

Relation of Speed and Speed Limits to Crashes

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Overview

- ◆ Relation of speeds to crashes
- ◆ Relation of speed to crash severity
- ◆ Relation of speed limit changes to speed and crashes
- ◆ Characteristics of excessive speeders

Relation of speed to crashes

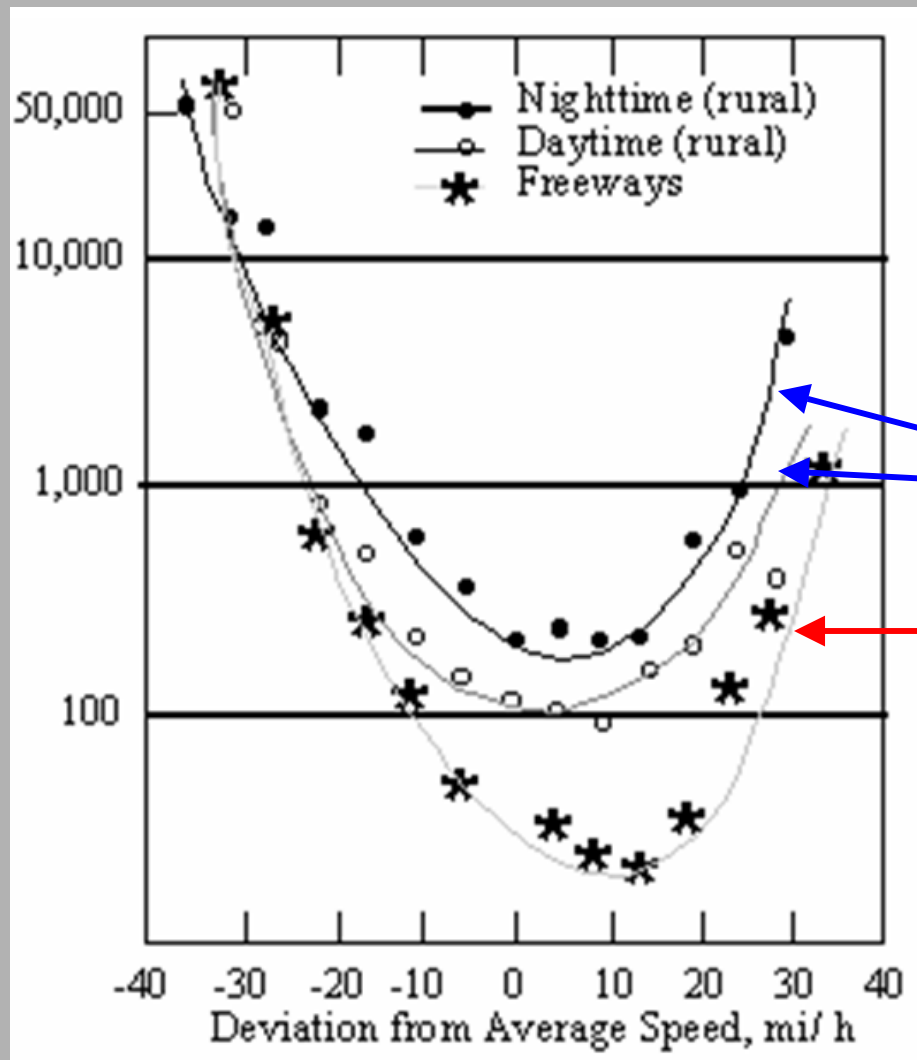
Solomon 1964, Cirillo 1968

- ◆ Solomon studied speeds of crash-involved vehicles and overall traffic speeds on rural highways
- ◆ Cirillo conducted a similar analysis for daytime crashes occurring on interstates; crash types limited to rear-end, angle, and same-direction side-swipes

Findings

- ◆ Both studies found a U-shaped relationship between vehicle speed and crash incidence
- ◆ Crash rates were lowest for drivers traveling near the mean speed, and increased with deviations above and below the mean
- ◆ Low-speed drivers were more likely to be involved in crashes than relatively high speed drivers

