CITY of ALBUQUERQUE
TWENTY FIFTH COUNCIL

COUNCIL BILL NO. O-23-78 ENACTMENT NO. ______________

SPONSORED BY: Brook Bassan, Isaac Benton, and Klarissa Peña by request

ORDINANCE

AMENDING CHAPTER 7, ARTICLE 15, SECTION 4, ENABLING THE CITY TO CREATE PARKING OFFENSE FOR VEHICLES WITH MULTIPLE ASE FINES CONCURRENTLY IN DEFAULT; AMENDING CHAPTER 8, ARTICLE 5, SECTION 1 CREATING A CITY CODE PETTY MISDEMEANOR OFFENSE FOR PARKING A VEHICLE ON CITY STREETS WITH MULTIPLE ASE FINES CONCURRENTLY IN DEFAULT.

WHEREAS, traffic safety is an important piece of the City's overall effort to improve public safety, and Automated Speed Enforcement ("ASE") supports that effort; and

WHEREAS, although a majority of individuals who receive ASE system fine notice pay their fines or complete community service pursuant to the ASE Ordinance, a small percentage receive three or more system fines and default upon those system fines; and

WHEREAS, the City seeks an additional enforcement mechanism to discourage scofflaws from chronic nonpayment of fines issued pursuant to the ASE Ordinance; and

WHEREAS, the parking function of the City is an enterprise function; and

WHEREAS, parking is an integral component of economic activity in the City; and

WHEREAS, enforcement of existing laws and regulations, as well as meaningful enforcement of said laws and regulations, are a key component of the City's police power to protect and preserve the health and safety of those in the City; and

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WHEREAS, it shall be improper for vehicles associated with multiple ASE system fine notices which are in default to park on city-owned property, on or in city-owned facilities; or on or in city-managed facilities; and

WHEREAS, the City should seek to accomplish the objectives set forth in the ASE Ordinance in a manner that preserves the safety of all residents and exhausts alternative avenues to promote compliance.

BE IT ORDAINED BY THE COUNCIL, THE GOVERNING BODY OF THE CITY OF ALBUQUERQUE:

SECTION 1. CHAPTER 7, ARTICLE 15 of the Albuquerque Municipal Code is amended to add the following subsection:

§ 7-15-4 ENFORCEMENT

[(I) *Effect of Multiple ASE System Fine Notices in Default*

(1) *Jurisdiction* This section of the ASE ordinance shall be enforced on all streets and roadways within the city; on or in any City-owned parking facility; on or in any City-managed parking facility; or on any other City-owned real property within the city limits. When a street is the boundary line between the city and the county, the entire public way shall be deemed within the city.

(2) *Notice of Multiple Concurrent ASE System Fine Notices in Default* If an alleged violator is concurrently in default on two or more ASE system fines, a letter shall be sent to the registered owner of such vehicle setting forth:

(a) the name of the registered owner;

(b) the dates of the ASE system fines were incurred;

(c) the type of violation,

(d) the dates, times, and locations of the violations;

(e) the license plate number(s) of the vehicle(s);

(f) the amount of the respective fines;

(g) the citation numbers associated with the unpaid fines;

(h) the response due date;

(i) and the return address;

(j) The notice shall furthermore recite the prescribed “Responses to an ASE fine notice” as set forth in § 7-15-4(C). The notice shall also inform the registered owner that the time to appeal the fine notice or elect to complete community service in lieu of payment has expired; and that if

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the registered owner fails to resolve a sufficient number of unpaid ASE fines within twenty (20) calendar days, such that the registered owner no longer has more than two (2) unpaid ASE system fine notices concurrently in default for any given vehicle, the registered owner may be subject to a parking citation and immobilization and impoundment of their vehicle, if their vehicle is found to be parked on any street or roadway within the city; on or in any City-owned parking facility; on or in any City-managed parking facility; or on any other City-owned real property within the city limits.]

SECTION 2. CHAPTER 7, ARTICLE 15, Part 5, Subsection A of the Albuquerque Municipal Code is amended as follows:

§ 7-15-5 ADMINISTRATION

(A) The Albuquerque Police Department [and the Department of Municipal Development] shall be responsible for administration of this article. Reasonable rules and regulations may be promulgated by the Mayor or the Mayor's designee to carry out the intent and purpose of this article.

SECTION 3. CHAPTER 8, ARTICLE 5, Part 1 of the Albuquerque Municipal Code is amended to add the following Section 43:

§ 8-5-1 GENERAL PROVISIONS

[§ 8-5-1-43 Repeated Nonpayment of Automated Speed Enforcement System Fines.

(A) Repeated Nonpayment of Automated Speed Enforcement ("ASE") System Fines consists of a vehicle owner who has accrued and defaulted upon three or more ASE system fines, as described in § 7-15-4(I);

(B) It shall be unlawful for any vehicle to park on any City streets or roadways, on or in any City-owned parking facility; on or in any City-managed parking facility; or on any other City-owned real property, if the vehicle has three or more accrued and defaulted ASE system fines, as described in § 8-5-1-43(A).]

SECTION 4. CHAPTER 8, ARTICLE 5, Part 3, Section 1, Subsection C of the Albuquerque Municipal Code is amended as follows:

§ 8-5-3-1 FREQUENCY OF PARKING CITATIONS

(C) *Parking Citation No More Frequently Than One For Every 24-Hour Period.* Whenever a vehicle is parked in violation of §§ 8-5-1-12, 8-5-1-

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19[,][~~and~~] 8-5-1-25 [and 8-5-1-43] and parking citations shall not be issued more frequently than one for every 24-hour period.

SECTION 5. COMPILATION. Sections 1 and 2 of this ordinance shall amend, be incorporated in and made part of the Revised Ordinances of Albuquerque, New Mexico.

SECTION 6. EFFECTIVE DATE. This ordinance shall take effect five days after publication by title and general summary.

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CITY OF ALBUQUERQUE

Albuquerque, New Mexico

Office of the Mayor

Mayor Timothy M. Keller

INTER-OFFICE MEMORANDUM

March 7, 2023

TO: Pat Davis, President, City Council

FROM: Timothy M. Keller, Mayor

SUBJECT: Amendments to Revised Ordinances of Albuquerque to Enable the City to Create Parking Offense for Vehicles with Multiple Automated Speed Enforcement Fines Concurrently in Default

The attached Ordinance would amend Chapter 7, Article 15, Section 4 to enable the City to create a parking offense for vehicles with multiple Automated Speed Enforcement (ASE) fines concurrently in default and Chapter 8, Article 5, Section 1 to create a petty misdemeanor offense for parking a vehicle on City streets or in City owned or managed parking facilities with multiple ASE fines concurrently in default.

The ASE Ordinance is an effective tool to improve public safety and additional enforcement mechanisms are needed to discourage scofflaws from chronic nonpayment of fines issued pursuant to the ASE Ordinance. These amendments would make it unlawful for persons with chronic non-payment of ASE fines to park their vehicle on City streets and in City owned or managed parking facilities to encourage these persons to pay their defaulted fines and to increase the effectiveness of the ASE Ordinance in improving public safety in the City.

This is forwarded for your consideration and favorable action.

Approved:

Lawrence Rael
Chief Administrative Officer

Date: 6/9/23

Approved as to Legal Form:

DocuSigned by:
Lauren Keefe
1A21D96D33C74EE...
Lauren Keefe
City Attorney

Date: 3/8/2023 | 2:16 PM MST

Recommended:

DocuSigned by:
Patrick Montoya
1ED93102F75A41F...
Patrick Montoya
Director, Department of Municipal Development

Date: 3/7/2023 | 5:24 PM PST

ATTACHMENT C

Appendix A

Cover Analysis

1. What is it?

This Ordinance would amend the Revised Ordinances of Albuquerque to create a parking offense for vehicles with multiple Automated Speed Enforcement (ASE) fines concurrently in default.

2. What will this piece of legislation do?

This legislation will make it unlawful to park a vehicle on any City street or City owned or managed facility if that vehicle has three (3) or more unpaid ASE fines in default. Upon passage of this legislation, the Department of Municipal Development will notify all persons with two (2) or more unpaid ASE fines in default that defaulting on any additional ASE fines or not resolving current ASE fines in default may result in a parking citation and vehicle immobilization and impoundment if the person parks their vehicle on any City street or in a City owned or managed facility. Municipal Development will then issue parking citations to vehicles that are unlawfully parked under the ordinance and may immobilize vehicles in accordance with Article 8, Article 5.

3. Why is this needed?

While many ASE fines are paid or resolved through community service, as prescribed under the ASE Ordinance, there remains persons that refuse to pay or resolve ASE fines and continue to accumulate ASE fines in default. The City seeks additional enforcement mechanisms to discourage these scofflaws from chronic nonpayment of fines.

4. How much will it cost and what is the funding source?

The funding source is the Parking Enterprise Fund, Fund 641. The cost is undetermined as parking enforcement is a regular part of Parking Enforcement Officer duties, and the Ordinance creates an additional parking offense.

5. Is there a revenue source associated with this Plan? If so, what level of income is projected?

The City anticipates additional parking revenues associated with creating a new parking offense; however, the amount is to be determined.

6. What will happen if the project is not approved?

Individuals may continue to not to pay or resolve ASE fines.

FISCAL IMPACT ANALYSIS

TITLE:
Parking Offense for Multiple ASE fines in Default

O:
FUND: 641

DEPT: Parking/Municipal Develop

[X] No measurable fiscal impact is anticipated, i.e., no impact on fund balance over and above existing appropriations.

[ ] (If Applicable) The estimated fiscal impact (defined as impact over and above existing appropriations) of this legislation is as follows:

	Fiscal Years 2023	2024	2025	Total
Base Salary/Wages				-
Fringe Benefits at				-
Subtotal Personnel	-	-	-	-
Operating Expenses		-		-
Property		-	-	-
Indirect Costs	-	-	-	-
Total Expenses	$ -	$ -	$ -	$ -
[ ] Estimated revenues not affected				
[ ] Estimated revenue impact				
Revenue from program				0
Amount of Grant		-	-	
City Cash Match				
City Inkind Match				
City IDOH	-	-	-	-
Total Revenue	$ -	$ -	$ -	$ -

These estimates do not include any adjustment for inflation.
* Range if not easily quantifiable.

Number of Positions created

COMMENTS: Financial impact to be determined in 6 months following implementation of Ordinance.

COMMENTS ON NON-MONETARY IMPACTS TO COMMUNITY/CITY GOVERNMENT:

PREPARED BY:
DocuSigned by: Christine Ching
FISCAL ANALYST

APPROVED:
DocuSigned by: Patrick Montoya 3/7/2023 | 5:24 PM PST
DIRECTOR (date)

REVIEWED BY:
DocuSigned by: Jennifer Brokaw
EXECUTIVE BUDGET ANALYST

DocuSigned by: Lawrence L. Davis 3/8/2023 | 1:27 PM MST
BUDGET OFFICER (date)

DocuSigned by: Christine Boerner
CITY ECONOMIST

ATTACHMENT C

Appendix A

Sec. 27-7. Safe Traffic Operations Program.

27-7.1 Short title.

Section 27-7 and its subsections shall be referred to as the Safe Traffic Operations Program ("STOP") and may sometimes be referred to as "this article."

27-7.2 Findings and intent.

(a) The governing body finds that there is a significant risk to the health and safety of the community from drivers who run red lights and exceed the posted speed limits. The governing body finds that the City of Las Cruces has a serious injury rate resulting from red light violations within the city. Drivers in the city shall progress away from the attitude that a red light is merely a suggestion to stop toward an appreciation that red light violations injure and even kill too many of our citizens. The governing body finds that red light violations are a nuisance. Within the City of Las Cruces, red light violations are a great matter of local concern due to high traffic volume and crowded intersections. The governing body finds that the state legislature does not intend for the State of New Mexico Motor Vehicle Code to apply statewide to the exclusion of local traffic laws.

(b) The governing body finds that many municipalities across the state have experienced substantial decreases in red light violations by using red light cameras. The governing body finds that red light cameras produce reliable evidence of red light violations. The governing body finds that it is reasonable for police officers to rely on red light camera evidence even if the officer did not personally observe the violation. The governing body finds that red light cameras save lives and make our streets safer.

(c) Red light violations are a nuisance that shall be abated by the assessment of fines to compensate the city and tax payers who do not commit these violations. The governing body finds that the current penalty under state law for running a red light is inadequate to meaningfully address the nuisance and that the city must implement meaningful civil remedial measures that will stop red light violations making the city's streets safer and saving lives. Red light violations are causally connected to death or serious injury to a degree not evident with regard to other traffic infractions.

(d) The governing body finds that some drivers in the city repeatedly violate posted speed limits. The governing body finds that state law against speeding does not prevent the city from having provisions in its ordinance to provide for public safety on its streets. The governing body finds that implementation of enforcement of speed limits by means of photographic and electronic equipment will abate the nuisance of speeding.

(e) The governing body declares that this article is a nuisance abatement article enacted pursuant to the city's inherent authority under state law and that the remedies are purely civil and not criminal in nature.

27-7.3 Definitions.

For the purposes of this article, the following definitions shall apply unless the context clearly indicates or requires a different meaning:

Authorized emergency vehicle means the same as defined under NMSA 1978, § 66-1-4.1(E) (2001), as amended from time to time and, without limitation on the foregoing, shall mean any fire department vehicle, police vehicle, ambulance and any emergency vehicles of municipal departments or public utilities that are designated or authorized as emergency vehicles by the Director of the New Mexico State Police Division of the Department of Public Safety or the Chief of Police of the Las Cruces Police Department.

Camera, speed device or *"CSD"* means the instrument that detects a violation of this article. The definition includes, but is not limited to, photo red light cameras and electronic speed detection equipment reasonably relied upon by police officers.

City means the City of Las Cruces.

City clerk means the city clerk of the city.

City manager means the city manager of the city.

Contractor means a person or entity that enters into a contract with the city to provide the city with photographic or electronic evidence of a violation through a CSD.

Default means the failure to pay a STOP fine or to timely pay a fine pursuant to a decision of a hearing officer under this article.

Delivery or *delivered* means the mailing of a STOP fine notification to a registered owner or nominee or personal service of a STOP fine notification or hearing officer decision on a registered owner or nominee.

Department means the city's police department which is the agency of the city that employs the police officer who issues a STOP fine notification or causes a STOP fine notification to be issued.

Department of motor vehicles or *DMV* means the motor vehicle division of the Taxation and Revenue Department of the State of New Mexico or its successor agencies.

Driver means the person operating a motor vehicle at the time of a violation.

Effective date means the date a STOP fine notification is mailed to the recipient by the contractor as indicated on the face of the STOP fine notification.

Finance department means the city's financial services department.

Hearing officer means a hearing officer, as appointed by the district court.

Identify means to submit all information on a driver sufficient to allow the city to locate and notify the driver in lieu of the registered owner including, but not limited to the name and address of the driver.

Nomination means identification of the actual driver of a car by the registered owner as the responsible party for a violation.

Nominee means the person or entity identified by the registered owner as the driver or responsible party.

Notice of default means a document delivered to the registered owner and stating that the registered owner is in default.

Nuisance means the act of operating a vehicle in violation of this article.

Owner's affidavit means a written statement signed under oath and submitted to the city or the city's contractor under penalty of perjury by the registered owner of a vehicle who asserts therein that the registered owner was not driving a vehicle at the time of a violation.

Police officer means a sworn member of the Las Cruces Police Department, Dona Ana County Sheriff's Office, the New Mexico State Police, or any other public official with authority to stop a vehicle for a traffic violation in the City of Las Cruces.

Public safety aide means a public safety aide of the Las Cruces Police Department.

Registered owner means the owner or owners of a vehicle according to the license plate number or information obtained from the department of motor vehicles, from similar motor vehicle agencies outside New Mexico, from information obtained from the Las Cruces Municipal Court, from the Dona Ana County Magistrate Court, from department records, from a CSD or from any other documentation or methods reasonably relied upon by police officers. The singular includes the plural.

Respondent means an accused violator who has received a STOP fine notification and requested a hearing.

School zone means a posted "safety zone" as that term is defined under NMSA 1978, § 66-1-4.16 (2001), as amended from time to time.

STOP fine notification means a written document mailed to the address of the registered owner or nominee stating that a violation has occurred and payment is due.

Violation or *offense* means a violation of this article.

27-7.4 Violation.

Any violation of section 27-12-5-6 or section 27-12-6-1.2 of the city's Municipal Code is a violation of this article. This article does not apply to authorized emergency vehicles responding to an emergency. This article does not apply to vehicles in an intersection during a red light while involved in a police officer or public safety aide controlled funeral procession or a city permitted parade or when responding to a police officer directing traffic.

27-7.5 Enforcement.

(a) *Criminal violation observed by police officer.* This article does not abrogate or impair enforcement authority of existing traffic laws by a police officer for a violation committed in their presence. Specifically, if a police officer personally and contemporaneously observes a traffic violation, the police officer may stop the vehicle and issue a citation under state law or the City of Las Cruces Traffic Code in the usual manner.

(b) *Violation recorded by CSD.* The contractor shall provide all evidence of a CSD recorded violation to a police officer. A police officer shall review all CSD evidence provided by the contractor. If the police officer determines that a violation has occurred, the police officer shall cause a STOP fine notification to be delivered to the registered owner. The registered owner is strictly and vicariously liable for the violation unless one of the exceptions herein applies. If there is more than one registered owner, all registered owners shall be jointly and severally liable.

(c) *STOP fine notification.*

(1) *Form and contents.* The STOP fine notification shall state and contain the name of the registered owner or owners or nominee, the effective date of the STOP fine notification, the type of violation, the date, time and location of the violation, a picture of the violation, the license number of the vehicle, the name and identification of the issuing police officer, the amount of the fine, whether the fine is a first or subsequent offense, the response due date and the address of the department. The STOP fine notification shall conspicuously and in bold face type state; "Failure to pay this fine on time will lead to serious legal consequences and the assessment of the costs of collections including service of process fees, court costs, and reasonable attorney fees." The STOP fine notification shall include an owner's affidavit form. The STOP fine notification shall contain a return envelope addressed to the contractor or the department. The STOP fine notification shall inform the registered owner or the nominee of the right to request a hearing by so indicating in a space provided on the form and returning same to the department.

(2) *Delivery.* The STOP fine notification shall be delivered to the address of the registered owner according to the address registered with the department of motor vehicles or to the address of the nominee according to the owner's affidavit. The registered owner has a duty to timely notify DMV of a change of address and the failure to do so does not entitle the registered owner to assert the defense of inadequate notice. The mailing of a STOP fine notification to the address of the registered owner of a vehicle according to the records of DMV or to the address of the nominee according to the owner's affidavit is constructive notice of a STOP fine notification.

(d) *Response to a STOP fine notification.* Within 35 days from the effective date, the registered owner shall pay the fine, file an owner's affidavit making a nomination, or request a hearing. To pay the fine, the recipient shall deliver the STOP fine notification with payment to the city or to the contractor according to the instructions on the STOP fine notification. To make a nomination, the recipient shall return the STOP fine notification with a completed owner's affidavit to the contractor. To request a hearing, the recipient shall return the STOP fine notification with the request for hearing to the department. Three days for mailing is not allowed and the response shall be actually received no later than 35 consecutive days (including holidays) from the effective date. The department shall forthwith notify the contractor concerning the receipt of a request for hearing. If the fine has not been paid, there has been no nomination or a request for a hearing within 35 days from the effective date, the contractor shall send written notice of default to the department and the registered owner or nominee or both.

(1) *Payment of STOP fine.* Upon receipt of the STOP fine notification, the recipient may elect to admit the violation and pay the fine. To proceed under this section, the recipient shall admit the violation by signing and dating the STOP fine notification on a space provided and returning the STOP fine notification with payment to the contractor or to the city within 35 days. The city may, but is not required to, adopt procedures for alternative methods of payment of fines using the internet or other on-line services. There shall be a $50.00 penalty for any payment tendered that is not honored or is returned for any reason.

(2) *Appeal.* The recipient of the STOP fine notification may request a hearing by so indicating and returning the STOP fine notification to the department within 35 days of the effective date. The hearing officer shall schedule a hearing.

(3) *Nomination.* Any registered owner who was not driving the vehicle at the time of the violation may either accept the responsibility or identify the driver so the contractor can send a notice of violation to the driver. The nomination procedure described in this paragraph is available to any registered owner and is not limited to corporations and governmental entities. If the registered owner claims that another person was driving the vehicle at the time of the violation, the registered owner shall so indicate on the owner's affidavit and identify the person who was driving the vehicle. The contractor shall forthwith deliver the STOP fine notification and owner's affidavit to the department to the attention of the issuing police officer. The police officer may send a new STOP fine notification to the nominee or cause the contractor to deliver a new STOP fine notification to the nominee. The effective date of the STOP fine notification sent to the nominee is the day the STOP fine notification is issued to the nominee as indicated on the face of the new STOP fine notification. If the nominee successfully appeals the allegation that he or she was the driver or defaults the city may proceed against the registered owner by issuing a subsequent STOP fine notification to the registered owner with the effective date being the date so indicated on the face of the subsequent STOP fine notification. If the city cannot assert jurisdiction over the nominee, the registered owner is responsible, subject to the remaining defenses available in this article. Any registered owner who submits an owner's affidavit does so under penalty of perjury. Without limitation on the foregoing, nomination may be used when:

(i) The registered owner is the United States of America, State of New Mexico, County of Dona Ana, or any other governmental entity that owns a vehicle that was being driven by a natural person who was the employee, contractor or agent of the business, corporation or other non-natural entity at the time of the alleged violation. Said entities shall nominate and identify the driver.

(ii) The registered owner is a place of business, corporation or other non-natural entity that owns a vehicle that was being driven by a natural person who was the employee, contractor or agent of the business, corporation or other non-natural entity at the time of the alleged violation. Said entities shall nominate and identify the driver.

(iii) The registered owner is an automobile rental business, automobile dealership or other business entity that, in the ordinary course of business, leases vehicles to others and the lessee was driving the vehicle at the time of the alleged violation. Said entities shall nominate and identify the driver.

(iv) The registered owner was not driving the vehicle at the time of the violation. To assert the defense mentioned in this paragraph, the registered owner shall identify the actual driver and comply with the nomination provision above.

(e) *Default.* If the city does not receive payment of the fine, a nomination or a request for a hearing within 35 days from the effective date, the registered owner is in default. Default automatically results in liability to the registered owner for the violation and the registered owner is barred from requesting or obtaining any hearing on the merits of the STOP fine after the date of the default. A default results in an additional penalty of $25.00. The department shall cause the contractor to mail the notice of default to the defaulting party. The notice of default shall inform the recipient that they have 20 days from the date of mailing of the notice of default to pay the fine or request a hearing from the department. If the default is not cured, the city may pursue all remedies for collection of a debt and is entitled to an award of reasonable attorney's fees incurred.

(f) *Hearing.* Pursuant to NMSA 1978, § 3-18-17 A(2)(e), the hearing provided for a contested STOP violation shall be held by a hearing officer appointed by the presiding judge of the civil division of the district court with jurisdiction over the municipality, and the hearing itself shall be conducted following the rules of evidence and civil procedure for the district courts. The burden of proof for offenses or violations and defenses is a preponderance of the evidence. A determination by the hearing officer shall not impose a total amount of penalties, fines, fees and costs in excess of that provided in this section. If the department prevails, the respondent shall pay the fine. The hearing officer shall render a decision in writing and provide the decision to the department and the finance department. Failure to pay a fine as ordered by the hearing officer within ten consecutive days from the date of the decision is a default. Following a hearing, the respondent may appeal the decision of the hearing officer, pursuant to Rule 1-074 of the Rules of Civil Procedure, to the Third Judicial District Court within 30 days of the decision and may recover the costs of filing the appeal if successful.

