Financial penalties for decreasing incidence, death and disability due to road traffic injuries:

Rapid Evidence Synthesis

This document is a supplement to the policy brief on the issue and is a working paper

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List of abbreviations

AIGGPA	Atal Bihari Vajpayee Institute of Good Governance and Policy Analysis
RTI	Road Traffic Injuries
LMIC	Low- and middle-income countries
NCRB	National Crime Records Bureau
GBD	Global Burden of Disease
MoRTH	Ministry of Road Transport and Highways
MVA	Motor Vehicles' Act
WHO	World Health Organisation
DUI	Driving Under Influence
EPOC	Cochrane Effective Practice and Organisation of Care Review Group
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
ESL	Excessive Speeding Legislation
SVN	Single Night-time Vehicle crashes
ZTL	Zero Tolerance Law
EL	Emilia Law
IRRTF	Incidence Rate of Road Traffic Fatality
IRRTI	Incidence Rate of Road Traffic Injuries
IRRRTO	Incidence Rate of Rural Road Traffic Offenses

1. Introduction

Road Traffic Injuries (RTI) are the leading cause of death among children and young adults aged between 5-29 years of age[1]. The burden of road traffic deaths is disproportionately high among LMICs in relation to size of population and number of motor vehicles[1]. In India, deaths due to RTI have increased by 58.7% from 1990 to 2017. As per the Global Burden of Disease[2] (GBD) data, pedestrians accounted for the highest number of deaths (35.1%) due to RTI followed by motorcyclists (30.9%), motor vehicle occupants (26.4%) and cyclists (7%)[2].

The Sustainable Development Goal 3.5, adopted in 2015, aimed to reduce road traffic deaths by 50% by 2020. However, the slow progress towards achieving it meant that there was a call during the 3rd Global Ministerial Conference on Road Safety held in Stockholm for an extension to 2030 [3]. In 2019, the Government of India amended the Motor Vehicles Act (MVA) on several counts, including increasing penalties and better enforcement measures for ensuring safe road user behaviour such as helmet and seat belt-use and deterring drunk driving, over-speeding, and driving without license [4]. However, implementation of the act has been challenging in several states, owing to the quantum of penalty hike for violation.

The rapid evidence synthesis team in The George Institute for Global Health, India received a request from Atal Bihari Vajpayee Institute of Good Governance and Policy Analysis (AIGGPA) to understand the evidence base behind the effectiveness of penalty measures in decreasing incidence and mortality due to road traffic injuries.
We conducted a rapid evidence synthesis within a span of 6 weeks to understand the effectiveness of monetary fines (financial penalty) for traffic violations on the incidence, death and disability due to RTI.

2. Methods

We have used Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guidelines[5] to report the study.

Protocol registration

We developed a protocol for the study a priori (with SB acting as a custodian). However, the protocol was not registered owing to the rapid nature of the evidence synthesis.

Eligibility Criteria (PICOS)

We included studies, which met the following criteria:

Population

Our population of interest were road users including but not limited to drivers, passengers and pedestrians.

Intervention

Our intervention was financial penalties (fines) alone with or without non-financial penalties for violation/infringement of helmet use, seat belt use, driving under influence of alcohol (DUI) and excessive speeding. We selected these because they are contextually relevant and are some of the major causes of RTI as reported by the Ministry of Road Transport and Highways (MoRTH) report in 2017[6] and on discussion with the requesters for the evidence synthesis. Also, these are major modifiable behavioural risk factors as specified by World Health Organization (WHO) with targeted interventions (using the "safe systems" approach) to address RTI.

Comparison

Our comparison group were non-financial penalty alone or no penalty

Outcome

We considered the following outcome variables for the study

- Incidence of RTI
- Incidence of road traffic crashes
- Death (mortality) due to RTI/ road traffic crashes
- Disability (physical/mental) due to RTI/road traffic crashes (as defined by primary study authors)
- Severity of RTI/ road traffic crashes (as defined by primary study authors)

Study designs

We included the following study designs for our review:

- Randomised controlled trials
- Non-randomised controlled trials
- Controlled before-after studies
- Interrupted time series studies
  (with minimum 3 time points before and after intervention)

We restricted the study to intervention study designs as per the Cochrane Effective Practice and Organisation of Care Review Group (EPOC) criteria to look at study designs which provide good quality evidence for decision making in the absence of randomised controlled trial.

