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XIII INTERNATIONAL WINTER ROAD CONGRESS

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SUSTAINABLE WINTER SERVICE FOR ROAD USERS

Long-term Trends in Snowfall-related Crash Risks

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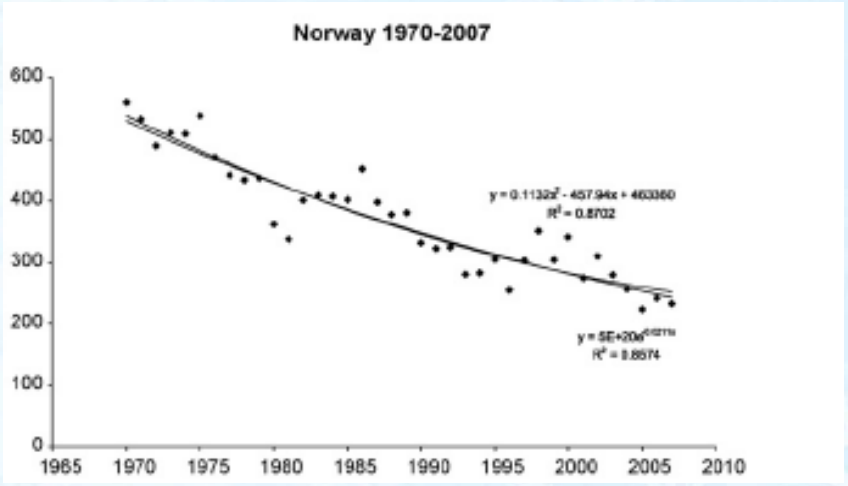
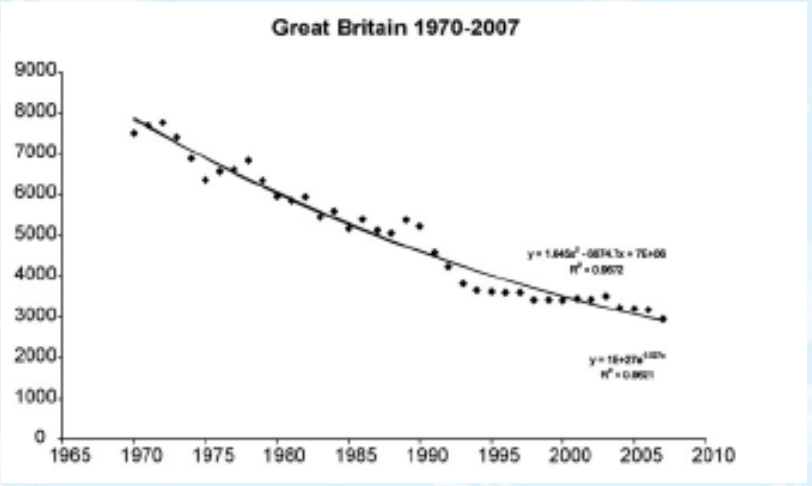
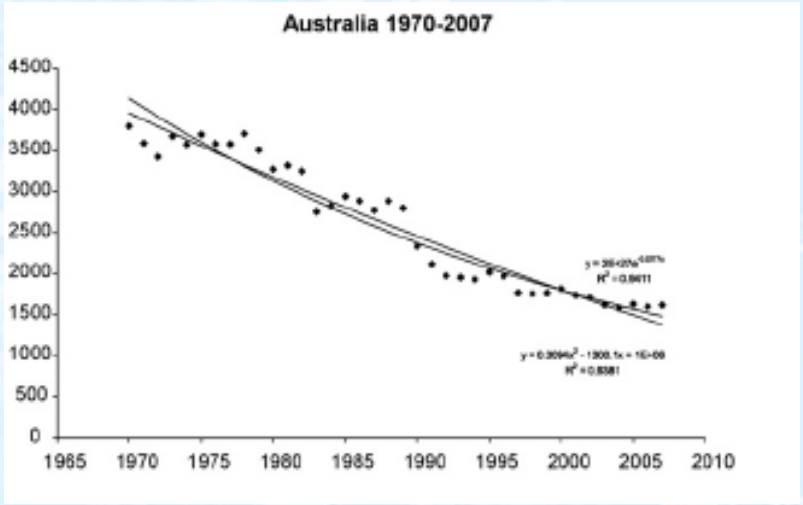
LONG-TERM TRENDS IN TRAFFIC FATALITIES







Source: Elvik, R. (2010) The stability of long-term trends in the number of traffic fatalities in a sample of highly motorised countries. *Accident Analysis and Prevention* 42:245-260.

