9
Jewell and Hupp (2005)	Randomized Controlled Trial	Effects of Fatal Vision Goggles on attitudes and behaviors related to drinking and driving	251	College students (majority female, mean age 19.5 years)	Fatal Vision Goggles, control videos	United States (Midwest)	Not specified	Control groups (two types: one with unrelated video, one with a drinking and driving video)	7
Clapp et al. (2005)	Quasi-experimental non-equivalent comparison group design	Efficacy of an environmental prevention campaign to reduce DUI among college students	4832	College students from two large public universities along the US/Mexico border	Social marketing campaign, media advocacy, increased law enforcement (DUI checkpoints and patrols)	US/Mexico border	National Institute on Alcohol Abuse and Alcoholism, Center for Substance Abuse Prevention, US Department of Education	Experimental university vs. comparison university	9
Fell et al. (2008)	Case-Control Study	Evaluating the relationship between underage drinking laws and reductions in drinking drivers involved in fatal crashes	Not specified	Youth aged 20 and younger involved in fatal crashes	Core and expanded MLDA laws	United States	National Institute on Alcohol Abuse and Alcoholism, Robert Wood Johnson Foundation	States with and without MLDA laws	7
Murphy et al. (2010)	Randomized Clinical Trials	Impact on discrepancy, motivation, and drinking	207	Study 1: 74 (59% women, 23% African American); Study 2: 133 (50% women, 30% African American)	Alcohol 101 CD-ROM, e-CHUG, Assessment-only	United States	Not specified	BASICS, Alcohol 101, e-CHUG	9
Borsari et al. (2012)	Randomized Clinical Trial	Addressing alcohol use and problems in mandated college students	598	College students mandated to attend an alcohol program following a campus-based alcohol citation (67% male, 96% Caucasian, mean age 18.68)	Step 1: Brief Advice session; Step 2: Brief Motivational Intervention (BMI) or Assessment-Only control	Northeast United States	National Institute on Alcohol Abuse and Alcoholism Grants	BMI vs. Assessment-Only control	8
Spera et al. (2012)	Pre-test/Post-test intervention comparison	Influence of the Enforcing Underage Drinking Laws (EUDL) program on alcohol-related outcomes	Not specified	Communities surrounding Air Force bases	Environmental strategy approach to reduce underage drinking and associated misconduct	Five communities near Air Force bases in the USA (Great Falls, MT; Tucson, AZ; Phoenix, AZ; Honolulu, HI; Sacramento, CA)	National Institute on Alcohol Abuse and Alcoholism (NIAAA) and Office of Juvenile Justice and Delinquency Prevention (OJJDP)	Pre-test vs. Post-test outcomes in intervention communities	9
Kypri et al. (2017)	Controlled before-and-after comparison	Long-term effects of lowering the alcohol minimum purchasing age on traffic crash injury rates	Not specified	Drivers of all ages involved in traffic crashes, with a focus on 18- to 19-year-olds and 15- to 17-year-olds	Comparison of traffic injury rates before and after the minimum purchasing age change	New Zealand	Health Research Council of New Zealand (Project Grant 12/492)	18- to 19-year-olds vs. 20- to 21-year-olds	8
Johnson (2016)	Mixed-model analysis	Effectiveness of a high-visibility enforcement campaign to reduce underage drinking and driving	6,825 drivers (roadside surveys) and 2,061 students (web surveys)	Drivers stopped, interviewed, and breathalyzed on weekend nights; college students from large state universities	Increased high-visibility enforcement of drinking and driving laws, use of passive alcohol sensors, and a coordinated publicity campaign	Two college-town communities in the mid-Atlantic region of the USA	National Institute on Alcohol Abuse and Alcoholism (R01 AA017186)	Baseline vs. intervention and follow-up periods	8

