APPLICATION AND EFFECTIVENESS OF LAWS

First Experiences with the New Law on DUID in Belgium: Alcohol and Medicines in Drug Negative Cases

[1]V. Maes, [2]N. Samyn, [2]G. De Boeck, [3]M. Willekens and [4]A. Verstraete

[1]Department of Clinical Chemistry-Toxicology, Academic Hospital-VUB, Brussels, [2]National Institute of Criminalistics and Criminology, Brussels,
[3]Federal Police, DGJ-DJP, Drugs Program, Brussels,
[4] Laboratory of Clinical Biology-Toxicology, University Hospital, Ghent

Keywords
Traffic law, driving under the influence (DUID), impairment, psychoactive substances

Abstract
In March 1999 a new law prohibiting driving while impaired by illegal drugs was introduced in Belgium. The legal procedure consists of a) a field impairment test, b) a urine immunoassay for 4 drug groups and c) ultimate proof by plasma analysis (GC-MS with fixed cut-offs). Over about two years the analysis of 896 blood samples revealed the presence of illicit drug(s) above cut-off in 85% of the cases. For the 15% "false positives" (failed impairment test and positive urine assay without confirmation in plasma) we investigated the possible reasons for impaired behavior.

The presence of alcohol and psychoactive medication stands for an important number of our 'false positives'. The results adduce arguments for introducing psychotropic medicines in our traffic law. Our findings further suggest that false positive cases can be reduced by minimizing the delay before blood sampling and optimizing sample preservation. Harmonization of the strategy for detection and penalization of impaired drivers (alcohol and/or drugs) is highly recommended.

Introduction
In March 1999 a new law on driving under the influence of illegal drugs was introduced in Belgium. The legal procedure is a three-step process: a) a field impairment test, i.e. the assessment of external signs of the presence of drugs by a standardized test battery, b) an on-site immunoassay for amphetamines, cannabinoids, cocaine metabolites or opiates in urine and c) blood sampling for plasma GC/MS analysis with the following analytical cut-offs: THC (tetrahydrocannabinol) 2 ng/mL, free morphine 20 ng/mL, amphetamine, MDMA (ecstasy), MDEA, MBDB, benzoylecgonine (BE) or cocaine 50 ng/mL. The urine test resp. the plasma analysis are performed on the condition that the driver fails the preceding test(s) (1,2).

In 2000-2001 the analysis of 896 blood samples revealed the presence of one or more illicit drug(s) above cut-off in 85% of the cases (2). We investigated the 15% 'false positives', i.e. cases where the driver failed the field impairment test and the urine immunoassay test was positive for at least one drug group, but where the plasma GC-MS analysis revealed no prohibited drug above cut-off. In such cases the full legal procedure for driving under the influence of illicit drugs was completed but the driver was not fined or penalized.

Methods

Sample selection

For a more detailed description of the target population in this study (DUID cases in Belgium), we refer to the proceedings article of Willekens et al. in the T2002 issue (2).
After the requested GC-MS confirmations for illicit drugs, the plasma samples from all DUID cases were stored at –20°C.
The samples in which no drugs were detected above the legal cut-off values ('false positives') were retrospectively analyzed for the presence of alcohol and psychoactive medicines.
For comparison the same analyses were performed on a 'control group' of 74 plasma samples of legally positive DUID cases. The selection of samples was based on the prevalence of the different illicit drugs in the total DUID population.

Analytical methods

Alcohol was determined by a direct GC-FID method (LOQ 0.05 g/L). The measured plasma alcohol level was converted to the corresponding whole blood concentration by dividing by 1.14 (3). Psychoactive medicines were detected and quantified by an HPLC-PDA method, covering the benzodiazepines, the antidepressants and some neuroleptics and narcotic analgesics.

Results

In 2000-2001, 896 blood samples were transferred to the National Institute of Criminalistics and Criminology for GC-MS analysis of illicit drugs in plasma obtained from drivers with a failed field impairment test and a positive urine immunoassay for at least one drug group. The presence of one or more drugs above the legal cut-off was confirmed in 85% of these cases.

'False positives'

For the 133 cases (15% of total) where the GC-MS analysis revealed no illicit drugs above cut-off the corresponding urine and plasma data are presented in Tables 1-4.

1) Urine tests

No urine sample was provided in 12 cases. Cannabis was most frequently detected (80%) and was the only positive parameter in 61 % of the samples.