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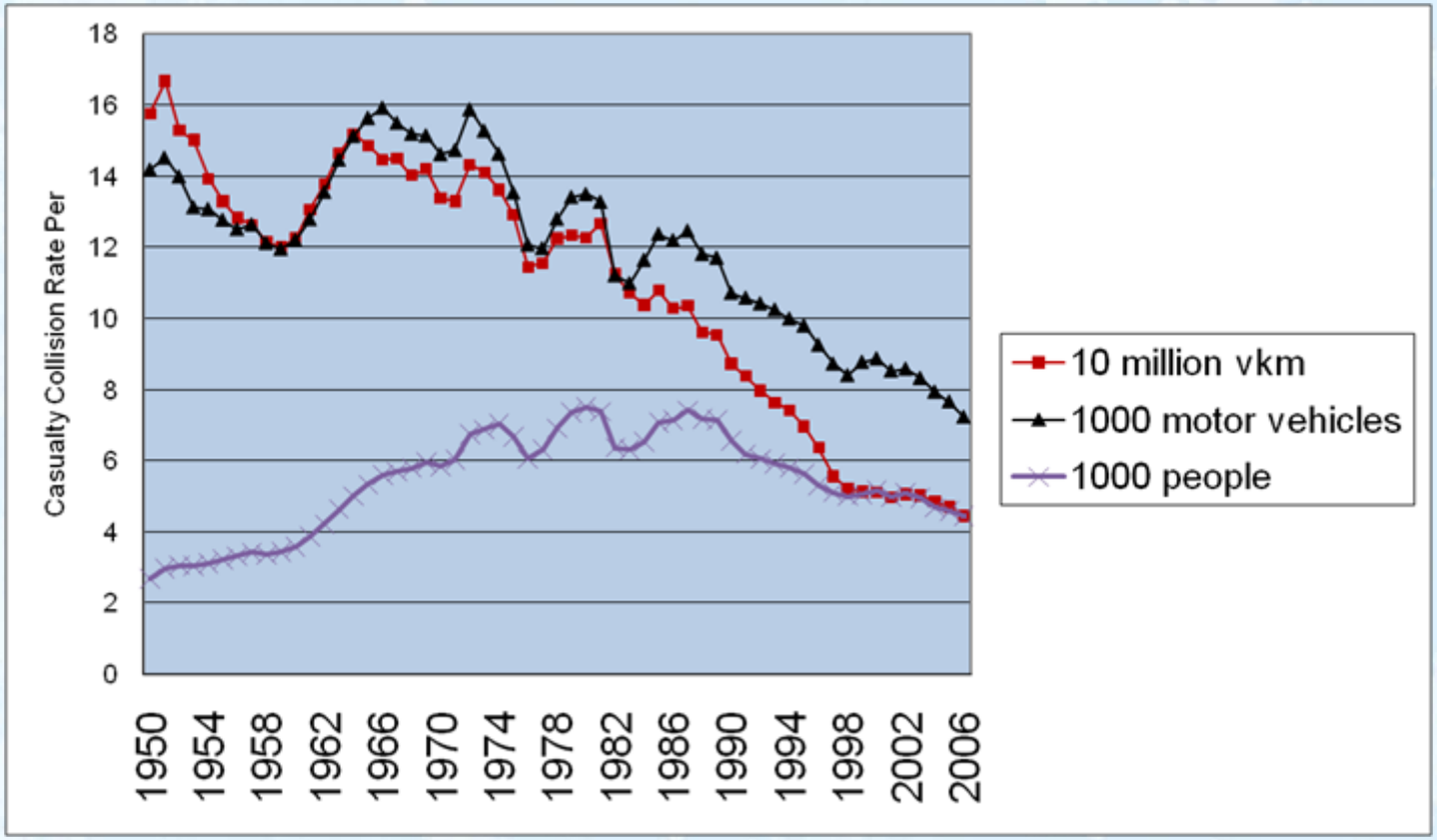
TRENDS IN ROAD CRASHES INVOLVING INJURY, CANADA



