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Approaches to the Effective Prevention of Road Traffic Injuries in Sub-Saharan Africa: A Systematic Review

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Abstract

Introduction: Road traffic injuries (RTI) are projected to become the 7th leading cause of mortality worldwide by the year 2030. It is projected that 90% of the global road traffic injury burden will be borne by Low and Middle-Income countries (LMICs), including sub-Saharan Africa. We undertook a systematic literature review to assess the effectiveness of implemented traffic injury prevention initiatives in sub-Saharan Africa. **Methodology:** A systematic review of the English literature was undertaken per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Studies were identified by searching the electronic databases Embase, Pubmed, Medline, The Cochrane Library and an additional review of reference lists. In addition, published studies from 1990 to 2020 were extracted and analysed. **Results:** The literature search generated 638 articles. Twenty-two duplicates were removed, and after title and abstract screening and full-text screening, 22 articles were retained. The interventions were broadly categorised into education, enforcement, Legislation, speed control, road safety and combined interventions. **Conclusion:** Combined multi-faceted injury prevention strategies are most effective in Sub-Saharan Africa. Enforcement of safety regulations ensures compliance and sustainability of prevention interventions. Speed control measures are useful in calming vehicular speeds, but poor design and citing can endanger road users. Road safety, education and Legislation have little to no effect when imple-

mented alone; however, when combined with other measures, they can lead to significant reductions in road traffic injuries and fatalities.

Keywords

Road Traffic Injury, Prevention, Sub-Saharan Africa

1. Introduction

Globally, 5 million people die from injuries annually (World Health Organization, n.d.). A quarter (approximately 1.25 million) of these deaths are due to road traffic injuries (World Health Organization, n.d.). However, these deaths represent a small percentage of the injured, with the majority surviving with temporary or permanent disabilities (World Health Organization, n.d.).

Road traffic injuries (RTI) are projected to become the 7th leading cause of mortality worldwide by the year 2030 and are currently the leading cause of morbidity and mortality in people aged 15 - 29 years worldwide (World Health Organization, n.d.).

Africa is the youngest continent, with an estimated 60% of its population being under age of 25 in 2019 (United Nations, 2020). Projections show that 90% of the global road traffic injury burden will be borne by Low- and Middle-Income Countries (LMICS), including those in sub-Saharan Africa (Bonnet et al., 2018).

In LMICs, approximately 90% of deaths from road traffic injuries occur in pedestrians, passengers of buses, trucks, mini buses and motor cyclists including motorized tricycles that lack basic safety features (Nantulya & Reich, 2002). These modes of transport are relatively affordable for most low-income earners in Sub-Saharan Africa. This coupled with deplorable road infrastructure, speeding, drunk driving and ineffective road traffic regulation enforcement expose the individual to increased risk of RTIs (Nantulya & Reich, 2002).

Ralaidovy and colleagues, in their assessment of the cost-effectiveness of preventive RTI strategies in LMICs, concluded that combined enforcement strategies represented an effective means of reducing the burden of RTIs (Ralaidovy et al., 2018). Likewise, the Save LIVES project, a WHO RTI prevention program revealed that road safety legislation and its enforcement constituted the mainstay of effective interventions (WHO, n.d.).

Despite efforts launched by the World Health Organization through the Decade of Action for Road Safety in 2011, mortality from road traffic injuries remains high in LMICs, especially in Sub-Saharan Africa (United Nations, n.d.; World Health Organization, 2015). Injuries can be prevented and a plethora of preventive strategies exist (Krug et al., 2000). The successful prevention of such injuries is necessary to save lives and prevent disability. We reviewed the literature to assess the effectiveness of road injury prevention initiatives undertaken in Sub-Saharan Africa where RTI carries a large burden.

1.1. Aim (Research Question)

Are road injury prevention initiatives successful in Sub-Saharan Africa?

1.2. Objectives

Identify preventive measures instituted in Sub-Saharan Africa:

- Evaluate models that have been successfully implemented.
- Explore the barriers to implementation and reasons for failure.
- Formulate recommendations on road injury prevention.

2. Methodology

A systematic review of the English literature was undertaken per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Studies were identified by searching the electronic databases Embase, Pubmed, Medline, The Cochrane Library and an additional review of reference lists. Published studies from 1990 to 2020 were extracted. Papers not published in the English language or studies published before January 1990 were excluded. The primary author (SG) executed the database search, screened titles and excluded duplicated studies. Articles were considered suitable if they scrutinized road injury prevention in sub-Saharan African countries and reported outcomes concerning the reduction in road crashes, deaths and morbidity. The eligibility of full-text articles included in the review was assessed by SG and co-author DKY. Obtaining a consensus in disagreements was done upon discussion with a third co-author (PK).

The PRISMA flow chart was adopted to ensure the phases of literature identification, screening, eligibility and inclusion were followed. Furthermore, the checklist (**Appendix 1**) was incorporated as a guide to ensure the review was thorough and that no subject areas were overlooked.

Search Strategy

The literature search focused on articles in the English language. We included keywords [Mesh] and {tiab} field code to maximise search and retrieve articles that may not yet be indexed in the databases. The Pubmed search strategy is shown below:

"Accidents, Traffic" [Mesh] OR "Motor Vehicles" [Mesh] OR "Off-Road Motor Vehicles" [Mesh] OR "traffic accident*" [tiab] OR "traffic injur*" [tiab]

AND

Accident Prevention" [Mesh] OR

"prevention and control" [Subheading] OR "road safety program*" OR "Road safety intervention" OR "evaluation of road safety" OR "accident prevention" [tiab] OR "traffic injury prevention" [tiab] OR "road safety program*" [tiab] OR "road safety intervention" [tiab] OR "evaluation of road safety" [tiab]

AND

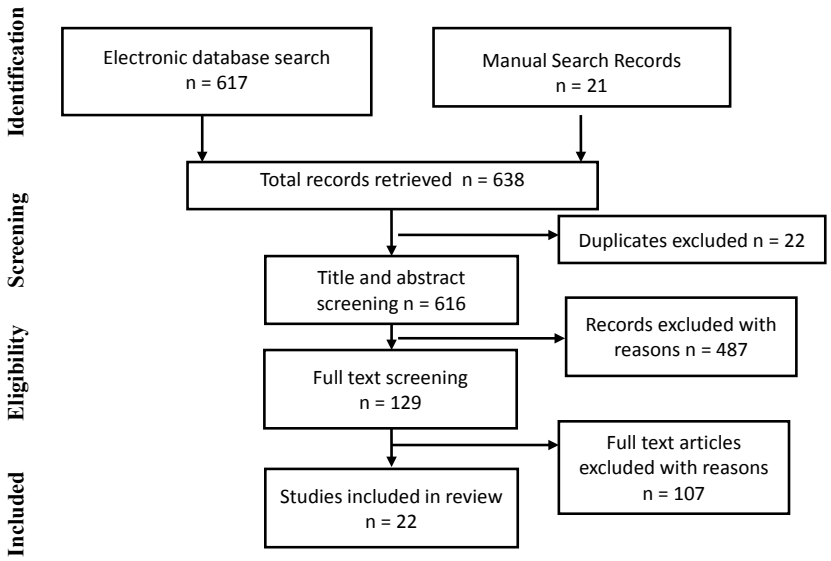
"Africa South of the Sahara" [Mesh] OR "africa south of the sahara" [tiab] OR