(g) *Defenses.* The respondent may present the following defenses in addition to any other defenses available under law and has the burden of proof concerning the defenses:

(1) The vehicle was stolen or otherwise being driven without the registered owner's knowledge or permission at the time of the alleged violation. The registered owner shall have a police report pertaining to the theft to avail the owner of this defense.

(2) The ownership of the vehicle had lawfully been transferred and conveyed from the registered owner to another person before the time of the alleged violation. To assert this defense, the registered owner shall identify the transferee and provide proof of conveyance.

(3) The evidence does not show that a violation was committed involving the subject vehicle.

(4) The registered owner was not driving the vehicle at the time of the violation. To assert the defense mentioned in this paragraph, the registered owner shall identify the actual driver and comply with the nomination provisions above.

(5) The registered owner did not receive notice because the STOP fine notification was not mailed to the address of record with the DMV.

(h) *Fine.*

(1) The fine for the violation for running a red light or speeding is $100.00.

27-7.6 Administration.

(a) The department shall be responsible for administration of this article. Reasonable rules and regulations may be promulgated by the city manager or his designee to carry out the intent and purpose of this article.

(b) Any and all revenue obtained through the Las Cruces Safe Traffic Operations Program shall be used by the Las Cruces Police Department and the city's traffic engineering department for service enhancement and public safety.

27-7.7 Severability.

If any section, paragraph, sentence or clause of this section is held to be invalid or unenforceable by any court of competent jurisdiction, such decision shall not affect the validity of the remaining provisions of this section. The city council hereby declares that it would have passed this section irrespective of any provision being declared unconstitutional or otherwise invalid. Additionally, should any provision of this section conflict with a provision of another applicable civil law or regulation relating to STOP, the stricter provision shall apply, unless more specifically preempted, in which case, the severability provision above will govern.

(Ord. No. 2474, §§ 1—8, 9-15-08; Ord. No. 2495, § I, 1-5-09; Ord. No. 2527, § I, 6-15-09; Ord. No. 2709, § I(Exh. A), 4-7-14)

Row Labels	Count of Case Number
Speeding 6-10 mph over	1334
Speeding 11-15 mph over	1167
Display Of Current Valid Registration Plate	840
Speeding (Over 11/15)	796
Speeding (Over by 1/10)	792
Mandatory Financial Responsibility	711
Speeding 1-5 mph over	374
Speeding 16-20 mph over	362
Failure to Yield/Stop at Sign	337
Speeding (Over 16/20)	268
Evidence of Registration to be Signed and Exhibited on Demand	257
No proof of insurance	255
Operators and Chauffeurs Must Be Licensed	211
Speeding 1-5 mph over (Enhanced)	130
Speeding (Over 11/15) (Construction Zone)	120
Evidence of registration	108
Speeding (Over 21/25)	96
Tail Lamps	95
Failure to Obey Signal	88
Suspended/Revoked	83
Improper Display of Registration Plate	76
Headlamps on Motor Vehicles	74
Mandatory Use of Seatbelts	73
Speeding 21-25 mph over	67
Following Too Closely	62
Vehicles subject to registration	52
Following Too Closely (accident)	52
Noiver's license	50
Speeding (Over 16/20) (Construction Zone)	50
No seat belt	50
Speeding (Over by 1/10) (Construction Zone)	47
Improper Equipment/Failure to Have Operating Registration Plate Lamp	44
Improper Lane	41
Speeding 26-30 mph over	38
Driver's license not in possession	37
Speeding (Over 21/25) (Construction Zone)	37
Failure to Yield Right-of Way at Intersection (accident)	35
Improper Equipment/Operating Vehicle Without Required Headlamps	34
Speeding (Over 26/30)	33
Improper Stopping, Starting or Turning	33
Traffic-Control Signal Legend/Failure to Obey Signal	32
Open Container	32
Improper Equipment/Failure to Have Operating Tail Lamps	30
Speeding (Over 16/20) (Safety Corridor)	29
Illegible registration plate	29
Failure to maintain traffic lane	27
Obedience to Traffic-Control Device	24
Signals by Hand and Arm or Signal Device	23
Driver's license notice of change of address etc.	23
No insurance	23
Speeding (Over 11/15) (Safety Corridor)	23
When Lighted Lamps Are Required	22
Failure to comply with requirements of sun screening material on windshields and windows	22
Stop Lamps, Signal Lamps, and Signal Devices	20
Traffic Lanes	20

Count of Violation Description	**Column Labels**							
Row Labels	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**Grand Total**
Alcohol/Drugs/Paraphanelia		10	25	8	2	4		49
Backing						1		1
Careless Driving	3	51	52	51	42	29	20	248
Child Passenger Restraint			1	1	1	1		4
Direction Control				1			2	3
Due care					1	1	1	3
DWI/DUI			1	1		1		3
Emergency Vehicle			2	1	2	4		9
Failure to comply		1	1	4	8	5	3	22
Failure to maintain lane	1		4	2	8	7	5	27
Failure to notify		9	14	12	11	15	3	64
Failure to Obey		24	13	42	57	31	16	183
Failure to Stop/Yield	4	68	85	55	69	56	116	453
Fleeing/Eluding					1	2		3
Following Too Closely	1	26	16	8	19	28	16	114
Headlights	1	16	17	12	23	21	15	105
Impeding		1	2	1	6	2	2	14
Improper Equipment	1	15	43	39	87	64	42	291
Improper Lane		18	16	14	17	25	33	123
Improper Load			1		1	1		3
Improper Passing		5	2	8	3	5	3	26
Improper Stopping	1	7	3	6	6	8	10	41
Limit on driving		1	1	1	1			4
MIP Alcohol		5	1	2	7	3	1	19
Mobile Phone	1			1	1	1		4
No Registration	3	147	154	174	249	419	313	1459
No seatbelt	1	17	25	18	29	20	15	125
Not insured	4	153	168	118	152	204	190	989
Not Licensed	1	43	69	57	65	99	47	381
Obstructing Driver's View		1	2	1	3		1	8
OHV			1		1			2
Open container		2	19	12	10	11	2	56
Racing		4	1			1		6
Reckless		9	13	7	5	7		41
Secure loads				1				1
Signals		1	1	2	2	2	2	10
Speed	37	990	1081	1301	919	833	779	5940
Suspended/Revoked		17	20	10	11	18	7	83
(blank)	8	152	144	177	216	213	169	1079
Grand Total	**67**	**1793**	**1998**	**2148**	**2035**	**2142**	**1813**	**11996**

Row Labels	2018	2019	2020	2021	2022	2023	2024	Grand Total
Careless Driving								
Accident		26	30	18	13	17	10	114
OHV		5	1			2		8
(blank)	3	20	21	33	29	10	10	126
Careless Driving Total	**3**	**51**	**52**	**51**	**42**	**29**	**20**	**248**
Failure to Obey								
Accident		3	1		3	8	1	16
(blank)		21	12	42	54	23	15	167
Failure to Obey Total		**24**	**13**	**42**	**57**	**31**	**16**	**183**
Failure to Stop/Yield								
Accident			1	1		1	2	5
(blank)	4	68	84	54	69	55	114	448
Failure to Stop/Yield Total	**4**	**68**	**85**	**55**	**69**	**56**	**116**	**453**
Following Too Closely								
Accident	1	10	6		8	16	11	52
(blank)		16	10	8	11	12	5	62
Following Too Closely Total	**1**	**26**	**16**	**8**	**19**	**28**	**16**	**114**
Speed								
01-05 Over SCHOOL ZONE		2	2	1			4	9
01-10 Over	6	97	133	247	185	76	102	846
06-10 Over	13	224	437	188	174	132	165	1333
06-10 Over			1					1
06-10 Over ENHANCED		11				3		14
06-10 Over SCHOOL ZONE		4	1	1	5	1	3	15
11-15 Over	9	329	347	531	340	300	281	2137
16-20 Over	3	106	87	197	98	164	65	720
21-25 Over		22	16	48	26	27	25	164
21-25 Over CONSTRUCTION ZONE		2	1			31	2	36
21-25 Over ENHANCED		1	1				1	3
21-25 Over SAFETY CORRIDOR				7		2		9
21-25 Over SCHOOL ZONE		1	1	1	1			4
(blank)	6	191	54	80	90	97	131	649
Speed Total	**37**	**990**	**1081**	**1301**	**919**	**833**	**779**	**5940**
Grand Total	**45**	**1159**	**1247**	**1457**	**1106**	**977**	**947**	**6938**

International Transport Forum

International Traffic Safety Data and Analysis Group

Speed and Crash Risk

Research Report

OECD

ATTACHMENT C

Appendix D

Speed and Crash Risk

International Traffic Safety Data and Analysis Group

Research Report

ATTACHMENT C

Appendix D

The International Transport Forum

The International Transport Forum is an intergovernmental organisation with 59 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is politically autonomous and administratively integrated with the OECD.

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

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Table of contents

Executive summary

What we did

This study aims to document objectively the relationship between vehicle speed and crash risks. It assesses to what extent recent changes in speed limits or the wide-scale introduction of automated speed enforcement have moderated actual average speeds, and whether this has delivered the safety impacts that theoretical models of the relationship between speed and crashes suggest. The cases analysed come from ten countries: Australia, Austria, Denmark, France, Hungary, Israel, Italy, Norway, Sweden and the United States. The report was prepared by the ITF's permanent working group on road safety, the International Traffic Safety Data and Analysis Group (IRTAD).

What we found

Speed has a direct influence on crash occurrence and severity. With higher driving speeds, the number of crashes and the crash severity increase disproportionally. With lower speeds the number of crashes and the crash severity decrease. This relationship has been captured in various models, most notably Nilsson's "Power Model". This shows that a 1% increase in average speed results in approximately a 2% increase in injury crash frequency, a 3% increase in severe crash frequency, and a 4% increase in fatal crash frequency. Thus, reducing speed by a few km/h can greatly reduce the risks of and severity of crashes. Lower driving speeds also benefit quality of life, especially in urban areas as the reduction of speed mitigates air pollution, greenhouse gas emissions, fuel consumption and noise.

All the cases indicated a strong relationship between speed and the number of crashes, i.e , an increase in mean speed was accompanied by an increase in the number of crashes and/or injured road users. Conversely, a decrease in mean speed was associated with a decrease in the number of crashes and injured road users. In no cases was an increase in mean speed accompanied by a decrease in the number of crashes or casualties. The pattern of the relationship is consistent across cases, although the size of the effect differs substantially between them. These differences are explained partially by varying definitions for injury crashes between countries and the small overall numbers of fatal crashes for some of the countries studied.

What we recommend

Reduce the speed on roads as well as speed differences between vehicles

To reduce road trauma, governments need to take actions that will reduce the speed on roads as well as speed differences between vehicles sharing the same road. For individuals, the risks of a severe crash might seem small, but from a societal point of view there are substantial safety gains from reducing mean speeds on roads.

Set speed limits according to Safe System principles

The design of the road system and the speed limits set for it must consider the forces the human body can tolerate and survive. Working towards a Safe System, reasonable speed limits are 30 km/h in built up areas where there is a mix of vulnerable road users and motor vehicle traffic. In other areas with intersections and high risk of side collisions 50 km/h is appropriate. On rural roads without a median barrier to reduce the risk of head-on collisions, a speed limit of 70 km/h is appropriate. In urban areas, speeds above 50 km/h are not acceptable, with the exception of limited access arterial roads with no interaction with non-motorised traffic. Where motorised vehicles and vulnerable road users share the same space, such as in residential areas, 30 km/h is the recommended maximum.

Improve infrastructure and enforcement if speed limits are to be increased

If an increase in the speed limit is envisaged, stricter enforcement or an upgrade of the infrastructure is recommended to compensate for the increased risk from higher mean speed. Without such compensatory measures, more deaths and more injured road users can be expected.

Use automatic speed control to reduce speed effectively

Experience worldwide has proven the effectiveness of automatic speed control systems in reducing speed, and in turn road crash frequency. Section control (using measurement of average speed over a section of road) is a relatively new measure, which seems to be very effective not only in reducing speed but also in contributing to more homogenised traffic flow.

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Chapter 1. The challenges of speed in road transport

This chapter highlights the political challenges of speed on the roads, summarising its relationship with road crash risk and environmental effects. It reviews trends in speed management in OECD countries and describes the objectives and methodology to undertake this study.

Speed on the roads: a political challenge

Speed is an important factor in transport. The effects of speed, both positive and negative, make speed a primary target for policy action. Speeds directly affect the mobility of persons and goods travelling from one location to another. Driving speeds also have a direct impact on the risk of the driver and other people being involved and severely injured in a crash as well as on noise and pollutant emissions.

In today's modern life, citizens want to have a high degree of mobility and the possibility to travel fast by air, rail or road has become a requirement of our societies. The time taken for a journey is clearly related to speed, especially in rural areas, and a right balance between mobility, safety and environmental aspects should be found.

Setting speed limits on different road types is often not just as simple as following strict safety criteria developed for each road type. Politicians and planners have to consider several challenges when deciding on speed limits, such as balancing safety and mobility aspects. There might also be synergies with other areas. One example is from France where it was possible to reduce speed limits on urban motorways for environmental reasons but not for safety reasons. A consequence in the opposite direction arises when politicians tend to accept higher speed limits on motorways to satisfy their voters.

Excessive speed is a major problem in all motorised countries. An estimate for Norway shows that if all drivers were driving below speed limits, the number of fatalities would be reduced by about 20% (Elvik, 2011). Speed enforcement is therefore a main challenge for all governments.

Relationship between speed and road crash risk

There have been a number of research efforts undertaken in the last few decades which have all shown a close correlation between speed, road crash frequency and severity: when speed increases, the risk of a crash and of its severity increases as well. While, at an individual level, the perceived risk is low, the societal risk is high and usually not well understood.

The severity of a crash follows from the laws of physics. At higher speeds, the kinetic energy released in a crash increase with the square of the speed and the changes of speed experienced by those struck by or occupying the vehicles involved increase with speed.

The increase in crash risk is explained by the fact that when speed increases, the time to react to changes in the environment is shorter and manoeuvrability is smaller. In traffic, drivers on average need about one second to react to an unexpected event and choose an adequate response – this is called the reaction time. The higher the driving speed is, the longer the distance you cover during this reaction time and before the response is initiated, reducing the opportunity to avoid a crash.

Environmental effects

In addition to its impact on road crashes, speed has important impacts on the environment as it is strongly related to the emissions of greenhouse gases (mainly CO2) and of local pollutants (CO, NOx, HC, particulates), as well as to fuel consumption.

The pollutant production processes are complex, and vary within vehicles as well as across vehicle classifications and engine technologies. Oxides of nitrogen (NOx) are produced particularly at high engine operating temperatures (e.g. steady high speed driving) and a reduction in speed leads to a significant reduction in these emissions. The effects of speed reduction strategies on carbon monoxide and hydrocarbons are less clear. Hydrocarbons (HC) emissions reduce with lower speed, whilst carbon monoxide (CO) and particulates (PM) have the lowest emission levels at medium speeds.

The optimum speed (speed at which emissions are minimised), varies according to the type of emission, but typically pollutant emissions are optimised for constant speeds of 40-90 km/h. It can also be noted that modern cars have much lower levels of local pollutants than older vehicles.

Carbon dioxide (CO2) is produced in proportion to fuel consumption, and is therefore also directly linked to speed. In non-congested conditions, fuel consumption – and as a consequence CO2 emissions increase with increasing speed. In such conditions, reducing speed from high levels leads to reduced fuel consumption and lower resource costs, and contributes to a less rapid depletion of the reserves of non-renewable resources. As an example, at constant speed, driving at 90 km/h in comparison to 110 km/h leads to around a 23% saving in fuel consumption. However, at lower speed levels, reduced speeds do not necessarily lead to reduced fuel consumption. At speeds below around 20 km/h, for example, fuel consumption increases significantly.

Speed has a considerable effect on the exterior noise that a vehicle emits. The relationship is monotonic, with a lower speed always resulting in a lower noise level, although other factors, such as the frequency of accelerations, can in some cases be more important than the mean speed (OECD, 2006 and Elvik et al, 2009).

A Safe System approach

It is important that the drivers understand what speeds they are expected to drive at. Road design should be self-explaining, reflecting the speed limits and guiding road users in choosing the right speed. This is a part of the so called sustainable safety concept that aims at preventing serious road crashes and where not possible – limiting their consequences (SWOV 2013). A motorway with no at level crossings, exclusively soft curves and an extensive view will invite drivers to go much faster than for example an access road with private homes on each side. Mono-functionality of roads and road course predictability are ways to enable mobility while keeping a safety focus.

Moreover, a traffic system adapted to the physical limitations of the road users is needed. Such an approach is often called “a safe system” and is exemplified by Sustainable Safety (Netherlands), Vision Zero (Sweden) and the Safe System approach (Australia). The aim of a safe system is to offer a road system that can accommodate the unavoidable human error without leading to death or serious injury. This means that the forces a human body can tolerate and still survive must be considered when designing the road system and setting the speed limits. Such physical limitations are for example that most unprotected road users survive if hit by a vehicle at up to only 30 km/h, a modern car can protect occupants up to 50 km/h in a side collision and a safe car can protect occupants up to 70 km/h in a head-on collision. Vulnerable road users should always be given a special concern when it comes to speed limits. The risk of being killed is almost five times higher in collisions between a car and a pedestrian at 50 km/h compared to the same type of collisions at 30 km/h (Kröyer et al., 2014). Considering this, there is a strong recommendation to reduce speed in urban areas

Working towards a safe system, the following speed limits are reasonable:

- 30-40 km/h in built up areas where there is a mix of vulnerable road users and motor vehicle traffic
- 50 km/h in areas with intersections and high risk of side collisions
- 70-80 km/h on rural roads without median barrier, presenting a risk of head-on collisions.

If vulnerable road users are separated from the motorised traffic, higher speed limits than 30–40 km/h can be used in built up areas. For rural areas, higher speeds than 80 km/h can be acceptable if you have a safe road design with directions physically separated and forgiving road sides. It can also be mentioned that complementary measures like speed enforcement can be an additional measure to work towards a safe system, i.e. in France, the implementation of the speed camera program is a fundamental characteristic of the safe system approach.

Trends in speed management policies in OECD countries

During recent years, OECD countries have witnessed a number of changes in speed limits and enforcement practice on various road types. Trends in speed management policies were surveyed through a questionnaire amongst IRTAD countries.

Speed limits

While several countries introduced speed limits as early as the beginning of the 20th century, the definition of speed limits became more systematic after the Second World War. In 1973, the oil crisis was in many countries a starting point to set or review the speed limits of their motorway networks. Not for road safety reasons but due to the shortage of oil. While in some countries, there are very frequent adjustments to speed limits (sometimes pushed by political decisions), in other countries changes are less frequent, and respond to in-depth consideration of the impact of possible changes.

Change in speed limits is often subject to intense social and political debates. In many countries, raising the speed limit on the motorway network is a recurrent political argument.

In *urban areas*, all countries have progressively moved towards a maximum speed limit of 50 km/h or less. In 2017, nearly all IRTAD countries had a default speed limit in urban areas of 50 km/h, with often lower speed limits (20, 25, 30 or 40 km/h) in residential areas or around schools. Higher default speed limits (usually 60 km/h) are found in Chile, Korea, Mexico, Morocco and during night-time in Poland (60 km/h). When there are discussions whether to change the speed limits in urban areas, they are mostly about lowering the speed in residential areas. Some countries are considering adopting a 30 km/h default speed limit, with higher limits on main arterial roads. In the Netherlands, following a full review of road classification, 70% of road in urban areas are limited to 30 km/h. Poland is considering lowering the speed limit from 60 to 50 km/h at night-time (the limit is already 50 km/h during daytime).

On the *road network outside built-up areas, and excluding motorways*, speed limits typically vary between 80 and 100 km/h. Most countries have lower speed limits for trucks, buses, and vehicles towing a trailer. There are regular discussions on increasing or decreasing the speed limit by 10 km/h on this network. Based on the responses received, regarding the years to come, the trend is more in lowering the speed limit in countries with the highest limits (e.g. from 100 to 90 km/h).

The *motorway network* can be subject to frequent changes and political debates. In 2017, the general speed limits on non-urban motorways varied from 100 km/h (in Japan, New Zealand and Nigeria) to 140 km/h (in Poland). In Germany there is a recommended maximum speed of 130 km/h. There is usually a lower speed limit for urban motorways and lower limits for trucks and vehicles towing a trailer. In the past 20 years, nearly all countries have either increased or decreased their speed limits on the motorway network, without any clear direction. These changes are often pushed by political decisions. When the speed limit is reduced, the environmental benefits of reduced speed are often put forward.

See in Appendix 1 the prevailing speed limits in IRTAD countries (ITF, 2017).

Other speed management measures

Based on the responses received to the survey, in the past decade most speed management measures have focused on the enforcement side, and there has been less effort in adapting the road infrastructure and the road environment to promote lower speeds.

Many countries have now implemented automated enforcement of speed limits, including in some countries the section control system in which a speed limit is enforced automatically in terms of average speed travelled over a section of road. Several countries have also strengthened their sanctions and penalties regimes for speeding violations. This has been accompanied when needed by a change in legislation to allow the principle of “owner’s liability”, i.e. that the owner of the vehicle is by default responsible for the violation.

In many countries, there is a trend into generalising the 30 km/h zones in city centres and residential areas. As mentioned above, some countries are considering setting 30 km/h as a default speed limit in urban areas, with possible higher limits on arterial roads. Most countries report undertaking regularly communication campaigns to promote lower speeds and better compliance with the speed limits.

Description of the case studies

This report analyses eleven cases illustrating either a change in speed limit or a wide implementation of automated enforcement of speed limits. The main criteria to select a case study studies was the availability of evaluation studies including detailed data on both driving speed and crash occurrence before and after the measure was implemented. The eleven case studies are analysed in Chapter 3. They comprise (by type of measure and chronological order):

Changes in speed limits

- **Hungary:** Decrease in speed limit inside built-up areas (1993)
- **Hungary:** Increase in speed limit outside built-up areas (2001)
- **Australia:** Decrease in speed limits in urban areas (1997 – 2003)
- **Denmark:** Increase in speed limit on part of the motorway network (2004)
- **Norway:** Environmental speed limits on major roads in the city of Oslo (2004)

- **Sweden:** A fundamental change in speed limits on the rural roads (2008 and 2009)
- **Israel:** Increase in speed limits on selected rural roads and motorways (2011 and 2013)

Introduction of automated speed enforcement

- **France:** Implementation of nationwide automated speed enforcement (2003)
- **United States:** automated speed enforcement in 14 corridors in the city of Charlotte, North Carolina (2004)
- **Italy: S**peed section control, Safety TUTOR, on motorways (2005)
- **Austria;** Section control (2012)

The motivation to change the speed limit or to introduce automated speed enforcement differs from one case to another and includes road safety concerns, environmental concerns and purely political decisions. In Denmark, the speed limit was raised as a result of a political decision that has been described as a trade-off between drivers' right of individual choice of speed on one side and road safety and environmental concerns on the other (Sørensen and Larsen 2013). In Sweden, road safety concerns drove the fundamental change into more variation in speed limits: decreasing the speed limits on the 'risky' roads while accepting higher speed limits on the 'safest' roads. Speed cameras programmes in France, United States, Italy and Austria were motivated by safety reasons.

