Literature Review: Road Safety Work Group

Background:

Preventing injuries from road traffic collisions is simultaneously one of the greatest public health achievements of the 20th century1 and one of the most strategic public health priorities. These collisions are responsible for 1.27 million deaths and 24.3 million injuries worldwide per year2.

Although rates of injury and death due to road traffic collisions have been steadily declining in Canada3 and Ontario4 over the past four decades, these rates are still considerably high. According to the Canadian Motor Vehicle Traffic Collision Statistics 2011, there were 2,006 fatalities, and 166,725 injuries of which 10,443 were serious injuries5. Furthermore, motor vehicle collisions are the leading cause of unintentional injury death for all Canadians6, and are the leading cause of injury-related death for Canadian children.

Road traffic collisions dwarfs most of the other causes of preventable death7. Continued efforts to implement the interventions that prevent collisions is crucial to improving safety for all road users.

Interventions for Preventing Motor Vehicle Related Injuries on Public Roads:

We searched the literature to identify effective public health and public policy interventions that reduce injuries and deaths associated with the use of streets, roads and highways by pedestrians, cyclists, public transit users, and users of private motor vehicles.

Due to vast extent and diversity of literature assessing the effectiveness of various different types of interventions and programs for preventing motor vehicle related injuries and fatalities, we primarily considered systematic or literature reviews to synthesize evidence for primary outcomes of interest. The interventions or potential remedies were broadly classified in five categories:

1. Stricter laws and enforcement
2. Safety education and programs
3. Roads and transportation infrastructure
4. Design of cars
5. Others

Stricter Laws and Enforcement:

- **Reduced Speed Limit Zones**: One review also looked at the effectiveness of reduced speed limit zones (20 mph zones) and showed a reduction of 42% in the frequency injury accidents and a reduction of 53% in the frequency of fatal or serious injury accidents.8

- **Speed Cameras and Radars**: Two systematic reviews looked at the effectiveness of speed enforcement detection devices such as speed cameras and radar for reducing road traffic collision related injuries. One systematic review showed a reduction of 17% to 58% in fatal or serious...
injuries and a reduction of 17% to 23% in injury crashes. The other systematic review showed a reduction of 12% to 65% for injuries (fatal and non-fatal) and 17% to 71% reduction for crash related mortality in the immediate vicinity of speed camera.

- **Red Light Cameras:** One systematic review looked at the efficacy of red light cameras for the prevention of road traffic casualties and showed a reduction of 29% (Adjusted RR = 0.71, 95% CI 0.55 to 0.93) in total casualty crashes.

- **Seat Belt Laws:** One systematic review evaluated the effectiveness of safety seat belt laws and showed a median decrease of 9% (range: 2.0% to 18%) in fatal crash injuries and a median decrease of 8.0% (range: 3.0% to 20%) in overall crash injuries (fatal and non-fatal).

- **Child Safety Seat Laws:** One systematic review evaluated the effectiveness of child safety seat laws (i.e. child restraints, booster seats appropriate for the child’s age and size) and showed a median decrease of 35% (range: 25.0% to 57.3%) in fatal crash injuries and a median decrease of 17.3% (range: 10.5% to 35.9%) in overall crash injuries (fatal and non-fatal).

- **Bicycle Helmet Legislation:** Two systematic reviews evaluated the effectiveness of bicycle helmet legislation and use of helmet for preventing head and facial injuries in bicyclists. The first review found a reduction of 52% in mortality for the younger age group (age 16 years and under) and a reduction of 45% in head injuries after enactment of helmet legislation. The 2nd review found a reduction of 65% in upper and mid facial injuries and 68% reduction for head injury with a summary odds ratio of 0.31 (95% CI 0.26 to 0.37).

- **Motorcycle Helmet Legislation:** One systematic review evaluated the effectiveness of helmet use for preventing injuries in motorcycle riders and found a reduction in risk of death by 42% (OR = 0.58, 95% CI 0.50 to 0.68) and reduction in risk of head injury by 69% (OR = 0.31, 95% CI 0.25 to 0.38).

- **Maximum Blood Alcohol Concentration Laws:** One systematic review evaluated the effectiveness of laws mandating a maximum blood alcohol concentration (BAC) of 0.08 g/100ml for drivers 21 years or over and found a decrease of 7% (IQR: 4% to 15%) in alcohol-related motor vehicle fatalities.

- **Zero Tolerance Law:** Two systematic reviews evaluated the effectiveness of ‘zero tolerance law’ with lower BAC limits for younger and inexperienced drivers (18-20 years old). The first review reported a reduction of 9% to 24% in fatal crashes and a reduction of 3.8% to 17% in injury crashes (fatal and non-fatal). The 2nd review also reported a reduction of 11% to 33% in injury crashes (fatal and non-fatal).