"sub-saharan africa" [tiab] OR "Cameroon" [tiab] OR "Cameroun" [tiab] OR "Central african republic" [tiab] OR "Chad" [tiab] OR "Congo" [tiab] OR "Democratic republic of Congo" [tiab] OR "Equitorial Guinea" [tiab] OR "Gabon" [tiab] OR "Sao Tome" [tiab] OR "Burundi" [tiab] OR "Djibouti" [tiab] OR "Eritrea" [tiab] OR "Ethiopia" [tiab] OR "Kenya" [tiab] OR "Rwanda" [tiab] OR "Somalia" [tiab] OR "South Sudan" [tiab] OR "Sudan" [tiab] OR "Tanzania" [tiab] OR "Uganda" [tiab] OR "Angola" [tiab] OR "Botswana" [tiab] OR "Swaziland" [tiab] OR "Lesotho" [tiab] OR "Malawi" [tiab] OR "Mozambique" [tiab] OR "Namibia" [tiab] OR "South Africa" [tiab] OR "Zambia" [tiab] OR "Zimbabwe" [tiab] OR "Benin" [tiab] OR "Burkina Faso" [tiab] OR "Cabo Verde" [tiab] OR "Cote d'Ivoire" [tiab] OR "Ivory Coast" [tiab] OR "Gambia" [tiab] OR "Ghana" [tiab] OR "Guinea" [tiab] OR "Guinea Bissau" [tiab] OR "Liberia" [tiab] OR "Mali" [tiab] OR "Mauritania" [tiab] OR "Niger" [tiab] OR "Nigeria" [tiab] OR "Senegal" [tiab] OR "Sierra Leone" [tiab] OR "Togo" [tiab]

3. Results

The literature search generated 638 articles. Twenty-two duplicates were removed, and after title/abstract screening and full-text screening, 20 articles were retained. Reasons for exclusion included studies not being conducted in Subsaharan Africa, and outcomes were not measured concerning crash reduction, injury or fatality rates, whilst others were purely descriptive studies. The flow chart of the search is as indicated in the diagram below:

Flow Chart



3.1. Countries of Intervention

Five (5) interventions were recorded in Ghana, Uganda had four (4) studies, whilst Nigeria, Burkina Faso and Tanzania had two (2) each. There were single (1) interventions documented in Botswana, Kenya, Rwanda, South Africa, and Ethiopia. Geographically, this represents the western, eastern, and southern

sub-Sahara with the central regions unrepresented: Figure 1.

3.2. Description of Interventions

We used the template for intervention description and replication (TIDieR) checklist to generate a summary table of the intervention types (Table 1). The complete TIDier template is attached as **Appendix 2**.

Table 1. Summary of types of interventions.

Intervention Category/ Authors	*Country*	*Study Design*	*Target Population*	*Summary Outcome*
Combined				
Roehler et al., 2013	Uganda	Cross-sectional/Time Series	Motorcyclist	Trend towards reduced helmet use from 46% to 30.5%
Muni et al., 2019	Uganda	Matched Control/Time Series	Motorcyclists	43% reduced traffic crash risk
Sebego et al., 2014	Botswana	Interrupted time series	All Drivers	12% reduction in fatal road crashes
Brown, 2007	Rwanda	Interrupted Time Series	All road users	30% overall reduction in road traffic crashes
Education				
Johnson & Adebayo, 2011	Nigeria	Interrupted Time series	Motorcyclist	61% increase in safety knowledge and 52% increased compliance
Blantari et al., 2005	Ghana	Cross sectional	Drivers	No significant change in risky driving behavior
Anakwah et al., 2015	Ghana	Cross sectional	Drivers	No impact on risky driving tactics
Sween-Cadieux et al., 2018	Burkina Faso	Interrupted time series	All road users	Increased surveillance at accident prone intersections
Enforcement				
Bishai et al., 2008	Uganda	Interrupted time series/Cost effectiveness	Drivers	Significant 17% reduction in fatalities
Muguku et al., 2010	Kenya	Interrupted Time Series	Traffic injury victims	No statistically. Significant change in injury severity
Nwagwu et al., 2020	Nigeria	Cross sectional	All road users	No improvement in road safety
Legislation				
Abegaz et al., 2014	Ethiopia	Interrupted time series	All road users	Significant 19% decrease in non fatal crash, 12.4% reduction in fatal crashes
Road Safety				
Sumner et al., 2014	Tanzania	Cluster randomized control trial	Motorcyclists	Increase in reflective vest use by 9.5%
Zimmerman et al., 2015	Tanzania	Non-randomized matched control	All road users	Increased road traffic injuries at intervention site
Dagenais et al., 2021	Burkina Faso	Interrupted time series	Police	Increased road surveillance, rapid response to crash site
Speed Control				
Mutto et al., 2002	Uganda	Cross-sectional/Interrupted time series	Pedestrians	25% reduction in crash fatalities

Continued

Nadesan-Reddy & Knight, 2013	South Africa	Interrupted time series	All road users	23% overall improvement in pedestrian safety
Afukaar, 2003	Ghana	Interrupted time series	Drivers	50% reduction in crash fatalites
Bawa & Damsere-Derry, 2018	Ghana	Interrupted time series	All road users	Insignificant improvement in injury fatalities
Damsere-Derry et al., 2019	Ghana	Non-randomized/matched control	Drivers	Higher odds of pedestrian injury without rumps

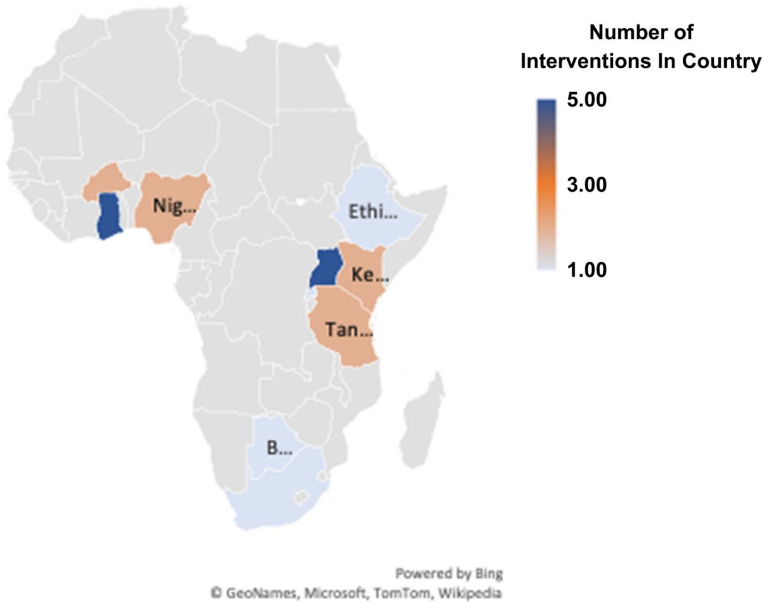


Figure 1. Geographical distribution of interventions.