Information sources and search

We conducted a comprehensive search (SB, SP and SM) in five major databases (Cochrane Library, Ovid Medline, Health Systems Evidence, EMBASE and Safety Lit) on 2nd July 2020 using the search strategy provided in Table 1 of Appendix. We looked through the reference lists of included studies to identify any potentially relevant papers. We only included studies published in English and no date limits were applied.

Study selection and data collection process

The search results from the different electronic databases were combined into a single file and the duplicates were removed by SP. Two reviewers (SP and SM) then independently screened titles, abstracts and evaluated the full-text articles against the pre-specified inclusion criteria. One reviewer (JT) did quality check in 25% of the articles as third reviewer. SP extracted the relevant data from all eligible publications. SM assessed and ensured the correctness of data extraction. Any inconsistencies were resolved through consensus (SP and SM)

Assessment of risk of bias in included studies

Risk of bias was not assessed for the eligible studies.

Data synthesis

We narratively synthesised the findings of the studies. The narrative summary explored the effectiveness of penalties (financial or non-financial) on violations in RTI and deaths. We summarised estimates or summary statistics (as reported without any meta-analysis) using a structured tabulation of results across studies (grouped according to different types of violations for which financial penalties, alone or in combination with other penalties, were instituted) and reported range and magnitude of observed values.