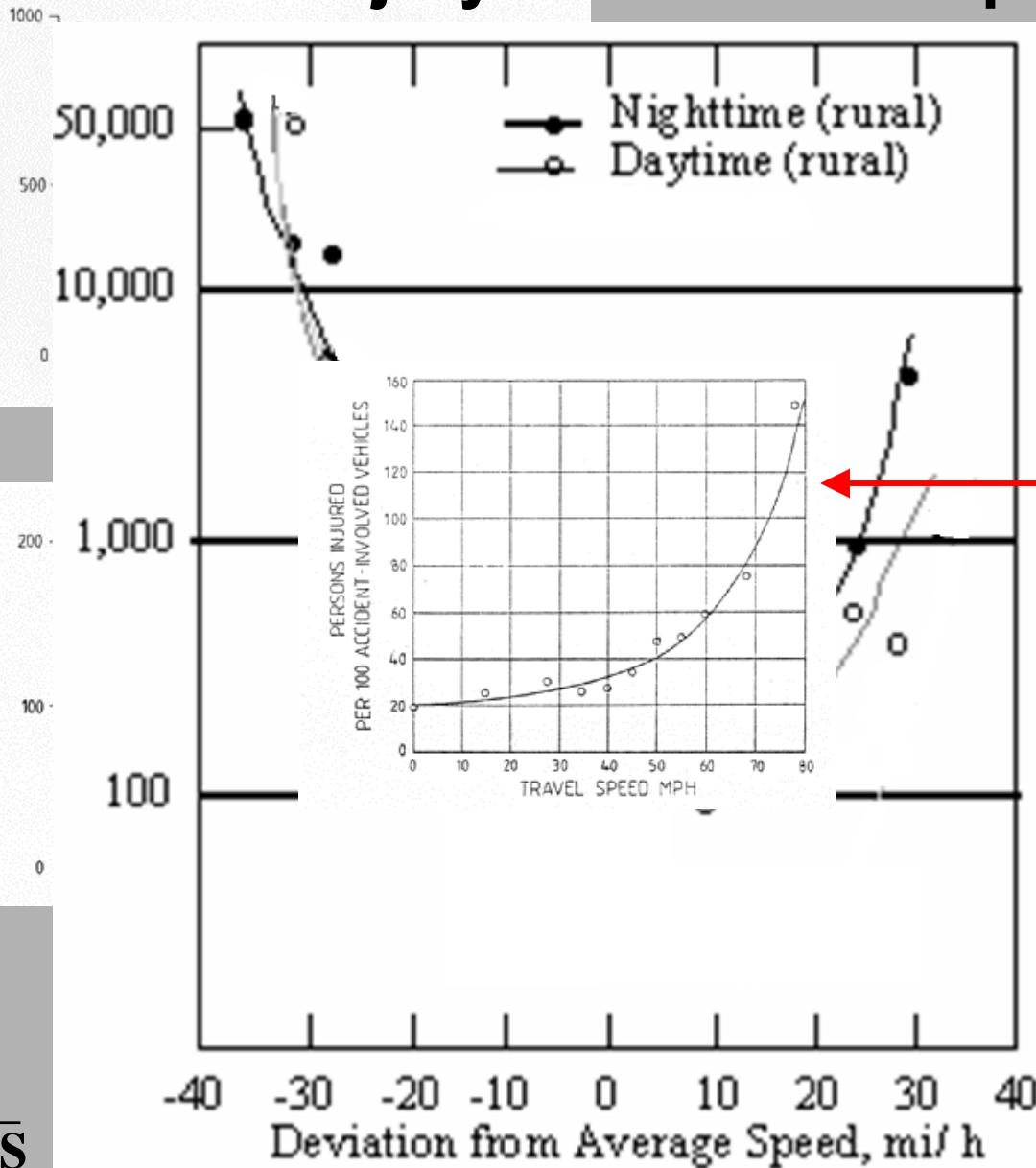
U-shaped curve- Solomon/Cirillo



Explaining Solomon's and Cirillo's findings

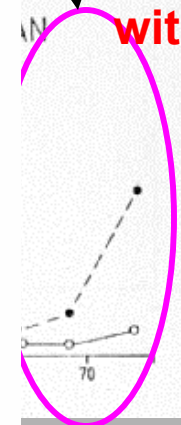
- ◆ Solomon:
 - many crashes occurred at intersections and involved stopped or slowing vehicles
 - data were collected on 1950s era roads, which lacked turn lanes and passing lanes
- ◆ Cirillo:
 - many crashes, especially rear-end collisions, may have been related to traffic congestion, which by definition involves stopped or slowing vehicles