We broadly categorised the areas of intervention into Education, Enforcement, Road Safety, Speed Control and Combined interventions.

Speed control was the highest documented intervention and formed 25% (n = 5) of the articles. Education and combined interventions formed 20% each (n = 4). Enforcement and Road Safety contributed three articles each representing 15%. Legislation was the least documented intervention with 5% (n = 1).

The percentage distribution is represented in the pie chart shown in **Figure 2**.

3.2.1. Enforcement

Bishai and colleagues examined the cost-effectiveness of enforcing traffic regulations on major roads in Uganda (Bishai et al., 2008).

They recorded a considerable increase in citations and a statistically significant decrease of 17% in road traffic mortalities after police patrols were initiated. A subsequent cost-benefit analysis found that investment in traffic safety enforcement was low compared to the expected lives saved and revenue mobilised (Bishai et al., 2008). They concluded that increased enforcement of existing traffic regulations was a highly cost-effective public health strategy in low-income countries (Bishai et al., 2008).

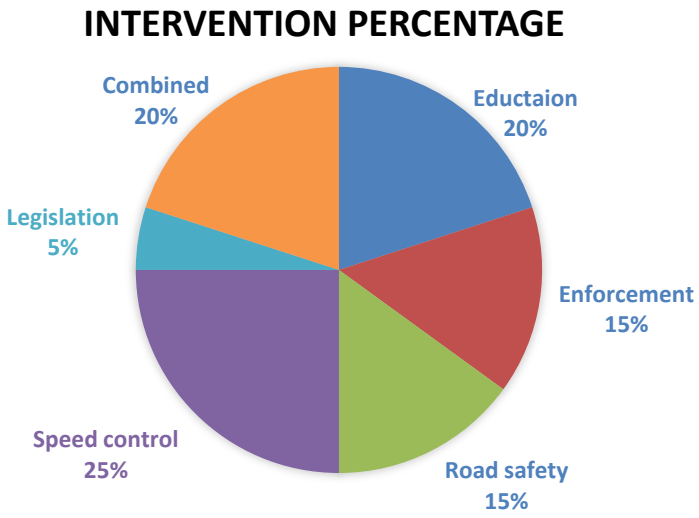


Figure 2. Pie chart.

Muguku et al. studied the effects of traffic act enforcement on injury severity amongst victims admitted to a provincial hospital in Kenya (Muguku et al., 2010). Their results showed no statistically significant differences in the road traffic injury severity amongst victims admitted to the hospital. This finding is at variance with other findings of decreased road traffic injuries after rigorous enforcement of road safety regulations reported in the literature (Yannis et al., 2007).

The Nigerian Federal Road Safety Corps (FRSC) role in enforcing traffic safety laws was evaluated by Nwagwu et al. (Nwagwu et al., 2020). The authors used a descriptive research survey approach to ascertain if road safety education failed to protect road users. They found that the FRSC yielded minimal results in bringing sanity to the roads and ensuring safety. They outlined several challenges in the execution of the FRSC mandate including inadequate institutional capacity, poor financing and lack of standards in their operations (Nwagwu et al., 2020).

3.2.2. Legislation

Abegaz et al. used an interrupted time series design to examine the usefulness of passing additional laws on road safety in Ethiopia (Abegaz et al., 2014). The new law prohibited cell phone conversations whilst behind the wheel and prohibited driving without a seatbelt or using a motorcycle without a helmet. A statistically significant 19% decrease in non-injury crashes (property only) were recorded after the law was passed. In the absence of the law, there would have been 178 deaths per 10,000 vehicles (19) which translate into 12.4% of deaths prevented by implementing the new law.

Bloomberg Philanthropies (BP) initiated a Blomberg Road Safety Program (BRSP) through the World Health Organization (WHO) (Toroyan, 2007) that included Kenya and nine other LMICs (Esperato et al., 2012). Miller et al. used a multistep modelling approach that combined local data on enforcement with

existing literature on prior, effective analogous interventions to estimate lives saved by the laws and regulations that emanated from the BRSP (Miller et al., 2018). Kenyas' drink driving law was estimated to be 4% effective, whilst the BRSP was projected to amount to a 1.9% reduction in fatalities from 2014-2023 (22). The authors concluded that legislative action and the advocacy that generates it potentially have a major influence on road safety (Miller et al., 2011).

3.2.3. Education

Johnson and Adebayo examined the effect of road safety education on the knowledge and compliance with highway safety codes amongst commercial motorcycle drivers (Johnson & Adebayo, 2011). Two groups of registered motorcyclists were recruited, and their baseline information on road safety compliance was obtained. Participants in the intervention group received education on the relevance of complying with road safety signs. At three months follow up, compliance with road safety signs increased from 15% to 70% in the intervention group as compared to an increase from 12% at baseline to 18% post-intervention in the control group. Assessment of compliance was however done through the administration of a questionnaire and not by direct measurement.

Blantari and colleagues evaluated televised road safety messages on driver attitudes on Ghanas' roads (Blantari et al., 2005).

The Ghana National Road Safety Commission introduced a series of televised advertisements targeting commercial long-distance drivers, taxi drivers, intra and inter-city bus and mini-bus drivers. Though the drivers admitted the messages in the advertisements were clear, they noted language as a barrier.

The actual behaviour of the study participants was not measured (Blantari et al., 2005). Besides, drivers were selected using a convenience sampling technique and may not represent the general commercial driver population (Blantari et al., 2005).

Anakwah et al. assessed the operationality of using fear-based video clips on the risky driving behaviour of commercial drivers (Anakwah et al., 2015). Sixty (60) second fear based video clips were shown to the intervention group and the control group saw a commercial sales advertisement that had no fear content. The study found fear-based messages had no impact on risky driving behaviour and recommended that such tactics be used with caution in road safety campaigns (Anakwah et al., 2015). They further argue that road traffic injury prevention resources could be channelled into other more effective prevention measures than fear-based messages (Anakwah et al., 2015).