Data Sources: Transport Canada, Environment Canada

CHANGES IN MOBILITY IN CANADA

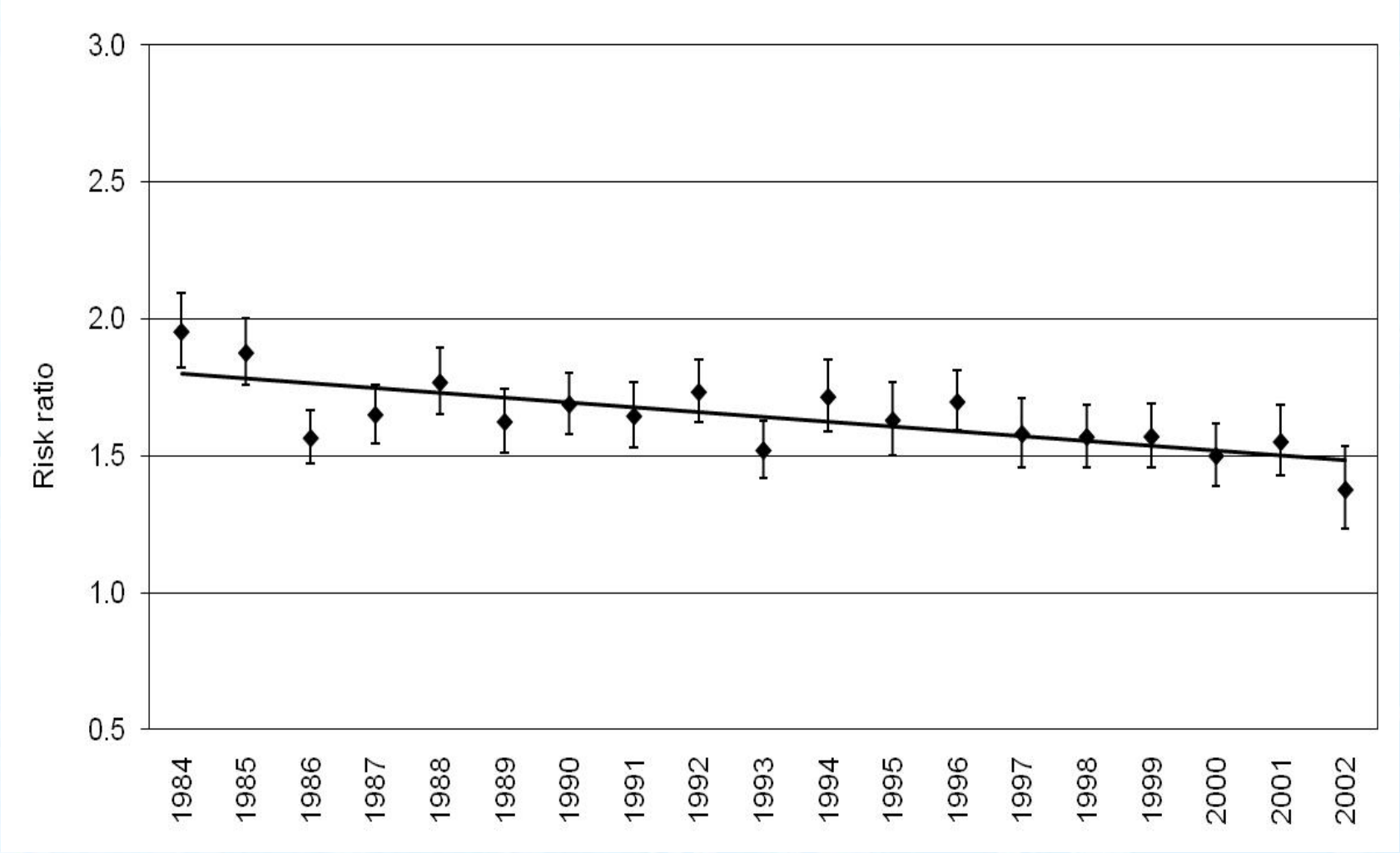
Year	Population (millions)	Registered Vehicles (millions)	Auto-mobility (persons/vehicle) (km/vehicle) (km/person)
1950	13.7	2.6	5.3 9000 1700
1973	22.6	10.2	2.2 11000 4900
2006	32.6	20.0	1.6 16000 10000

SITUATIONAL RISK FACTORS

- Darkness → roadway lighting
- For young drivers, passengers → novice restrictions
- Roadside obstacles → obstruction removal

- Weather that reduces friction, impairs visibility or makes vehicle handling more challenging increases driving risks
- Injuries typically increase by 50 to 100 percent and sometimes more during precipitation
- In terms of weather-related crash risk, what is the combined effect of improved tires, better roadway and vehicle engineering, changes in roadway maintenance, and individual driver decisions?