3. Results

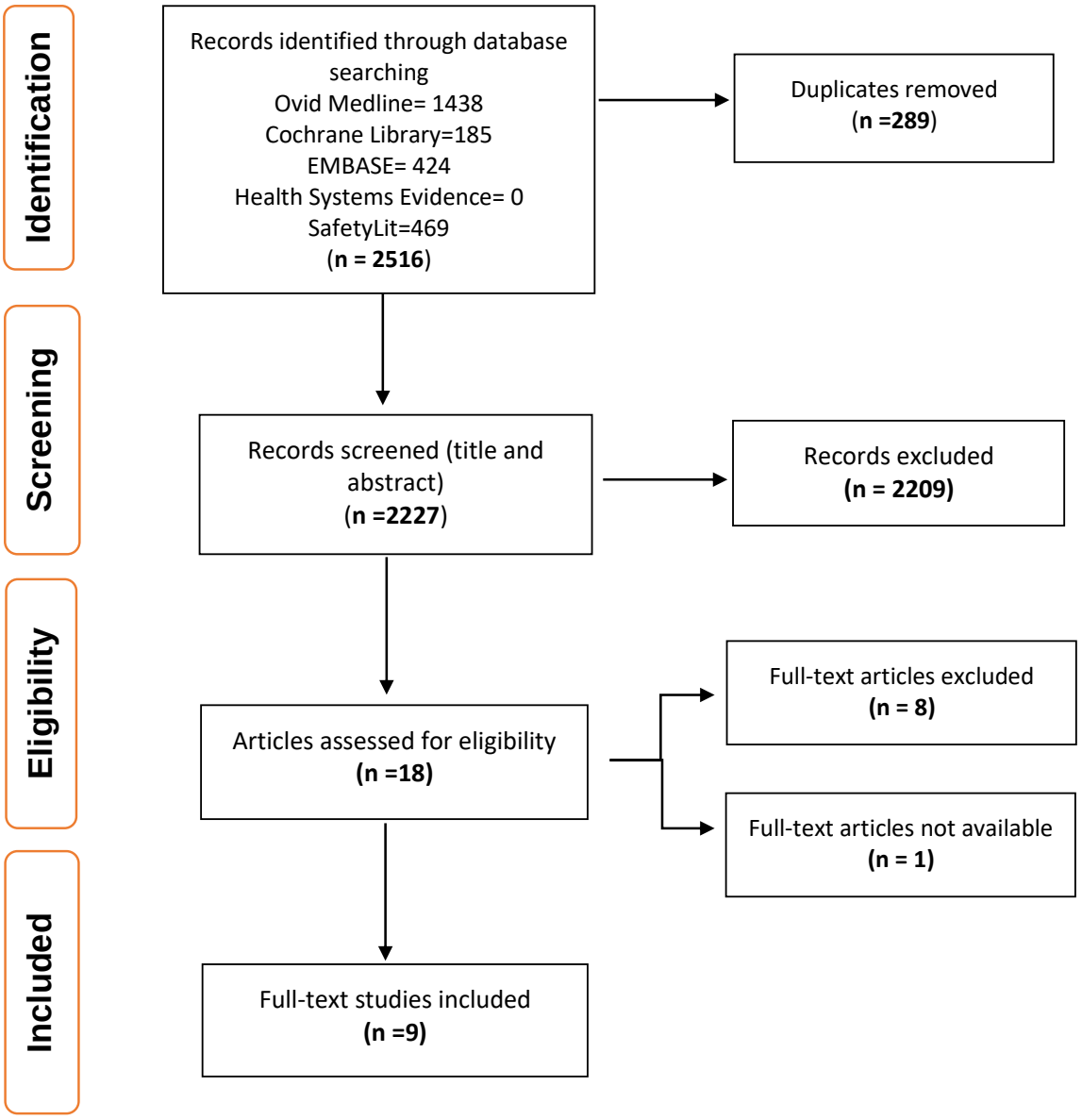
Search results and study selection

We retrieved 2516 records by searching five electronic databases. After screening the records for relevance and removing duplicates, we identified 9 studies that met the inclusion criteria. Figure 1 reports the study selection through the different phases of a review, using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.[5]

Characteristics of included studies

We included 9 studies for the review. All the included studies were interrupted time series design, and we found no randomised or non-randomised controlled trials or controlled before-after studies. Interrupted time series study designs are useful to evaluate effectiveness of population level interventions, implemented in a define point in time[7]. Among the 9 included studies, 4 were conducted in the United States[8-11] and 1 each in Canada[12], Chile[13], Iran[14], Japan[15], and Taiwan[16]. We found no studies which have evaluated the effect of financial penalties for violations of helmet use or seat belt use laws. Evidence was available for financial penalties for excessive speeding in one study and DUI in eight studies.

Figure 1: PRISMA Study Selection Flowchart



Summary of findings

Effect of intervention for excessive speeding on road traffic deaths and injuries

We found only 1 study which looked at this aspect as shown in the table below:

Table 1: Study reporting on effect of intervention for excessive speeding on road traffic deaths and fatalities

Study citation	Study objective	Study setting	Study design	Sample Size/No. of observations	Intervention description	Study outcome
Suliman A. Gargoum and Karim El Basyounya (2016)	To analyse the effects of the Excessive Speeding Legislation (ESL) on fatal collision counts at each of the three provinces in Canada	Ontario (ON), British Columbia (BC) and Quebec (QC) in Canada	Interrupted time series	Number of observations ON: n=125 BC: n=97 QC: n=122	**ON (Oct 2007):** 1st Offence: 7-day License Suspension (LC) and Vehicle Impoundment (VI), $368/483 fine, 3 pts, $210 fee 2nd Offence: 30-day VI, $700 fee **QC (Apr 2008):**1st Offence: 7-day LC, Double fines and points, 2nd Offence: 30-day LC&VI, double fines **BC (Sept 2010):**1st Offence: 7-day LC&VI, [$2000-10,000 fine, 6 pts, jail term, 2 yr LC], 2nd Offence: 10 yr LC	Number of fatal collisions in each province **Timing of assessments:** Monthly collision data from 2005-2014

The study from Canada [12] investigated the effects of excessive speeding legislation (ESL) on fatal collisions in three provinces. Different types of penalty systems were instituted, and corresponding evidence is presented subsequently.

Fines in combination with license suspension, vehicle impoundment and demerit point system

The study found that the legislative changes of financial penalties in combination with license suspension, vehicle impoundment and demerit point system led to a statistically significant drop of average monthly collisions causing death in Ontario (drop by 11 monthly fatal collisions; 18.3% in post intervention, $p<0.01$) and a statistically non-significant drop in Quebec (drop by 3 collisions; 5% post intervention, $p<0.621$).

Fines in combination with license suspension, vehicle impoundment, demerit point system and jail sentence

In the British Columbia province, where jail term was also added along with fines, demerit points and vehicle impoundment, there was a statistically significant drop of around 6 fatal collisions (22%, $p<0.01$) in the post-intervention period.

Effect of intervention for driving under influence (DUI) on road traffic deaths and injuries

We found 8 studies[8-11 13-16] that reported on this as shown below in Table 2.