Researchers in Burkina Faso employed a mixed-method evaluation to assess knowledge translation amongst key stakeholders on road traffic injuries (Sween-Cadieux et al., 2018). The study identified accident-prone areas in the capital and collated data on injuries and fatalities from road traffic crashes. The researchers then organised two one-day workshops ten weeks apart that brought together road users and stakeholders. The authors contend that deliberative

workshops enhance the translation and application of scientific, research-based knowledge in Burkina Faso (Sween-Cadieux et al., 2018).

3.2.4. Speed Control

Mutto and colleagues studied the effect of overpass construction on pedestrian injuries in Uganda (Mutto et al., 2002). Two cohorts of pedestrians—overpass users and non-overpass users—were interviewed using convenient sampling. Even though 77.9% (total 13,064) of respondents were concerned about road safety, only 6.6% of them identified the overpass as an appropriate safeguard (30). Additionally, 62.8% of non-overpass users cited extra walking time, distance and high stairs for their non-use of the overpass (Mutto et al., 2002). More than 90% of pedestrians failed to recognise the safety benefits of the overpass (30). The researchers identified a sharp rise in pedestrian injuries near the overpass and a doubling in the number of pedestrian casualties 12 months after the overpass was constructed. However, the mortalities decreased from 8 to 2 (Mutto et al., 2002).

Nadesan-Reddy and Knight used an interrupted time series design to study traffic calming effect on pedestrian injuries and vehicular crashes in two communities (Chatsworth and KwaMashu) in the eThekwini municipality in South Africa (Nadesan-Reddy & Knight, 2013). The researchers collected pedestrian-vehicular and motor vehicle collisions data 2 years before and two years after the construction of speed humps. There were 553 pedestrian-vehicle collisions (PVC) and 588 pedestrian injuries before hump construction in Chatsworth. After installation, the PVCs were reduced to 490, representing a 17% decline (Nadesan-Reddy & Knight, 2013). KwaMashu recorded 163 crashes before hump installation, and this reduced to 97 representing a 44% decline. Fatal crashes decreased by 68% in Chatsworth and 50% in KwaMashu, and pedestrian safety improved by 23% at both study sites (Nadesan-Reddy & Knight, 2013).

Afukaar analysed the effectiveness of rumble strips on the incidence of road traffic crashes and injuries at an accident-prone spot in Ghana (Afukaar, 2003). Published work indicated the speed factor as the leading cause of traffic crashes in Ghana and was implicated in 50% of crashes (Afukaar, 2003). The investigator relied on Police reports of crashes at the chosen site before and after rumble strip installation. There was a 55% reduction in crashes and a 35% reduction in fatalities within 16 months of installing the rumble strips (Afukaar, 2003). The study showed that physical speed calming measures installed at appropriate sites on roads effectively decrease traffic crashes and fatalities (Afukaar, 2003).

Modern roundabouts are known to reduce road traffic injury and severity and have been employed in many jurisdictions to mitigate conflicts at traffic intersections (Jensen, 2013; Mauro et al., 2015). However, Taekratok identified critical situations in which modern roundabouts may not be helpful: 1) when an acceptable geometric design cannot be constructed due to lack of space or unsuitable topography, 2) higher traffic flows in one or more approaches creating an imbalance 3) mix of vehicles includes disproportionate large numbers of huge

dimension vehicles (Taekratok, 1998). Bawa & Damsere-Derry investigated the safety performance with regards to the relative risk of death or injury at four modern roundabouts constructed in Ghana (Bawa & Damsere-Derry, 2018). The results indicated the four roundabouts performed sub-optimally as 12% of the 119 injuries recorded resulted in fatalities and 18% resulted in serious injuries (Bawa & Damsere-Derry, 2018). There were notable flaws in the construction of all four roundabouts. Firstly, there is the dual carriage Kumasi-Accra highway narrowing into a single lane upon entry and throughout the roundabout. Secondly, the highway is riddled with heavy-duty goods vehicles with high centres of gravity. These vehicles encounter extreme difficulties when manoeuvring the roundabout's tight corners, leading to frequent accidents and topple overs (Bawa & Damsere-Derry, 2018). The authors cautioned, roundabouts should be avoided on major arterial routes and roads patronised by large buses and other vehicles with high centres of gravity (Bawa & Damsere-Derry, 2018).

Damsere-Derry and colleagues evaluated the effectiveness of traffic calming measures on vehicular speed and the association of these measures with pedestrian injury severity (Damsere-Derry et al., 2019). Speed data was obtained on 11,329 vehicles in 38 townships using radar speed guns in a snapshot manner over six years (2006-2011). The results indicated vehicular speeds were considerably higher in settlements without speed calming measures than those with measures.

The odds of pedestrian fatalities were three times higher in settlements without speed calming installations (Damsere-Derry et al., 2019). Speed tables had the greatest effect of reducing vehicular speeds among the speed calming measures (Damsere-Derry et al., 2019).

3.2.5. Road Safety

Sumner et al. used a cluster randomised control trial to determine the effect of free distribution of safety equipment on utilisation amongst taxi motorcyclists in Tanzania (Sumner et al., 2014). The authors recruited motorcycle taxi drivers in clusters from multiple motorcycle taxi stands and randomised participants into either control or intervention groups. All participants were educated on conspicuity measures, and those in the control group were given free reflective fluorescent vests. The study enrolled 180 participants with equal numbers in both arms.

At three months follow-up, he overall usage of reflective vests was low—9.5% in the intervention group, 2% in the control group; however, motorcycle taxi drivers in the intervention group were five times more likely to use a reflective vest (Sumner et al., 2014). There was a 37% reduced risk of a motorcycle crash using protective reflective vests (Sumner et al., 2014).

Zimmerman and colleagues evaluated the efficiency of a road safety program on injuries on rural roads in Tanzania in 2014 (39). The program involved a one-week training on road safety for 100 motorcyclists who also received reflective vests and two helmets each. Other measures included training of teachers and students, provision of reflection-enhanced school bags and distribution of

reflective stickers at the intervention site.

The communities at the control site received the same education and materials after the study's follow-up data was completed.

The incidence of road traffic injuries overall increased at the intervention site during the study but remained relatively the same at the control site. The authors stipulated that increased traffic injury incidence at the intervention site could be due to the increased sensitisation through the education offered, leading to an increased tendency to report and recall such events (39).

Dagenais and colleagues published the Police perspective on the results of a deliberative knowledge translation workshop on road crashes in Burkina Faso (Dagenais et al., 2021). The authors interviewed the heads of Police crash unit divisions involved in earlier research on road safety and the capability of surveillance systems to assess road traffic crashes. Rapid response to crash sites, the increased presence of Police at accident-prone intersections and the stringent enforcement of the highway code were listed as benefits of the program (Dagenais et al., 2021). The crash units also maintained crash data to inform other stakeholders on trends in the road safety sector. One significant drawback, however, was the decreased road surveillance over time due high staff turnover and lack of resources (Dagenais et al., 2021).