Authors	Study Design	Focus	Sample Size	Sample Characteristics	Interventions	Location	Funding Source	Comparison Groups	NOS score
Callaghan et al. (2016)	Regression-Discontinuity	Impacts of drinking-age legislation on alcohol-impaired driving crimes among young people	55,679 (total incidents)	Drivers aged 15–23 years (female: n = 10,706; male: n = 44,973)	Minimum Legal Drinking Age (MLDA) laws	Canada	Not specified in the context	Drivers just older vs. just younger than MLDA	9
Burns et al. (2016)	Cross-sectional evaluation	Evaluation of an alcohol intervention targeting hazardous drinking among university students	2465 (T1), 2422 (T2)	18-24 years old students from a large metropolitan university in Perth, Western Australia	Multi-strategy intervention based on Social Cognitive Theory, including educational and organizational actions	Perth, Western Australia	Healthway (The Western Australian Health Promotion Foundation)	Low risk drinkers vs. hazardous drinkers	5
Haegerich et al. (2016)	Longitudinal Study	Predictive influence of youth assets on drinking and driving behaviors	1,111 youth/ parent pairs	Socio-demographically diverse youth aged 12-17 years living with a parent or guardian in Oklahoma City	Assessment of individual, relationship, and community assets	Oklahoma City, USA	Centers for Disease Control and Prevention (CDC) and Inasmuch Foundation	Youth with assets vs. youth without assets	9
Lavoie et al. (2017)	Interrupted Time Series Analysis	Effect of Maryland's 2011 Alcohol Sales Tax Increase on Alcohol-Positive Driving	794,729 drivers involved in injury crashes from 2001 to 2013	Drivers aged 15–95 years involved in motor vehicle crashes causing injury	Analysis of police crash reports before and after the tax increase	Maryland, USA	National Institute on Alcohol Abuse and Alcoholism (NIAAA) and Robert Wood Johnson Foundation	Pre-tax vs. Post-tax rates of alcohol-positive drivers	9
(Teeters et al., 2018)	Randomized Controlled Trial	Mobile phone-based brief intervention for reducing driving after drinking (DAD) among college drinkers	84	College students (67.1% women; average age = 23; 52.4% White) who reported DAD	DAD-specific mobile brief alcohol intervention with personalized feedback and interactive text messaging	Southern United States	American Psychological Association and National Institute on Alcohol Abuse and Alcoholism (R01AA020829)	DAD information condition vs. DAD mobile BAI	8
Cancilliere et al. (2018)	Randomized Controlled Trials (RCTs)	Brief alcohol interventions for youth in the emergency department and their proximal and distal outcomes	4 trials (N not specified)	Adolescents and young adults (ages 13-24) treated in ED for alcohol-related issues	Motivational Interviewing (MI) and Treatment as Usual (TAU)	Northeastern United States	National Institute on Alcohol Abuse and Alcoholism (NIAAA)	MI vs. TAU, MI + Family Check-Up vs. MI	8
Colby et al. (2018)	Randomized Clinical Trial	Efficacy of Brief Motivational Intervention (BMI) for underage young adult drinkers	167	Non-treatment-seeking underage drinkers aged 17-20, 42% female, 59% non-Hispanic White	BMI vs. Relaxation Training (REL)	Rhode Island, USA	National Institute on Alcohol Abuse and Alcoholism (R01AA016000; Colby), R01AA020829 (Murphy), R01AA023194 (Magill)	BMI vs. REL	8
White et al. (2018)	Repeated cross-sectional surveys	Adolescents' alcohol use and strength of policy relating to youth access, trading hours, and driving under the influence	9,805 to 13,119 (varies by survey year)	Students aged 12-17 years from four Australian capital cities	Not specified	Australia	National Health & Medical Research Council (NHMRC) Partnership Project Grant #1037104	Not specified	9
Yockey et al. (2024)	Cross-sectional survey	Influence of parenting behaviors on adolescent drunk and drugged driving	17520	Adolescents aged 16-17 years, nationally representative sample	Not specified	USA	National Survey on Drug Use and Health (NSDUH)	Not specified	8
Schulte et al. (2024)	Longitudinal Study	Association of parental monitoring knowledge (PMK) with recurrent driving after drinking	5261	Participants aged 12-18 in 1997, followed up in 2002 and 2007	PMK assessed at ages 14-17; driving after drinking measured in 2002 and 2007	United States	National Longitudinal Survey of Youth 1997 (NLSY97)	PMK at different ages vs. recurrent driving after drinking	9
Martens et al. (2013)	Randomized controlled trial	Efficacy of single-component brief motivational interventions (PNF and PBSF) among at-risk college drinkers	365	Undergraduate students from a large Midwestern university (65% women; 89% White)	Personalized Normative Feedback (PNF) and Protective Behavioral Strategies Feedback (PBSF) vs. Alcohol Education (AE)	Midwestern United States	National Institutes of Health Grant R21AA016779	PNF vs. PBSF vs. AE	6