- **Minimum Legal Drinking Age (MLDA) Laws:** Two systematic reviews assessed the effectiveness laws mandating the minimum legal drinking age. The first systematic review reported a median decrease of 17% (range: 7% to 30%) in fatal injury crashes and a median decrease 15% (range: 6% to 33%) in injury crashes (fatal and non-fatal) after raising MLDA from 18 to 21 years. The 2nd systematic review showed a statistically significant inverse relationship between MLDA and injury crashes (fatal and non-fatal) across 51% of included studies.

- **Random Breath Testing (RBT):** Two systematic reviews evaluated the effectiveness of RBT checkpoints. The first systematic review reported a median decrease of 22% (range: 13% to
36%) in fatal injury crashes and a median decrease of 16% (range: 11% to 20%) in injury crashes (fatal and non-fatal). The 2nd systematic review reported a decrease of 16.2% to 29% in fatal injury crashes and a decrease of 10% to 28% in injury crashes (fatal and non-fatal).

- **Selective Breath Testing (SBT):** One systematic review evaluated the effectiveness of SBT checkpoints reported a median decrease of 23% (range: 20% to 26%) in fatal injury crashes and a median decrease of 20% (range: 5% to 23%) in injury crashes (fatal and non-fatal).

- **Graduated Driver Licensing (GDL):** One systematic review evaluated the effectiveness of GDL program in young drivers (teen age) and showed a median reduction of 36% (range: 15% to 57%) in fatal crashes and a median reduction of 14% (range: 4% to 23%) in injury crashes (fatal and non-fatal) at first year post-GDL. The review also evaluated the effectiveness beyond first year post-GDL and reported a median reduction of 18% (range: 1% to 110%) in fatal crashes and a median reduction of 20% (range: 7% to 36%) in injury crashes (fatal and non-fatal).

We also identified reviews evaluating interventions that have in-conclusive evidence for their effectiveness in preventing road traffic injuries and fatalities, such as:

- **Increased police patrols for preventing alcohol-impaired driving:** Inconclusiveness was due to less than optimal quality of the studies included in the review "Methodological limitations included inadequate sample size, dissimilar baseline measures, contamination, and inadequate data analysis".

- **Lowering the BAC Limit to .05 in Canada:** "Independent reviews of the research conclude that the scientific literature on the effects of lower BAC limits is mixed and fails to provide consistent and compelling evidence of traffic safety benefits.

**Safety Education and Programs**

- **Problem Drinking Counseling:** One systematic review assessed the effectiveness of interventions (such as counselling in the clinical setting) in problem drinkers designed to reduce alcohol consumption and preventing motor-vehicle related crash injuries. The review reported a reduction of 27% to 65% in injury crashes (fatal and non-fatal) and a trend towards reduction in crash injury-related deaths (RR = 0.65, 95%CI 0.21 to 2.0).

- **Alcohol Server Setting Interventions:** One systematic review evaluated the effectiveness of interventions in the alcohol server setting and training programs for preventing motor-vehicle related crash injuries. The review reported a reduction of 15% in injury crashes (fatal and non-fatal) but found no difference for fatal crashes.

We also identified reviews evaluating interventions that have in-conclusive evidence for their effectiveness in preventing road traffic injuries and fatalities, such as:
• Safety education of pedestrians for injury prevention: “Pedestrian safety education can result in improvement in children's knowledge and can change observed road crossing behaviour, but whether this reduces the risk of pedestrian motor vehicle collision and injury occurrence is unknown. There is evidence that changes in safety knowledge and observed behaviour decline with time, suggesting that safety education must be repeated at regular intervals.”

• Motorcycle rider training: “Due to the poor quality of studies identified, we were unable to draw any conclusions about the effectiveness of rider training on crash, injury, or offence rates. The risk of crashes, injuries or offences in motorcyclists, and a best rider training practice can therefore not be recommended. As some type of rider training is likely to be necessary to teach motorcyclists to ride a motorcycle safely, rigorous research is needed.”

• Designated driver program: “There is insufficient evidence to draw conclusions about the effectiveness of population-based campaigns or incentive programmes based in drinking establishments.”

We also identified reviews evaluating interventions that found no evidence for their effectiveness in preventing road traffic injuries and fatalities, such as:

• School-based driver education: “The results show that driver education leads to early licensing. They provide no evidence that driver education reduces road crash involvement, and suggest that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes.”

• Post-license driver education: “This systematic review provides no evidence that post-licence driver education is effective in preventing road traffic injuries or crashes... Because of the large number of participants included in the meta-analysis (close to 300,000 for some outcomes) we can exclude, with reasonable precision, the possibility of even modest benefits.”