3.2.6. Combined Interventions

In 2013, Roehler and colleagues used a mixed-methods design to inform the Ugandan Helmet Vaccine Initiative (UHVI) (Roehler et al., 2013). Evidence shows motorcycle helmets decrease the rider's risk of mortality by 42% and the risk of head injury by 69% (Liu et al., 2008). The UHVI was initiated in 2010 to improve helmet use and promote high-quality helmets as a "vaccine" that protects against head injury (Roehler et al., 2013). The researchers used focused group discussions, structured roadside interviews and direct roadside observations to collect data on helmet wearing attitudes and behaviours. This baseline data was fed into the UHVI media campaigns. The messages addressed the reasons for non-helmet use amongst motorcyclists and passengers; helmet comfort, cost and helmet obstructing the vision of motorcyclists. Other limitations to helmet use were the lack of quality helmets compatible with the tropical weather of Uganda (Roehler et al., 2013).

In 2019, Muni and colleagues reviewed the association between education programs on road safety and reduced risk of road traffic crashes amongst motorcyclists in Uganda (Muni et al., 2019). One such program is the SafeBoda which provides its motorcyclists multiphase safety training, basic first responder training and helmets. In addition, passengers of SafeBoda who are concerned with contracting skin diseases from the use of helmets are provided with hairnets. The study authors recruited two cohorts of 171 SafeBoda and 171 regular drivers over four months using convenient purposive sampling. The enrolled participants were administered two questionnaires that collected demographic data, data on safe riding behaviour and knowledge of traffic signs and regula-

tions.

There was a 43% lower risk of road traffic crashes among SafeBoda drivers compared to regular riders during the first six months of follow up. Overall, SafeBoda drivers were more likely to employ safe riding behaviour on the road than regular drivers. The provision of safety training, having access to safety equipment, and the strict adherence to a code of conduct amongst the SafeBoda community could be additional factors that explain the lower risk of crashes (Muni et al., 2019). However, several limitations were identified; firstly, the main outcome measure of traffic crashes was self-reported introducing bias and measurement error. Secondly, the absence of probability sampling limits the generalisation of the results and finally, the mediation analysis required some assumptions to be made to establish a true causal effect.

Botswana implemented three policies between October 2008 and November 2010 targeting the impact of alcohol on road traffic safety (Sebego et al., 2014). Sebego and colleagues used time series analysis to determine if the passage and enforcement of these policies resulted in decreased road traffic crashes and increased safe driving behaviour (Sebego et al., 2014). An interrupted time-series analysis was used to examine all traffic crash data over an eight-year period (2004-2011). The data was collated from the Traffic Branch Database of the Botswana Police service.

The results showed a significant decline in overall crash rates at the beginning of 2009 through 2011. The combination of levies, increased traffic offence penalties, intensified education, and enforcement of regulations lead to an overall decrease in road traffic crashes (Sebego et al., 2014).

Poswayo et al. assessed the impact of a School Area Road Safety Assessment and Improvement (SARSAI) Program on traffic injury prevention amongst Tanzanian children (Poswayo et al., 2019). Selected schools were divided into intervention and control groups. Upon completion of data collection, the schools in the control group received the same injury prevention interventions. There was a statistically significant reduction in road traffic injuries at the interventions schools (66 vs 125) with a $p < 0.001$ (45). The highest reductions were in motorcycle pedestrian crashes and morning crashes (Poswayo et al., 2019). The authors believed that scientifically-driven injury prevention programs are attainable even in low resource settings with unacceptably high rates of traffic injuries in children of school-going age (Poswayo et al., 2019).

In 1996, Rwanda had one of the worst traffic injury records worldwide (46). An accident was reported to have occurred every two and half hours, with the majority resulting in injuries that carry a 10% fatality rate (Brown, 2007). Following broad stakeholder consultations and financing from the WHO, the Rwandan government completely reviewed its regulations on road safety. Subsequently, legislative changes with strict enforcement of road safety regulations, increased penalties and fines together safety campaigns were launched (Brown, 2007). Mortalities from road traffic crashes fell by 30% as a result of these interventions (46). Additionally, the country reinforced its traffic Police unit to fur-

ther enforce the law and beef up educational campaigns to enhance road safety conduct among road users (Brown, 2007).

4. Discussion

This review identified 20 articles from 10 countries in sub-Saharan Africa with a disproportionate spread of interventions favouring the geographical East and West sub-Saharan nations. Only two of the 20 articles recorded interventions from Francophone countries in the sub-Sahara. Other investigators have documented this paucity of interventions from Francophone countries in the literature (Bonnet et al., 2018, 2020). Though this could be due to a flawed search strategy, other researchers have also noted the paucity of road injury prevention measures in Francophone sub-Sahara (Bonnet et al., 2018, 2020). In addition, Bonnet et al., indicate, Francophone countries in sub-Saharan Africa lack robust databases to support their applications for funding from international donors; moreover, these countries may not be eligible for projects supported by the Bloomberg Foundation and the Road Safety Program (Bonnet et al., 2018).

Combined interventions provided the most robust evidence for a reduction in road traffic injuries, crashes and fatalities. This category appears to be unique to our study as it has not been found in similar articles that review the subject of road traffic interventions in Africa (Bonnet et al., 2018; Staton et al., 2016). We categorised an intervention as "combined" if its implementation involved two or more of the other categories.

Enforcement was mentioned in 11 out of the 20 articles as a key factor in ensuring sanity on the roads. Therefore, enforcement should be considered an integral part of any future prevention interventions in the sub-Sahara. Gilchrist et al. state that active police enforcement of road safety regulations is efficient and has a long-lasting impact (Gilchrist et al., 2000).

Similarly, Yannis et al. in their study on the regional effect of enforcement on traffic injuries noted a considerable reduction in injuries with enforcement (Yannis et al., 2007). Akama et al. who also reported outcomes of enforcement in Kenya using patient data, opined that traffic injuries are markedly reduced after enforcement (Akama et al., 2007).

There was only one study on Legislation. This may be because most countries already have well-framed Legislation on road safety. What is deficient is the enforcement of these already existing laws. Staton, in his metasummary on road injury prevention interventions in LMICs, also found only one strategy on legislation in sub-Saharan Africa (Staton et al., 2016).

Though some studies reported favourable outcomes after implementation of speed calming measures, others were counterproductive. An example is the four modern roundabouts constructed on a major arterial highway in Ghana (Bawa & Damsere-Derry, 2018). In their detailed safety evaluation work roundabouts, Qin et al. postulate that a properly constructed roundabout should eradicate fatal or serious injuries (Qin et al., 2011). Poorly sited and engineered bridges, by-

passes and alternate paths further compromise pedestrian safety on roads (Forjuoh, 2003).