Table 26. Mann-Kendall Tests

Country	Trend	p-value
Argentina	Increasing	0
Brazil	Increasing	0
Dominican Republic	Increasing	0
Belize	Increasing	> 0.000001
Bolivia	Increasing	0.00067
Costa Rica	Increasing	0
Cuba	No Trend	0.81858
El Salvador	Increasing	0
Honduras	Increasing	0.03377
Nicaragua	Increasing	0.00477
Panama	No Trend	0.26465
Total	Increasing	0

Appendix 3. Drink-driving Awareness Tool

Building on the data collected from YouTube for sentiment analysis and topic modelling, a prototype AI-based tool was developed that can be used to provide information on drink-driving to users. The drink-driving awareness tool leverages the reasoning and question-answering capabilities of LLMs in conjunction with the RAG technique. This allows the tool to provide answers based on real-world stories and documentaries about drink-driving from YouTube. The tool utilizes open-source LLMs (specifically llama3.1-70b and llama3.2-3b) hosted on a local server. This section outlines the process of creating the vector database and provides details about the architecture of the drink-driving awareness tool.

The application's front-end serves as the user interface, allowing users to interact with the LLM. Streamlit, an open-source Python framework specifically designed for creating interactive applications tailored to artificial intelligence and machine learning projects, was used to build this interface. Figure 26 displays the interface of the drink-driving awareness tool.For the back-end development, LangChain, an open-source framework designed for building applications powered by LLMs, was used. This framework facilitated the creation of a processing pipeline that seamlessly integrated the vector database, retriever, prompts, LLM, and output parsers.

The LLM-based drink-driving awareness tool is a core module comprised of three primary components. First, the multi-query retriever retrieves relevant contextual information chunks from the vector database based on the input question.

Next, the answer generator utilizes the retrieved contextual information to generate a detailed and accurate response to the user's question.

Finally, the quiz generator creates an interactive quiz based on the generated answer to enhance user engagement and verify their comprehension of the information provided. The high-level architecture of the drink-driving awareness tool is illustrated in Figure 27. In this application, Step 1 begins by sending the question to a multi-query retriever module when a user submits a question related to drink-driving.