Roads and Transportation Infrastructure

• On-road Marked Bike Lanes: One systematic review assessed the impact of transportation infrastructure modifications on injuries to cyclists. The review found that on-road marked bike lanes had a positive safety effect and resulted in an estimated reduction of 50% in injury rate compared to unmodified roadways. The review also concluded that most serious injuries were significantly associated with motor vehicle involvement, one-ways streets and unlit roads at night.

• Street Lighting: One systematic review evaluated the effectiveness of street lighting for preventing road traffic injuries. The review found that as compared to an area control of no street lighting, the street lighting showed a 22% reduction (RR = 0.78, 95% CI 0.63 to 0.97) in injury crashes (fatal and non-fatal). When compared with a day-time control, the street lighting showed a 32% reduction (RR = 0.68, 95% CI 0.61 to 0.77) in injury crashes and a 66% reduction (RR = 0.34, 95% CI 0.17 to 0.68) in fatal crashes. The review also reported that when
compared with a day-time control, continuous Improvement in street lighting was associated with a reduction of 28% (RR = 0.72, 95% CI 0.57 to 0.90) in injury crashes and a reduction of 66% (RR = 0.34, 95% CI 0.17 to 0.68) in fatal crashes.

• Reducing the volume of traffic through community design
  Two systematic reviews evaluated the effectiveness of community design on decreasing injuries and deaths from Motor Vehicle Collisions (MVC's). One systematic review showed the potential to reduce MVC's by reducing the volume of traffic through community design (reducing the need to drive by providing public and active transportation options, and reducing travelling distances with complete, compact communities).33
  
  The other review showed an association between reducing traffic volume and hence injuries and deaths from MVC's. Public Health benefits of creating complete streets and communities that support and place a priority on traffic demand management and all modes of transportation – especially walking, cycling and public transit.34

• Various Area-wide Calming Measures: Another systematic review looked at the effectiveness of various area-wide calming measures (e.g. road humps, speed cushions, raised crosswalks, road surface treatment, audible measures, permanent or temporary blocking of road, creation of one-way streets, reduced speed limit zones etc.) for preventing traffic accident related injuries. The review showed a reduction of 15% (pooled RR = 0.85, 95% CI 0.75 to 0.96) in road traffic crashes resulting in injuries (fatal and non-fatal) and 21% reduction (pooled RR = 0.79, 95% CI 0.23 to 2.6) in road traffic crashes resulting in deaths.35
  
  We also identified reviews evaluating Interventions such as “increasing pedestrian and cyclist visibility”36 but found inconclusive evidence for their effectiveness in preventing road traffic accident related injuries and fatalities. The review stated “the effect of visibility aids on pedestrian and cyclist safety remains unknown. A cluster randomised controlled trial involving large communities may provide an answer to this question. It would, however, be a challenging trial to conduct. Studies that collect data of road traffic injuries relating to the use of visibility aids also warrant consideration”.36

Design of Cars

• Airbags: A review of reviews evaluated the effectiveness of Airbags for preventing traffic accident related injuries in adults. The review reported that combined use of airbag with seat belt had a protective effect for the risk of cervical spine and facial injuries (OR = 0.19, 95% CI 0.12 to 0.30) in adults.7 The review also reported that motor vehicles with side air bags offered better protection in terms of lower head injuries.7

• Daytime Running Lights: One systematic review evaluated the effectiveness of daytime running lights on cars for preventing road traffic crashes and injuries and showed the use of DRL on cars was associated with a 10% to 15% reduction in day time accidents.3736 The review did not report any evidence on crash injuries and fatalities.
- **Alcohol Ignition Interlock**: One systematic review evaluated the effectiveness of alcohol ignition interlock programs for reducing drink driving recidivism and reported a relative reduction of 64% (RR = 0.36, 95% CI 0.21 to 0.63) in recidivism rates. The review did not report any evidence on crash injuries and fatalities.

We were not able to identify reviews evaluating public policy or interventions aimed at regulating the trend of increasing introduction of various entertainment distractions in vehicles by manufacturers.

**Others**

- Two systematic reviews evaluated the effectiveness of multi-component community interventions that combine multiple strategies such as education/training programs, legislations and traffic calming measures in preventing road traffic accident related injuries and fatalities. First review assessed the effectiveness of multi-component community based programs to prevent pedestrian injuries in children 0 -14 years and found a median reduction of 45% (range: 12% to 54%). The 2nd systematic review evaluated the effectiveness of WHO safe communities model to prevent injury in whole populations and found some evidence of reduction in frequency of crash injuries but concluded the need of further research due to insufficient evidence.

**References:**