All three studies on road safety noted the absence of enforcement as a limitation to achieving the desired results of these interventions (Dagenais et al., 2021; Sumner et al., 2014; Zimmerman et al., 2015). However, it has been documented that in the presence of active police law enforcement, conspicuity strategies and road safety interventions are effective and sustainable over longer periods (Gilchrist et al., 2000).

The articles on education clearly demonstrate that knowledge about road safety and traffic signs and fear-based appeals do not translate into a commensurate attitudinal and behavioural change on the road (Anakwah et al., 2015; Blantari et al., 2005; Johnson & Adebayo, 2011). Our findings on the use of the media, especially threat-based messages, align with other reports in the literature. Elliot and colleagues recommend avoiding the use of threat appeals altogether, or when employed, should be used with the utmost caution (Elliott, 2003). Evoking the fear of personal death, states Ben-Ari, is not necessarily the best means of changing dangerous behaviour, especially amongst young males (Taubman-Ben-Ari et al., 2000). In their work on the role of fear appeals in improving the safety of drivers, Lewis et al. concluded that, in the setting of road safety, it is justifiable to explore other effective prevention initiatives than the use of fear appeals (Lewis et al., 2007). They further stated, however, that the use or otherwise of fear-based messages in the road safety sector will continue to generate immense debate in the scientific world and amongst road transport stakeholders for some time to come (Lewis et al., 2007). The media-based education of motorists and pedestrians must be combined with other preventions strategies to yield meaningful, sustained results.

Staton et al. in their systematic review on road injury prevention initiatives in low and middle-income countries admitted, the adaptation and implementation of existing cost-effective measures in LMICs has been problematic and is beleaguered with infrastructural and resource constraints (Staton et al., 2016).

A ministerial conference in February 2020 was held to mark the end of the United Nations (UN) Decade of Action for Road Safety (2011-2020) (Bonnet et al., 2020). Etienne Krug is quoted to have said "not a single low-income country has reduced its road injury rates", thereby calling for multisector partnerships and global collaborations to stem the tide (Hyder, 2020).

Our review provides insights not only into effective prevention strategies in sub-Saharan Africa, but has also highlighted inefficient and failed interventions. Future interventions can draw from the strengths and weaknesses of the interventions listed in this review to structure more efficient injury prevention interventions.

5. Limitations

We identified some limitations in our review:

1) According to the United Nations Development Program (UNDP), only 22 (47.8%) of the 46 countries in sub-Saharan Africa are English speaking, according to the United Nations Development Program (UNDP). A review of the English literature will not capture other relevant interventions that may have been carried out in non-English-speaking countries and published in other languages.

2) The review takes a regional perspective of a geographic area made up of different economic zones such as the Economic Community of West African States (ECOWAS) and the Southern African Development Community (SADC). An evaluation of interventions within one zone may not be transferrable to the other.

3) The different study designs and outcomes identified in our review made it difficult to compare results.

6. Conclusion

Though several studies have looked at the effectiveness of road injury prevention strategies in low-middle income countries in general, none have been specific to sub-Saharan Africa. The many successful injury prevention strategies adopted by high-income countries are costly and may not apply to sub-Saharan Africa. Enforcement of safety regulations ensures compliance and sustainability of prevention interventions. Speed control measures are useful in calming vehicular speeds, but poor design and citing can endanger road users. Road safety, education and Legislation have little to no effect when implemented alone; however, when combined with other measures, they can lead to significant reductions in road traffic injuries fatalities.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Abegaz, T., Berhane, Y., Worku, A., & Assrat, A. (2014). Effectiveness of an Improved Road Safety Policy in Ethiopia: An Interrupted Time Series Study. *BMC Public Health, 14,* 539. https://doi.org/10.1186/1471-2458-14-539

Afukaar, F. (2003). Speed Control in Developing Countries: Issues, Challenges and Opportunities in Reducing Road Traffic Injuries. *Injury Control and Safety Promotion, 10,* 77-81. https://doi.org/10.1076/icsp.10.1.77.14113

Akama, M. K., Chindia, M. L., Macigo, F. G., & Guthua, S. W. (2007). Pattern of Maxillofacial and Associated Injuries in Road Traffic Accidents. *East African Medical Journal, 84,* Article 6. https://doi.org/10.4314/eamj.v84i6.9539

Anakwah, N., Akotia, C., Joseph, O., Parimah, F., Sarfo, J. O., & Aggrey, G. (2015). Risky Driving Attitudes in Ghana: Is the Use of Fear-Based Messages Operational? *European Researcher, 97,* 560-567. https://doi.org/10.13187/er.2015.97.560

Bawa, S., & Damsere-Derry, J. (2018). Assessment of the Road Safety Performance of Four Roundabouts in Kumasi, Ghana. *International Journal of Injury Control and*

Safety Promotion, 25, 239-246. https://doi.org/10.1080/17457300.2017.1345949

Bishai, D., Asiimwe, B., Abbas, S., Hyder, A. A., & Bazeyo, W. (2008). Cost-Effectiveness of Traffic Enforcement: Case Study from Uganda. *Injury Prevention, 14,* 223-227. https://doi.org/10.1136/ip.2008.018341

Blantari, J., Asiamah, G., Appiah, N., & Mock, C. (2005). An Evaluation of the Effectiveness of Televised Road Safety Messages in Ghana. *International Journal of Injury Control and Safety Promotion, 12,* 23-29. https://doi.org/10.1080/17457300512331342199

Bonnet, E., Lechat, L., & Ridde, V. (2018). What Interventions Are Required to Reduce Road Traffic Injuries in Africa? A Scoping Review of the Literature. *PLOS ONE*, *13*, e0208195. https://doi.org/10.1371/journal.pone.0208195

Bonnet, E., Nikiéma, A., Adoléhoume, A., & Ridde, V. (2020). Better Data for Better Action: Rethinking Road Injury Data in Francophone West Africa. *BMJ Global Health, 5,* e002521. https://doi.org/10.1136/bmjgh-2020-002521

Brown, H. (2007). Rwanda's Road-Safety Transformation. *Bulletin of the World Health Organization, 85,* 425-426. https://doi.org/10.2471/BLT.07.020607

Dagenais, C., Proulx, M., Sween-Cadieux, E. M., Nikiema, A. et al. (2021). Collaborative Research and Knowledge Translation on Road Crashes in Burkina Faso: The Police Perspective 18 Months On. *Health Research Policy and Systems, 19,* Article No. 3. https://doi.org/10.1186/s12961-020-00654-1