Table 1: On-site urine test results of the 'false positive' cases

Drug groups / U	N (= 121)	%
Cnb	74	61.2
Cnb/Amph	10	8.3
Cnb/Opt	7	5.8
Cnb/Coc	1	0.8
Cnb/Opt/Amph	2	1.7
Cnb/Opt/Coc	2	1.7
Cnb/Amph/Coc	1	0.8
Amph	10	8.3
Amph/Coc	2	1.7
Opt	8	6.6
Opt/Coc	2	1.7
Coc	2	1.7

2) Plasma drug levels detected below cut-off
In 39% of the 133 plasma samples one or more drug(s) were detected below the legal cut-off, mostly cannabis and amphetamines; here the presence of the illicit drugs was confirmed but the concentration was below the penalization limit.

Table 2: Number of cases with plasma levels of the target illicit drugs below the legal cut-off

Plasma levels < cut-off	N
THC < 2	32
Amphetamine or MDMA <50	15
Cocaine metabolite <50	10
Morphine <20	3
Total cases	52

3) Presence of alcohol
Of the 123 plasma samples available for alcohol analysis 37% proved to be positive, with a majority (70%) above the legal blood alcohol limit of 0.5 g/L (after conversion of the plasma level to the corresponding whole blood value: range 0.08-2.32 g/L; median 0.82 g/L).
Retrospective checking of the police reports showed that all cases of alcohol levels above 0.5 g/L had been detected by the road-side breath test and penalized accordingly. In 5 cases a positive breath test corresponded to blood alcohol levels slightly below the legal limit, while in 5 cases of negative breath tests a low blood alcohol was measured.
About half (43.5%) of the alcohol positives contained illicit drugs below cut-off, mostly cannabis and amphetamines.

Table 3: Number of cases with positive alcohol findings combined with illicit drug levels below the legal cut-off

		Alcohol > 0.5 g/L	Alcohol < 0.5 g/L
Alcohol + cnb<cut-off	12	*9*	*3*
Alcohol + amph<cut-off	5	*4*	*1*
Alcohol + cnb/amph<cut-off	1	*1*	*0*
Alcohol + coc<cut-off	2	*1*	*1*
Alcohol + drugs<cut-off	**20**	***15***	***5***

4) Presence of medication

Psychotropic medicinal drugs were screened in 128 plasma samples: 18 samples (14%) contained one to three medicinal drug(s), mainly benzodiazepines - with nordiazepam and bromazepam as principal compounds - (15 cases), antidepressants (n=5) and methadone (n=5). Benzodiazepine levels were above the therapeutic range in 10 cases (4). Alcohol and medication were combined in only 3 samples.

In 4 cases where the urine test only screened positive result for the opiates class, the corresponding plasma analysis by GC-MS was negative for the controlled substance morphine but picked up the opiate codeine (concentrations ranging from 12 to 62 ng/ml) which is frequently present in mild analgesics and cough suppressants.

Table 4: Detail of medication positives with the results of the urine screening and corresponding alcohol and illicit drug data

Medication (µg/L) (supra-therapeutic)	**Alcohol** (g/L)	**On-site urine test**	**Drug < cut-off plasma**
paroxetine (40), clonazepam (21), temazepam (78)		Cnb/Amph	MDMA
sertraline (<20)		Cnb	THC
methadone (82)		Cnb	
diazepam (450)/nordiazepam (425)	0.26	Coc	BE
bromazepam (945)		Cnb	
nordiazepam (12200), cetirizine		Opt/Coc/Cnb	BE, Morphine
bromazepam (540), methadone (<20))		Opt/Coc/Cnb	BE
paroxetine (51)	2.28	Cnb	
bromazepam (360)		Cnb	THC
nordiazepam (1415)		Amph	
nordiazepam (5760),bromaz (885), methad.(220)		Opt	
nordiazepam (<20)		Cnb	
nordiazepam (100)		ND	Morphine
diaz(910)/nordiaz(165), trazodone(230), methad.(<20)		Opt	
zolpidem (65)		Cnb	THC
bromazepam (860)	0.08	Amph	
bromazepam (685)		Opt/Coc	BE,Morphine
methadone (110)		Cnb/Amph	THC, MDMA
Total = 18	**Total = 3**		**Total =10**

5) No psychoactive substances

In one third (30%) of the ‘false positive’ cases no traces of alcohol, target drugs nor psychoactive medication were found.

‘Drug positive control group’

The selection of a ‘control group’ (n=74) was based on the prevalence of the different illicit drugs in the total DUID population: a large group of cannabis positives, a large one of stimulants (amphetamines and cocaine) and a potentially interesting population of opiate-positives. Detailed data about alcohol levels, psychoactive medicines and the corresponding illicit drugs are given in Tables 5-6.