Explaining the U-Shape Risk of Injury Crashes and Speed, Cowley 1987



Crash Rates (>70mph)
 Combining all we have
 this U shaped curve
 Rates constant (40-68mph)
 at Low Speeds (<40mph)

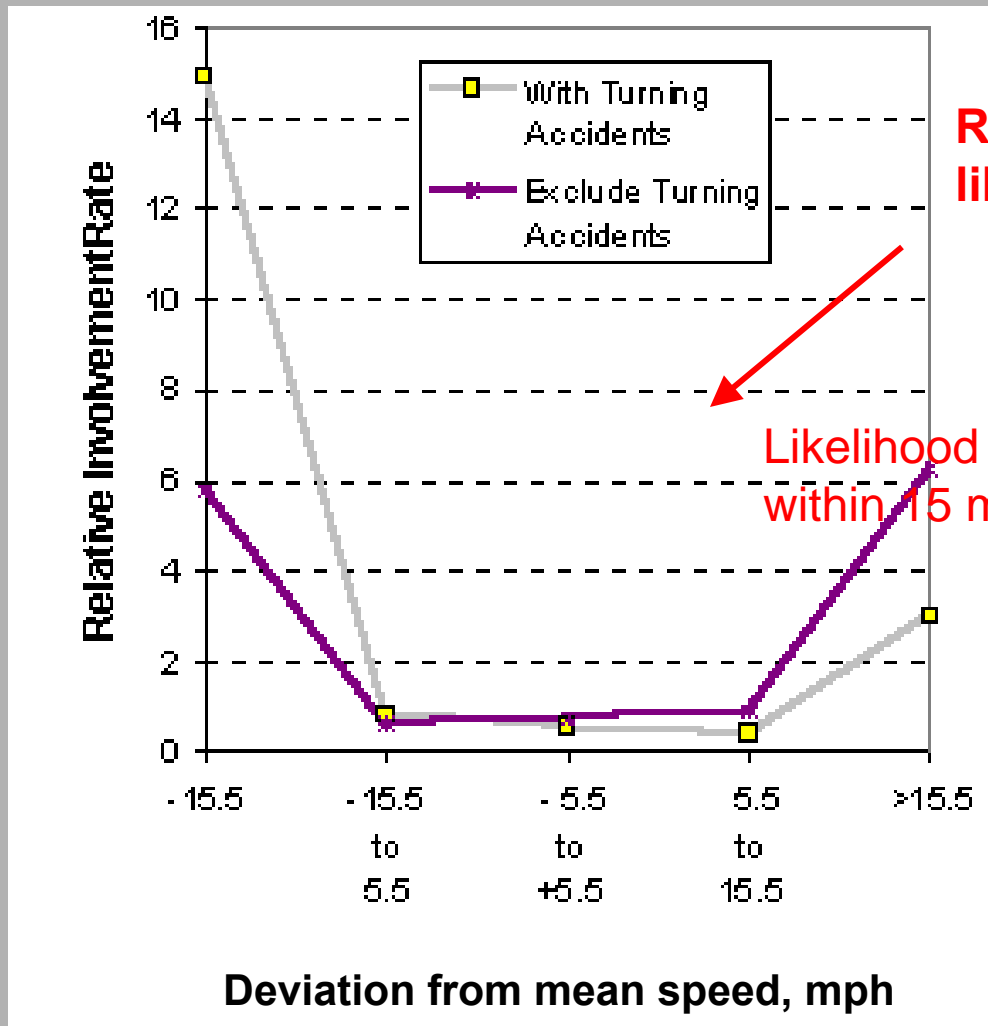
Injuries increase
 with speed



West and Dunn, 1971

- ◆ Data collected on a state highway in Indiana with speed limits of 40-50 mph
- ◆ Found a U-shaped relationship like some of the earlier studies
- ◆ Crash risk was greatest for vehicles traveling more than two standard deviations above the mean speed
- ◆ Does not explain significant percent of speeding-related single vehicle crashes