RAIN-RELATED CRASH RISK



Source: Andrey, J. (2010) Long-term trends in weather-related crash risks. *Journal of Transport Geography* 18:247-258.

STUDY OBJECTIVES

- To estimate the average relative risk of injury collision during snowfall and other winter weather

- To document the trend in relative risk of injury collision during these same conditions

- Focus is on 10 Canadian cities, 1984-2002

CITIES INCLUDED IN THE ANALYSIS

	Population, 2001 (city)	Annual # of Snow Days	Annual Snowfall (cm)	Annual Days with Max Temp ≤ 0 °C	% Time Snowing
London	336,539	66	202.4	61.3	9.8
Sudbury	155,219	78	274.4	103.9	10.6
Brampton	325,428	47	115.4	57.2	5.8
Toronto	2,481,494				
Ottawa	774,072	66	235.7	81.3	7.3
Gatineau	102,898				
Montreal	1,039,534	60	217.5	77.4	7.2
Chicoutimi-Jonquiere	114,850	75	303.3	111.0	14.6
Moncton	61,046	64	349.9	74.2	8.3
Halifax	185,033	60	230.5	57.1	5.6

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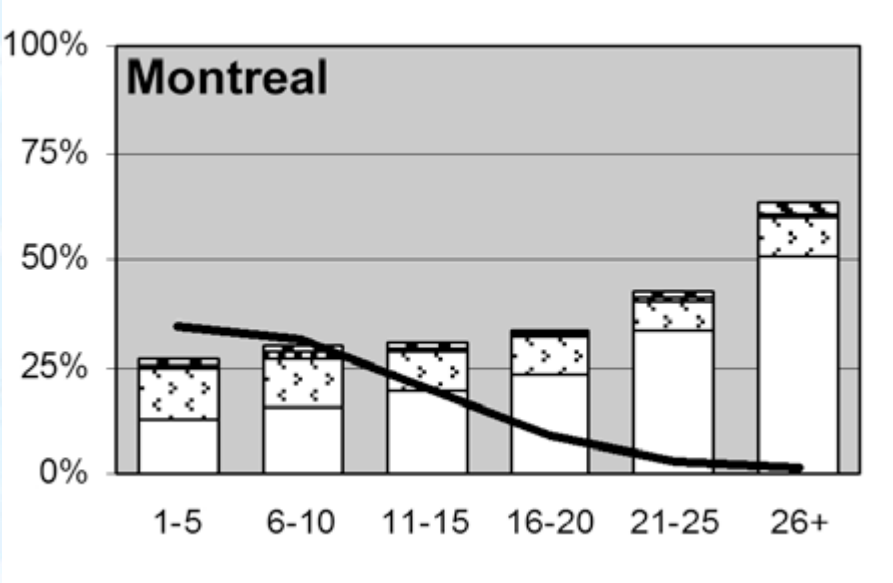
ILLUSTRATION OF WEATHER INCIDENCE AND RELATED DRIVING RISKS



x-axis indicates number of casualties per 6 hour period

% of 6 hour periods with:

Rain Snow Freezing Rain Rain with Snow

% of 6 hour periods by casualty count

SAMPLE DATA

	% Time Condition Met	% Events Included	Event-Control Pairs	# Injury Collisions
All Winter Precipitation	4.7	48	6,205	19053
6-hour Snowfall				
0.39 to 1.00 cm	1.4	47	1,709	3598
1.01 to 2.00 cm	0.8	45	953	3096
> 2.00 cm	1.2	49	1,646	5737
Both rain and snow	0.5	55	693	2537
Freezing rain, ice pellets	0.9	49	1,204	4085