Figure 26. Drink-driving awareness tool interface

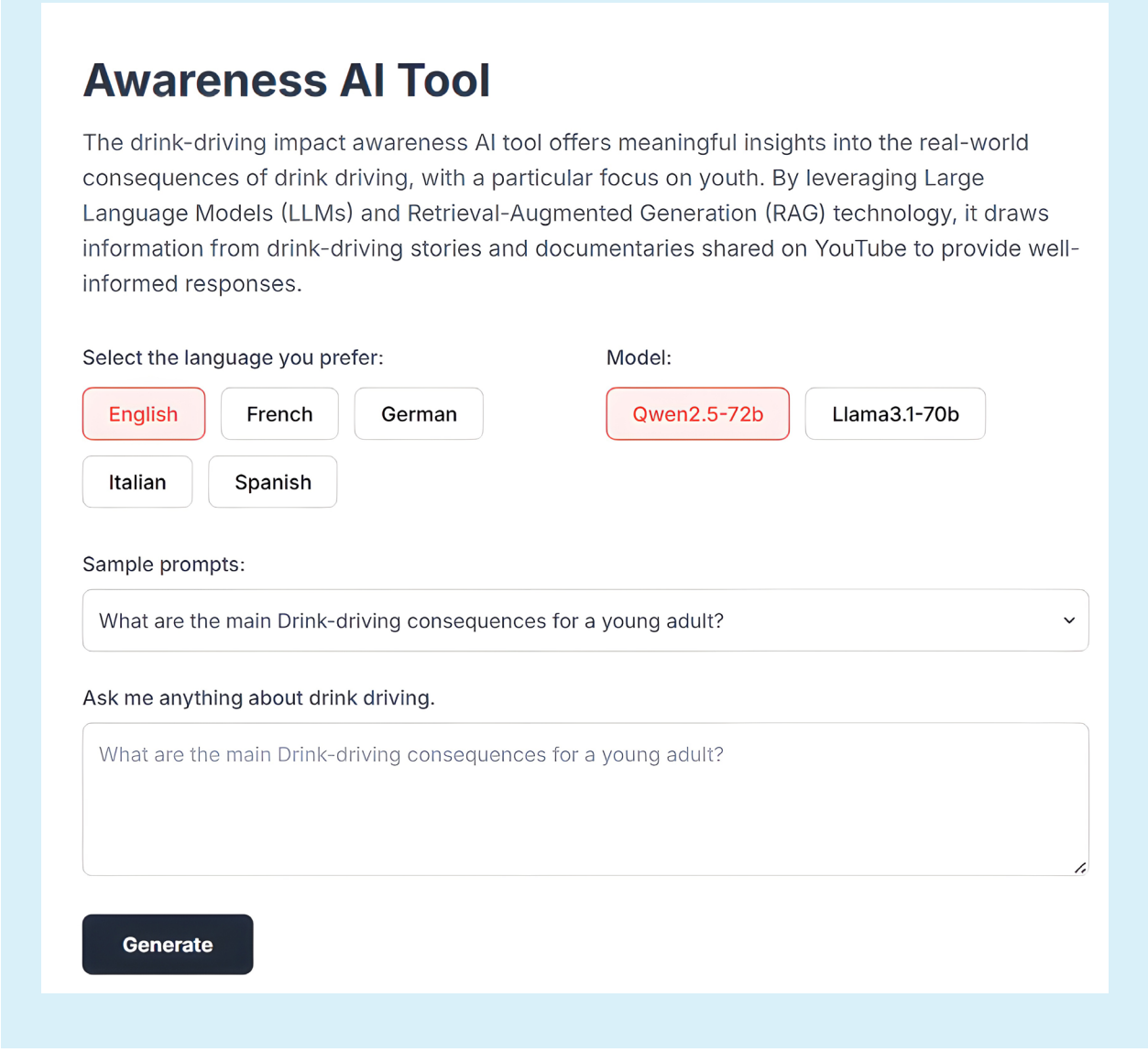
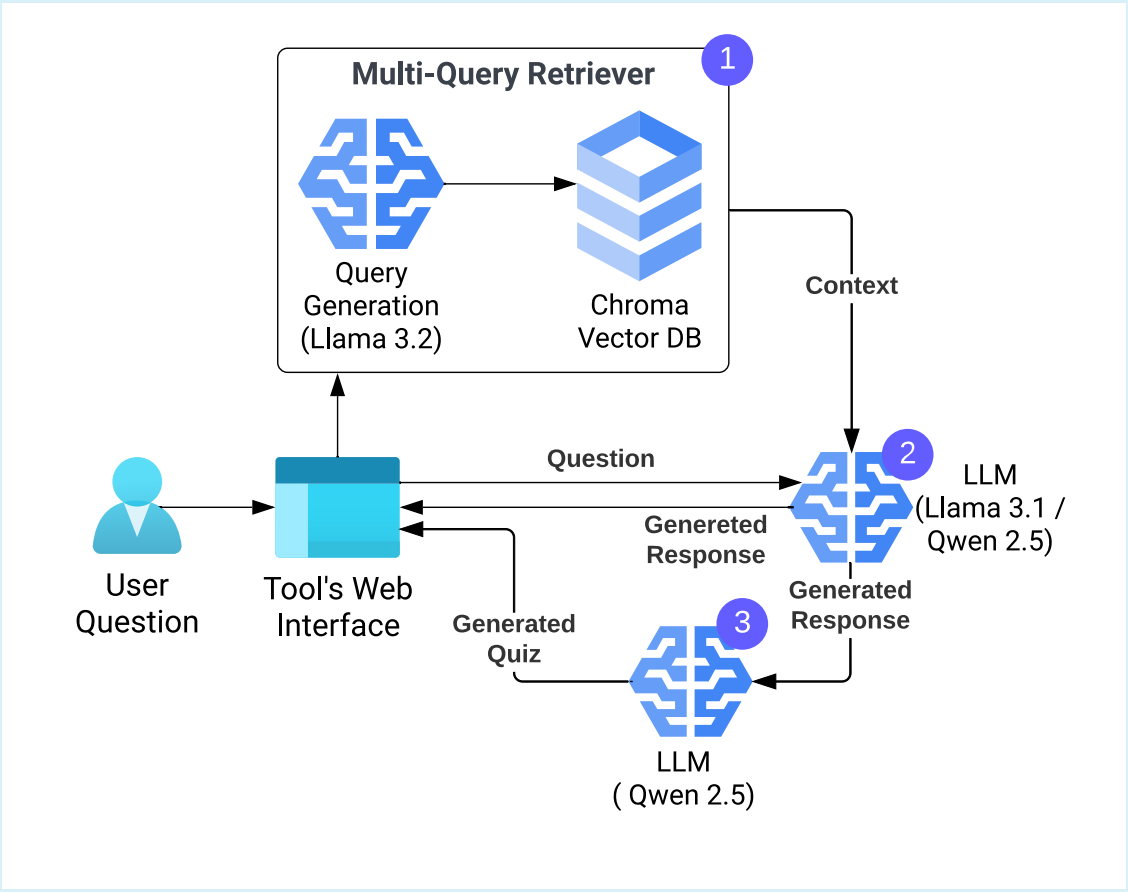