In Hungary, in 1993, speed limits in urban areas were lowered as part of the modification of the Hungarian Highway Code. The modifications were implemented to improve road safety. In 2001, speed limits were raised on Hungarian rural roads as a result of a political decision. In Israel, the increase in speed limits on selected rural roads and motorways followed after a re-consideration of the target speeds after infrastructure improvements on these roads. In Australia, the speed limit was reduced on the Great Western Highway from 110 to 100 km/h as the former limit was not consistent with the New South Wales speed zoning guidelines. In Norway, the temporary reduction of the speed limit was implemented for environmental reasons.

This report is based on the analysis of eleven case studies from ten countries for which detailed evaluation reports were available. However, the issue of decreasing or increasing the speed limits or adopting automated enforcement of speed limits is a topical one in many more countries worldwide. For example:

- In Spain, there was a temporary reduction of the speed limit on motorways due to environmental reasons (from 120 km/h to 110 km/h) from March to June 2011.

- In Japan, speed limit increased from 50 km/h to 60 km/h on urban roads with low levels of vulnerable road users; increased from 60 km/h to 80 km/h on four-lane roads with a hard median separator and forbidden to pedestrians, cyclists and mopeds; and decreased from 60 km/h to 30 km/h on urban residential streets. The increases in speed limit were motivated by the objective to reduce the difference between the actual speeds and the speed limits; while the speed limit decrease was to reduce traffic crashes.

- In the United Kingdom, there has been a wide implementation of speed cameras since the late 1990's motivated by the objective to increase traffic safety and reduce the number of fatalities and seriously injured.

Objective and content of the report

The aim of this report is to document objectively the relationship between speed and crash risks, based on the analysis of actual and recent case studies, and to assess how data from actual case studies match the theoretical and empirical models available.

The analyses focus on the impact of the measure (change in speed limit or introduction of automated enforcement of speed limits on mean speed, crash occurrence and their severity. This collection of case studies is meant to serve as a case-based catalogue that can be referred to in local / national debates on speed limits and automated speed enforcement. It is expected that this report will be useful in preparing evidence-based policies within the road safety area.

The report contains the following chapters:

- Chapter 1 presents a short introduction and background to the report.
- Chapter 2 describes the theoretical relationship between speed and crashes. It also describes the models that have been developed, based on past empirical studies, to describe this relationship.
- Chapter 3 describes the eleven case studies analysed to prepare this report.
- Chapter 4 analyses the results from the case studies.
- Chapter 5 presents the overall conclusions.
- Appendix 1 summarises the prevailing speed limits in the responding countries.

Bibliography

Elvik, R., Høye, A., Vaa, T., Sørensen, M. (2009). Handbook of road safety measures. Emerald Group Publishing limited. United Kingdom.

Kröyer. H. R. G., Jonsson, T., Varhelyi, A. (2014). Relative fatality risk curve to describe the effect of change in the impact speed on fatality risk of pedestrians struck by a motor vehicle. Accident Analysis and Prevention, 62, 143-152.

ITF (2017), *Road Safety Annual Report 2017,* IRTAD report, OECD Publishing, Paris.

OECD/ECMT (2006) Speed Management. Organisation for economic Co-operation and Development European Conference of Ministers of Transport Paris, France.

SWOV 2013: Sustainable Safety: principles, misconceptions, and relations with other visions. SWOV Fact sheet, SWOV Leidschendam July 2013.

Sørensen, C.H. and Larsen, L. 2013. Dansk hastighedspolitik – fire case-studier om konsensus og viden i politiske beslutningsprocesser (in Danish). DTU Transport notat 11, 2013. 86 pp.

Chapter 2. Speed, speeding and crashes: Theory and evidence

This chapter describes the theoretical relationship between speed and crashes. It also describes the models that have been developed, based on past empirical studies, to describe the relationship between speed and crash risk.

Introduction

This chapter summarises the theory and the empirical evidence so far about the relationship between speed, speeding, and crashes. The relationship between speed and road safety is a complex one; many physical and psychological factors play a role (for an overview, see Aarts & Van Schagen, 2006).

Speed and crash severity

First of all, there is a relationship between speed and crash severity. The higher the impact speed, the more serious the consequences in terms of injury and material damage. In the first instance, the source of the energy that produces injury and damage in a crash is the dissipation of the kinetic energy of the vehicle or vehicles just before the impact. This depends on the masses of the vehicles and the squares of their speeds. So, collisions at higher speeds and with a heavier vehicle have the potential to result in more severe consequences. The severity of injury to occupants of the vehicles and to pedestrians or cyclists that they strike depends, however, on the forces to which their bodies are subjected. These in turn depend on the amount by which the speeds at which their bodies are travelling are changed within the very short duration of the impact. The changes in speed are determined by the physical laws of momentum and depend on the speeds at impact and the relative masses of the colliding vehicles, or vehicle and pedestrian or cyclist. Although these changes in speed stem from the dissipation of the kinetic energy present before impact, they are determined directly by changes in momentum which are only indirectly related to amounts of kinetic energy.

Crush zones, airbags and seatbelts can reduce the severity of injury by spreading the sudden changes of speed of the vehicle occupants over a less short period of time, and thus reduce the forces imposed on their bodies. Some effect of this kind is provided to struck pedestrians and cyclists by pedestrian protection features of the fronts of vehicles.

In the case of a collision between a vehicle and a very solid object like a bridge abutment or a large tree, the speed of the vehicle and its occupants is reduced to zero in the short time of the impact.

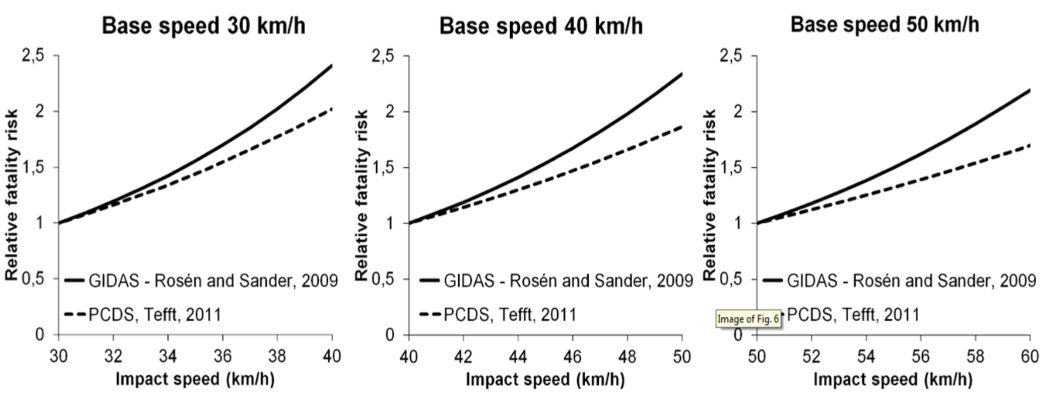
In case of a collision between two vehicles of different mass, the occupants of the lighter vehicle are generally worse off than those in the heavier vehicle. This is because the sudden change in speed experienced by the lighter vehicle is greater than that experienced by the heavier one, and so therefore are the forces imposed on their occupants. Generally speaking, the changes in speed are inversely proportional to the masses of the vehicles.

In today's traffic, there are large differences in vehicle masses, not only between passenger cars and HGVs or buses (a factor 10 or more), but also between different types of passenger cars (up to a factor 3). This vehicle incompatibility is also a road safety problem.

Mass differences are much more extreme in case of a collision between a motor vehicle and a vulnerable road user (pedestrians and two-wheelers). In that situation, mass differences range from a factor of 10 for light cars to nearly 700 for 50 tons HGVs, so that even for the light car the pedestrian is accelerated almost instantaneously from very low speed to roughly that of the vehicle at the time of impact. Figure 2.1 shows the fatality risk for a pedestrian hit by the front of passenger car. This demonstrates the crucial importance of low vehicle speeds in situations where vehicles and vulnerable road users physically meet. It shows, for example, that if impact speed increases from 30 to 40 km/h the risk of fatal injury is about doubled (Kröyer, Jonsson and Varhelyi, 2014).

The estimates in Figure 2.1 are corroborated by other research indicating (Rosen et al 2009, Kröyer et al., 2014) that the death risk is about 4-5 times higher in collisions between a car and a pedestrian at 50 km/h compared to the same type of collisions at 30 km/h. Considering this, there is a strong recommendation to reduce speed in urban areas. More than 50 km/h is not acceptable in situations where motorised vehicles and vulnerable road users have to mix and share the same space. In those cases, e.g. in residential areas, a limit of 30 km/h is to be preferred.

Figure 2.1. **Pedestrian fatality risk and impact speed**

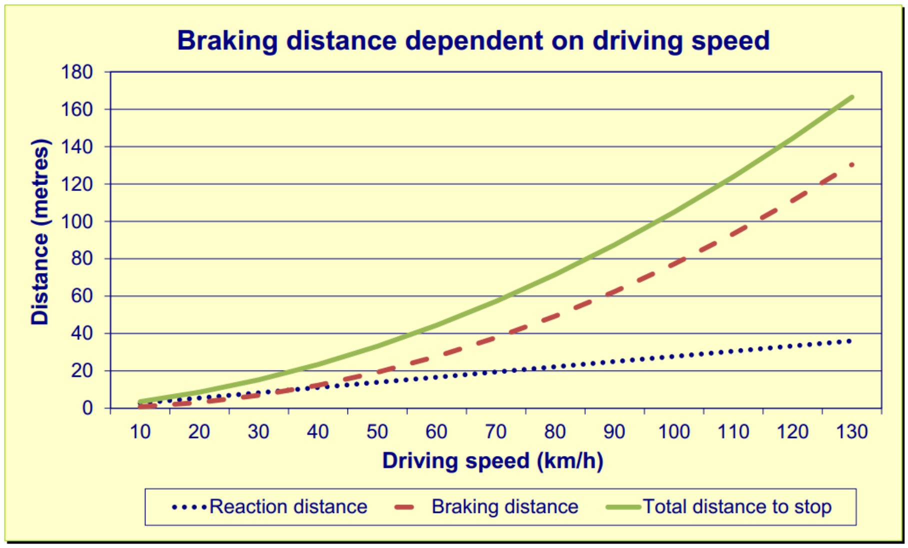


Source: Kröyer, Jonsson and Varhelyi (2014)

Speed and crash risk

There is also a relationship between speed and the risk of getting involved in a crash. First, the higher the *absolute speed*, the higher the risk of a crash. This can be explained by the fact that the driver needs a constant amount of time to react to unforeseen events. The faster they drive, the longer the vehicles moves before a reaction. At high speeds the time to react to changes in the environment is shorter, and manoeuvrability is smaller. In addition, as illustrated in Figure 2.2, the stopping distance is larger.

Figure 2.2. **Distance in metres needed for an emergency stop on a wet road surface at various speeds, with a one-second reaction time.**



Source: SWOV, 2012

Second, the larger the *differences* in speed, the higher the risk of getting involved in a crash. Speed differences increase the number of potentially conflicting situations. For example, they increase the probability of a rear-end collision with a slower car in front, and a head-on collision when overtaking a slower car.

The relationship between speed and crash risk is much less direct and much more complicated to quantify than the relationship between speed and crash severity. There are many additional factors that determine to what extent driving speed affects crash risk. One important factor is the layout and design speed of a road. Some roads can cope with higher driving speeds than others, without having serious consequences for the crash risk. Other important factors include traffic volume and traffic composition. Kloeden et al (1997, 2001, 2002) relate crash risk to individual driver's travel speed or the difference between it and the mean speed of traffic.

Effects of changes in average speed

There have been many empirical studies that have assessed to what extent a change in average speed on a road affects the number and severity of crashes on that road. The scientifically most robust type of studies are those that compare the average speed and the number of crashes before and after a speed management measure, e.g. a speed limit change or the introduction/intensification of speed enforcement. To ensure that there are no other factors that can explain a change in crash frequency (e.g. a change in traffic volume or an anti-speeding publicity campaign), results have to be compared to a comparable group of roads that were not affected by the speed management measure but can be taken to have been affected similarly by all other concurrent changes.

The power model of Nilsson

One of the first and probably most cited studies in this area is the one by Swedish researcher Nilsson, published in 1982. Nilsson studied the safety effects of a reduction of the maximum speed limit on Swedish rural roads from 110 km/h to 90 km/h and vice versa. The comparison group was a group of 90 km/h roads without limit change.

Nilsson (1982) used his data to show that the effect of the change of speed on the number of crashes could be expressed by the formula:

$$A_2 = A_1 \left(\frac{v_2}{v_1} \right)^2$$

This formula basically says that the number of crashes after the change in speed (A_2) equals the initial number of crashes (A_1) multiplied by the quotient of the average speed after (v_2) and the average speed before the change (v_1) to the second power.

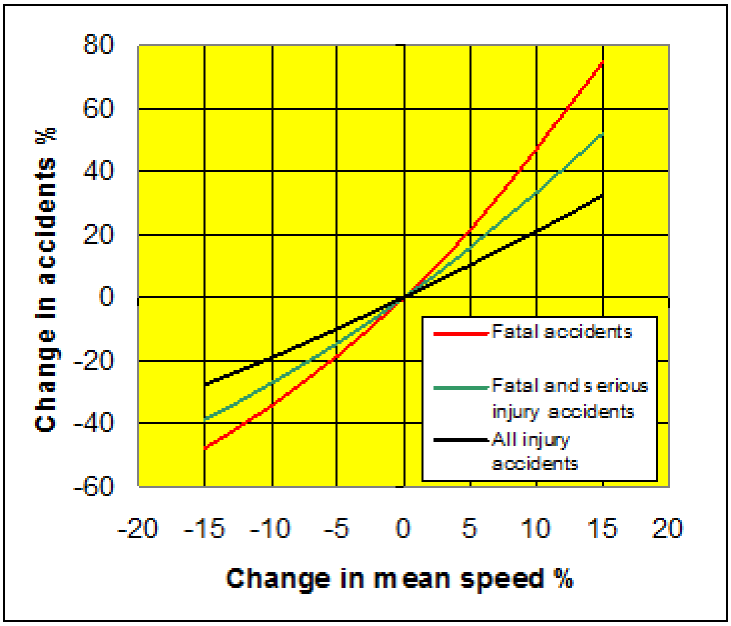
Based on the principles of kinetic energy, Nilsson reasoned that the number of serious crashes would be affected more by an increase in speed than crashes in general, and thus might be estimated with a larger exponent. He found that his data indicated that the exponent of the function could be increased to 3 to describe the change in serious injury crashes (I) and to 4 to describe the change in fatal crashes (F):

$$I_2 = I_1 \left(\frac{v_2}{v_1} \right)^3$$

$$F_2 = F_1 \left(\frac{v_2}{v_1} \right)^4$$

In Figure 2.3, the relationships between change in mean speed and crashes are illustrated. Based on the power model, as a rule of thumb, a 10% increase in mean speed will, on average and approximately, lead to a 20% increase in all injury crashes, a 30% increase in fatal and serious crashes and a 40% increase in fatal crashes.

Figure 2.3. **Illustration of the power model and the relationship between percentage change in speed and the percentage change in crashes**



Source: Nilsson (2004)

Further specification and validation of the power model

Since 1982, many empirical studies have been carried out in several countries and have resulted in more precise estimates of the effect of changes of average speed on crash occurrence and severities.

The empirical data confirmed the theory that the relationship between speed and road safety can be well described in terms of a power function and that a change in speed affects serious crashes substantially more than less serious crashes (Elvik, Christensen & Amundsen, 2004; Nilsson, 2004). The vast majority of data, however, related to rural roads and motorways. Later analyses, including more urban roads (Elvik, 2009; Cameron & Elvik, 2010) show that a change in average speed tends to have a larger effect on crashes and crash severity on rural roads and motorways than on urban and residential roads. Table 2.1 shows the exponents of the power model for different crash severities for different types of roads, based on empirical data from 115 studies (Elvik, 2009). It can be noted that the confidence intervals for the urban and residential roads are very large and that for each severity the exponents do not differ significantly between urban and rural roads.

Table 2.1. **Exponents of the power model for different crash/injury severities for rural roads/motorways and urban/residential roads, based on 115 empirical studies**

Crash/injury severity	Rural roads/motorways (80-130 km/h) Exponents		Urban/residential roads (30-50 km/h) Exponents	
	Best estimate	95% confidence interval	Best estimate	95% confidence interval
Fatal crashes	4.1	(2.9-5.3)	2.6	(0.3-4.9)
Fatalities	4.6	(4.0-5.2)	3.0	(-0.5-6.5)
Serious injury crashes	2.6	(-2.7-7.9)	1.5	(0.9-2.1)
Serious injuries	3.5	(0.5-5.5)	2.0	(0.8-3.2)
Slight injury crashes	1.1	(0.0-2.2)	1.0	(0.6-1.4)
Slight injuries	1.4	(0.5-2.3)	1.1	(0.9-1.3)

Source: Elvik, 2009

Taking account initial speeds: towards an exponential model

The finding that effects of speed changes tend to be larger on rural roads and motorways than on roads in built-up areas roads suggests that the initial speed is a relevant factor. This was confirmed in a re-analysis of the data (Elvik, 2013) that showed that the effect of a given relative change in speed on the number and severity of crashes is larger when initial speed is higher. In other words, a reduction of average speed of 10% will have a larger effect when it concerns a reduction from 100 to 90 km/h than when it concerns a reduction from 50 to 45 km/h. In absolute sense, a reduction in average speed of, for example, 10 km/h would result in comparable reduction of the number of crashes independent of the initial speed. This suggests that the relationship between speed and crashes can be better described by an exponential function than by a power function. Table 2.2 illustrates the difference between the power model and the exponential model and shows the expected percentage reduction in injury crashes for speed reductions of 10 km/h at different initial speeds.

Table 2.2. **Comparison of power model and exponential model for injury crashes**

	Percent change in the number of injury crashes associated with a change in speed of 10 km/h for different initial speeds			
Speed before (km/h)	**Speed after (km/h)**	**Relative speed reduction**	**Injury crash reduction in power model**	**Injury crash reduction in exponential model**
115	105	- 8.7%	-18%	-29%
105	95	- 9.6%	-19%	-29%
95	85	-10.6%	-21%	-29%
85	75	-11.8%	-23%	-29%
75	65	-13.4%	-26%	-29%
65	55	-15.4%	-30%	-29%
55	45	-18.2%	-35%	-29%
45	35	-22.2%	-41%	-29%
35	25	-28.6%	-51%	-29%

Consequently, in order to estimate the road safety effect resulting from expected speed changes using the power model, we need to know the speed both before and after a change to form a ratio between speed after and speed before. When using the exponential model, we only need to know the change in speed, not its absolute level, since this model uses the difference instead of the ratio of the mean speed levels before and after. The general formula in the exponential model is:

Relative number of crashes = $\alpha \cdot e^{\beta \cdot x}$

where x denotes the change in average speed, α is a constant term that does not depend on speed (and can therefore be disregarded when applying the model to estimate the effects of changes in speed). To apply the model and estimate the expected change in the number of crashes, one only needs to know the value of the coefficient β and then use the formula:

$$A_2 = A_1 \, e^{\beta \, (v_2 - v_1)}$$

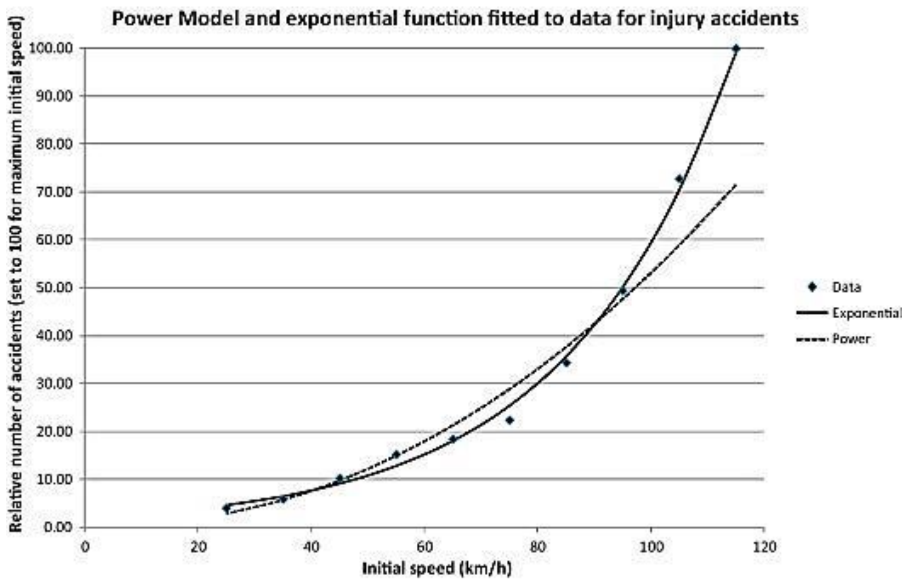
where A_2 equals the number of crashes after the speed change, A_1 the number of crashes before, v_1 and v_2 average speed before and after. For injury crashes, this coefficient is 0.034 (see Table 2.3). Thus, if speed is reduced by 5 km/h we get:

Change in injury crashes = $e^{(0.034 \cdot -5)}$ = 0.844 = 16 percent reduction of injury crashes.

Figure 2.4 compares the relationship between speed and the number of crashes for the power model and the exponential model with respect to injury crashes. It is seen that the power model is flatter than the exponential model, i.e. its curvature depends less on speed. In Elvik 2013, it is shown that the goodness-of-fit statistics (R^2-value) for the power function and exponential function are rather similar. It is in particular at the highest speed, that the exponential model fits the data better than the power model.

Figure 2.4. **Comparison of the power model and the exponential model with respect to injury crashes.**

Black dots = data. Solid curve = exponential model. Dashed curve = power model.

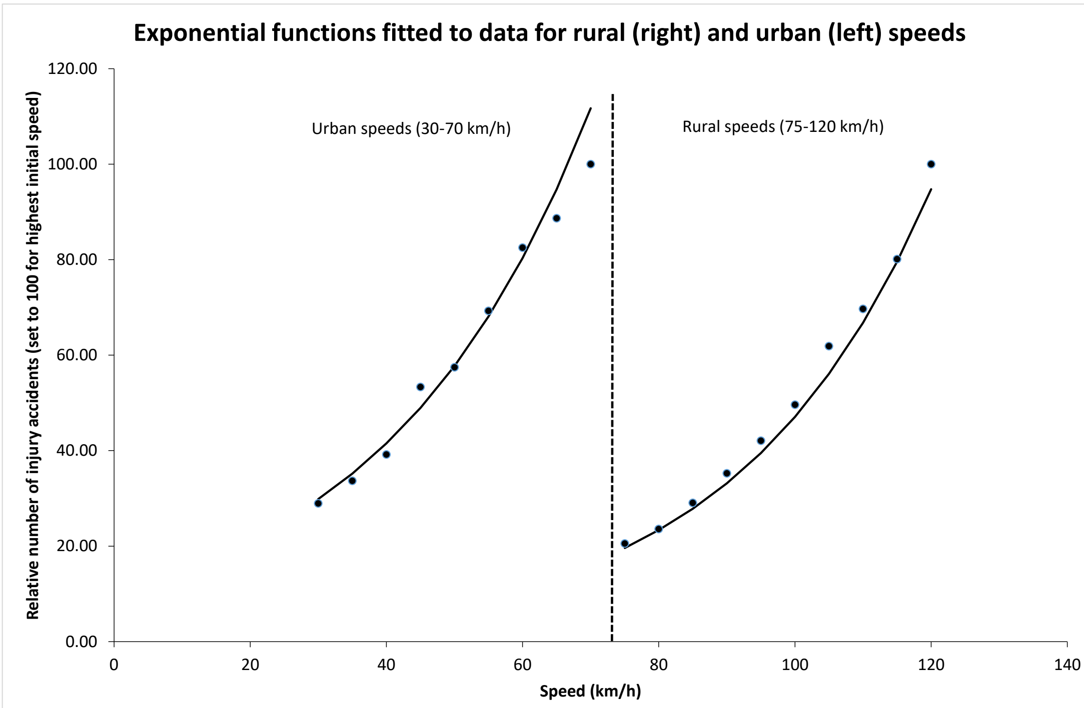


Source: based on Elvik (2013).