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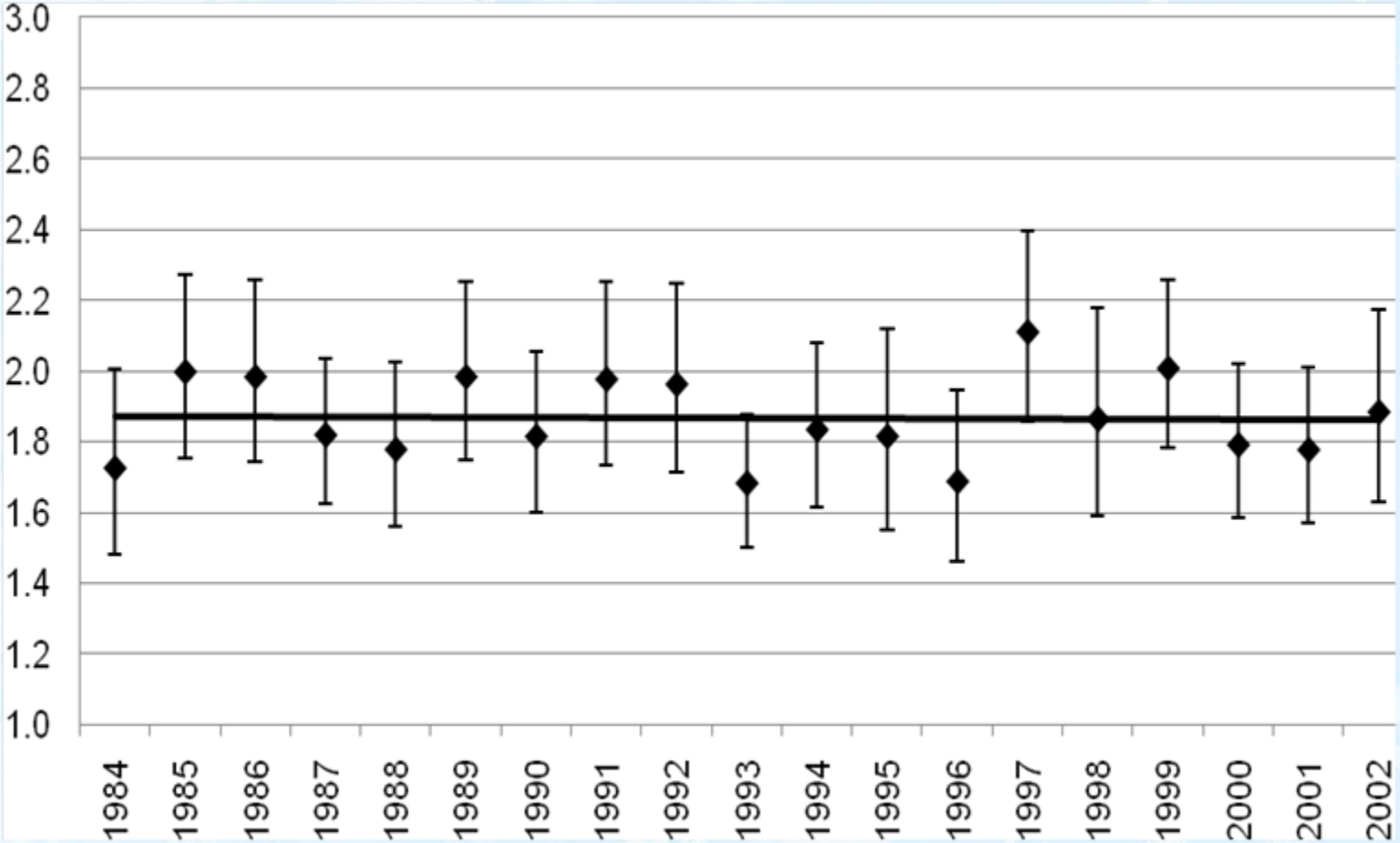
EVENT-CONTROL DEFINITIONS

6-hour Event Criteria	6-hour Control Criteria
At least 4 cm snowfall	No more than trace precipitation
Precipitation during at least 3 out of the 6 top-of-the-hour observations	Good visibility
'Weather' reported for at least 50% of crashes	No reports of 'weather' or icy roads