Figure 27. Architecture of the drink-driving awareness tool



Illustrates the high-level architecture of the drink-driving awareness tool

This module generates multiple queries to retrieve relevant documents from the vector database, addressing the limitations of relying solely on distance-based similarity searches for retrieving pertinent information.

Specifically, the multi-query retriever uses the llama3.2-3b LLM to generate five queries based on the prompt shown in Figure 28. These queries are then used to iteratively retrieve the 50 most relevant chunks to the user's question, leveraging the Maximal Marginal Relevance (MMR) algorithm.

After retrieval, the Cohere rerank-multilingual-v3.0 model re-ranks the retrieved chunks based on their relevance to the user's question, returning the top 20 chunks along with their metadata.

The metadata includes the video identity document ID and the corresponding YouTube Uniform Resource Locator (URL) with the relevant contextual information chunks retrieved from the vector database.

Figure 28. Multi-query generation prompt (default prompt for multi-query retrieval)

```
You are an AI language model assistant.  Your task is to generate five
different versions of the given user question to retrieve relevant
documents from a vector database.  By generating multiple perspectives
on the user question, your goal is to help the user overcome some
of the limitations of the distance-based similarity search.  Provide
these alternative questions separated by newlines.
Original question:{question}
```

Using this context, the llama3.1-70b LLM generates an answer to the user's question based on the retrieved relevant contextual information (Figure 29).
Finally, the generated response and the URLs of the two most relevant YouTube videos are sent to the front-end. The front-end streams the generated answer to the user's question and embeds the two videos, allowing the user to watch them for additional insights.

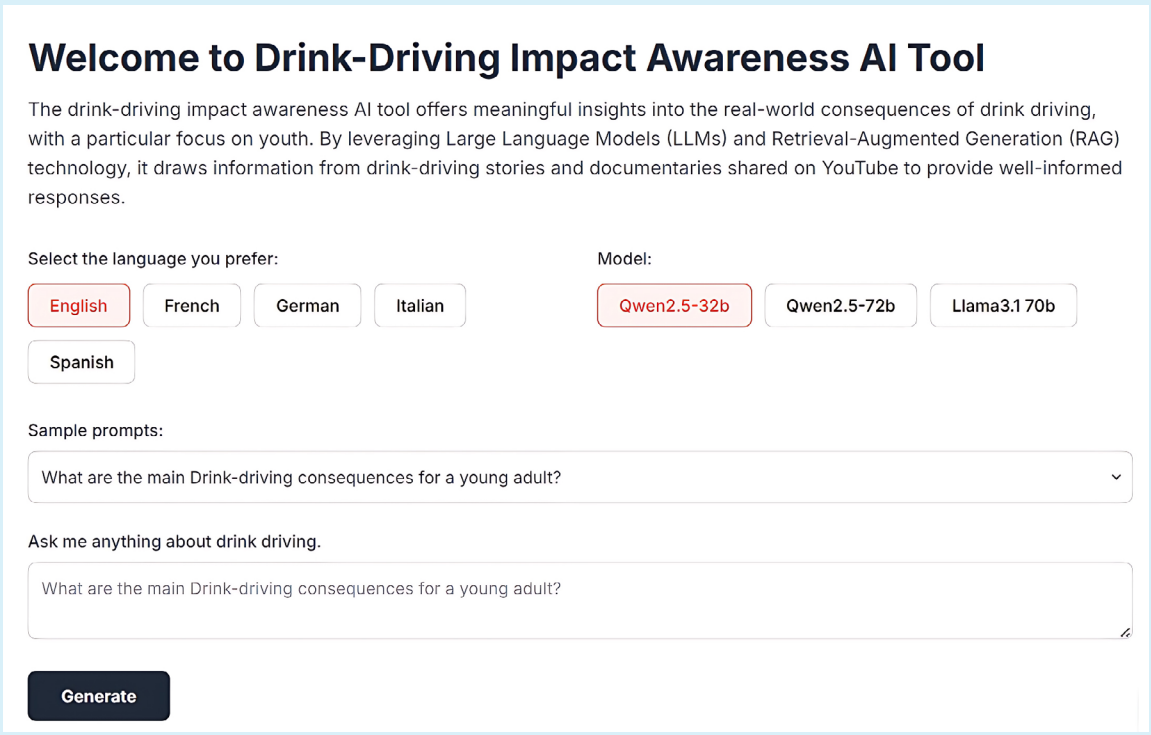
Figure 29. Answer generation prompt

```
You are an expert in providing information on drink driving, using
ONLY the information provided in the context to deliver accurate and
thoughtful responses.
{context}

1.  First, determine whether the user's question is related to
drinking and driving.
- If not related:  Respond "Please ask questions that are specifically
related to drink and driving." ONLY, do not provide any other text
other than this text."

2.Provide a Comprehensive Response If the question is related to drink
driving:
- First, lets think step by step.  - Provide a detailed and
descriptive explanation in {language} based ONLY on the context,
adopting a formal tone."

Make sure to indicate the whether the answer is generated using
context or existing knowledge of the model at the end.

Question {question}
```