The shape of the relationship between speed and the number of crashes is the same in urban and rural areas (it should be noted though, that the empirical data for the urban roads is still fairly limited). This is shown by the curves for urban and rural areas shown in Figure 2.5. The figure illustrates that even small increases in speed in low speed zones also result in a large increase of crashes.

Figure 2.5. **Exponential models fitted to speed data for rural and urban speeds.**

Number of crashes at highest initial speed set to 100. The highest initial speed is 120 km/h for the rural curve and 70 km/h for the urban. Injury crashes.



Source: Elvik (2014).

Table 2.3 shows the estimated values of the coefficients $\boldsymbol{\beta}$ for the exponential model ($A_2 = A_1\, e^{\beta\,(v_2 - v_1)}$ described earlier). Some of the coefficients were slightly adjusted by Elvik (2014) in order to ensure unbiased predictions.

Table 2.3. **Coefficients for the exponential model**

Crash or injury severity	Best estimate of β-coefficient	Standard error
Fatal injury	0.065	0.006
Fatal crash	0.045	0.012
Serious injury	0.061	0.006
Slight injury	0.028	0.005
Injury crashes (all)	0.034	0.001

Source: Elvik (2014).

Effects of individual speed choice

Another way of studying the relationship between speed and crash risk is to assess the crash risk of individual vehicles traveling at different speeds. This can be studied by comparing the (estimated) pre-crash speed of a crash-involved vehicle with the speeds of vehicles that were not involved in a crash but that are comparable otherwise (traveling on the same road, in the same direction, same day, same time, same weather, light and traffic conditions, same type of vehicle, etc.). These studies are known as case-control studies. Another way of studying this is a combination of observations and self-reports. In these studies, the speeds of passing vehicles are measured; subsequently drivers are stopped or receive a questionnaire in order to get information about their crash history.

The first studies that assessed the effects of individual speed choice were case-control studies and date from the 1960s and 1970s in the United States (e.g. Solomon, 1964). At that time, the conclusion was that both drivers driving faster than the average speed on a road and drivers driving slower had a higher risk of getting involved in a crash.

More recent studies confirmed the higher crash risk of drivers driving above the average speed. In Australia this conclusion was based on case-control studies (Kloeden et al. 1997, 2001, 2002). In Great Britain, a similar conclusion arose from a self-report study (Taylor, Lynam & Baruya, 2000). However, these recent studies did not find evidence for a higher crash risk for the driving below average speeds. This is most likely due to the fact that the older studies also included manoeuvring vehicles. Manoeuvring vehicles are more at risk and have, per definition, a low speed. These individual speed models in general estimate a higher individual risk, especially for excessive speeders, than do the aggregated Power and Exponential models based on mean speed. The latest Naturalistic Driving[1] techniques are expected to shed more light on the effect of speed on the individual driver. These and other future studies in this area should also explicitly look at the effect of intermediate factors that could explain the relationship between the speed of individual drivers and crash involvement, such as driver gender, age and experience, and vehicle age and condition.

Effects of speed variance

It has long been believed that speed variance is also related to safety. Older studies of this relationship were not entirely conclusive. Moreover, it is not completely clear what the relationship exactly means. In most studies speed differences reflect the range in speeds over 24 hours of measurements. This means that the measured speed differences include differences between peak and off-peak periods and related differences in traffic volume, and not just differences in speed between vehicles at a particular moment.

In the last 15 years, however, the use of loop detector data from freeways has made it possible to study the effects of speed variance in a much more rigorous and well-controlled manner than before. Data from loop detectors may, if stored in suitable format, be used to reconstruct traffic in great detail. It then becomes possible to determine if the period immediately before a crash occurred was characterised by a larger speed variance than other periods.

Elvik (2014) reviewed thirteen studies that evaluated the effects of speed variance on crash rates, based on loop detector data. Although almost all of these studies found that a large variance in speed increased the risk of crashes, the numerical estimates of effect varied greatly. Moreover, different studies employed different methods, making it impossible to formally synthesise the results of the studies by means of meta-analysis.

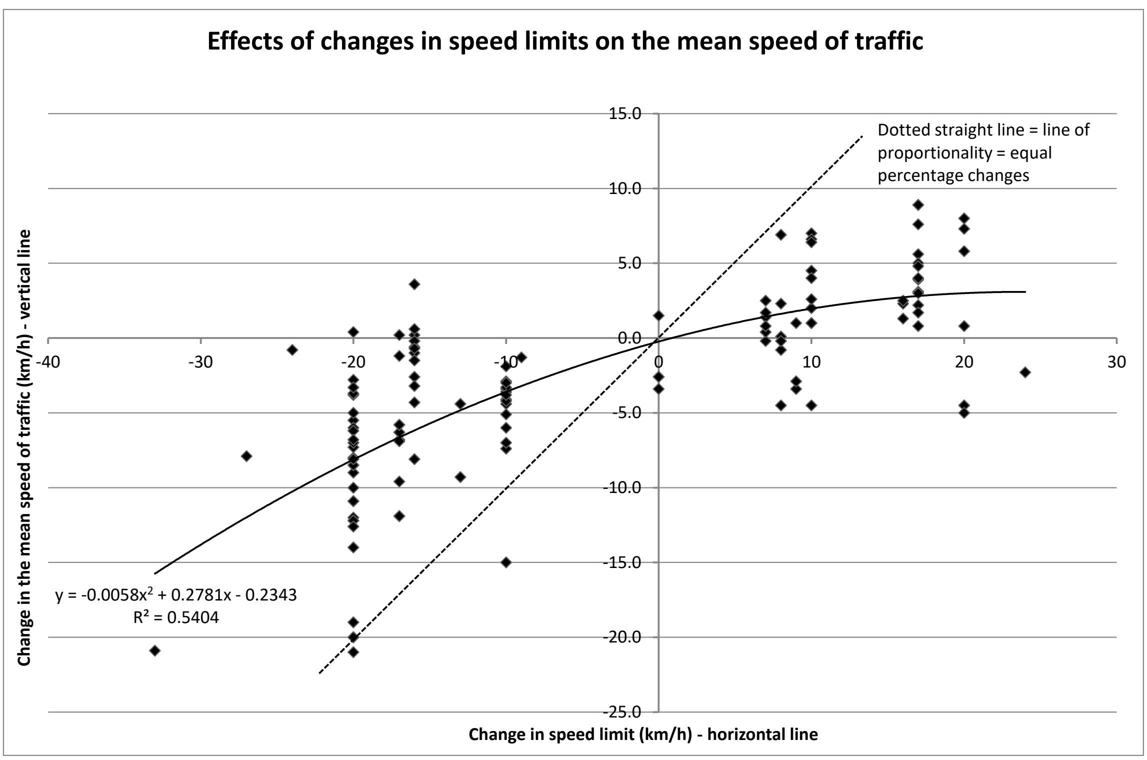
It is nevertheless clear that increased speed variance increases the risk of crashes. It should be added, however, that most of these crashes are probably property-damage-only crashes. Dense traffic characterised by frequent and sudden changes in speed is associated with a particularly high risk of crashes.

Realising changes in speed

The previous paragraphs showed that there is a strong relationship between driving speed and road crashes, and that a reduction in speed results in fewer crashes and less severe crashes. There are many measures that can be applied to realize a reduction in speed. The 2006 ECMT report *Speed Management* discusses these in detail.

The most straightforward measure is setting a changed speed limit. When estimating the potential road safety effect of a higher or lower limit it is important to be aware that the effect on the actual driving speeds is only a fraction of the increase or decrease of the limit. Figure 2.6 shows what effect on driving speed can be expected from just a speed limit change without accompanying measures. If, for example, speed limit is reduced by 20 km/h, the mean speed of traffic will be reduced by about 8 km/h. A corresponding increase in speed limit will be associated with an increase in the mean speed of traffic of about 3 km/h. Effects are influenced by the level of enforcement and it can be seen from Figure 2.6 that the effects of a given change in speed limit vary greatly around the curve fitted to the data points.

Figure 2.6. **Effects of changes in speed limits on the mean speed of traffic.**



Source: Elvik, R. "Speed limits, enforcement and health consequences." Annual Review of Public health, 2012, 33, 225-238.

Though the effect of speed limit changes on actual speeds is relatively small, it must be kept in mind that, as presented in the current chapter, even a change in speed of just 2 or 3 km/h has a large effect on road safety.

Conclusions

The main conclusion from this chapter is that speed is a very important factor in road crashes. Speed affects the number of crashes as well as the crash severity. This is a consequence of laws of physics that has been supported by large amounts of empirical evidence from all over the world. If on a particular road the average speed increases, then the number of crashes will increase with serious crashes increasing to a larger extent than less serious crashes. To present the power function of Nilsson as a rule of thumb, this would mean that a 1% change in speed results approximately in 2% change in injury crash frequency, 3% change in severe crash frequency, and 4% change in fatal crash frequency.

Over the years, additional evidence has helped to fine-tune and specify the percentage change in crashes resulting from a change in speed. The most recent data including more low speed urban roads suggest that the initial speed has to be taken into account when quantifying the relationship between changes in average speed and crash frequency. A specific percentage change in speed appears to have a larger effect if the initial speed is higher, suggesting that speed-crash relationship can be better described by an exponential model than by a power model. Reformulation of the Nilsson general rule of thumb would result in different rules of thumb for different speed categories as indicatively presented in Table 2.4. Additional data will help to consolidate these recent insights. The case studies in this report are a first important step towards this. The differences between the power model and the exponential model are rather small and the resulting conclusions are very similar. So, either model can be used to estimate the expected change in crashes following a change in mean speed.

Table 2.4. **Indicative expected change in crash frequency following a 5 km/h reduction in average speed on a road for different crash severities according to an exponential model.**

Initial speed stated in parentheses

	Urban roads (50→ 45km/h)	Rural roads (80→75km/h)	Motorways (120→115km/h)
All injury crashes	-15%	-16%	-16%
Serious injury crashes	-26%	-26%	-26%
Fatal crashes	-28%	-28%	-28%

Source: based on Elvik, 2009 and 2013

In addition to average speed on a road, differences in speed between vehicles also have an effect on crash frequency. The larger the differences, the higher the crash rate. In general, higher speeds result in more homogeneous speeds. Available data do not yet allow this relationship to be quantified. Further research into this aspect would need to have access to more disaggregated speed data than are available in the case studies reported here.

Bibliography

Aarts, L. & van Schagen, I. (2006). Driving speed and the risk of road crashes: a review. Accident Analysis and Prevention, 38, 215-224.

Cameron, M. H. & Elvik, R. (2010). Nilsson's Power Model connecting speed and road trauma: Applicability by road type and alternative models for urban roads. Accident Analysis and Prevention, 42, 1908-1915.

ECMT (2006), *Speed Management*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789282103784-en

Elvik, R. (2014). Fart og trafikksikkerhet. Nye modeller. Rapport 1296. Oslo, Transportøkonomisk institutt.

Elvik, R. (2013). A re-parameterisation of the Power Model of the relationship between the speed of traffic and the number of accidents and accident victims. Accident Analysis and Prevention, 50, 854-860.

Elvik, R. (2011). Public policy. Chapter 33 in Porter, B. (Ed). The Handbook of Traffic Psychology, 471-483. Amsterdam, Elsevier.

Elvik, R. (2009). The Power Model of the relationship between speed and road safety: update and new analyses. TØI Report ; 1034/2009. Oslo, Institute of Transport Economics TØI.

Elvik, R., Christensen, P. & Amundsen, A. (2004). Speed and road accidents. An evaluation of the Power Model. TØI report 740/2004. Institute of Transport Economics TOI, Oslo.

Garber, N. J. & Gadiraju, R. (1989). Factors affecting speed variance and its influence on accidents. 1989-01-01 1213. Transportation Research Record , Washington D.C.

Kloeden, C. N., McLean, A. J. & Glonek, G. (2002). Reanalysis of travelling speed and the rate of crash involvement in Adelaide South Australia. Report No. CR 207. Australian Transport Safety Bureau ATSB, Civic Square, ACT.

Kloeden, C. N., McLean, A. J., Moore, V. M. & Ponte, G. (1997). Travelling speed and the rate of crash involvement. Volume 1: findings. Report No. CR 172. Federal Office of Road Safety FORS, Canberra.

Kloeden, C. N., Ponte, G. & McLean, A. J. (2001). Travelling speed and the rate of crash involvement on rural roads. Report No. CR 204. Australian Transport Safety Bureau ATSB, Civic Square, ACT.

Kröyer. H. R. G., Jonsson, T., Varhelyi, A. (2014). Relative fatality risk curve to describe the effect of change in the impact speed on fatality risk of pedestrians struck by a motor vehicle. Accident Analysis and Prevention, 62, 143-152.

Nilsson, G. (2004). Traffic safety dimensions and the power model to describe the effect of speed on safety. Bulletin 221, Lund Institute of Technology, Lund.

Nilsson, G. (1982). The effects of speed limits on traffic crashes in Sweden. In: Proceedings of the international symposium on the effects of speed limits on traffic crashes and fuel consumption, Dublin.

Rosén, E., Stigson, H. & Sander, U. (2011). Literature review of pedestrian fatality risk as a function of car impact speed. Accident Analysis and Prevention, vol. 43, nr. 1, p. 25-33.

Schagen, I. van & Sagberg, F. (2012) The potential benefits of Naturalistic Driving for road safety research: Theoretical and empirical considerations and challenges for the future. Procedia - Social and Behavioral Sciences, Vol. 48, p. 692-701

Solomon, D. (1964). Crashes on main rural highways related to speed, driver and vehicle. Bureau of Public Roads, U.S. Department of Commerce. United States Government Printing Office, Washington, D.C.

SWOV (2012) Headway times and road safety. Factsheet December 2012. The Hague, SWOV Institute for Road Safety Research.

Taylor, M. C., Lynam, D. A. & Baruya, A. (2000). The effects of drivers' speed on the frequency of road accidents. TRL Report, No. 421. Transport Research Laboratory TRL, Crowthorne, Berkshire.

TRB (1998). Managing speed; review of current practice for setting and enforcing speed limits. Special report 254. Transportation Research Board (TRB). National Academy Press, Washington, DC.

Note

[1] A Naturalistic Driving study can be defined as “A study undertaken to provide insight into driver behaviour during every day trips by recording details of the driver, the vehicle and the surroundings through unobtrusive data gathering equipment and without experimental control” (Van Schagen & Sagberg, 2012).

Chapter 3. Case studies

This chapter describes the eleven case studies of recent experiences regarding either a change of speed limit or a wide scale implementation of automatic speed enforcement. For each case study, it summarises the evaluations that have been conducted on the impact of these measures on speed and crash occurrence.

Introduction

The working group analysed eleven cases representing either a change in speed limit or a wide implementation of automatic speed enforcement. The main criteria to select the case studies was the availability of evaluation studies, including detailed data on mean speed, crashes and casualties before and after the measure was implemented. The 11 case studies are presented in a common format and include the following items:

- A short summary of the case study
- A description and motivation of the measure
- A description of the data used for the evaluation, to highlight possible limitation in the analysis
- A description of confounding factors that may also have an influence in the change in speed and crash occurrence (e.g. general development in speed, improvement of the infrastructure, change in enforcement practice)
- A summary of the evaluation studies regarding the impact of the measure on mean speed and crash change.

A more detailed description of all case studies can be found in the references mentioned in relation to each case. The eleven case studies are listed below (by type of measure and chronological order):

Changes in speed limits

- **Hungary:** Decrease in speed limit inside built-up areas (1993)
- **Hungary:** Increase in speed limit outside built-up areas (2001)
- **Australia:** Decrease in speed limits in urban areas (1997–2003)
- **Denmark:** Increase in speed limit on part of the motorway network (2004)
- **Norway:** Environmental speed limits on major roads in the city of Oslo (2004)
- **Sweden:** A fundamental change in speed limits on the rural roads (2008 and 2009)
- **Israel:** Increase in speed limits on selected rural roads and motorways (2011 and 2013)

Introduction of automated speed enforcement

- **France:** Implementation of nationwide automated speed enforcement (2003)
- **United States:** automated speed enforcement in 14 corridors in the city of Charlotte, North Carolina (2004)
- **Italy: S**peed section control, Safety TUTOR, on motorways (2005)
- **Austria:** Section control (2012)

Hungary: decrease of the speed limit in urban roads[1]

The speed limit in urban areas changed from 60 km/h to 50 km/h on 1 March 1993. This measure, aimed at improving road safety, concerned 32 % of the state road network. Mean speeds decreased by 8 % and road fatalities decreased by 18 %.

Description and motivation of the measure

In Hungary, speed limit in urban areas decreased from 60 km/h to 50 km/h on 1 March 1993. The measure was implemented on all roads inside built-up areas, covering 32% of the whole state road network.

The decrease in speed limits in built up areas was motivated by the need to follow the European trend in terms of speed limit legislation and also by a strong recommendation by the World Bank to improve road safety inside built-up areas. The implementation was not part of a road safety plan.

Description of the data

- Speed data

Data on average speed were collected one year before and three years after the measure. Speed measurements concerned free speeds and were carried out at 24 different locations, representative of the urban road network.

- Crash data

The main measure studied in the evaluation was the number of road fatalities.

Confounding factors

- Speed

Regarding speed there were no confounding factors. The changes in average speed were not attributed to other measures.

- Crashes

A control group was selected to correct the confounding factors regarding crashes (general decreasing trend in the number of fatalities, introduction of other road safety measures at the same time outside built-up areas.)

Results

The average speed was 57 km/h in 1992, before the measure was implemented and 52.5 km/h immediately after the introduction of the new limit in April 1993. In March 1994, the average speed was recorded as 51.5 km/h. The decrease of the speed limit from 60 km/h to 50 km/h inside built up areas proved to be an effective road safety measure in Hungary. The greatest effect was achieved in the short run, which – along with other factors – was due to an intensive publicity campaign and police enforcement accompanying the introduction. The effect of the measure has been analysed by Holló (1999) and is illustrated in Table 3.1 below.

Table 3.1. **Impact of the decrease in speed limit**

	INTERVENTION ⇩		
Number of people killed in road accidents	"Before"-period: (01/03/1990-28/02/1993) [a]	"After"-period: (01/03/1993-29/02/1996) [b]	[b-a] / [a]
Test group (roads inside built up areas)	3,106	1,947	-37.3%
Control group (secondary roads outside built up areas)	1,181	905	-23.4%
Total	**4,287**	**2,852**	

χ^2 with 1 degree of freedom = 14.39 $p < 0.001$

Source: Hollo (1999)

Overall, a 37.7% decrease in the number of road fatalities was observed in roads inside built up areas. During the same period, the number of fatalities decreased by 23.4% on the "control group" roads (secondary roads outside built up areas). Taking into account the confounding factors, it is calculated[2] that the decrease of the speed limit from 60 km/h to 50 km/h inside built up areas reduced the number of crash deaths in the "after" period by 18.2%.

Table 3.2. **Impact of the reduction in speed limits**

Mean Speed			Number of fatalities			Reduction of fatalities due to other effects (trends, policy context, confounding factors)	Net effect of speed measures after correction for confounding factors
Before	After	% change	Before	After	% change		
57 km/h	52,5 km/h	-7,8%	3106	1947	-37,3%	-23,4%	-18,2%

Bibliography

More information can be found in the following references.

Holló, P. (2006), Impact of changes in speed limits in Hungary. 3rd IRTAD Conference on Road Traffic Accident Data – Improved Data for Better Safety. Brno, the Czech Republic 26-28 November 2006

Holló, P. (2006), Introduction of a 50 km/h speed limit in urban areas in Hungary, in: A methodological approach to national road safety policies, ETSC, Brussels, 2006, chapter 3.5., pp. 35-36.

Holló, P. (2006), Experience in Hungary with changes in speed limits, in: Speed management, ECMT, Paris, 2006, box 5.3., pp. 101-102.

Holló, P. (1999), Impact analysis of road safety measures with special emphasis on the methodology of international comparison. Hungarian Academy of Sciences, Budapest,

Mocsári, T. (2012), A gépjárművek sebességének hatása közúti közlekedés biztonságára (Effects of cars's speed on road safety), PhD thesis, Széchenyi István University, Győr, 2012

Mocsári, T. (2004), The driver's speed choice affecting parameters, „On safe roads in the XXIst century" conference, 25-27 October 2004, Budapest, Hungary.

Szilháti, S. (1994), Forgalomtechnikai eszközök és beavatkozások minősítési módszereinek fejlesztése. Sebességmérések értékelése. (Development of qualification methods of traffic engineering measures and interventions. Evaluation of speed measurements), report Nr.: 213-004-1-3, KTI Institute for Transport Sciences, 1994, Budapest.

Hungary: Increase of the speed limits in rural roads[3]

As a result of a political decision, in May 2001 the speed limits outside built-up areas were increased from 120 km/h to 130 km/h on motorways, from 100 km/h to 110 km/h on motor roads (semi-motorways) and from 80 km/h to 90 km/h on rural roads. The evaluation concerns the roads where the speed limit changed from 80 km/h to 90 km/h. On these roads, the mean speed increased by 2.5% and fatalities increased by 13%.

Description and motivation of the measure

On 1 May 2001, the speed limits outside built-up areas were increased from 120 km/h to 130 km/h on motorways, from 100 km/h to 110 km/h on motor roads (semi-motorways) and from 80 km/h to 90 km/h on rural roads. The changes concerned all roads outside built-up areas, covering 68% of the whole state road network.

The decision to increase the speed limits was part of a political process and was taken against the expert opinion of KTI. It led to modification of the Hungarian Highway Code

Description of the data

- Speed data

Speed measurements were only made on rural roads where the speed limit was increased from 80 to 90 km/h and which are considered as the most sensitive from a road safety point of view because they are in general more risky roads.

- Crash data

The main measure studied in the evaluation was the number of road fatalities.

Confounding factors

- Speed

The authors' opinion was that there were no confounding factors regarding speed, i.e. there is no other factor that could explain the increase in speed.

- Crashes

With regard to crashes, the ARIMA model and the seasonal decomposition method (Brockwell and Davies, 2002 and Makridakis et al., 1998) were used to compensate the confounding effects of extreme weather conditions and to differentiate between predicted and observed number of fatalities, in other words to analyse and isolate the effects of intervention.

Results

Between the period before (i.e. before 1 May 2001) and after the Highway Code's amendment (2004) the average free speed of motor vehicles increased by 2.1 km/h on rural roads and by 0.7 km/h inside built up areas.

It is remarkable that, although the speed limit increase only concerned roads outside built up areas, a sustained and explicit increase was also observed on roads in built-up areas.

The negative impact on road safety was experienced immediately after the measure was introduced (2002). The number of fatalities increased practically to the level of the year 1995.