Table 2: Studies reporting on effect of intervention for driving under influence (DUI) on road traffic deaths and fatalities

Study citation	Study objective	Study setting	Study design	Sample Size/No. of observations	Intervention description	Study outcome
Wagenaar et al (2007)	To examine effects of state statutory changes in Driving Under Influence (DUI) fine or jail penalties for first time offenders from 1976 to 2002	48 states of US	Interrupted time series	Monthly crashes from Jan 1976-Dec 2002	Statutory DUI fine and jail penalties	Alcohol- related fatal crashes
Mohammadzadeh Moghaddam A, Fakoor V (2020)	To evaluate the effects of the law enforcement on reduction in the incidence rate of road traffic fatality (IRRTF), the incidence rate of road traffic injuries (IRRTI) and the incidence rate of rural road traffic offenses (IRRRTO)	Iran	Interrupted time series	Monthly incidence rate of road traffic injuries in Iran from 2009-2016	April 2011: Law enforcement for reducing traffic offenses such as speeding, illegal overtaking and drink driving March 2016: increased traffic tickets fines, for example drunk driving from 1 million to 4 million Rials	Incidence rate of road traffic fatalities, injuries and offences in urban, rural and rural roads
Nazif-Muñoz JI, et al (2020)	To evaluate the impact of three interventions on alcohol-related traffic fatalities and injuries per 1 000 000 population in three urban conglomerates for the period 2010–2017	Santiago, Valparaíso and Concepción in Chile	Interrupted time series	All weekly alcohol related crashes from Jan 2010-Dec 2017	Two state interventions—the 'zero tolerance law' (ZTL), which decreased BAC, and the 'Emilia law' (EL), which increased penalties for drunk drivers	All alcohol-related crash fatalities and injuries
Stephen G. West et al. (1989)	To evaluate the effectiveness of the new drunk driving law on number of motor vehicle fatalities	City of Phoenix, US	Interrupted time series	Monthly data from Jun 1984-Aug 1985 from Phoenix	Mandatory jail sentence of not less than 24 hours, automatic license suspension, and a fine of not less than $250 for first offense DWIs	Traffic Fatalities
Y.S. Chan et al (2017)	To examine the effects of sanction changes on the reduction of drunk-driving injuries and deaths from early 2006-end of 2014	Taiwan	Interrupted time series	Monthly injuries and deaths caused by DUI-related accidents early 2006-end of 2014	**Amendment in Jan 2008**: penalized with imprisonment up to 1-year, criminal detention, or a fine, but the pecuniary punishment increased 5 times, from the original NT$30,000 (US$1,000) to now NT$150,000 (US$5,000) **Amendment in Dec 2011**: period of	Number of injuries and deaths in drunk-driving accidents

Study citation	Study objective	Study setting	Study design	Sample Size/No. of observations	Intervention description	Study outcome
					incarceration, doubled to 2 years, and the fine increased to up to NT$200,000 (US$6,666). For offenders who caused injuries, imprisonment would be 0.5–5 years. For those who caused deaths, imprisonment would increase to 1–7 years **Amendment in 2013:** increasing the pecuniary punishment NT$15,000-NT$90,000 (US $500-US$3,000). Drivers caught with BAC exceeding 0.55 mg/L in the breathalyser test would face imprisonment up to 2 years, criminal detention, or a fine up-to NT$200,000 (US$6,666). Drunk drivers who caused injuries faced 1–7 years of incarceration, but drunk drivers who caused deaths would face a longer incarceration of 3–10 years	
Shore Elsie R et al(1988)	To examine the effectiveness of changes in the Kansas Driving Under Influence (DUI) law on fatal accidents	State of Kansas, US	Interrupted time series		**Kansas DUI Law:** 1st offence-spend at least 48 hours in jail and pay a 200-dollar fine. Offenders eligible for diversion to alcohol education or substance abuse treatment programs. 2nd offence-500 dollar fine and a minimum of five days in jail. Second offenders were eligible for reductions in jail time if they entered treatment. 3rd offence: third offender, viewed as "a hardened alcoholic criminal," received a ninety day minimum sentence	Fatal accident rates and vehicle miles travelled (VMT) Timing of assessment: Monthly fatal accident rates and VMT from Jan 1975-Dec 1983