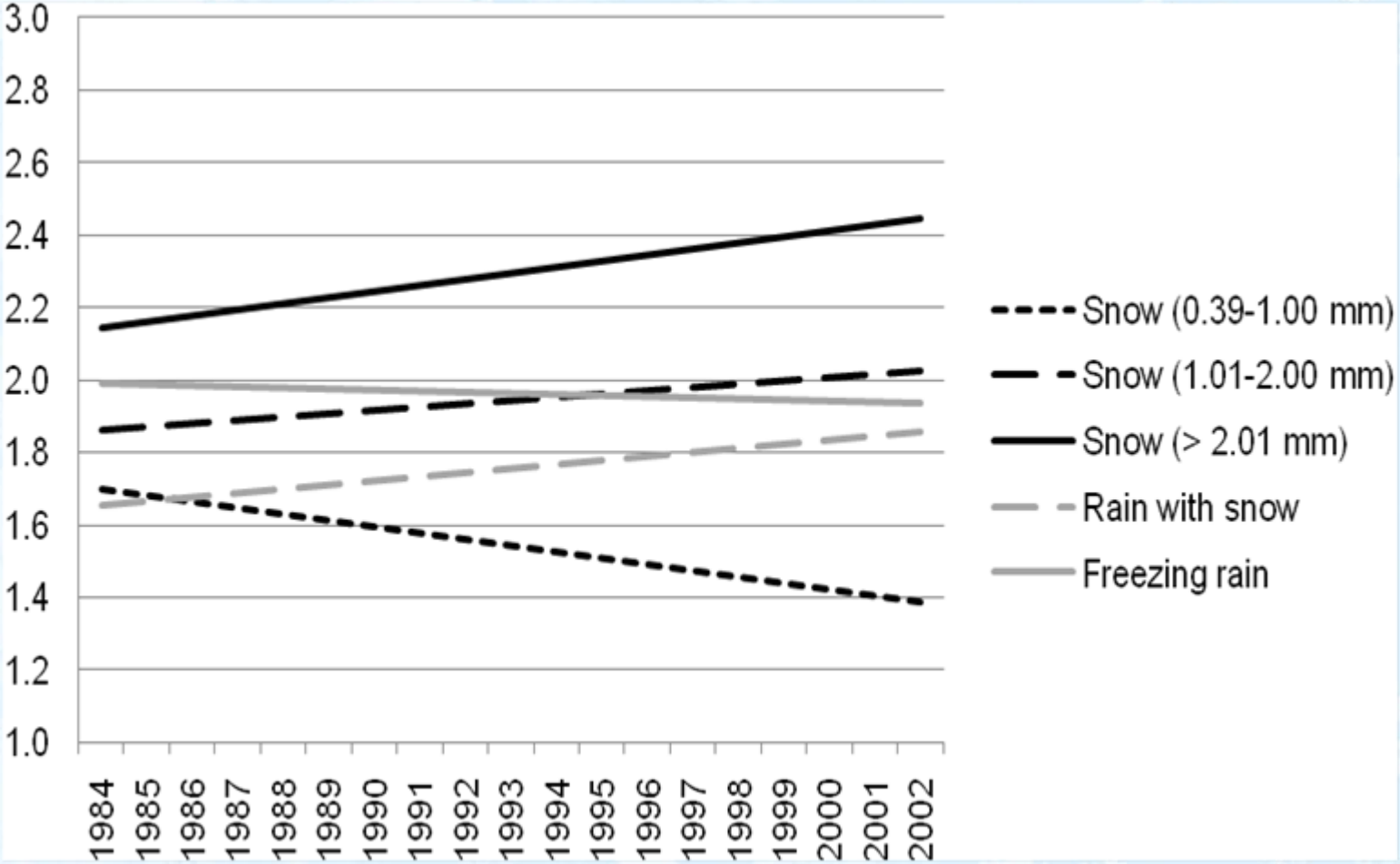
RISK ESTIMATES AND TRENDS

	Risk Ratio Relative to Good Seasonal Conditions	Trends in Risk Ratio
All Winter Precipitation	1.865	-0.0008
6-hour Snowfall		
0.39 to 1.00 cm	1.476	-0.0174
1.01 to 2.00 cm	1.888	+0.0089
> 2.00 cm	2.189	+0.0166
Both rain and snow	1.716	+0.0110
Freezing rain, ice pellets	1.935	-0.0031

TREND IN THE RELATIVE RISK OF INJURY COLLISION DURING WINTER PRECIPITATION



TRENDS BY PRECIPITATION TYPE AND AMOUNT



CONCLUSIONS

- Per capita injury rates are approximately the same as they were in the early 1960s
- Crash risk during winter precipitation is highly elevated (relative risk of injury collision = 1.87 ± 0.20)
- There is no temporal trend in the relative risk of injury collision during winter precipitation events
- This suggests the need for more pointed interventions