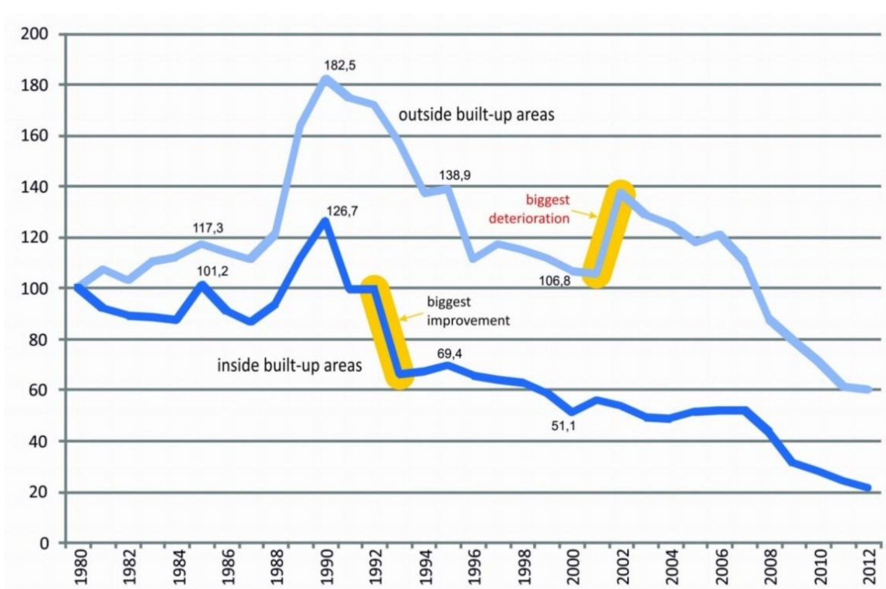
Table 3.3. **Impact of the increase of speed limits on fatalities and speed on rural roads**

	Mean speed (km/h)			Number of fatalities			Change in fatalities due confounding factors	Net effect of speed measures after correction for confounding factors
	Before	After	% change	Before 1 May 2000-30 Apr. 2001	After 1 May 2001-30 Apr.2002	% change		
Rural roads	78.0	80.1	+2.6%	608	735	+20.9%	+ 6.6 %	+13.4%

Other information

For both of the Hungarian case studies, the biggest changes in the number of fatalities could be experienced at the time of the speed limit changes, see Figure 3.1.

Figure 3.1. **Time series of the number of people killed in road traffic crashes inside and outside built-up areas**



Bibliography

More information can be found in the following references.

Brockwell, P.J. and Davies, R.A. (2002) Introduction to time series and forecasting. Springer- Verlag, New York.

Holló, P. (1999), Impact analysis of road safety measures with special emphasis on the methodology of international comparison. Hungarian Academy of Sciences, Budapest, 1999.

Holló, P. (2006), Impact of changes in speed limits in Hungary. 3rd IRTAD Conference Road Traffic Accident Data – Improved Data for Better Safety. Brno, the Czech Republic 26-28 November 2006

Holló, P. (2006), Experience in Hungary with changes in speed limits, in: Speed management, ECMT, Paris, 2006, box 5.3., pp. 101-102.

Olivér Zsigmond; Dr.habil Péter Holló (2004), Practical forecast experiences concerning the road safety impact analysis of increased speed limits On Safe Roads in the XXIst Century 3rd Conference, 25-27 October, 2004, Budapest, Hungary Proceedings, Meeting Budapest Ltd. (CD-ROM)

Makridakis, S., Wheelwright, S. C. and Hyndman, R.J. (1998), Forecasting; Methods and applications. John Wiley & Son, Inc.

Mocsári, T. (2004), The driver’s speed choice affecting parameters, „On safe roads in the XXI. century” conference, 25-27 October 2004, Budapest, Hungary.

Mocsári, T. (2012), A gépjárművek sebességének hatása közúti közlekedés biztonságára (Effects of cars’s speed on road safety), PhD thesis, Széchenyi István University, Győr, 2012.

Australia: Reduction of the speed limit in urban areas[4]

Between 1997 and 2003, all Australian jurisdictions (with the exception of the Northern Territory) lowered their urban default speed limit from 60 km/h to 50 km/h. The aim was to increase traffic safety.

The evaluation presented here mainly concerns results from New South Wales. The results showed that the mean speed decreased by 0.5 km/h, while the total number of crashes decreased by 25.3% and the number of persons injured by 22.3%.

Description and motivation of the measure

Between 1997 and 2003, all Australian jurisdictions (with the exception of the Northern Territory, which retained a 60 km/h default urban limit) lowered their urban default speed limit from 60 km/h to 50 km/h. The purpose of the change was to reduce the incidence and severity of road crashes, including those involving vulnerable road users (Horeau et al. 2006). The change mainly concerned residential streets, with higher speed limits retained on urban arterial roads.

Description of the data

Evaluations were undertaken in the five Australian jurisdictions affected by the change (Victoria, New South Wales, Western Australia, South Australia and Queensland). They were conducted independently of one another as each jurisdiction changed its limits at a different time.

All the studies used a quasi-experimental approach where the after speeds were compared with the before speeds at treatment sites and control sites. Although all five studies followed a similar approach, there are differences in the numbers of sites, the selection of control sites, and the treatment of crashes and injuries. Some studies were based on extensive trials of 50 km/h zones, others were based on system-wide introduction of the 50 km/h limits.

The sections below are mainly based on the results of the New South Wales evaluation (Roads and Traffic Authority (RTA), 2000). In this instance, the change in speed limit was undertaken on a trial basis with a number of local government areas reducing their default speed limits, while others remained unchanged. References for the other evaluations are listed in more detail in the bibliography.

- Speed data

Speed survey data were collected in each of the 26 local government areas which participated in a trial of the 50 km/h speed limit and 26 matched control local government areas. These data were collected before and after the speed limit was changed (RTA, 2000).

- Crash data

The numbers of fatalities, injuries and crashes occurring on local streets were obtained for each of the treatment and control areas. Data were obtained for a three-year period before the introduction of the 50 km/h speed limit and a 21 months after period.

Confounding factors

All the studies used a quasi-experimental approach where the after speeds were compared with the before speeds at treatment sites and control sites. For crashes, a before and after analysis with a treatment and a control group to account for confounding factors was performed.

Results

The table below summarises the impact of the lower urban speed limits in the five Australian jurisdictions.

Table 3.4. **Summary of speed and crash changes resulting from lower urban speed limits in Australia**

Jurisdiction	Source	Mean speed reduction	Casualty crash reduction	Fatal crash reduction
New South Wales	Roads and Traffic Authority (2000)	0.5 km/h 0.9%	22%	45%*
Victoria	Horeau et al. (2006)	2–3 km/h*	12%	21%*
Queensland	Haworth et al. (2001) Walsh and Smith (1999)	6 km/h	N/A	18%
Western Australia	Horeau and Newstead (2004)	0.3 km/h (Perth) 3.0 km/h (regional centres)	21% (Perth) 16% (all crashes in regional centres)	N/A
South Australia	Kloeden et al. (2007)	3.8 km/h 2.1 km/h on unchanged arterials	23%	40%*

* Result is not statistically significant.

The more detailed information below concerns the New South Wales Evaluation.

- Speed

The aggregated speed survey data for the introduction of the 50 km/h urban speed limit are presented in Table 3.5. Prior to the introduction of the 50 km/h speed limit, the mean speed was 57.2 km/h, which reduced to 56.7 km/h. The proportion of vehicles exceeding 60 km/h reduced from 37.6% to 15.6%, and the proportion of vehicles travelling at more than 70 km/h reduced from 9.6% to 2.6%.

Table 3.5. **Aggregated speed survey data for 50 km/h speed limit introduction, New South Wales**

Time period	Mean speed km/h	Proportion of vehicles exceeding 60 km/h (%)			
		By 1-10 km/h	By 11-20 km/h	By21-30 km/h	By 31+ km/h
Before	57.2	28.0	8.1	1.5	0.0
After	56.7	13.0	2.6	0.4	0.0

- Road crashes and casualties

Log-linear analysis was applied to the crash and injury data. The number of crashes (both non-injury and injury) was reduced by 25.3% (statistically significant), the number of injury crashes was reduced by 22.3% (statistically significant) and the number of fatalities by 44.5% (not significant).

Table 3.6. **Impact of the lower urban speed limit on speed and injury crashes New South Wales**

	Mean speed Before	Mean speed After	% change	Change in crashes	Change in injuries	Change in fatalities
Reduction of the speed limit from 60 km/h to 50 km/h	57.2 km/h	56.7 km/h	-0.9%	-25.3% statistically significant	-22.3% statistically significant	-44.5% Not statistically significant

Other information

The New South Wales case study of urban speed limit reductions in five Australian States is an example and not necessarily typical for all five states. In New South Wales, the reduced limit was implemented by signage in residential streets (non-arterial roads) and the other States reduced their general urban speed limit to 50 km/h and in many cases signed their arterial roads at the former speed limit of 60 km/h. The results refer to the initial trial period at 26 local government areas in NSW, and might not be typical of effects when the signage was expanded to all residential streets (as was the case for other states). It can also be noted that the reductions in the proportions of vehicles exceeding 60, 70 and 80 km/h were all much more substantial than the reduction in the mean speed, suggesting that a different mechanism than a downward shift in the speed distribution was operating. This may be due to the atypical nature of the speed limit reduction in NSW and/or due to the likelihood that the signed residential streets were strongly enforced in the period. Gavin et al. (2011) presents comparisons of the effects on speeds and crashes associated with a 10 km/h limit reduction on a major rural highway and with the implementation of fixed speed cameras in NSW. They consider the congruence of the measured crash reductions with that expected by weighting the before and after speed distributions by Kloeden et al’s (2001, 2002) relative risk estimates.

Looking at severe crashes, the covert use of mobile speed cameras in Victoria, Australia, has been shown to be very effective in reducing injury crashes and fatal outcomes (Cameron and Delaney, 2008). Recent research has also shown that only 7% of injury crashes in Melbourne are now attributable to high-level speeding, compared with 24-34% in other Australian major cities where mobile cameras are operated less effectively (Cameron, 2015).

Bibliography

More information can be found in the following references.

Cameron, MH. (2015), "Estimating crashes attributable to low and high level speeding: Melbourne compared with Perth and urban Queensland". Journal of the Australasian College of Road Safety, Vol. 26, No. 3. http://acrs.org.au/wp-content/uploads/Journal_Vol-26_No3_Final_Web_Low-Res.pdf

Cameron, MH, and Delaney, A., (2008), "Speed enforcement - Effects, mechanisms, intensity and economic benefits of each mode of operation". Journal of the Australasian College of Road Safety, Vol. 19, No. 4.

Gavin A, Walker E, Fernandes R, Graham A, Job RFS, Sergeant J. (2011), 'Creation and validation of a tool to measure the real population risk of speeding'. Proceedings of the Australasian Road Safety Research, Policing and Education Conference.
http://acrs.org.au/files/arsrpe/Creation%20and%20validation%20of%20a%20broadly%20applicable%20tool%20to%20measure%20the%20real%20population%20risk%20of%20speeding.pdf

Haworth, N, Ungers, B, Vulcan, P & Corben, B (2001), Evaluation of a 50 km/h default urban speed limit for Australia, National Road Transport Commission, Melbourne, Vic.

Hoareau, E, Newstead, S & Cameron, M (2006), An evaluation of the default 50 km/h speed limit in Victoria, report no. 261, Monash University Accident Research Centre, Clayton, Vic.

Hoareau, E & Newstead, SV (2004), An evaluation of the default 50 km/h speed limits in Western Australia, report no. 230, Monash University Accident Research Centre, Clayton, Vic.

Kloeden, C, Woolley, J & McLean, J (2007), 'A follow up evaluation of the 50km/h default urban speed limit in South Australia', Road safety research, policing and education conference, 2007, Melbourne, Victoria, The Meeting Planners, Collingwood, Victoria.

Roads and Traffic Authority (2000), 50 km/h urban speed limit evaluation: summary report, RTA, Sydney, NSW.

Walsh, D & Smith, M (1999), 'Effective speed management: the next step forward: saving lives by decreasing speeds in local streets', Road safety research, policing, education conference, 2nd, 1999, Canberra, ACT, Australian Transport Safety Bureau, Canberra, ACT, pp. 685-94.

Denmark: Increase in the speed limit on the motorway network[5].

In Denmark, on 30 April 2004 the general speed limit on motorways was raised from 110 km/h to 130 km/h. In practice, it affected around half of the Danish motorway network. This was a political decision described as a trade-off between drivers' right to individual choice of speed on one side and road safety and environmental concerns on the other.

After implementation of the higher speed limit, the number of injury crashes and the number of personal injuries were significantly higher on the roads raised to 130 km/h than on the control roads. The mean speeds decreased markedly on all road types immediately after implementation of the new speed limit. The introduction of a demerit point system in 2006 had also an effect on mean speed.

Overall, during the entire study period, mean speed gradually increased significantly on all road types.

Description and motivation of the measure

On 30 April 2004, the general speed limit was raised on Danish motorways from 110 km/h to 130 km/h. In practice, this increase affected about half the Danish motorway network following a detailed assessment study on the entire motorway network (Fogh and Mathiasen 2003). Speed limits increased on motorways outside urban areas with the smallest traffic volumes. Thus, despite making up half of the motorway network length in 2002, these motorways supported only one third of the total motorway traffic volume.

The speed limit was raised as a result of a political decision that has been described as a trade-off between drivers' right to individual choice of speed on one side and road safety and environmental concerns on the other (Sørensen and Larsen 2013).

The analysis concerned 3 categories of roads:

- Motorways, where speed limit increased from 110 to 130 km/h (referred to as 130 roads)
- Motorways, where speed limit remained at 110 km/h (referred to as 110 roads)
- Motorways in the Copenhagen area, where speed limit remained at 110 km/h (referred to as Cph roads).

In the analysis, motorways within Greater Copenhagen area (Cph-roads) were separated from 110-roads, even though both types of motorways have speed limits of 110 km/h, because they are structurally different: Cph-roads have more exits per km than 110-roads and denser traffic. Both factors may influence mean speed. Motorways with a speed limit below 110 km/h as well as motorways with large construction works in the evaluation period (mainly in the Greater Copenhagen area) were excluded from the analysis.

Description of the data

- Speed

Mean speeds were recorded for passenger cars and vans only. The mean speed for free flow traffic was calculated each month for each road type. Speed measurements from congested periods were excluded from the analyses.

- Crashes

The analysis is based on police-recorded numbers of personal injury crashes and the number of people killed and injured.

Confounding factors

In the months up to the change in speed limit, some safety-related infrastructural improvements were carried out on the parts of the motorway network where the speed limit was raised subsequently. On the 110-roads, speed limit signs were posted as from 30 April 2004. In addition, speeding fines were raised. Speeding enforcement by the police was intensified, as was the media coverage. Changes were implemented that apply to the 110-roads as well as to the 130-roads.

Results

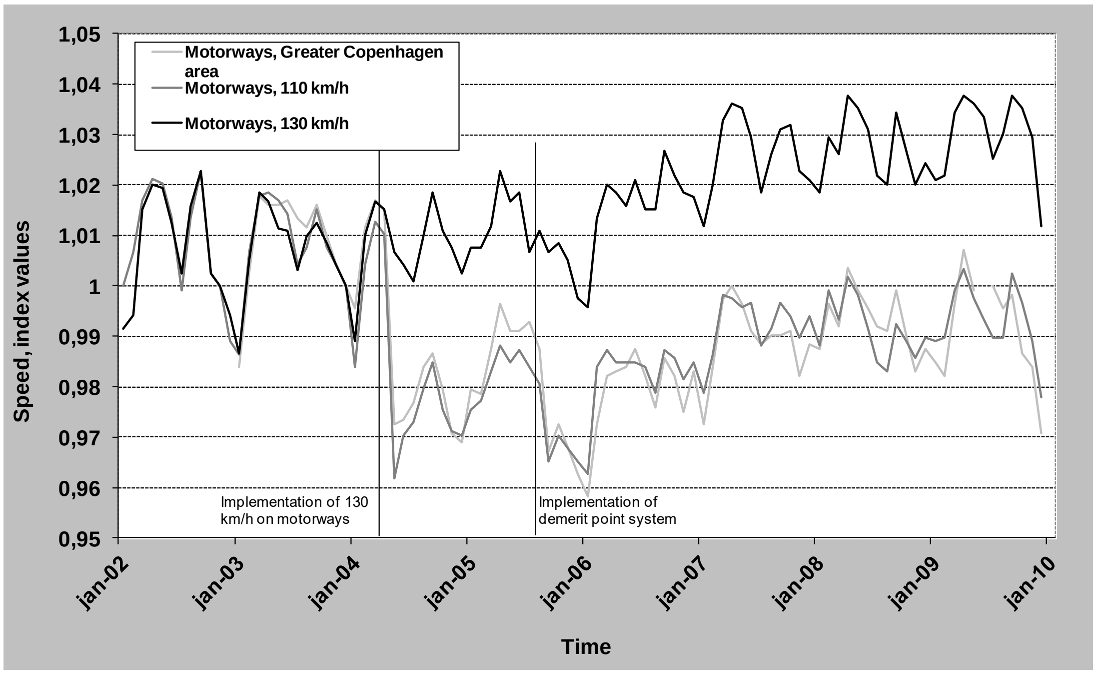
- Speed and speed distribution

Figure 3.2 shows the mean speed development (indexed values). The three road types have different mean speed levels; and the 110- and 130-roads have higher mean speeds than Cph-roads. The initial speeds were as follows: 110-roads: 118.2 km/h (January 2002); 130-roads: 118.1 km/h (January 2002); Cph-roads: 110.7 km/h (January 2003).

During the entire study period, mean speed gradually increased significantly on each road type. On all road types, there were considerable seasonal fluctuations in mean speed, significantly lower speed in winter compared to other seasons (Hels et al. unpublished). Mean speed on all road types decreased abruptly at the implementation of the new speed limit. The overall change in mean speed from the before period to the initial period was significant. Mean speed decreased again on the 110-roads and Cph-roads following the implementation of the demerit point system (Figure 3.2). On the 130-roads, mean speed increased slightly. For further details of the results, see Hels et al. (unpublished).

Figure 3.2. **Development in mean speed on the 3 road categories.**

Index values on the y-axis; for each road type December 2003-value has index 1.



- Changes in crashes

Changes in the number of crashes were compared with changes on a control group of rural roads, which were not affected by the new speed limit (Hels et al. unpublished). For 110-roads, the yearly number of crashes decreased in both study periods (Table 3.7). For 130-roads, however, the number of crashes increased in the first after period followed by a decrease in the second after period. The number of personal injury crashes on the 130-roads showed a significant increase relative to the control group (rural roads), both in the first and second after period.

The results indicate that after the implementation of the higher speed limit, the number of injury crashes showed a significant increase on the 130-roads, but not on the 110-roads, compared to the control roads.

Table 3.7. **Yearly rates of personal injury crashes.**

Personal injury accidents per year (one or more road user injured and/or killed)					
	130 roads	P	110 roads (incl. Cph-roads)	P	Rural roads (country roads and highways, not motorways)
Before (Jan 2002 – Apr 2004)	112		154		2485
After1 (Sept 2004 – Aug 2005)	125		107		2053
Change from Before to After1 (compared to rural roads)	12% (+36%)	0.008	-30% (-16%)	0.14	-17%
After2 (Sept 2005 – Aug 2009)	103		103		1904
Change from Before to After2 (compared to rural roads)	-8% (+21%)	0.028	-33% (-12%)	0.09	-23%

χ^2-tests have been carried out on total numbers for the periods, not on yearly numbers.
* Significant at the 0.05-level.

Bibliography

More information can be found in the following references.

Andersen, B., Carstensen, G., Christensen, L., Fosgerau, M., Greibe, P., Larsen, L., Lund, H.(2002), 130 km/t på motorveje – konsekvenser af ændret hastighedsgrænse (130 km/h on motorways – implications of changed speed limit, in Danish). DTF Note no. 4, 2002. 44 pp.

Hels, T., Kristensen, N.B., Reiff, L.K., Foldager, I., Hemdorff, S., Lund, H., Abele, L. (unpublished manuscript): Consequences on raising the speed limit on motorways in Denmark: Speed and accidents.

Reiff, L.K., Foldager, I., Hels, T., Hemdorff, S., Lund, H. (2008), 130 km/t på motorveje. Virkning på faktisk hastighed, uheld og miljøbelastning (130 km/h on motorways – implications on speed, accidents and environment, in Danish with an English summary). Road Directorate report no. 337. 23 pp.

Norway: Introduction of environmental speed limits[6]

> In 2004, an environmental lower speed limit was introduced on 3 main urban roads in the city of Oslo. The speed limit was decreased from 80 to 60 km/h during the winter season in 2004-2007 between November and March. On the roads with a reduced speed limit, mean speeds decreased by 7.5%, from 76 km/h to 71 km/h. Injury crashes decreased by 28%. The measure was given up in 2011, after it had been found not to be legally founded.

Description and motivation of the measure

In Norway, environmental speed limits to reduce air pollution were introduced in 2004 during the winter season. The speed limit was reduced from 80 km/h to 60 km/h on three major urban roads of the city of Oslo – totalling a length of 28 km. These roads were designed as freeways with 4 to 6 lanes and median barrier and passed by large residential areas. The reduced speed limit was in force from November 1 to March 31. The decision to reduce speed limit was taken by the Municipality of Oslo and was motivated by environmental reasons to reduce the spread of micro-particles torn off the road surface by studded tyres.

The reduced speed limit was challenged on legal grounds and given up in 2011. Legal experts concluded that the law did not permit the use of such speed limits. Work is going on to change the law to permit re-introduction of the speed limits.

Description of data

- Speed data

All three roads had permanent traffic counting stations that monitored speed continuously. It measured the mean speed of traffic, including all traffic during 24 hours every day.

- Crash data

The number of crashes was recorded for three years before and three years after the introduction of the lower speed limit. Only injury crashes were recorded.

Confounding factors

- Speed

Speed data were not corrected for any confounding factors. One could argue that only speeds outside rush hours should be used, because the mean speed of traffic during rush hours is considerably below the speed limit on all roads. However, speed data applying only outside rush hours were not available.

- Crashes

The study applied the empirical Bayes method and controlled for changes in traffic volume, seasonal variation in crash counts, long term trends in the total number of crashes and regression-to-the-mean. Regression-to-the-mean is the tendency for the number of accidents to go down if a randomly high number occurred, or to go up if a randomly low number occurred. Details of the method are given in Elvik (2013).

Results

The results are summarised in the table below. While the main tendency of the results makes sense, it is not clear that the entire reduction in the number of crashes was caused by the speed reduction. Other factors may also have contributed, in addition to those the study controlled for.

Table 3.8. **Effect of the reduced speed limit on speed, crashes and fatalities**

	Mean speed (km/h)			Number of injury crashes			Change of injury crashes due to confounding factors (trends, policy context, etc.)	Net effect of speed measures after correction for confounding factors
	Before	After	% change	Before	After	% change		
Road 4	76.7	70.2	-8.5%	78	49	-37%	-19%	-22%
Ring 3	76.3	69.9	-8.4%	83	62	-25%	+6%	-29%
European road 18	76.0	72.9	-4.0%	22	16	-27%	+14%	-36%
All	76.3	70.6	-7.5%	183	127	-31%	-4%	-28%

Other information

Repeated speed measurements on one of the roads indicate that the effects of the measure declined over time, mainly because there was no enforcement. The police were opposed to the speed limits and in the end succeeded in having them repealed on legal grounds.

Bibliography

More information can be found in the following reference.

Elvik, R. (2013), A before–after study of the effects on safety of environmental speed limits in the city of Oslo, Norway. Safety Science 55 (2013) 10–16.