Study citation	Study objective	Study setting	Study design	Sample Size/No. of observations	Intervention description	Study outcome
					with no treatment option.	
Patrice n. Rogers and Steve e. Schoenig (1994	To evaluate the impact of 1982 legislative reforms on alcohol-related fatal and injury accident rates, both state-wide and in counties sharing similar demographic and enforcement patterns.	State of California, US	Interrupted time series	Aggregated state-wide monthly fatal injury accident rates from Jan 1979-Dec 1986	**California DUI law**: New laws introduced new penalties, adjudication and enforcement procedures designed to increase the certainty and severity of punishment for DUI offenders, and contained provisions intended to assure greater uniformity in court sentencing.	Number of fatal injuries and accidents, occurring at night-time, in single vehicle and those who had been drinking
T Nagata et al (2008)	To estimate the effect of a new road traffic law against alcohol-impaired driving in Japan	Japan	Interrupted time series	Monthly data on the total number of traffic fatalities and injuries from January 1998 to December 2004	**New law:** Reduced the allowable breath alcohol test from 0.25 to 0.15 mg/l and blood alcohol concentration (BAC) from 0.05% to 0.03%, and increased the penalties from approximately 50 000 to 500 000 Yen (US$425 to $4250 in 2002), and driver's license points were severely imposed. Moreover, the law made bartenders and passengers culpable in addition to arrested drivers.	Number of traffic fatalities, severe traffic injuries, and all traffic injuries and the injuries, fatalities with DUI

The studies reported different intervention for the violation which are categorized below:

Fines or financial penalties only

The study by Wagenaar et al [8] in USA reported that the pooled estimates of 18 states that implemented mandatory increase of fines excluding other DUI policies, observed a statistically non-significant decrease of estimated 1.3% (averaging 1 per state per year) in single night-time vehicle crashes (SVN). The study found that each dollar (USD) increase in mandatory fine was associated with a significant decline of 0.023 driver involvements in SVN fatal crashes per state per year.

The second study by Mohammadzadeh et al [14] in Iran found that increase in traffic ticket fines lead to a statistically non-significant reduction of deaths due to RTI in urban roads by -22.58% (-43 to -2.15, 95%CI), and no reduction in deaths due to RTI rural roads (-9.83% -20.16,0.5 95% CI).

The third study was conducted in Chile by Nazif-Muñoz et al[13] which evaluated the impact of three interventions on alcohol-related traffic fatalities and injuries per 1,000,000 population in three urban conglomerates. One of the interventions was "Emilia law' (EL), which increased penalties for DUI. The study found that EL model to be effective with 41% decrease (95% CI 5.5 to 93.2) in Santiago, 28.9% of short-term reduction (95% CI 4.3 to 62.7) in alcohol-related crash injuries and fatalities in Concepción and it had no effect on the outcome in Valparaiso-Viña del Mar. This shows that there isn't a uniform effect of the intervention on reducing the traffic fatalities.

The findings from the three studies show that financial penalties (or fines) alone do not have any sustainable statistically significant reduction in RTI deaths and injuries. There is also a variation in the results in different regions (as seen in the studies in US and Chile) which suggests that the intervention doesn't have consistent effect in all contexts.

Fines in combination with jail sentence and license suspension

The study by Wagenaar et al [8] in USA found a statistically significant reduction in SVN crashes by 6.4% (averaging 5 state per year) across 26 states that implemented mandatory fine policies along with mandatory imprisonment and revocation of driver's license.

Another study conducted in the city of Phoenix in United States[9] found that, in the first month of the implementation of the penalty system, there was an immediate initial reduction of 7.44 vehicular fatalities. However, this effect gradually dissipated over time, so that after 20 months of implementing the law, approximately about 0.75 fatalities per month was estimated to remain. Similar results were found in San Diego too. The study also assessed the effect of media and found that 6 months before the enactment of the law there was a drop of about 8.5 fatalities per month for 6-month owing to extensive media coverage around the law.

Fines in combination with jail sentence

The study by Y.S. Chan et al[16] examined the effects of sanctions on reduction of drunk-driving injuries and deaths from 2006-2014. There were three amendments of Article 185 in 2008, 2011 and 2013, wherein there was an increase in combination of fines and duration of imprisonment. The details of the intervention are provided in Table 2. The study found that there was an immediate decline in the number of injuries and deaths after the first amendment (which was statistically significant, $p<0.01$), but no sustained reduction was found. Similar results were seen after the second amendment and third amendments, but the results were not statistically significant.

Another study by Shore et al[11] examined the effectiveness of changes in Kansas DUI laws on fatal accidents. The Kansas DUI law stated 48-hour jail and a $200 fine for first offence, 500$ fine and minimum five days of jail for second offence and for third offence they received a minimum 90-day imprisonment. The first offenders were eligible for diversion to alcohol education or substance abuse treatment programs, second offenders were eligible for reductions in jail time if they entered treatment and third offenders did not receive any treatment option. The study found an immediate statistically significant decrease of 8.1 fatal crashes per month which was sustained for the duration of the eighteen-month post- intervention period.