Damsere-Derry, J., Ebel, B. E., Mock, C. N., Afukaar, F., Donkor, P., & Kalowole, T. O. (2019). Evaluation of the Effectiveness of Traffic Calming Measures on Vehicle Speeds and Pedestrian Injury Severity in Ghana. *Traffic Injury Prevention, 20,* 336-342. https://doi.org/10.1080/15389588.2019.1581925

Elliott, B. (2003). The Psychology of Fear Appeals Revisited. In *Road Safety Research, Policing and Education Conference* (pp. 266-273). Roads and Traffic Authority (RTA). https://trid.trb.org/view/706141

Esperato, A., Bishai, D., & Hyder, A. A. (2012). Projecting the Health and Economic Impact of Road Safety Initiatives: A Case Study of a Multi-Country Project. *Traffic Injury Prevention, 13,* 82-89. https://doi.org/10.1080/15389588.2011.647138

Forjuoh, S. N. (2003). Traffic-Related Injury Prevention Interventions for Low-Income Countries. *Injury Control and Safety Promotion, 10,* 109-118. https://doi.org/10.1076/icsp.10.1.109.14115

Gilchrist, J., Schieber, R. A., Leadbetter, S., & Davidson, S. C. (2000). Police Enforcement as Part of a Comprehensive Bicycle Helmet Program. *Pediatrics, 106,* 6-9. https://doi.org/10.1542/peds.106.1.6

Hyder, A. A. (2020). Another Summit on Global Road Safety? Key Questions to Ask Ministers. *The Lancet, 395,* 477-479. https://doi.org/10.1016/S0140-6736(20)30159-8

Jensen, S. U. (2013). Safety Effects of Converting Intersections to Roundabouts. *Transportation Research Record, 2389,* 22-29. https://doi.org/10.3141/2389-03

Johnson, O. E., & Adebayo, A. (2011). Effect of Safety Education on Knowledge of and Compliance with Road Safety Signs among Commercial Motorcyclists in Uyo, Southern Nigeria. *Ghana Medical Journal, 45,* 89-96.

Krug, E. G., Sharma, G. K., & Lozano, R. (2000). The Global Burden of Injuries. *American Journal of Public Health, 90,* 523-526. https://doi.org/10.2105/AJPH.90.4.523

Lewis, I., Watson, B., Tay, R., & White, K. M. (2007). The Role of Fear Appeals in Improving Driver Safety: A Review of the Effectiveness of Fear-Arousing (Threat) Appeals in Road Safety Advertising. *International Journal of Behavioral Consultation and Therapy, 3,* 203-222. https://doi.org/10.1037/h0100799

Liu, B. C., Ivers, R., Norton, R., Boufous, S., Blows, S., & Lo, S. K. (2008). Helmets for Preventing Injury in Motorcycle Riders. *The Cochrane Database of Systematic Reviews, 1,* CD004333. https://doi.org/10.1002/14651858.CD004333.pub3

Mauro, R., Cattani, M., & Guerrieri, M. (2015). Evaluation of the Safety Performance of Turbo Roundabouts by Means of a Potential Accident Rate Mode. *The Baltic Journal of Road and Bridge Engineering, 10,* 28-38. https://doi.org/10.3846/bjrbe.2015.04

Miller, T. R., Bhattacharya, S., & Zaloshnja, E. (2011). Fruits of 20 Years of Highway Safety Legislative Advocacy in the United States. *Annals of Advances in Automotive Medicine/Annual Scientific Conference, 55,* 357-363.

Miller, T. R., Levy, D. T., & Swedler, D. I. (2018). Lives Saved by Laws and Regulations That Resulted from the Bloomberg Road Safety Program. *Accident Analysis & Prevention, 113,* 131-136. https://doi.org/10.1016/j.aap.2018.01.014

Muguku, E., Ouma, J., & Yitambe, A. (2010). Effects of Enforcement of the Traffic Act on Injury Severity among Patients Admitted at the Rift Valley Provincial General Hospital, Nakuru. *East African Medical Journal, 87,* 436-442.

Muni, K., Kobusingye, O., Mock, C., Hughes, J. P., Hurvitz, P. M., & Guthrie, B. (2019). Motorcycle Taxi Programme Is Associated with Reduced Risk of Road Traffic Crash among Motorcycle Taxi Drivers in Kampala, Uganda. *International Journal of Injury Control and Safety Promotion, 26,* 294-301. https://doi.org/10.1080/17457300.2019.1594952

Mutto, M., Kobusingye, O. C., & Lett, R. R. (2002). The Effect of an Overpass on Pedestrian Injuries on a Major Highway in Kampala—Uganda. *African Health Sciences, 2,* 89-93.

Nadesan-Reddy, N., & Knight, S. (2013). The Effect of Traffic Calming on Pedestrian Injuries and Motor Vehicle Collisions in Two Areas of the eThekwini Municipality: A before-and-after Study. *SAMJ: South African Medical Journal, 103,* 621-625. https://doi.org/10.7196/samj.7024

Nantulya, V. M., & Reich, M. R. (2002). The Neglected Epidemic: Road Traffic Injuries in Developing Countries. *BMJ: British Medical Journal, 324,* 1139-1141. https://doi.org/10.1136/bmj.324.7346.1139

Nwagwu, E. J., Udegbunam, K. C., & Uwaechia, O. G. (2020). Federal Road Safety Corps and Administration of Traffic Laws in South-East Nigeria: An Appraisal. *International Journal of Injury Control and Safety Promotion, 27,* 510-519. https://doi.org/10.1080/17457300.2020.1815794

Poswayo, A., Kalolo, S., Rabonovitz, K., Witte, J., & Guerrero, A. (2019). School Area Road Safety Assessment and Improvements (SARSAI) Programme Reduces Road Traffic Injuries among Children in Tanzania. *Injury Prevention, 25,* 414-420. https://doi.org/10.1136/injuryprev-2018-042786

Qin, X., Khan, G., Bill, A., & Noyce, D. A. (2011). Comprehensive Safety Evaluation of Roundabouts in Wisconsin. *Journal of Transportation Safety & Security, 3,* 289-303. https://doi.org/10.1080/19439962.2011.624290

Ralaidovy, A. H., Bachani, A. M., Lauer, J. A., Lai, T., & Chisholm, D. (2018). Cost-Effectiveness of Strategies to Prevent Road Traffic Injuries in Eastern Sub-Saharan Africa and Southeast Asia: New Results from WHO-CHOICE. *Cost Effectiveness and Resource Allocation, 16,* 59. https://doi.org/10.1186/s12962-018-0161-4