Sweden: Increase and decrease of speed limits in 2008 and 2009[7]

The entire speed limit system of Sweden was reformed in 2008. A new set of limits, i.e., 80, 100, and 120 km/h, was introduced on rural roads to complement the previous limits of 70, 90, and 110 km/h. As a consequence, the speed limit was reduced on many rural roads from 90 km/h to 80 km/h and increased on some motorways with high standards from 110 km/h to 120 km/h. The motivation was to adapt speed limits to the safety classification of each road, but also a balance between environment and mobility needs. On rural roads where the speed limit was reduced from 90 – 80 km/h, the mean speed decreased by 3.1 km/h, the number of fatalities decreased by 41% and the number of seriously injured did not change significantly. On motorways where the limit was increased, the mean speed increased by 3.4 km/h, number of seriously injured increased by 15 seriously injured per year and no significant change was seen in the number of fatalities

Description and motivation of the measure

In 2008, the Swedish government decided to introduce a new set of limits. On rural roads, 80, 100, and 120 km/h, were introduced to complement the previous limits of 70, 90, and 110 km/h. The Swedish Transport Administration performed an in-depth review and took decisions on changed limits.

The long-term vision was that speed limits should be adapted to the safety classification of each road and be in line with the concept of Vision Zero. A total of approximately 20 500 km of roads, corresponding to 21% of the length of all state roads in Sweden, were assigned new speed limits. The main group of roads with new speed limits was rural two-lane roads, where the speed limit was reduced from 90 to 80 km/h. This group accounted for more than 60% by length of the roads with changed speed limits. It was predominantly roads with a low safety standard and inadequate road shoulders that were selected for the introduction of reduced speed limits, while roads with a good traffic safety standard were selected for increased speed limits. In addition, roads important to local economic activity, transport, and commuting were assigned higher speed limits than were roads less important from a local economic point of view.

The motives behind the speed limit changes were based on a government commission in 2004 whereby the Swedish Road Administration (SRA) were to present a strategy for gradual adjustment of the speed limits in line with the concept of Vision Zero but also consider accessibility requirements, good environment, regional development and a gender equal transport system. SRA was also commissioned within the framework of this approach to propose a new speed limit system or changes in the current speed limit system that had the possibility within a balanced fulfilment of the transport policy goals to contribute to the interim road safety targets.

Description of data

- Speed data

The effects on speed were mainly evaluated using a sample survey in which vehicle speed was measured at a random sample of road sites. Speed measurements concerned passenger cars, trucks without trailers and trucks with trailers. Speeds of all cars were included in the analyses (not only free speeds). Based on the sample survey, space-mean speed, 85th percentile speed and proportion of speed violations were estimated.

- Crash data

The traffic safety evaluation was based on the empirical outcome in terms of crashes reported by the police (the Swedish crash data base STRADA).

Confounding factors

- Policy context/enforcement activities/infrastructure measures

During the introduction of new speed limit systems and the study period there were no additional enforcement activities, nor any major changes in the infrastructure. In the evaluation, only roads that were not affected by other measures than the speed limit changes were considered.

- Speed

To control for confounding factors, approximately 20 fixed sites on roads with unchanged speed limit were used as control sites for speed measurements.

- Crashes

The method used is a before and after study with control group and corrections for changes in traffic volumes and the general road safety trend were made. Roads with new measures (i.e. speed cameras) introduced during the before or after period were excluded in the analyses.

Results

- Speed

The speed limit changes for all vehicles are presented in Table 3.9. Speed changes for different vehicle types (cars, HGV´s) are presented in Vadeby et al. (2014). On motorways, where the speed limit increased from 110 to 120 km/h, the mean speeds increased by 3.4 km/h. On rural roads where the speed limit decreased from 90 to 80 km/h, the mean speed decreased by 3.1 km/h. The changes are significantly different from zero. No significant change in mean speed was found on roads where the speed limits increased from 70 to 80 km/h (0.2 ± 1.9).

Table 3.9. **Space-mean speed of all vehicles before and after the speed limit changes, 95 % confidence intervals.**

Group	Space-mean speed, before (km/h)	Space-mean speed, after (km/h)	Change, before–after (km/h)
2+1 roads, decrease from 110 to 100 km/h	100.5	98.4	-2.1 ± 0.5
Rural roads, decrease from 110 to 100 km/h	98.4	96.7	-1.7 ± 0.7
Rural roads, decrease from 90 to 80 km/h	87.7	84.7	-3.1 ± 0.9
Rural roads, decrease from 90 to 70 km/	82,6	79.4	-3.1 ± 1.1
Motorways, increase from 110 to 120 km/h	111.9	115.3	3.4 ± 0.5
2+1 roads, increase from 90 to100 km/h	92.9	95.9	3.1 ± 0.5
Rural roads , increase from 70 to 80 km/h	84.6	84.8	0.2 ± 1.9

*Significant at 0.05 level

- Road crashes and casualties

The empirical results show that in total about 17 lives per year, about 6 % of the previous number of fatalities, have been saved on the road network with changed speed limits while no significant change was seen for the seriously injured (Table 3.10). Lives have been saved predominantly on rural roads where speed limits were reduced from 90 to 80 km/h. On rural roads with speed limit reduced from 90 – 80 km/h, the number of fatalities decreased by 41% and about 14 lives per year have been saved. No significant changes were seen for the seriously injured. On motorways with a speed limit increased to 120 km/h, the number of seriously injured increased by about 15 per year, but the number of deaths does not yet show whether this number has changed because the number of fatalities in the after-period is so far just 6. This can be compared to the total number of fatalities and seriously injured per annum in Sweden, i.e., approximately 300 and 3 000, respectively.

Table 3.10. **Empirical change of fatalities and KSI (killed and seriously injured) per year based on crashes from STRADA.**

Results corrected for confounding factors

	Empirical change (%) Not corrected for confounding factors		Relative empirical change (%). Corrected for confounding factors. 95 % confidence intervals.		Empirical change number per year. Corrected for confounding factors.	
Group	KSI	Fatalities	KSI	Fatalities	KSI	Fatalities
2+1 roads, decrease from 110 to 100 km/h (at grade separated)	-45	-71	-38 ± 27	-58 ± 71	-5.1	-0.6
2+1 roads, decrease from 110 to 100 km/h	-65	-64	-60 ± 18	-48 ± 65	-12.2	-1.0
Rural roads, decrease from 110 to 100 km/h	-24	-36	5 ± 28	-19 ± 64	1.3	-0.6
Rural roads, decrease from 90 to 80 km/h	-33	-53	-7 ± 9	-41 ± 15	-12.6	-14.2
Rural roads, decrease from 90 to 70 km/h	-13	-17	21 ± 41	2 ± 78	1.8	0.0
Motorways, increase from 110 to 120 km/h	55	-57	128 ± 61	-20 ± 76	15.5	-0.3
2+1 roads, increase from 90 to100 km/h	-2	-40	12 ± 34	99 ± 276	2.7	0.4
Rural roads , increase from 70 to 80 km/h	-29	-2	-4 ± 29	44 ± 137	-0.8	0.6

Bibliography

More information can be found in the following references.

Vadeby, A., Björketun, U. (2015), New speed limits in Sweden – long term traffic safety effects. Report 860 - 2015. VTI. Linköping. In Swedish, English summary.

Vadeby, A., Forsman, Å. (2014), Evaluation of New Speed Limits in Sweden: A Sample Survey. Traffic Injury Prevention, Vol 15(8), pp 778-785.

Vadeby, A., Forsman, Å. (2014), Speed distribution and traffic safety measures. Paper for TRA, Paris France 14-17 April, 2014.

Vadeby, A., Forsman, Å. (2013), Speed management in Sweden: evaluation of a new speed limit system. In: Proceedings of the 16th International Conference on Road Safety on Four Continents, Beijing, China, 15 –17 May, 2013.

Vadeby, A., Forsman, Å., Carlsson, A., Björketun, U., Yahya, M-R. (2012), Evaluation of the new speed limits – traffic safety and environmental effects. VTI notat 34-2012. VTI. Linköping. In Swedish, English summary.

Vadeby, A. and Forsman, Å. (2012), Evaluation of the new speed limits – the effect on vehicle speeds, Phase 2. VTI notat 16-2012. VTI. Linköping. In Swedish, English summary.

Vadeby, A. and Forsman, Å. (2010), Evaluation of the new speed limits – the effect on vehicle speeds, Phase 1. VTI notat 14-2010. VTI. Linköping. In Swedish, English summary.

Vadeby, A. and Yahya, M-R. (2012), Speed of motorcyclists – levels and changes on roads with new speed limits. VTI rapport 760-2012. VTI. Linköping. In Swedish, English summary.

Israel: Increase of speed limits on high-level roads in 2011 and 2013 [8]

In 2011 and then in 2013 speed limits were increased on selected sections of high-level non-urban roads: from 100 to 110 km/h on motorways, and from 90 to 100 km/h on dual-carriageway roads with interchanges, i.e. with all junctions grade-separated.

The main motivation was to achieve a balance between safety and mobility needs on the road network.

The results showed that the 2011 change in the speed limits was not associated with an increase in the mean speeds or in the number of injury crashes, whereas an increase was observed in severe crashes (serious and fatal together). However, following the 2013 change, the mean speeds increased by 2.8-6.8 km/h, while in total injury crashes and, particularly, in severe crashes, increases were observed, with mean changes of 11% and 39%, respectively. None of the observed changes in numbers of crashes was found to be statistically significant

Description and motivation of the measure

Until 2010 and according to the traffic regulation in Israel, the speed limits on non-urban roads were 90 km/h on dual-carriageway roads and 110 km/h on motorways. However, on the majority of motorways the actual speed limits were lower.

In 2011, the Ministry of Transport introduced two changes:

- a new rural road type was defined - dual-carriageway roads with interchanges only, i.e. with all junctions grade-separated (DCI) and with a speed limit of 100 km/h;
- actual speed limits were increased on selected sections of motorways, from 100 km/h to 110 km/h, and on DCI roads, from 90 km/h to 100 km/h.

At the beginning of 2013, speed limits were raised again on selected sections of both motorways and DCI roads. Table 3.11 summarizes the changes applied on various road types. In total, the speed limits were raised on about 176 km of roads (4% of the rural road network).

Typically, higher speed limits were introduced on road sections with better road infrastructure design standards, carrying the highest traffic volumes and representing the main traffic arterials of the country.

Table 3.11. **Higher speed limits introduced in 2011 and 2013**

Year of change	Road type	Change in speed limit, km/h	Total length of roads with a speed limit change
2011	Motorways	100 → 110 km/h	39.8 km
2011	DCI	90 → 100 km/h	54.5 km
2013	Motorways and DCI	100 → 110 km/h	60.0 km
2013	DCI	90 → 100 km/h	21.6 km

The main motivation which led to speed limit changes was to have a better adaptation between the quality of the infrastructure and the authorised speeds. It came from a reconsideration of the target speeds on various road types, to reach a balance between the mobility and safety needs on the road network, in general, and to promote the ‘self-explaining roads’ approach.

The previous speed limits were introduced in Israel about two decades ago, in 1993. Since then, substantial road infrastructure improvements have been carried out on the road network. In addition, the speed limit of 110 km/h was applied on one motorway only (the Cross-Israeli toll road), whereas on other motorways the actual speed limits were lower. The argument was that speed limits which are better fitted to the road infrastructure would be more credible to the drivers.

Description of data

- Speed data

Monitoring of changes in the actual travel speeds was carried out using the data collected by annual national speed surveys. Free-flow speed indicators were estimated based on the speed measurements performed by means of pneumatic traffic counters which are left on site for 24 hours. For the study, the survey sites belonging to the motorways and the DCI roads were selected and subdivided into two groups: those where the speed limits were raised (treatment sites) and those where the speed limits were not changed (comparison sites). This was done twice, once in 2011 and once in 2013, giving two pairs of groups of sites.

- Crash data

The number of crashes was collected from the police records for three years before and three years after the change of the speed limits. For some roads, the pre-defined three-year periods were reduced to exclude the periods of major road-works or to separate the impact of the first and the second increase in the speed limits. Total numbers of injury crashes and numbers of severe crashes (serious + fatal) were examined.

Confounding factors

- Speed

To control for confounding factors, comparison sites were considered. The speed indicators were estimated for free-flow hours only.

- Crashes

The study applied the empirical Bayes evaluation controlling for changes in traffic volume, long-term trends in the total number of crashes (by means of using of comparison-group sites) and regression-to-the-mean (RTM). The evaluation considered short-term crash data thus an RTM effect was suspected. To control for it, long-term expected numbers of crashes, at each site, were estimated as a weighted mean of the model-predicted number and the recorded number of crashes (as common in the empirical Bayes evaluation).

- Impact of other activities

During the study periods there were no additional enforcement activities, nor any major changes in the infrastructure, on the study sections.

Results

- Speed

Following the speed limit changes in 2011, contrary to the expectations (and accounting for the mean travel speed changes at the comparison sites), a decrease in the actual travel speeds was observed: -2.6 km/h for motorways (mean speed before 107.2 km/h), -7.0 km/h for the DCI roads (mean speed before 110.6 km/h). In 2013, following the increased speed limits, travel speeds increased. Accounting for a slight decrease in the mean travel speeds of the comparison sites, the net increase in the actual travel speeds was: +2.8 km/h for motorways (mean speed before 107.8 km/h) and +6.8 km/h for the DCI roads (mean speed before 95.9 km/h).

- Crashes

Table 3.12 presents the changes estimated for numbers of total injury and severe crashes at the treatment-group versus comparison-group sites as well as the changes in mean speeds. The changes in numbers of crashes are not significant (see the length of the confidence intervals in Table 3.12), thus indicating only a tendency to change in the direction found.

For motorways where the speed limits were raised from 100 to 110 km/h in 2011, a consistent tendency to increase was observed both in total crashes and in severe crashes. Similar results were obtained for motorways and the DCI roads where the speed limits were raised from 100 to 110 km/h in 2013.

On the other hand, for the DCI roads where the speed limits were raised from 90 to 100 km/h in 2011, a consistent tendency to decrease was observed both in total and severe crashes (a significant decrease in total crashes). This result was in line with changes observed in the actual travel speeds.

For a similar change in speed limits on the DCI roads in 2013, a tendency to increase was indicated both in speeds and in total and severe crashes of the treatment sites. A tendency to increase was found in 2011 in total and severe crashes on motorways, in spite of a decrease observed in the mean speeds of the treatment sites. A possible explanation for this finding can be that the speed measurement sites included in the treatment group were not representative enough of the speed changes that occurred on motorways following the introduction of the raised speed limits in 2011.

Table 3.12. **Changes in mean speeds and in crashes, in the treatment sites, versus comparison-group sites, corrected for confounding factors**

	Mean speed Before, km/h	Mean speed change, km/h (corrected for changes in the comparison group)	%-change of mean speed (after correcting changes in the comparison group)	Weighted mean change in injury crashes [95% CI]	Weighted mean change in severe crashes [95% CI]
2011 motorways 100 to 110 km/h*	107.2	-2.6	-2.4%	+12% [-20%; +56%]	+36% [-39%;+204%]
2011 DCI roads 90 to 100 km/h*	110.6	--7.0	-6.3%	-38% [-54%; -18%]	-7% [-52%; +81%]
2013 motorways and DCI roads 100 to 110 km/h*	107.8	+2.8	+2.6%	+9% [-23%; +54%]	+61% [-31%; +275%]
2013 DCI roads 90 to 100 km/h*	95.9	+6.8	+7.1%	+14% [-30%; +85%]	+5% [-68%; +241%]

*The comparison groups differ for the different road types.

Bibliography

More information can be found in the following references.

Gitelman V. (2014a). Establishing a national system for monitoring safety performance indicators in Israel; An example of a national speed survey. International Conference on Transport Safety Performance Indicators, Serbia, Belgrade, March 2014.

Gitelman V. (2014b). An examination of the relationship between the speed limit changes on inter-urban roads and travel speeds and accidents. Research report; Research Unit, National Road Safety Authority, Israel.

France: Introduction of automated speed cameras in 2003[9]

> Automated speed cameras were introduced in France in 2003 following a decision by President Chirac in 2002 to make road safety one of the three major nation priorities during his mandate. Between 2003 and 2009, 1 661 fixed speed cameras were implemented supplemented by 932 mobile cameras.
>
> Between 2002 and 2005 the mean speeds fell by 8.9 km/h on secondary roads and by 7.7 km/h on two or three lanes highways (two-way roads). Fatalities decreased by 25-35% in rural areas, 38% on urban motorways and 14% on urban roads.

Description and motivation of the measure

Fixed and mobile speed cameras were implemented progressively, with a first stage between November 2003 and March 2004 for the first hundred fixed units, followed by stagnation until the end of summer 2004. All fixed cameras were advertised by a sign about 1 kilometre upstream. From autumn 2004, the implementation accelerated. Then, the extension of the network of fixed speed cameras continued to reach 1 661 in 2009 supplemented by 932 mobile speed cameras. The first cameras were installed by central decision at points in the network with most traffic. Then, the locations were decided at the local level taking into account the characteristics of the infrastructure and levels of crash risk.

On 14 July 2002, President Chirac decided to make road safety one of the three major national priorities during his five years' mandate. The decision to adopt speed cameras was taken on 18 December 2002 by the Interministerial Committee for Road Safety, with the announcement of the implementation of 1 000 radars by the end of 2005.

Description of data

- Speed data

362 observation points (285 for daytime and 77 for night-time), representative of the French road network, were selected to measure speed. Measurements were conducted by 50 investigators based on a predefined distribution of days in the month and time slots. Measurements were conducted every four months at the same points and at the same day and time. Observations were distributed to spread evenly over four months, to cover all types of days and all time slots between 9:30 and 16:30 on daylight and between 22:00 and 2:00 at night. Speed measurements were made on six network categories: national roads in urban areas, national roads in rural areas, secondary roads in rural areas, 2x2 lanes national roads in rural areas, urban motorways, and interurban motorways.

- Crash data

Four studies were undertaken to evaluate the impact of the speed cameras on the number of fatalities and crashes. The first study (ONISR, 2006) was based on the analysis of annual statistics between 2002 and 2005. The second evaluation (Calvet, 2011) was based on the use of simple annual risk trend model. The third evaluation (Lassarre, 2009) was based on a model of annual fatalities depending on the number of vehicle-kilometres and a deterministic linear trend. The fourth evaluation (Carnis and Blais, 2013) estimated the effects through a time series model (an ARIMA intervention model) on monthly data of the ratio of the numbers of fatalities and non-fatal traffic injuries per 100 000 registered vehicles.

Confounding factors

During the introduction of the speed camera programme, there was no additional enforcement activity or major change in the infrastructure. However, the programme was accompanied by a large communication campaign in the media and through the social network about the deployment and the effectiveness of the system.

- Speed

To compare the evolution on time before and after the implementation, trend and control were modelled for factors which could influence the measurements and the trend, such as weather conditions, and fuel price.

- Crashes

Different time-series models were applied to correct for change in traffic volumes and the general road safety trend.

Results

- Speed

Table 3.13 shows the evolution in the mean speed of cars between 2000 and 2005 under daylight conditions and for four different road types. Between 2002 and 2005, the mean speed fell by 8.7 km/h on secondary roads and 7.7 km/h on highways (two-way roads) with two or three lanes.

Table 3.13. **Mean speed of cars (km/h) under day light conditions by road network**

Year	Motorways	National rural roads Dual two lane roads	National rural roads, 1x1 two-way roads	Secondary rural roads
2000	127 km/h	112 km/h	89 km/h	95 km/h
2001	126 km/h	112 km/h	90 km/h	93 km/h
2002 *Introduction of automated speed cameras*	126 km/h	112 km/h	88 km/h	93 km/h
2003	124 km/h	109 km/h	85 km/h	90 km/h
2004	121 km/h	104 km/h	84 km/h	88 km/h
2005	119 km/h	99 km/h	81 km/h	86 km/h

- Road crashes and casualties

The results are summarized in Table 3.14.

Table 3.14. **Impact of the introduction of automatic speed cameras on mean speed and fatalities**

	Mean speed (km/h)			Number of fatalities			Reduction of fatalities due to confounding factors	Net effect after correction for confounding factors
	Before	After	% change	Before	After	% change		
Rural motorways	126	119	-5.6%	351	224	-36.1%	-13%	-31.4%
National roads	88	81	-8.0%	1 914	1 142	-40.3%	-13%	-35.1%
Main rural roads	93	86	-7.5%	4 049	2 861	-29.3%	-13%	-25.5%
Urban motorways	112	109	-2.7%	176	100	-43.3%	-13%	-37.7%

Other information

A more recent evaluation is found in Blais and Carnis, (2015) where they refined the results by looking at the effects by road user categories. Results for all types of road users can be found in Blais and Carnis, 2013 and 2015).

The same speed data as used in this study is also studied in Viallon and Laumon (2013) who provide trends over 2001 to 2010 in the distribution of speeds and the fraction of fatal crashes, but limited to the secondary road network. Viallon and Lamon (2013) showed that the French speed camera programme reduced the proportion of fatal crashes attributable to high-level speeding (>20 km/h over the limit) from 25% to 6% over the period 2001-2010 and increased the proportion attributable to low-level speeding from 7% to 13%.

Bibliography

More information can be found in the following references.

Blais, E, and Carnis, L (2015), ‘Improving the safety effect of speed camera programs through innovations: Evidence from the French experience’. Journal of Safety Research, Vol. 55.

Calvet M. (2011), Une évaluation du dispositif de contrôle-sanction automatisée de la vitesse. Le Point sur, Commissariat général au développement durable, La défense.

Carnis L., Blais E. (2013), An assessment of the safety effects the French speed camera program, Acc. Anal. & Prev. 51, 301-309.

Carnis L. (2009), Le contrôle automatisé de la vitesse en France et en Grande-Bretagne. Deux régimes de régulation des vitesses distinctes ? In Delorme R., Lassarre S coordinateurs, Les régimes français et britannique de régulation du risque routier : la vitesse d’abord. Synthèse INRETS n° 57.

Carnis L., Hamelin P. (2007), Le contrôle sanction automatisé de la vitesse : une machine à remonter le temps ? Une analyse comparée France/Grande-Bretagne. Politiques et management public, vol. 25 n° 2, pp. 103-128.

Chassagne-Mottin R. (2007), Exploitation des données longitudinales des vitesses du panel INRETS-ISL : Modélisation des impacts de la mise en place des radars automatiques fixes en France. Rapport de stage de fin d’études Mastère sécurité des transports. INRETS, Champs sur Marne.

Delorme R., Lassarre S.,coordinateurs (2009), Les régimes français et britannique de régulation du risque routier : la vitesse d'abord. Synthèse INRETS n° 57.

Dupont E. & Martensen H. (Eds.) (2012), Forecasting road traffic fatalities in European countries. Deliverable 4.4 of the EC FP7 project DaCoTA.

Lassarre S., Hoyau P.-A (2009), Evolution récente du risque routier en France et en Grande-Bretagne. In Delorme R., Lassarre S coordinateurs, Les régimes français et britannique de régulation du risque routier : la vitesse d'abord. Synthèse INRETS n° 57.

Lassarre S. (2005), Modélisation du changement de comportement vitesse. Note interne, INRETS, Champs sur Marne.

Martensen & Dupont (Eds.) (2010), Forecasting road traffic fatalities in European countries: model and first results. Deliverable 4.4 of the EC FP7 project DaCoTA.

ONISR (2006), Evaluation de l'impact du contrôle sanction automatisé sur la sécurité routière (2003-2005), mars, 87 p.

Pianelli, C., Saad, F. and Abric, J-C (2008), Social representations of speed, automatic speed control and acceptability of LAVIA (French ISA system). 4th International Conference on Traffic & Transport Psychology. Washington, DC, USA Auguste31 – September 4, 2008

Ternier M., Phelippeau E., Malibert P., Vilmart C. (2003), La politique de sécurité routière : les systèmes locaux de contrôle, Conseil national de l'évaluation; Commissariat général du plan, la Documentation française

Roux S. Zamora P. (2010), The Effect of Fixed Speed Enforcement Cameras on Accidents in France: Two Complementary Approaches. CREST, Montrouge.