Similar study was conducted in California[10] where they evaluated the impact of the 1982 California DUI legislation alcohol related fatal and injury accidents. The study found an immediate statistically significant decrease in crashed and fatal injuries after the implementation of the law. The study also analysed the social change environment and found that formation of anti-drunk driving citizens' group named Mothers Against Drunk Driving in California had a sustainably larger impact in the pre-legislation phase in 1980 as compared to the marginal added impact of the legislation. This shows that the publicity and social factors which started before 1982 may have triggered the passage of the legislation.

The findings show that DUI fines in combination with only imprisonment are effective in immediate reduction in road traffic crashes and fatalities. Also, findings from the large time-series study, covering all states of US, and the one conducted in Phoenix, suggest that fines in combination with imprisonment and license suspension can be effective in reducing road fatalities related to DUI.

However, for sustained effect of the intervention, it is important to accompany it with extensive media coverage, involvement of social groups or civil societies in advocacy and strict enforcement. Here it is important to note that, ensuring road safety requires integration of stakeholders from different areas (like legal, police, civil societies, media, health facilities, community). This is equally crucial in implementing and sustaining interventions.

Fines in combination with demerit points

There was only one study conducted in Japan[17] to estimate the effect of new road traffic law against road traffic fatalities and injuries. The new law reduced breath alcohol test from 0.25 to 0.15 mg/l and blood alcohol concentration from 0.05% to 0.03%, and increased the penalties for DUI. The fine was increased from approximately 50 000 to 500 000 Yen (US$425 to $4250 in 2002), and driver's license points were severely imposed. Moreover, the law made bartenders and passengers equally at fault in

addition to arrested drivers. The study found that there was a reduction in DUI traffic fatalities and injuries by 38% and 14% respectively and all traffic fatalities by 14%. They found a significant change in the level of DUI traffic fatalities (20%), severe injuries (23%) and all DUI traffic injuries (32%) per billion kms driven after adjusting for baseline trends, seasonality and autocorrelation from the period 1998-2004. These results were consistent across all traffic injuries-both alcohol and non-alcohol related-severe traffic injuries and total traffic fatalities. The study concluded that the new law was successful in reducing road traffic fatalities.

4. Policy considerations

- The rapid evidence synthesis is the first of its kind, reporting on effect of financial penalties on hard outcomes of RTI crashes and deaths (fatalities) instead of measurement of process indicators like behaviour change or prosecutions for violations.
- There is no evidence from interventional study designs on effect of financial penalties for violation of helmet and seatbelt in reducing road traffic injuries or deaths. As such, the lack of evidence in these domains indicates the need for policy makers to fund research to understand these aspects better. While controlled clinical trials are difficult to be conduct, controlled before-after and interrupted time series studies might be relatively easier to conduct. Routine data, if available, might be analysed in interrupted time series manner to help understand the impact of financial penalties better.
- There is no evidence around financial penalties alone for excessive speeding violations. Fines in combination with license suspension, vehicle impoundment and demerit point system with or without jail sentences for excessive speeding violations may lead to statistically significant decrease in deaths due to RTI depending on several contextual issues, including but not limited to nature and rigour of implementation. However, the evidence base for this is thin and from a single study in a HIC context.
- Mandatory fines alone for DUI violations does not lead to statistically significant and sustainable decrease in road traffic fatalities and injuries. The evidence base from this comes from studies in Chile, Iran and USA.
- Mandatory fines in combination with jail sentences with or without license suspension for DUI was seen to lead to statistically significant decrease in road traffic crashes and injuries but in some studies, it was reported that the effect gradually wears over time. To sustain the effect over a period of time, there is a need for sustained involvement of social groups or civil societies in advocacy and maintaining enforcement through local contextual reforms. The evidence base for this is however typically from a high-income country context.

- Mandatory fines with only demerit points for DUI violations was showed a large and significant decrease, which was sustained over time in a study from Japan, but the law made both the bartender and the driver legally responsible. Institution of such laws might be considered.
- The legislative changes should be accompanied by extensive media coverage and publicity, strict enforcement and involvement of social groups for advocacy and compliance. This ensures sustainable reduction of injuries and deaths from road crashes.
- Integration of different departments such as road transport, police, civil societies, judiciary, local bodies of the community are important in implementing and sustaining interventions.