West and Dunn speed curve

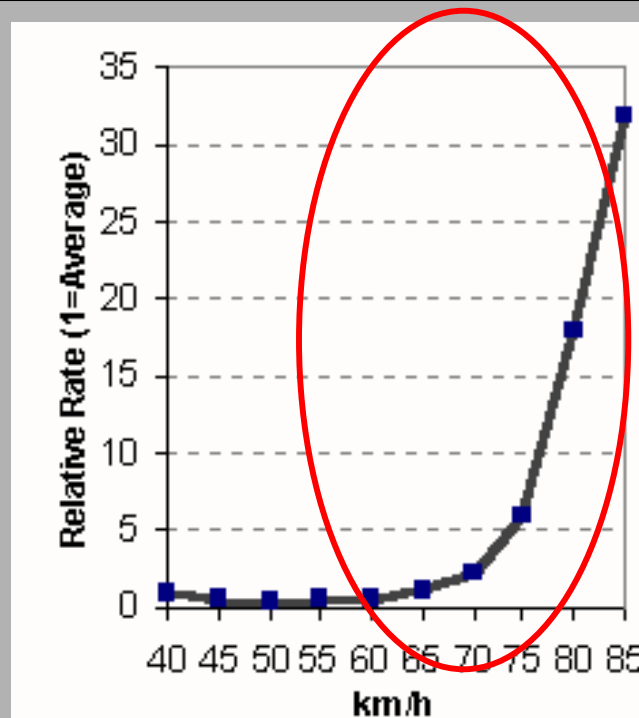


Replicated U shape
like previous studies

Likelihood of being involved in crash flat
within 15 mph of mean speed

Kloeden et al., 1997

- ◆ Risk of being involved in an injury crash was lowest for vehicles traveling near or below the median speed and increased exponentially at higher speeds



Risk increases exponentially

Shinar, TRB Special Report 254 (1998)

On the relation of speeds to crashes

- ◆ There is sufficient evidence to indicate a driver's speed is a correlate of crash involvement
- ◆ Speed deviation of crash-involved vehicles from the average appears to be positively related to crash probability, especially for arterial highways and interstates
- ◆ The principal factor...is the requirement to slow down to make turns and to enter and exit high-speed roads

Relation of speed to crash severity

- ◆ The relationship between vehicle speed and crash severity is unequivocal and based on the laws of physics
- ◆ Velocity change in a crash (ΔV) is a critical measure of crash severity

Speed and crash severity (continued)

- ◆ The likelihood of being injured, and injury severity in a crash, depend on the change in speed (ΔV) at impact (Bowie and Waltz, 1994)

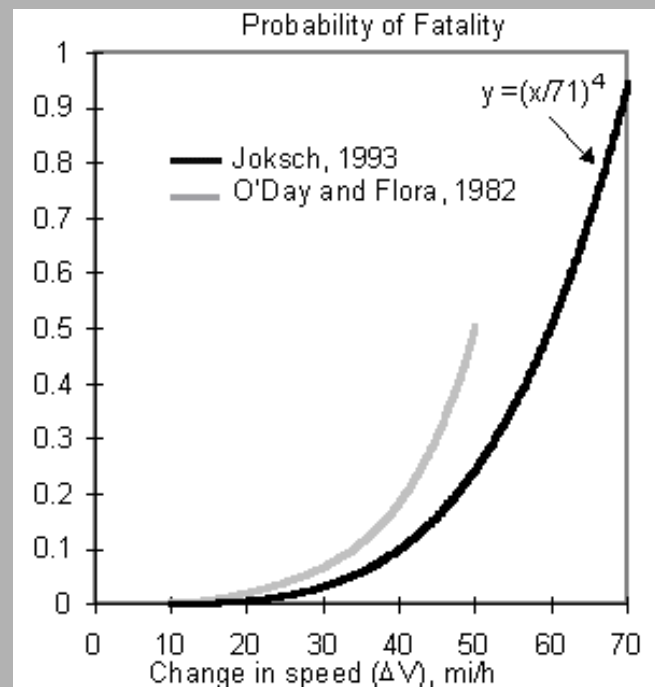
Injuries per 100 Occupants by Change in Speed (delta V) at Impact

delta V mi/h	Moderate Injury AIS 2+	Serious Injury AIS 3+
1-10	4.5	1.0
11-20	10.6	2.6
21-30	29.2	11.1
31-40	53.4	27.9
41-50	67.2	40.6
50+	69.3	54.3

As ΔV increases
injury risk also
increases


Speed and crash severity (continued)

- ◆ O'Day and Flora (1982) and Joksch (1993) found that the risk of a car driver being killed in a crash increased with increases in speed