Viallon, V, and Laumon, B (2013), 'Fractions of fatal crashes attributable to speeding: Evolution for the period 2001-2010 in France'. Accident Analysis and Prevention, Vol. 52.

United States: Introduction of automated speed cameras in 2004

In 2004, a 3-year pilot programme of automated speed enforcement, named Safe Speed, started in Charlotte, North Carolina.

The programme was implemented in 14 corridors selected on the basis of high numbers of collisions, perceptions of speeding problems, and balanced geographic location throughout the city.

The results indicate that the camera programme likely reduced the collisions in corridors with automated enforcement and that the speed compliance increased.

Description and motivation of the measure

In June 2003, the North Carolina Senate and House of Representatives passed a Bill allowing a 3-year pilot program of automated speed enforcement in Charlotte, North Carolina. This program, named Safe Speed, started in August 2004. The city selected 14 corridors for automated speed enforcement on the basis of high numbers of collisions, perceptions of speeding problems, and balanced geographic location throughout the city. A sign "Photo Enforced" was placed under each speed limit sign along each of the 14 treated corridors. Signage was deployed in April 2004, just before a media campaign began. The City of Charlotte had three mobile automated speed enforcement units that were moved between the corridors.

The speed enforcement program (both speed cameras and red light cameras) stopped in 2006 as the result of a North Carolina Court of Appeals decision which determined that the State Constitution required that proceeds from traffic enforcement belong to the counties and must be used exclusively for maintaining public schools.

Description of data

- Speed measurements

Speed data were collected at each site during three periods: August 2003 (before the programme started), September to October 2004 (just after the programme began, called "after1"), and September to October 2005 ("after2"). Data were collected during similar seasons to avoid seasonal bias using standard stationary speed detection equipment. Speeds of individual cars were measured and mean speed, median speed, and 85th percentile speed were analysed as well as the percentage of drivers speeding. All speed measures were calculated at both treatment sites and comparison sites during the three time periods. The data were collected at free-flow speed locations to remove the effect from downstream signals.

- Crash data

Collisions were analysed in a before and after analysis using the comparison group analysis methodology in Hauer (1997). All reported collisions were analysed, not just speed-related crashes, since speed could have contributed to all reported collisions. The analysis focused on crashes occurring between January 2000 and December 2004 with the addition of data from all of 2005. The analysis was conducted to determine whether there was a carry-over effect of the speed camera as a countermeasure into the following year.

Confounding factors

There was no change in the level of traditional patrolling during the camera program. Early in the programme, the city also designated 11 comparison corridors ("control case") to identify the effects from confounding variables. These comparison corridors were also primarily high volume, multilane, urban arterials, and were geographically scattered throughout the city. The comparison corridors had somewhat lower collision rates, however, and their perceived speeding problem was somewhat less critical, than the treated corridors. Various types of media were used to make the public aware of the upcoming automated speed enforcement program in Charlotte.

The Empirical Bayes methodology (Hauer, 1997) allows a reasonable accounting for many confounding variables, including seasonal patterns, weather and special events, changes in traffic volumes, changes in driver and vehicle mixes, changes in laws or driving customs and regression to the mean. Regression-to-the-mean is the tendency for the number of accidents to go down if a randomly high number occurred, or to go up if a randomly low number occurred.

Results

- Speed

Mean speeds were 0.82 mph and 0.67 mph respectively lower during the after1 and after2 periods, compared with the before period. However, the difference of 0.15 mph between the mean speeds in the after1 and after2 periods was not statistically significant. For the comparison sites, although the difference of 0.28 mph between the mean speeds in the before period and the after1 period was not statistically significant, mean speeds decreased by 0.75 mph between the before period and the after2 period and by 0.47 mph between the after1 period and the after2 period. The results for median speed and 85th percentile speeds were very similar to those for mean speed.

The evaluation also looked at the number of vehicles travelling more than 10 mph over the speed limit. The percentage of speeding in the before period was 1.55 times the percentage of speeding in the after1 period and 1.23 times the percentage of speeding in the after2 period at the treatment sites. There was no statistically significant difference in percentage of speeding between after1 and after2 periods. For the comparison sites, the changes in percentage of speeding vehicles were not statistically significant between the three time periods.

- Crashes

Table 3.15 summarises findings from two different analyses. The only difference is the time period of the study in the after period. Total collisions for the entire period were analysed to get an overall picture of the effects of automated speed enforcement and all indications are that the camera program was still reducing collision frequencies in 2005. Note that all percentage decreases in collisions shown in the table were greater than one standard deviation away from zero. One final note on the collision analysis is that the researchers did analyse changes in collision severity during the before and after periods. The research report contains a description of the complete analysis (Cunningham et al., 2008). The results show that changes in severity were small.

Table 3.15. **Impact of the speed camera programme in Charlotte (United States) on speed and the number of crashes**

	Number of crashes						Mean speed	
	Before cameras		After cameras				Change after cameras	
Study period	Treated corridors	Comparison corridors	Treated corridors	Comparison corridors	Index of effectiveness[a] (%)	Standard deviation	Treated corridors	Comparison corridors
After 1 (up to December 2004)	8098	2898	1767	725	-12.9	±4.3	-0.82 mph	- 0.29 mph
After 2 (up to December 2005)	8098	2898	6236	2462	-13.7	±4.0	-0.67 mph	-0.75 mph

[a]Index of effectiveness is a measure of the percentage increase or decrease in collisions.

Bibliography

More information can be found in the following references.

Cunningham, C., J. Hummer, and J.-P. Moon (2008), Analysis of Automated Speed Enforcement Cameras in Charlotte, North Carolina. Transportation Research Record: Journal of the Transportation Research Board, No. 2078, Transportation Research Board of the National Academies, Washington, D.C., 2008, pp. 127–134. DOI: 10.3141/2078-17.

Cunningham, C., J. Hummer, and J.-P. Moon (2008), An Evaluation of the Safety Effects of Speed Enforcement Cameras. North Carolina State University, Institute for Transportation Research and Education, Raleigh, N.C., 2005.

Hauer, E. (1997), Observational Before–After Studies in Road Safety. Pergamon, Oxford, United Kingdom, 1997.

Italy: Implementation of Section Control (Safety Tutor)[10]

Section control of speed was introduced on the Italian motorway network in December 2005. In 2014, it comprised a total of 320 camera sites which covered more than 2 900 km of the motorway network.

The evaluation conducted showed a clear decrease in the mean speed and also an impressive reduction in the speed variability. On the A56 urban motorway, mean speed of light vehicles decreased by 10 % and the number of crashes decreased by 32%.

Description and motivation of the measure

Automated section control of speed or point-to-point (P2P) speed enforcement is a relatively new approach to traffic law enforcement. Its technology allows automatic identification of vehicles whose average speed, over the controlled section, exceeds the speed limit and automatic processing of an offence report and of the related fine. It therefore encourages compliance over distances longer than those observed where spot enforcement technologies have been in place.

Section control of speed, known in Italy as Safety Tutor, was initially introduced on the Italian motorway network in December 2005. In 2014, it comprised 320 speed cameras sites covering more than 2 900 km of the motorway network (about 40% of the Italian motorway network managed by Autostrade per l'Italia). In 2012, the implementation of the system was extended to three national expressways. Further installations of the system are planned also on regional and provincial highways. The evaluation presented in this report concerns the A56 urban motorway and the A1 motorway.

The programme was implemented to improve road safety. Speeding is a main contributing factor of most fatal crashes on the Italian motorway network. It is therefore important to improve speed compliance. The measure was decided upon by the motorway operator, Autostrade per l'Italia, following discussion with the traffic police and the consumer protection association.

Description of data

- Speed measurements

Individual ATS (Average Travel Speeds) of vehicles on sections of the A56 motorway "Tangenziale di Napoli" were analysed before and after the system activation (on 9th February 2009). In total, there were more than 22 million observations and speed monitoring was carried out in four periods:

- Before_2009: 12 days before the implementation of the P2P system (from 28th January to 8th February);
- After_2009: 77 days after the implementation of the P2P system (from 18th February to 5th May);
- After_2010: 21 days in 2010 (from 12th May to 1st June); and
- After_2011: 23 days in 2011 (from 29th March to 20th April).

- Crash data

On the A56, crash data covered 2006 to 2011, with a before period of 3.1 years and an after period of 2.9 years. Crash count for all treatment sites was 559 in the before period and 279 in the after period.

On the A1 Milan-Naples, the analysis period was 2001–2009, with a before period of 6.5 years and an after period of 2.5 years. Crash count for all treatment sites was 1 922 in the before period and 477 in the after period.

Confounding factors

Crash data were investigated by the before and after empirical Bayes (EB) methodology, which represents the state-of-the-art approach for safety evaluations. This methodology is rigorous and properly accounts for regression-to-the-mean (which may be relevant since sites for automatic speed control are selected also because of abnormal crash frequencies in the short term), accounts for other changes over time not due to the treatment being evaluated, overcomes the difficulties of using crash rates in normalizing for traffic volume differences between the before and after periods, and reduces the level of uncertainty in the estimates of the safety effect.

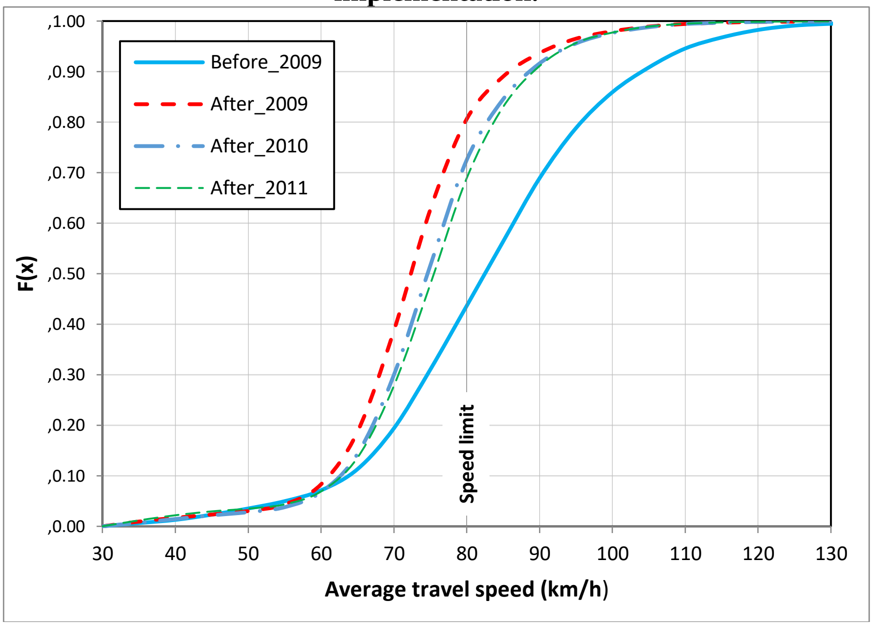
Results

- Speed

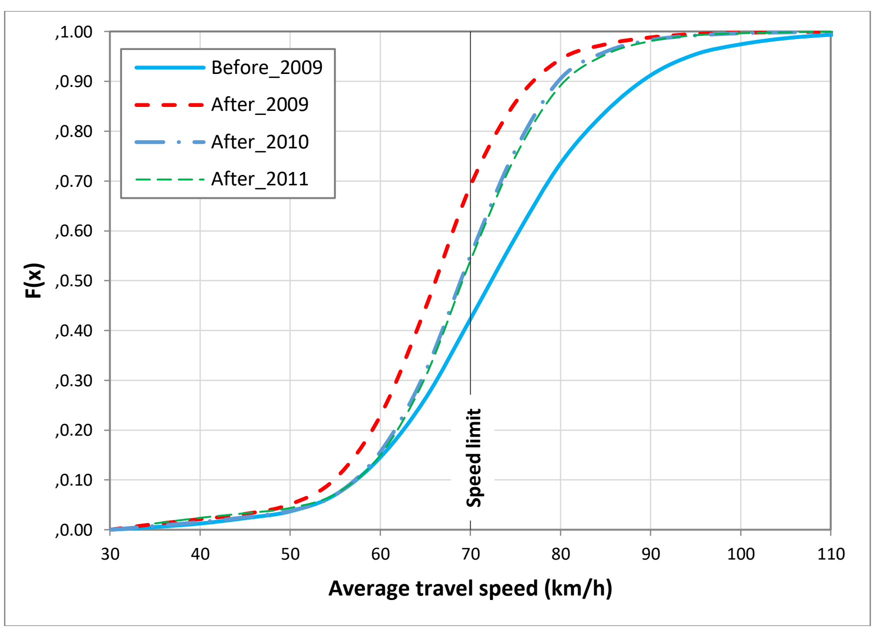
On the A56 the average speed of light vehicles decreased from 83.4 to 75.2 km/h, i.e., a 10% reduction. A greater reduction was observed for the 85th percentile of the speed distribution (V85) which decreased from 100.0 to 85.9 km/h, i.e., a 14 % reduction. Speed reduction for heavy vehicles was lower than for light vehicles: the mean speed of heavy vehicles decreased only by 5% and the 85^{th} percentile speed by 8%. Night-time speeds were higher than daytime speeds by about 3 km/h but average speed reduction was greater in daytime than in night-time: 9.9% vs. 9.2%. It is worthwhile to observe that the system was more effective in reducing excessive speeding behaviour. Indeed, the speeding reduction was 45% for vehicles exceeding the speed limit and 84 % for vehicles exceeding the speed limit more than 20 km/h (see also Figure 3.3).

One of the most important effects of the system is an impressive reduction of the speed variability. The standard deviation of average speeds of light vehicles over the study sections decreased from 16.5 to 12.2 km/h (from 13.1 to 10.5 km/h for heavy vehicles), i.e. a 26% reduction (20% for heavy vehicles). The greater reduction in standard deviation of speed (-31.2%) was observed in night-time.

Figure 3.3. **Speed distribution in the motorway A56 before and after the P2P implementation.**



a) Light vehicles (weight ≤ 3.5 tons)



b) Heavy vehicles (weight > 3.5 tons)

- Crashes

On the A56 urban motorway, the evaluation study estimated a crash reduction of 32.0%, with a lower 95% confidence limit of 22.3%.

On the A1 Milan-Naples motorway, the evaluation study estimated a crash reduction of 31.2%, with a lower 95% confidence limit of 24.3 %. The greatest crash reductions were observed for severe crashes (-55.6%) and crashes on curves (-26.6%).

Table 3.16. **Impact of Safety Tutor on speed and crashes**

	Mean speed before (daytime)	Mean speed after (daytime)	Change in mean speed %	Reported crashes before ($count_b$)	Expected crashes ([illegible])	Reported crashes ([illegible])	Index of effectiveness ([illegible])	Standard deviation ([illegible])	Crash reduction		
									95% Confidence interval lower limit (%)	Estimate (%)	95% Confidence interval upper limit (%)
A56 urban motorway	83.4 km/h	75.2 km/f	-10%	559	409	279	0.68	0.05	22.3	32.0	41.6
A1 Milan-Naples				1 922	692.96	477	0.69	0.04	24.3	31.2	38.1

Other information

On both the A56 and the A1 motorways the safety effectiveness of the system decreases over time. For the A56, crash reduction estimate was 37.3% in the first year after the activation of the system, while it was 29.9% in the second year and 27.9% in the third year. This declining effect was accompanied by a declining effect on speed, with reductions of 13.5%, 10.3% and 9.8% respectively in the first, second, and third year. On the A1, the crash reduction was 39.4% in the first semester after the system activation while it was 18.7% in the fifth semester.

Bibliography

More information can be found in the following references.

Cascetta E., Punzo V., Montanino M., (2011), Empirical Evidence of Speed Management Effects on Traffic Flow at Freeway Bottleneck. Transportation Research Record 2260, 83–93.

Cascetta E., Punzo V., Sorvillo R., (2010), Impact on vehicle speeds and pollutant emissions of a fully automated section speed control scheme on the Naples urban motorway. Proceedings of the 89th Transportation Research Board Annual Meeting, Washington, D.C.

Montella A., Imbriani L.L., Marzano V., Mauriello F., (2015), Effects on speed and safety of Point-to-Point speed enforcement systems: evaluation on the urban motorway A56 Tangenziale di Napoli. Accident Analysis and Prevention 75, 164–178.

Montella A., Punzo V., Chiaradonna S., Mauriello F., Montanino M., (2015), Point-to-Point speed enforcement systems: Speed limits design criteria and analysis of drivers' compliance. Transportation Research Part C : Emerging Technologies, 53, 1–18.

Montella A., Andreassen D., Tarko A., Turner S., Mauriello F., Imbriani L.L., Romero M. (2013), Crash Databases in Australasia, the European Union, and the United States: Review and Prospects for Improvement. Transportation Research Record 2386, 128–136.

Montella A., Persaud B., D'Apuzzo M., Imbriani L.L., (2012), Safety Evaluation of an Automated Section Speed Enforcement System. Transportation Research Record 2281, 16–25.

Montella, A., Punzo V., Montanino M., (2012), Analysis of drivers' compliance to speed limits enforced with an automated section speed enforcement system. Proceedings of 91st Transportation Research Board Annual Meeting, Washington, D.C.

Austria: Introduction of section control (2012)[11]

The first section control (point-to-point speed enforcement) on Austrian motorways was installed in 2003 in the Kaisermühlen Tunnel near Vienna). Since then, several sections of the Austrian motorway network have been equipped with section control (both fixed and mobile units).

In 2012, the first implementation on the secondary road network took place on an interurban section of 4.5 km in length, with a 2+1 cross section without median barrier. The average number of injury crashes went down from 5/year to 1.55/year, the average speeds decreased by between 3.3 km/h and 10.9 km/h.

Description and motivation of the measure

In June 2012, section control was installed on the LB37 in Lower Austria on a road section of 4.5 km. The LB37 is an interurban road with a 2+1 cross section without median barrier. The speed limit is 100 km/h. The section control enforcement was implemented to improve road safety. The stretch of road had been identified as a high-risk section.

Figure 3.4. **Section Control LB37, "Gföhler Berg"**

Description of data

- Speed data

The road authority of the region of Lower Austria (Niederösterreich) carried out the speed assessment.

Before data were collected the year before the implementation, in August and September 2011, at five points along the stretch of 4.5 km. Following the implementation (June 2012), the after measurements took place at the same five locations roughly one year after the before assessment, in August 2012.

Speed was measured with 24-hour automatic traffic counts using portable traffic data collectors (magnetic traffic lane sensors mounted to the road surface).

- Crash data

The crash analysis was done by KfV, based on disaggregated police data provided by the Austrian Bureau of Statistics. The analysis focused on the number of injury crashes, the number of road deaths, and the number of people injured and seriously injured. The analysis was done for the two following periods:

- Before: 1 June 2007 to 31 May 2012
- After: from 1 June 2012 to 31 December 2014

Confounding factors

A simple before and after study (speed and crashes) was conducted.

Results

The average speeds were reduced at all five measurement points, by between 3.3 km/h and 10.9 km/h., corresponding to speed reductions of between 3.1% and 10.7%.

The counts of injury crashes per year decreased from 5 per year to 1.55/year, corresponding to a 69% reduction.

The number of fatalities was reduced to zero, from a level of 0.6 per year.

The number of people injured decreased by 37% and the number of people seriously injured decreased by 61%. However, since the study did not control for confounding factors, the results must be treated with caution.

Table 3.17. **Impact of the implementation of section control on mean speed and fatalities**

	Mean speed			Crash data			Reduction of fatalities due to confounding factors	Net effect of speed measures after correction for confounding factors
	Before	After	% change	Before	After	% change		
Site 1	101.5	90.6	-10.7					
Site 2	106.6	103.3	-3.1					
Site 3	100.0	90.4	-9.6					
Site 4	102.1	95.0	-7.0					
Site 5	86.4	82.1	-5.0					
			Number of injury crashes / year	5	1.6	-69	Not investigated	
			Fatalities/ year	0.6	0	-		
			Severely Injured/ year	3	1.2	-61		
			Injured / year	7.4	4.6	-37		

Bibliography

KFV Sicherheit-Service GmbH. (2016), *Section Control. Wirksamkeit und Einsatzempfehlungen.* Wien

KFV Sicherheit-Service GmbH. (2013), *Section Control „Gföhler Berg“, L B37 km 13.000 – 17.500.* St. Pölten

Notes

[1] This case study was prepared by Prof. DSc. Péter Holló and by Phd.Tibor Mocsári

[2] Since (1,947x1,181)/(3,106x905)=0.818, the estimated percentage reduction in deaths is 18.2.

[3] The case study was prepared by Prof. DSc. Péter Holló and Phd.Tibor Mocsári

[4] The case study was prepared by Michael Tziotis, Australian Road Research Board, Australia.

[5] The case study was prepared by Tove Hels, Danish Police, Denmark.

[6] This case study was prepared by Rune Elvik, TOI, Norway

[7] The case study was prepared by Anna Vadeby, VTI, Sweden.

[8] Case study prepared by Victoria Gitelman, Technion University, Israel

[9] This case study was prepared by Sylvain Lassarre, IFSTTAR and Manuelle Salathé, ONISR. The automated control system department was consulted during the initial drafting

[10] This case study was prepared by Davide Shingo Usami and Vincenzo Punzo, University la Sapienza, Rome.

[11] This case study was prepared by Bernd Strnad & Klaus Machata, KfV, Austria.

Chapter 4. Analysis of the results

This chapter analyses the results of the case studies and compare them with results that could have been expected using empirical models. It also discusses the limitations of the study and aspects of the evaluation methods.

Introduction

The aim of this report is to illustrate the effects of speed changes on the number of road crashes and casualties. The analysis was based on eleven case studies from ten countries, studies that concerned either speed limit changes or a wide implementation of speed cameras. The main criteria for selecting the case studies were the availability of evaluation studies with speed and crash data. If available in the case studies, also changes in speed distribution were studied.

Limitations of the study

When interpreting the results, it must be kept in mind that the case studies analysed for this report present important differences in terms of geographical scope and evaluation methods used.

In the case studies from Denmark, France, Hungary and Sweden, the measures under review represented a major change of speed limits or the implementation of speed cameras on a large part of the road network. The evaluations carried out in these countries were based on speed surveys and crash statistics covering the entire road network affected by the change. Crashes and casualty data were compared to equivalent data on a control road network (not affected by the measure under review) to correct for confounding factors like long-term trend and changes of traffic volume.

For Italy, the implementation of the section control covered a large part (2 900 km) of the motorway network but the evaluation was carried out only on two road sections covering 120 km. The case studies from Israel, the United States and Norway covered a limited part of the road network: 180 km in Israel, 14 road sections in the United States and 28 km in Norway. However, the evaluations for these four countries used the Empirical Bayes methodology (EB) which represents the state of the art for safety evaluations. EB enables corrections for changes in traffic volume, seasonal variation in crash counts, long-term trends in the total number of crashes and regression-to-the-mean.

The case from Australia is also limited to a smaller part of the road network, but in contrast to the EB-methodology used in Israel, Norway and the United States, the evaluation method was based on a log-linear analysis and did not consider regression to the mean.

Summary of the results

Impact of speed changes on fatalities

The impact of the different case studies on fatalities are summarised in Figure 4.1 and Table 4.1. In Figure 4.1, the red dots illustrate changes in urban areas and blue dots changes in rural areas.

Since the cases are based on evaluation studies that used different methods analyses, it is not possible to streamline the final results. The information should be seen an illustration and not a strict analysis.