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6. Appendix

Appendix 1: Search Strategies

OVID MEDLINE

No.	Search Query	Number of hits
#1	helmet.mp. or exp Head Protective Devices	5100
#2	(head adj1 (protect* or shield*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	3684
#3	exp Seat Belts/ or exp Child Restraint Systems/ or seat restraint*.mp.	4086
#4	seat belt*.mp.	4650
#5	exp Driving Under the Influence	568
#6	((dr*nk* or alcohol or intoxicat*) adj2 driv*).mp.	3359
#7	exp Aggressive Driving	13
#8	exp Distracted Driving	188
#9	exp Road Rage	**4**
#10	(driving adj1 (aggress* or reckless or negligent or distract* or inattentive or careless)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading	**606**

No.	Search Query	Number of hits
	word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	
#11	(speed* or overspeed or over-speed).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	143427
#12	**1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11**	**156234**
#13	exp Punishment	5571
#14	(punishment* or penalt* or fine*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	157086
#15	**13 or 14**	**157086**
#16	randomized controlled trial.pt	508360
#17	controlled clinical trial.pt.	93717
#18	pragmatic clinical trial.pt.	1417
#19	multicenter study.pt	274669
#20	non-randomized controlled trials as topic	706
#21	interrupted time series analysis	895
#22	controlled before-after studies	521
#23	(randomis* or randomiz* or randomly).ti,ab.	771691
#24	groups.ab.	1761042
#25	(trial or multicenter or multi center or multicentre or multi centre).ti.	223905
#26	(intervention? or effect? or impact? or controlled or control group? or (before adj5 after) or (pre adj5 post) or ((pretest or pre test) and (posttest or post test)) or quasiexperiment* or quasi experiment* or evaluat* or time series or time point? or repeated measur*).ti,ab.	8257833
#27	**16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26**	**9217896**
#28	**12 and 15 and 27**	**1438**

Cochrane Central Register of Controlled Trials

No.	Search Query	Number of hits
#1	helmet.mp. or exp Head Protective Devices	442
#2	(head adj1 (protect* or shield*)).mp. [mp=title, original title, abstract, mesh headings, heading words, keyword]	146

No.	Search Query	Number of hits
#3	exp Seat Belts/ or exp Child Restraint Systems/ or seat restraint*.mp.	49
#4	seat belt*.mp.	80
#5	exp Driving Under the Influence	0
#6	((dr*nk* or alcohol or intoxicat*) adj2 driv*).mp.	479
#7	exp Aggressive Driving	0
#8	exp Distracted Driving	0
#9	exp Road Rage	0
#10	(driving adj1 (aggress* or reckless or negligent or distract* or inattentive or careless)).mp. [mp=title, original title, abstract, mesh headings, heading words, keyword]	52
#11	(speed* or overspeed or over-speed).mp. [mp=title, original title, abstract, mesh headings, heading words, keyword]	16728
#12	**1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11**	**17715**
#13	exp Punishment	126
#14	(punishment* or penalt* or fine*).mp. [mp=title, original title, abstract, mesh headings, heading words, keyword]	5541
#15	**13 or 14**	**5541**
#16	randomized controlled trial.pt	495880
#17	controlled clinical trial.pt.	91540
#18	pragmatic clinical trial.pt.	1377
#19	multicenter study.pt	86583
#20	non-randomized controlled trials as topic	35
#21	interrupted time series analysis	11
#22	controlled before-after studies	25
#23	(randomis* or randomiz* or randomly).ti,ab.	936346
#24	groups.ab.	467613
#25	(trial or multicenter or multi center or multicentre or multi centre).ti.	343083
#26	(intervention? or effect? or impact? or controlled or control group? or (before adj5 after) or (pre adj5 post) or ((pretest or pre test) and (posttest or post test)) or quasiexperiment* or quasi experiment* or evaluat* or time series or time point? or repeated measur*).ti,ab.	1247672
#27	**16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26**	**1502095**
#28	**12 and 15 and 27**	**185**