**Risk Increase
Exponential**

Speed Increase



Relation of Speed Limit Changes to Speeds and Crashes

1974 National Maximum Speed Limit (NMSL) legislation

- ◆ In 1974, Congress established the NMSL of 55 mph
 - mainly implemented to conserve fuel
 - traffic fatalities declined 16 percent, from 54,052 in 1973 to 45,196 in 1974

US DOT study

- ◆ Joint NHTSA-FHWA task force studied safety effects of the NMSL (1980)
 - while the precise number of lives saved is unknown, an estimated *20,000 to 30,000 lives were saved by the NMSL from 1974-1978*

TRB Special Report 204

1984

Concluded:

The lower limit [of the NMSL] reduced both travel speeds and fatalities, although driver speed compliance gradually eroded

Partial repeal of the NMSL in 1987

- ◆ States granted authority to raise speed limits to 65 mph on rural interstates

Effects of the 1987 speed limit changes

Speed

- ◆ McKnight et al., 1989: 65 mph states, 48% increase in drivers exceeding 65 mph; 55 mph states, 18 % increase
- ◆ NHTSA, 1992:
 - 3 mph increase in average speeds
 - 4 mph increase in 85th percentile speeds
 - 0.7 mph increase in standard deviation

Effects of the 1987 speed limit changes

Crashes

- ◆ Garber and Graham, 1989:
 - 15% increase in fatalities on rural interstates
 - 5% increase in fatalities on rural non-interstates

- ◆ McKnight et al., 1989:
 - 22% increase in fatal crashes on rural interstates
 - 1% increase in fatal crashes on 55mph roads

Effects of the 1987 speed limit changes

Crashes (continued)

- ◆ Baum et al., 1991:
 - 19% increase in fatalities on rural interstates relative to other rural roads

- ◆ NHTSA 1992:
 - No increase in fatality rates on rural interstates
 - 12% decrease in fatality rates on rural interstates in states that retained 55 mph

Effects of the 1987 speed limit changes:

Crashes (continued)

- ◆ Lave and Elias, 1994:
 - reported a 3 to 5 percent decrease in statewide fatality rates in states that raised speed limits to 65 mph

Full repeal of the NMSL in 1995

- ◆ States granted full authority to establish speed limits on all roads

Effects of full repeal of the NMSL

Interstate and freeway speeds

- ◆ Retting and Green, 1997:
 - mean speeds and 85th percentile speeds increased by 2 to 5 mph
 - proportion of cars exceeding 70 mph increased by 15 to 50 percent
 - speed variation, as measured by the standard deviation, increased by 5 to 15%

Effects of full repeal of the NMSL:

Crashes

- ◆ Farmer et al., 1999:
 - 15% increase in fatalities and 17% increase in fatality rates on interstates with increased speed limits
 - no significant change on non-interstate roads
- ◆ Frith et al., 2002:
 - 35% increase in fatalities in 70 mph states
 - 38% increase in fatalities in 75 mph states

Effects of full repeal of the NMSL

Crashes (continued)

- ◆ NHTSA, 1998:
 - 6% increase in fatalities and 15% increase in injuries on interstates
 - 2% decrease in fatalities and 3% increase in injuries on non-interstate roads

Effects of full repeal of the NMSL

Crashes (continued)

- ◆ McCarthy (TRB Report 254), 1998:
 - positive relationship between crash severity and speed dispersion for rural interstates
 - speed dispersion is very important for fast drivers

- ◆ Cato Institute, 1999:
 - raising speed limits reduced injuries significantly, increased fatalities insignificantly and had a considerable net cost benefit

Conclusions

- ◆ Overall crash involvement as a function of travel speed generally follows a U-shaped curve
- ◆ Lower than average traffic speeds are unavoidable due to traffic conditions and vehicle maneuvers that require low speeds
- ◆ Higher than average speeds generally violate traffic laws and can be addressed through consistent law enforcement

Conclusions (continued)

- ◆ Higher and lower than average speeds don't have equal consequences; as crash speeds increase, so does crash severity
- ◆ The overwhelming majority of evidence suggests that reductions in speed limits reduce vehicle speeds and crashes; increases in speed limits increase speed, as well as crashes
- ◆ Excessive speeders are more likely to be male, younger, and to have poor driving records