Roehler, D. R., Naumann, R. B., Boniface, M., Mable, N., Mwanje, B., Lotte, B., Blanchard, C., Baldwin, G. T., & Dellinger, A. M. (2013). Using Baseline and Formative Evaluation Data to Inform the Uganda Helmet Vaccine Initiative. *Global Health Pro-*

motion, 20, 37-44. https://doi.org/10.1177/1757975913509657

Sebego, M., Naumann, R. B., Rudd, R. A., Voetsch, K., Dellinger, A. M., & Ndlovu, C. (2014). The Impact of Alcohol and Road Traffic Policies on Crash Rates in Botswana, 2004-2011: A Time-Series Analysis. *Accident Analysis & Prevention, 70,* 33-39. https://doi.org/10.1016/j.aap.2014.02.017

Staton, C., Vissoci, J., Gong, E., Toomey, N., Wafula, R., Abdelgadir, J., Zhou, Y., Liu, C., Pei, F., Zick, B., Ratliff, C. D., Rotich, C., Jadue, N., de Andrade, L., von Isenburg, M., & Hocker, M. (2016). Road Traffic Injury Prevention Initiatives: A Systematic Review and Metasummary of Effectiveness in Low and Middle Income Countries. *PLOS ONE, 11,* e0150150. https://doi.org/10.1371/journal.pone.0144971

Sumner, S. A., Pallangyo, A. J., Reddy, E. A., Maro, V., Pence, B. W., Lynch, C., Turner, E. L., Egger, J. R., & Thielman, N. M. (2014). Effect of Free Distribution of Safety Equipment on Usage among Motorcycle-Taxi Drivers in Tanzania—A Cluster Randomised Controlled Trial. *Injury, 45,* 1681-1686. https://doi.org/10.1016/j.injury.2014.04.034

Sween-Cadieux, E. M., Dagenais, C., & Ridde, V. (2018). A Deliberative Dialogue as a Knowledge Translation Strategy on Road Traffic Injuries in Burkina Faso: A Mixed-Method Evaluation. *Health Research Policy and Systems*, *16,* Article No. 113. https://doi.org/10.1186/s12961-018-0388-8

Taekratok, T. (1998). *Modern Roundabouts for Oregon* (#98-SRS-522; p. 134). Oregon Department of Transportation, Research Unit.

Taubman-Ben-Ari, O., Florian, V., & Mikulincer, M. (2000). Does a Threat Appeal Moderate Reckless Driving? A Terror Management Theory Perspective. *Accident; Analysis and Prevention, 32,* 1-10. https://doi.org/10.1016/S0001-4575(99)00042-1

Toroyan, T. (2007). Road Traffic Injury Prevention Receives Boost from Bloomberg Family Foundation. *Injury Prevention, 13,* 431. https://doi.org/10.1136/ip.2007.017459

United Nations (2020). *World Population Prospects 2019—Volume II: Demographic Profiles*. UN.

United Nations (n.d.). *Decade of Action for Road Safety 2011-2020, May 2011.*

WHO (n.d.). *Save Lives: A Road Safety Technical Package*. https://www.who.int/publications/i/item/save-lives-a-road-safety-technical-package

World Health Organization (2015). *Global Status Report on Road Safety 2015: Supporting a Decade of Action.* WHO.

World Health Organization (n.d.). *Injuries and Violence: The Facts 2014*. https://www.who.int/violence_injury_prevention/key_facts/VIP_key_facts.pdf

Yannis, G., Papadimitriou, E., & Antoniou, C. (2007). Multilevel Modelling for the Regional Effect of Enforcement on Road Accidents. *Accident Analysis & Prevention, 39,* 818-825. https://doi.org/10.1016/j.aap.2006.12.004

Zimmerman, K., Jinadasa, D., Maegga, B., & Guerrero, A. (2015). Road Traffic Injury on Rural Roads in Tanzania: Measuring the Effectiveness of a Road Safety Program. *Traffic Injury Prevention, 16,* 456-460. https://doi.org/10.1080/15389588.2014.973491

Appendix 1

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	

Continued

	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.
RESULTS		
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.
Study characteristics	17	Cite each included study and present its characteristics.
Risk of bias in studies	18	Present assessments of risk of bias for each included study.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.
	20c	Present results of all investigations of possible causes of heterogeneity among study results.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.
DISCUSSION		
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.
	23b	Discuss any limitations of the evidence included in the review.
	23c	Discuss any limitations of the review processes used.
	23d	Discuss implications of the results for practice, policy, and future research.

Continued

OTHER INFORMATION		
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.
Competing interests	26	Declare any competing interests of review authors.
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372: n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Appendix 2

The TIDieR (Template for Intervention Description and Replication) Checklist*:

Information to include when describing an intervention and the location of the information

Item number	Item	Where located**	
		Primary paper (page or appendix number)	Other† (details)
	BRIEF NAME		
1.	Provide the name or a phrase that describes the intervention.	_____	_____
	WHY		
2.	Describe any rationale, theory, or goal of the elements essential to the intervention.	_____	_____
	WHAT		
3.	Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (e.g. online appendix, URL).	_____	_____
4.	Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.	_____	_____
	WHO PROVIDED		
5.	For each category of intervention provider (e.g. psychologist, nursing assistant), describe their expertise, background and any specific training given.	_____	_____
	HOW		

Continued

6.	Describe the modes of delivery (e.g. face-to-face or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group.	_____	_____
	WHERE		
7.	Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features.	_____	_____
	WHEN and HOW MUCH		
8.	Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity or dose.	_____	_____
	TAILORING		
9.	If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how.	_____	_____
	MODIFICATIONS		
10.‡	If the intervention was modified during the course of the study, describe the changes (what, why, when, and how).	_____	_____
	HOW WELL		
11.	Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them.	_____	_____
12.‡	Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned.	_____	_____

Authors—use N/A if an item is not applicable for the intervention being described. **Reviewers—use "?" if information about the element is not reported/not sufficiently reported. †If the information is not provided in the primary paper, give details of where this information is available. This may include locations such as a published protocol or other published papers (provide citation details) or a website (provide the URL). ‡If completing the TIDieR checklist for a protocol, these items are not relevant to the protocol and cannot be described until the study is complete. *We strongly recommend using this checklist in conjunction with the TIDieR guide (see *BMJ* 2014; 348: g1687) which contains an explanation and elaboration for each item. *The focus of TIDieR is on reporting details of the intervention elements (and where relevant, comparison elements) of a study. Other elements and methodological features of studies are covered by other reporting statements and checklists and have not been duplicated as part of the TIDieR checklist. When a **randomised trial** is being reported, the TIDieR checklist should be used in conjunction with the CONSORT statement (see https://www.consort-statement.org/) as an extension of **Item 5 of the CONSORT 2010 Statement.** When a **clinical trial protocol** is being reported, the TIDieR checklist should be used in conjunction with the SPIRIT statement as an extension of **Item 11 of the SPIRIT 2013 Statement** (see https://www.spirit-statement.org/). For alternate study designs, TIDieR can be used in conjunction with the appropriate checklist for that study design (see https://www.equator-network.org/).