EMBASE

No.	Search Query	Number of hits
#1	helmet.mp. or exp Head Protective Devices	7528
#2	(head adj1 (protect* or shield*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	426
#3	exp Seat Belts/ or exp Child Restraint Systems/ or seat restraint*.mp.	5243
#4	seat belt*.mp.	3225
#5	exp Driving Under the Influence	2750
#6	((dr*nk* or alcohol or intoxicat*) adj2 driv*).mp.	6113
#7	exp Aggressive Driving	20
#8	exp Distracted Driving	252
#9	exp Road Rage	13
#10	(driving adj1 (aggress* or reckless or negligent or distract* or inattentive or careless)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	840
#11	(speed* or overspeed or over-speed).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	242212
#12	**1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11**	**260850**
#13	exp Punishment	14939
#14	(punishment* or penalt* or fine*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	260242
#15	**13 or 14**	**260242**
#16	randomized controlled trial.pt	0
#17	controlled clinical trial.pt.	0
#18	pragmatic clinical trial.pt.	0
#19	multicenter study.pt	0
#20	non-randomized controlled trials as topic	10837
#21	interrupted time series analysis	212802

No.	Search Query	Number of hits
#22	controlled before-after studies	218201
#23	(randomis* or randomiz* or randomly).ti,ab.	1270488
#24	groups.ab.	2962164
#25	(trial or multicenter or multi center or multicentre or multi centre).ti.	376416
#26	(intervention? or effect? or impact? or controlled or control group? or (before adj5 after) or (pre adj5 post) or ((pretest or pre test) and (posttest or post test)) or quasiexperiment* or quasi experiment* or evaluat* or time series or time point? or repeated measur*).ti,ab.	12969614
#27	**16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26**	**14465876**
#28	**12 and 15 and 27**	**2660**
#29	**limit 28 to exclude medline journals**	**424**

SafetyLit

No.	Search Query	Number of hits
#1	head protective devices or helmet or helmeted or protective headgear or head protection	3638
#2	seatbelt or seat belt or Road Vehicle Occupant Belt Restraints or seat restraint or seat belted	4378
#3	drink driving or drunk driving or driver behaviour	6112
#4	speeding or driving too fast for conditions or careless driving or distracted driving or aggressive driving	2070
#5	punishment or penalty or penalties or fines or driver penalties	4862
#6	**1 or 2 or 3 or 4 and 5**	**469**

Health Systems Evidence database

Keywords used, since the database was intuitive

helmet OR seatbelt OR drink driving OR drunk driving OR driving under the influence OR speeding OR aggressive driving OR reckless driving OR negligent driving OR distracted driving OR inattentive driving- zero hits

Appendix 2. List of Excluded Studies with Reasons for Exclusion

No.	Bibliographic citation	Reasons for exclusion
1.	Hingson, R. W.; Howl;J.; Levenson, S (1988), Effects of legislative reform to reduce drunken driving and alcohol-related traffic fatalities, Public health reports (Washington, D.C.: 1974)	• A report discussing the different reforms to reduce drunken driving • Not appropriate study design

2.	Lahrmann, Harry; Agerholm, Niels; Tradisauskas, Nerius; Berthelsen, Kasper K.; Harms, Lisbeth (2012), Pay as You Speed, ISA with incentive for not speeding: results and interpretation of speed data, Accident; analysis and prevention - Volume 48, Issue 0, pp. 17-28	• Outcome is not appropriate for inclusion
3.	Shimizu, S.(1866) Tougher penalties for drink driving in Japan, Addiction - Volume 96, Issue 12	• Not appropriate study design • It is a commentary compiling news on penalties in Japan
4.	Watson, B.; Siskind, V.; Fleiter, J. J.; Watson, A.; Soole, D (2015), Assessing specific deterrence effects of increased speeding penalties using four measures of recidivism	• Observational study design
5.	Weatherburn, Don; Moffatt, Steve (2011), The Specific Deterrent Effect of Higher Fines on Drink-Driving Offenders	• Observational study design
6.	Borschos, B, An evaluation of the swedish drunken driving legislation implemented on February 1, 1994	• Intervention was only imprisonment, no financial penalty
7.	Zambon, Francesco; Fedeli, Ugo; Visentin, Cristiana; Marchesan, Maria; Avossa, Francesco; Brocco, Stefano; Spolaore, Paolo, Evidence-based policy on road safety: the effect of the demerit points system on seat belt use and health outcomes	• Intervention was only demerit point system, no financial penalty
8.	Layton, A. P, The Impact of Increased Penalties on Australian Drink Driving Behavior	• Outcome not appropriate for inclusion
9.	Duguet, A.; Telmon, N.; Grezes-Rueff, C. Penalties for driving under the influence of alcohol and new proceedings	• No full text available