For all of the cases studies included in Figure 4.1 and Table 4.1, the changes in fatalities were corrected for confounding factors such as long-term road safety trend and changes in traffic volume.

Only the results of case studies with enough data are presented here. For case studies, like Sweden, where the data in the after period is very limited for some of the road types, results are only presented for roads for which we had enough data. Since not all cases report confidence intervals for the changes in fatalities, only the point estimates are shown in Figure 4.1.

It is clear from Figure 4.1 that for all cases studied a decrease in mean speed is associated with a decrease in fatalities, although the size of the change differs. On the other hand, in the one case of an increase in mean speed this is associated with an increase in the number of fatalities.

Figure 4.1. **Relationship between change of mean speed and change in the number of fatalities (blue = rural roads, red = urban roads).**

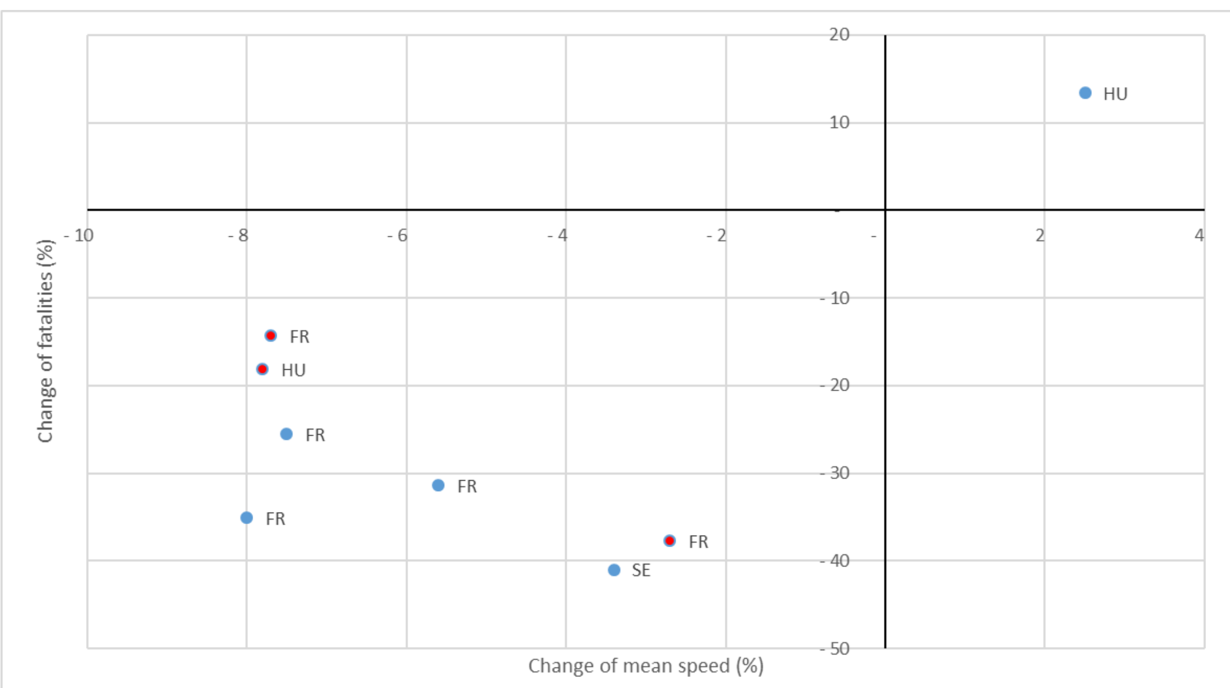


Table 4.1. **Relationship between change of mean speed and change of the number of fatalities**

	Road type	Mean speed change (%)	Change of fatalities (%)
Case studies with a decrease in mean speed			
Hungary (60→50 km/h)	Urban	-7.8	-18.2
Sweden (90→80 km/h)	Rural	-3.4	-41.0
France (speed cameras)	Rural motorways	-5.6	-31.4
France (speed cameras)	Main Rural roads	-7.5	-25.5
France (speed cameras)	National roads	-8.0	-35.1
France (speed cameras)	Urban motorways	-2.7	-37.7
France (speed cameras)	Urban roads	-7.7	-14.3
Case studies with an increase in mean speed			
Hungary (80→90 km/h)	Rural	2.6	13.4

Impact of speed changes on the number of crashes and casualties

The impact of speed changes on the number of crashes and injured road users for the different case studies are summarised in Table 4.2. In Table 4.3, the impact on speed changes on the number of severe crashes is shown. The changes are corrected for confounding factors such as long-term road safety trend and changes in traffic patterns (e.g. vehicle-kilometres or traffic volumes). Cases for countries where the data in the after period is very limited and the effects therefore are very uncertain are not presented here. The case study from Israel was excluded since the results rather reflect that a new category of roads was created, and therefore the changes in numbers of crashes and casualties do not stem wholly from a change in speed or speed limits. The US case is excluded since it does not present the mean speed before speed cameras and it is therefore not possible to calculate the percentage change. The interested reader is referred to the more detailed description of the results in Chapter 3 and the related references.

In Tables 4.2 and 4.3 the pattern is very clear and shows that for all cases (apart from one case in Israel, but as mentioned above the results rather reflects that a new category of roads was created) an increase in mean speed led to an increase in the number of crashes and/or injured road users and a decrease of mean speed was associated with a decrease in the number of crashes and injured road users. The size of the effect differs substantially between the studies, but the pattern is consistent. These differences can be explained partially by differences in the definition of injury crashes between countries and rather small numbers for some of the countries (Norway and Sweden).

Table 4.2. **Relationship between change of mean speed and change in the number of crashes and personal injury crashes.**

Country (measure)	Road type	Mean speed change (%)	Change of crashes/injured (%)	Type
Case studies with an increase in mean speed				
Denmark (110→130 km/h)	Motorways	1.9	21.0	Personal injury crashes
Denmark (110→130 km/h)	Motorways	1.9	24.0	Slight and seriously injured
Israel (100→110km/h)	Motorways/DCI 2013	2.0	9.0	All injury crashes
Israel (90→100km/h)	DCI 2013	6.7	14.0	All injury crashes
Case studies with a decrease in mean speed				
Israel (90→100km/h)	DCI 2011	-4.1	-38.0	All injury crashes
Italy (speed cameras)	Motorways	-9.8	-32.0	Total crashes
Norway (80→60 km/h)	Arterial	-7.5	-28.0	Injury crashes
Australia (60→50 km/h)	Urban	-0.9	-25.3	All injury crashes

Table 4.3. **Relationship between change of mean speed and change in the number of severe crashes.**

Country (measure)	Road type	Mean speed change (%)	Change of crashes/injured (%)	Type
Case studies with an increase in mean speed				
Sweden (110→120 km/h)	Rural motorways	3.0	128.0	Killed and seriously injured
Israel (100→110km/h)	Motorways/DCI 2013	2.0	51.0	Severe crashes
Israel (90→100km/h)	DCI 2013	6.7	0.0	Severe crashes
Case studies with a decrease in mean speed				
Israel (90→100km/h)	DCI 2011	-4.1	-7.0	Severe crashes
Sweden (110→100 km/h)	2+1 roads	-2.1	-49.0	Killed and seriously injured
Sweden (90→80 km/h)	Rural roads	-3.4	-7.0	Killed and seriously injured

In summary, an increase in mean speed was associated with an increase in the number of road users killed or seriously injured and in the number of crashes independent of road types and motives behind the changes. And accordingly, a decrease in mean speed was associated with a decrease in the number of road users killed or seriously injured as well as in the number of crashes. For none of the cases was an increase in mean speed associated with a decrease in the number of crashes or casualties.

Impact of speed changes in speed distribution

As regards impact of speed changes in speed distribution several of the cases confirm that speed cameras are effective in reducing both mean speed and especially excessive speeding. In France, the French speed camera programme reduced the proportion of fatal crashes attributable to high-level speeding (>20 km/h over the limit) from 25% to 6% over the period 2001-2010 and increased the proportion attributable to low-level speeding from 7% to 13%. The case study in Italy showed that on the A56 motorway, the average speed of light vehicles decreased from 83.4 to 75.2 km/h, i.e., a 10% reduction. A greater reduction was observed for the 85th percentile of the speed distribution (V85) which decreased from 100.0 to 85.9 km/h, i.e., a 14% reduction. It is worthwhile to observe that the system was more effective in reducing excessive speeding behaviour. Indeed, the speeding reduction was 45% for vehicles exceeding the speed limit and 84% for vehicles exceeding the speed limit more than 20 km/h. One of the most important effects of the system is an impressive reduction of the speed variability. The standard deviation of average speeds of light vehicles over the study sections decreased from 16.5 to 12.2 km/h (from 13.1 to 10.5 km/h for heavy vehicles), i.e. a 26% reduction (20% for heavy vehicles). The greater reduction in standard deviation of speed (-31.2%) was observed in night-time.

In Victoria, Australia, the covert use of mobile speed cameras has been shown to be very effective in reducing injury crashes and fatal outcomes and research has shown that only 7% of injury crashes in Melbourne are now attributable to high-level speeding, compared with 24-34% in other Australian major cities where mobile cameras are operated less effectively.

Effectiveness of speed management measures

The effectiveness of automatic speed enforcement has been demonstrated mainly through the cases from France and Italy. The largest speed reductions are seen for the highest speeds and the speed variances are decreased as well. Both section control and fixed speed cameras are shown to reduce mean speeds substantially. Other studies (Soole et al., 2013) have shown that section control has also been seen to produce a number of ancillary benefits, including more homogenised traffic flow and increased traffic capacity resulting from reduced variability in vehicle speed and subsequent increased headway.

It should however be stressed that in nearly all cases, speed enforcement measures were accompanied by intense communication campaigns.

Regarding a reduction in speed limits, the case studies showed that without enforcement activities, the measure has little impact. In Sweden, the decrease of the speed limit from 90 km/h to 80 km/h was associated with a decrease of mean speed at 3.1 km/h leading to worse compliance with speed limits when there was no additional enforcement. In this context it can also be noted that if the enforcement is not maintained, the effects are usually not maintained either. However, still small reductions in mean speed can lead to important reductions in severe crashes.

Comparison with empirical models

Chapter 2 described the two models that have been developed based on previous empirical studies and which describe the relationship between a change in mean speed and the associated change in the number of crashes: the power model and the exponential model. Both models can be used to estimate the expected changes in the numbers of crashes and causalities.

Table 4.4 provides a comparison between the results of the case studies and the theoretical results obtained when these two models are applied. The comparison is made for fatalities only since there are differences between countries and studies in the way injury severity is defined. To ensure that there are no other factors that can explain the empirical change in the number of fatalities (e.g. a change in traffic volume or an anti-speeding publicity campaign), the analysis relied on a comparison group of roads not affected by the speed limit changes. The exponent and the associated confidence interval (CI) used for the power model are 4.6 (CI: 4.0-5.2) for rural roads and 3.0 (CI: -0.5-6.5) for urban roads according to Table 2.1 and the coefficient and CI for the exponential model are 0.065 (CI: 0,053-0,077) for both urban and rural roads and according to Table 2.3. If the empirical estimate of the change of fatalities is within the confidence interval, the effect is estimated to be in line with the model.

The comparison shows that all the empirical results from the cases are in the same direction as estimated by the power and the exponential model. However, not for all cases is the size of the change within the confidence interval. For two cases (Sweden and France) the empirical results are larger than estimated by the models, and in five cases the empirical estimates are in line with at least one of the models. In two cases, the empirical results are in line with the power model, but smaller than estimated by the exponential model. Though no general conclusions can be drawn from this comparison, it can be concluded that the empirical results from the cases are in the same direction as estimated by the power and the exponential model and that both models fit rather well to the cases.

Table 4.4. **Comparison between the empirical outcome from cases (corrected for confounding factors) and the outcomes estimated by the Power and Exponential models**.

Country (measure)		Mean Speed			Fatalities			
		Before Km/h	After km/h	Change (%)	Empirical change fatalities (%)	Expected change based on Power model (%)	Expected change based on Exponential model (%)	Comment
Case studies with a decrease in mean speed								
Hungary (60→50 km/h)	Urban	57	52.5	**-7,9**	**-18**	-22; CI = (-41, -4)	-25; CI = (-29, -21)	Empirical result **in line** with Power model, but **smaller** than by the Exponential
Sweden (90→80 km/h)	Rural roads	87.7	84.7	**-3,4**	**-41**	-13; CI = (-15, -12)	-18; CI = (-21, -15)	Empirical result **larger** than estimated with Power and Exponential models
France (speed cameras)	Rural motorways	126	119	**-5,6**	**-31**	-23; CI = (-26, -20)	-37; CI = (-42, -31)	Empirical result **in line** with Exponential model and **larger** than Power model
France (speed cameras)	National roads	88	81	**-8,0**	**-35**	-32; CI = (-35, -28)	-37; CI = (-42, -31)	Empirical result **in line** with results from Power and Exponential models
France (speed cameras)	Main rural roads	93	86	**-7,5**	**-26**	-30; CI = (-33, -27)	-37; CI = (-42, -31)	Empirical result **smaller than** estimates from Power and Exponential models
France (speed cameras)	Urban motorways	112	109	**-2,7**	**-38**	-08; CI = (-16, 1)	-18; CI = (-21, -15)	Empirical result **larger** than estimated with Power and Exponential model
France (speed cameras)	Urban roads	52	48	**-7,7**	**-14**	-21; CI = (-41, 4)	-23; CI = (-27, -19)	Empirical result **in line** with Power model but **smaller** than Exponential
Case studies with an increase in mean speed								
Hungary (80→90 km/h)	Rural roads	78.0	80.1	**2,6**	**13**	12; CI = (11, 14)	0.14; CI = (0.11, 0.14)	Empirical result **in line** with estimates from both Power and Exponential model

Discussion

When looking at the summarised results it is important to bear in mind that the evaluation methods differ between the cases. However, the main conclusions from this report are that all the cases show that an increase in mean speed is associated with an increase in the number of crashes and injured and a decrease in mean speed is associated with a decrease in the number of crashes, fatalities and injured. The case studies largely support results from previous studies and the theoretical models (Power model and Exponential model) developed to estimate the relationship between mean speed and the number of fatalities.

As regards effectiveness of speed cameras, a literature review by Soole et al. (2013) concluded that section control is effective in reducing mean speed, P85 and speed variations between vehicles. They showed that the decrease in P85 was greater than the decrease in mean speed, which agrees well with the Italian and French case studies and suggests a change in the shape of the speed distribution. The Italian case study (Montella et al., 2015) showed a displacement of the speed distribution with larger displacements for higher speeds. Viallon and Lamon (2013) showed that the French speed camera programme reduced the proportion of fatal crashes attributable to high-level speeding (>20 km/h over the limit) from 25% to 6% over the period 2001-2010 and increased the proportion attributable to low-level speeding from 7% to 13%.

It is also clear from the studies that the evaluation method can have a great impact on the conclusions reached and how the results are interpreted. If a simpler evaluation method is used where no corrections for the general trend or regression to the mean is used, the conclusions might well not be reliable. For all of the cases in this report, a before and after study was done. It means that the crash and/or injury outcome before the measure (new speed limit or speed cameras) is compared to the outcome after the measure. Three types of methods were used:

- Empirical Bayes
- Before and after study with control group
- Before and after study without control group

The Empirical Bayes (Hauer, 1997) is generally considered to be the most advanced method that corrects for both regression to the mean as well as changes in traffic volume and long term trends in the total number of crashes. The EB method is recommended as the gold standard for before and after evaluations, though not always possible to perform due to data limitations. A before and after study with control group is regarded as the second best.

Bibliography

Hauer, E. (1977), Observational before-after studies in road safety. Pergamon, Oxford.

Soole, D.W., Watson, B.C., Fleiter J.J. (2013), Effects of average speed enforcement on speed compliance and crashes: A review of the literature. Accident analysis and Prevention 54, s 46-56.

Chapter 5. Conclusions and recommendations

Vehicle speed is a topic for recurrent political and societal debates about mobility, environmental concerns and safety concerns. Proposals to either decrease or increase speed limits are often presented and discussed but not always motivated by sound analysis and reflection on their impact.

The objective of this study is to document objectively the current state of knowledge in the contributing and similar countries about the relationship between speed and crash and injury risks and to produce an accessible report for the attention of policy makers and their advisors that can be referred to in national / local debates on speed management policies. It is based on case studies from countries which have recently introduced either a change in speed limits or a wide implementation of automated speed enforcement: the report covers 11 case studies from 10 countries: Australia, Austria, Denmark, France, Hungary (2), Israel, Italy, Norway, Sweden and the United States. The reasons that motivated these changes are usually in some degree political and arise from concerns ranging over aspects of safety and the environment. The criteria for including a case study in our analysis were the availability of an evaluation report regarding both the impact on speed and effect on the occurrence and severity of crashes.

All the case studies indicate a strong relationship between speed and the number of crashes, i.e. when the mean speed decreases, the number of crashes and casualties decreases and likewise for increases. For none of the cases was an increase in mean speed associated with a decrease in the number of crashes or casualties.

The cases presented in this report, are mainly measures implemented on the rural road network. However, in aggregate over all roads many of the injured road users are vulnerable road users, such as pedestrians and cyclists. Such casualties are more common in urban areas. Research has indicated that the death risk is about 4-5 times higher in collisions between a car and a pedestrian/road worker on foot at 50 km/h compared to the same type of collisions at 30 km/h. Considering this, there is a strong recommendation to reduce speed in urban areas.

To estimate the expected change in the number of crashes, two empirically based models can be used, the Power model and the Exponential model (which considers the initial speed). While the numerical results from these case studies did not match exactly with the results expected by applying these models, they were nevertheless in line with these. The Power Model provides a good representation of the relationship between speed and crash risk and is easy to apply: as a rule of thumb it shows that a 10% increase in mean speed leads to a 20% increase in all injury crashes, a 40% increase in fatal and serious crashes and a 40% increase in fatal crashes. Accordingly, a 10% decrease in mean speed leads to 20% decrease in injury crashes and a 40% decrease in fatal crashes. This means that even small changes in driving speeds can have a substantial effect on road safety.

To reduce road trauma, i.e. fatalities and injuries, governments need to take actions to reduce the speed on our roads and also to reduce differences in speed. As individuals, the risks for a severe crash might seem small, but from a societal point of view, there are substantial safety gains when the mean speeds and speed differences on the roads are reduced.

In addition to a reduction of the number of crashes and the severity of injuries, lower vehicle speeds contribute to reductions in other negative effects of the use of motor vehicles such as greenhouse emissions, fuel consumption and noise. Lower speeds will also reduce adverse impacts on quality of life, especially for people living in urban areas.

If a speed limit increase is envisaged, compensation measures should be considered, such as more enforcement or an upgrade of the infrastructure. If not, more deaths and injured road users can be expected. It is important to ensure that the compensation measures are effective enough, otherwise they will only compensate partly for the increased speed limits.

Speed limits should be set based on the Safe System principles and taking into account the function and use of the roads. The aim of a Safe System is to offer a road system that can accommodate the unavoidable human error without leading to death or serious injury. This means that the forces a human body can tolerate and still survive must be considered when designing the road system and setting the speed limits. Such physical limitations are for example that most unprotected road users survive if hit by a vehicle at up to 30 km/h, a modern car can protect occupants up to 50 km/h in a side collision and a safe car can protect occupants up to 70 km/h in a head-on collisions. In urban areas, where there is a mix of motorised and non-motorised road users sharing the same space, speed limits above 50 km/h are not acceptable. In areas with a high density of vulnerable road users, a limit of 30 km/h is to be preferred.

This report has confirmed the effectiveness of automatic speed enforcement. The case studies presented in this report reported important reduction in mean speeds. The largest speed reductions are seen for the highest speeds and the speed differences are decreased as well. Section control (using measurement of average speed over a section of road to detect a driver’s failure to comply with the speed limit there) is a relatively new measure, which seems to be very effective not only in reducing speed but also in contributing to more homogenised traffic flow and increased traffic capacity resulting from reduced variability in vehicle speed. It has also been shown that speed cameras tend to reduce the severe speeding offences to a larger extent than mean speed.

Measures taken in isolation are less effective than an integrated speed management approach. Automated speed enforcement should be accompanied by important communication efforts. Changes in speed limit alone have little effect, unless there are accompanied by other measures (enforcement, communication, education). Efforts must be maintained over time. When enforcement is not maintained, the effects of enforcement are usually not maintained either and driving speeds are becoming higher again.

Appendix 1
General speed limits for passenger cars, 2017 (km/h)

Country	Urban areas		Rural roads	Motorways	
Argentina	40-60	(Buenos Aires City has a range of 20 to 70 km/h	110	120-130	
Australia	50 60-80	 (arterial roads - increasing use of 40 km/h or lower limits in urban areas with high pedestrian activities)	100, 110	Set by each state (e.g.130km/h in the Northern Territory)	
Austria	50		100	130	
Belgium	30-50		70-90	120	
Cambodia	30-40 40	(motorcycles, tricycles) (passenger cars)	90	No motorways	
Canada	40-70		80-90	100-110	
Chile	60		100	120	
Czech Republic	50		90	130	
Denmark	50		80	130	(110 for certain sections)
Finland	50	(sections with 30, 40, or 60)	100 (80 in winter)	120	(100 near cities)
France	50		90 (80 in wet weather, for novice drivers)	130	(110 in wet weather and for novice drivers)
Germany	50		100	None	(130 recommended)
Greece	50		90	130	
Hungary	50		90	130	(110 on "motor roads")
Iceland	50		90 (paved roads) 80 (gravel roads)	n.a.	
Ireland	<=60	(can be 60 on arterial roads, 30 in built up areas)	80, 100	120	
Israel	50-70		80, 90, 100	110	
Italy	50		70-90 (110 on some main dual carriageways)	130	(110 km/h in wet weather, 100 for novice drivers. Motorway operator may increase speed limit up to 150 if stringent requirements are met)
Jamaica	50		50	70, 110	
Japan	40, 50, 60		50, 60	100	
Korea	60		60-80	110	(100 in urban areas),
Lithuania	50		90 (70 on gravel roads and for novice drivers)	120,130 (110 in winter, 90 for novice drivers)	
Luxembourg	50		90	130	(110 in wet weather)
Malaysia	50		90	110	
Mexico	10-80		100	110	(100 on high-speed roads)
Morocco	60		100	120	
Netherlands	30-50		60-80	100-130	
New Zealand	50	(sections may have higher or lower limits)	100 (specific sections may have lower limits)	100	
Nigeria	50	(45 for tankers, trailers)	80 (differentiated by vehicle type)	100	(differentiated by vehicle type)
Norway	50	(30 on residential streets)	80	90,100,110	
Poland	50	(60 at night time)	90, 100, 120	140	
Portugal	50		90	120	
Serbia	50		80, 100	120	

Slovenia	50	90 (110 on expressways)	130
South Africa	60	100	120
Spain	50	90,100	120
Sweden	30, 40, 50	60,70,80,90,100	110,120
Switzerland	50	80	120
United Kingdom	48 (30 mph)	96, 113 (60, 70 mph)	113 (70 mph)
United States	Set by each state	Set by each state	88-129 (55-80 mph, set by each state)
Uruguay	45	90	No motorways

Source : IRTAD, 2017 Annual Report on Road Safety

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International Transport Forum

Speed and Crash Risk

Inappropriate speed is responsible for 20 to 30 % of all fatal road crashes. After reviewing the current knowledge on the relationship between speed and crash risk, this report analyses eleven cases from ten countries that have recently changed speed limits or introduced a large-scale automatic speed control. The analysis confirms the very strong relationship between speed and crash risk and that higher speed is associated with increased occurrence and severity of road crashes.

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