The Drink-driving Awareness Tool is designed to provide users with informative responses to questions related to drink-driving, including its impact, consequences, laws, and preventive measures. Depending on the requested language and the selected model for response generation, the tool delivers an answer in the desired language, along with two relevant videos that users can view directly within the application without needing to navigate to YouTube. After generating the response, another LLM generates a quiz consisting of five questions based on the content provided. Users can interactively answer the quiz and check their responses.

Figure 30 presents a screenshot of the Drink-driving Awareness Tool, showcasing its interface and output.The tool's main purpose is to use AI to extract the most relevant information from social media (in this case, YouTube videos) through large-scale language processing. The tool, in its current form, can be used by everyone interested in the Drink-driving topic. This could include the general public, policymakers, educators, organizations, and those looking for relevant information to use for personal or organizational purposes. it is possible to make it more relevant to interventions by customising the tool to extract information about drink-driving interventions, their effectiveness, their issues, case studies, and end users' sentiments. It can provide those who are involved in interventions with a tool to find out about interventions that work best with some rationale and reasoning behind them.

Figure 30. Output of the drink-driving awareness tool



✓ Generation completed!

The main consequences for a young adult convicted of drink driving can be both severe and long-lasting. Below is an itemized list detailing these potential repercussions:

1. **Fines:** The financial burden imposed by fines can range from 500 to 2,500, depending on the severity and jurisdiction.

2. **Jail Time:** A conviction may result in up to 2 years of incarceration, with a mandatory minimum sentence ranging from 48 hours to 1 year.

3. **Ignition Interlock Device (IID):** Installation of an IID is often required, which prevents the vehicle from starting if alcohol is detected on the driver's breath.

4. **Community Service:** Young adults convicted may be ordered to perform community service as part of their sentencing.

5. **Alcohol Education Program:** Participation in a formal alcohol education program may also be mandated, aimed at educating individuals about the dangers and consequences of drunk driving.

6. **Increased Insurance Rates:** A conviction can lead to significantly higher insurance premiums, making it more expensive for young adults to maintain car insurance.

7. **Criminal Record:** Perhaps one of the most impactful long-term effects is the creation of a criminal record, which can affect future employment opportunities and personal credibility.

8. **Loss of Driving Privileges:** A conviction may result in the suspension or revocation of driving privileges, leading to difficulties in commuting to work or school.

These consequences are designed not only as punitive measures but also to deter individuals from engaging in drunk driving behavior in the future. It is crucial for young adults to understand and take these repercussions seriously to avoid experiencing such severe consequences.

Answer Generated Using Context Provided: Yes.

✓ Generation completed!

Question 1: What is the minimum jail time a young adult may face if convicted of drink driving?

- ○ a. No jail time at all
- ○ b. At least 48 hours, but up to a year
- ○ c. Mandatory five years

Question 2: Which device may be required in their vehicle to prevent operation if alcohol is detected?

- ○ a. An ignition interlock device (IID)
- ○ b. A breathalyzer
- ○ c. A dashcam

Question 3: How can a criminal record from a drink driving conviction impact the individual?

- ○ a. It will prevent them from voting in elections
- ○ b. It can affect future employment opportunities and personal credibility
- ○ c. It only affects international travel

Check

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