Table 5: Detail of alcohol positives in the ‘control group’

Alcohol +	Medication	Drugs
0.12	+	THC
0.19		BE, MDMA
0.30		THC, MDMA
0.34		THC, MDMA, Amph
0.43		BE, MDMA
0.51	+	BE, MDMA, Amph
0.89		THC, MDMA
0.92		BE, MDMA
0.99		BE, MDMA

Table 6: Detail of medicine positives in the ‘control group’

Medicines (µg/L, supratherapeutic)	Alcohol (g/L)	Drugs
flunitrazepam (92), desmethyl+amino, nordiazep (95)		THC
diazepam (37), nordiazepam (80)		THC, Amph, MDMA
diazepam (430), nordiazepam (190)	0.51	BE, Amph, MDMA
bromazepam (3100)		Morph
bromazepam (380), methadone (180)		Morph, BE
bromazepam (540), tetrazepam (36), methadone (135)		Morph
nordiazepam (280), methadone (340)		Morph, BE
diaz (75), nordiaz (1500), bromaz (90), alpraz (47), methadone(195), trazodone (300)		BE, MDMA
diazepam (80), nordiazepam (60)		Morph, BE
bromaz (32), diazepam (900), nordiaz (600), lormetaz (47)	0.12	THC
bromazepam (1100)		Morph, THC
bromazepam (415), nordiazepam(3200), tetrazepam (185)		THC
diazepam (420), nordiazepam (500)		Morph, BE, THC
Total = 13	**Total = 2**	

In all but one of the 9 alcohol positive samples MDMA was detected in combination with THC or benzoylecgonine. An important number of medicine users were also found in the control group; here again preferably benzodiazepines were used and abused.

Discussion

'False positives'

The validity of the new legal procedure for detecting drivers under the influence of illicit drugs is reflected in the number of positive plasma confirmations. As the 15% of not-confirmed cases seemed rather high we investigated the possible reasons for a failed field impairment test, a positive urine test but no illicit drugs above cut-off in the blood.

- In 39 % of the cases illicit drugs were present in concentrations below cut-off. Shortening the delay for blood sampling may increase legal detection. Moreover, as some analytes e.g. THC and cocaine are unstable in biological matrices, precautions should be taken for storage and transport of the blood samples. Another issue is the possible abolition of the legal cut-off values for drugs in plasma, leading to a real 'zero-tolerance' policy following the German example. As a consequence, quality assessment schemes should guarantee consistent results between laboratories.

- About one quarter of the studied population had an alcohol level above the legal 0.5 g/L limit. These drivers appeared to have been detected by the roadside breath test and penalized (no driving for 6 hours + fine). It is clear that here the impairment is mainly due to the influence of alcohol. However it is conceivable that low alcohol levels in combination with low illicit drug concentrations (5 cases) may impair the driver to a degree that is detected by the field sobriety test.

- The results of the medication analyses show that a considerable part of the studied drivers use psychoactive medication - benzodiazepines being very popular -, wether in combination with illegal drugs or not. Except for one driver, no or low levels of alcohol were found in combination with the medicines. The impact of benzodiazepine use on driving behavior was demonstrated in many studies (5). Supra-therapeutic and toxic medication levels are probably responsible for the detected impairment, a valid argument for introducing psychoactive medication in the traffic law as was recently done in Sweden (6).

- Finally, for the remaining third of the study subjects no traces of alcohol, target drugs nor psychoactive medicines were detected in plasma. Possible alternative explanations for their impairment may be: the presence of other drugs not specified in the traffic law (e.g. GHB, LSD); physiological conditions such as illness or fatigue; inefficiently performed field impairment tests due to the inexperience of the police officer.

'Control group'

A large number of THC-only cases were selected from roadblocks for the 'coffee shop' visitors. As expected none of these drivers were positive for alcohol – these shops having no license to sell alcoholic beverages. On the contrary, visitors of 'after-clubs', frequent users of cocaine and other stimulants, do combine these drugs with alcohol.
The results suggest that the majority of the apprehended heroin users proved to drive under the influence of multiple drugs and psychoactive medicines.

The National Circular for Police Services expresses the political will to penalize driving under the influence of alcohol as well as illicit drugs. Thus a failed field impairment test must be followed by a breath test for alcohol and a urine test for drugs, a positive immunoassay leading to a plasma analysis. When following this procedure a number of 'false positives' must be expected, i.e. the alcohol positives where the illegal drugs are no longer detectable or below cut-off in plasma (thus no effect due to the drugs). Introducing the penalization of driving while impaired by psychoactive medicines - primarily the abuse of benzodiazepines - would lead to the removal of another risk population from traffic.

Acknowledgements
The authors would like to express their special thanks to B. Laeremans and A. Coppe for their help and participation in the data search and processing.

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First Experiences with the New Law on DUID in Belgium: Field Results and Plasma Levels of Illicit Drugs

[1]M. Willekens, [2]N. Samyn, [2]G. De Boeck, [3]V. Maes and [4]A. Verstraete

[1] Federal Police, DGJ-DJP, Drugs Programme, Brussels
[2] National Institute of Criminalistics and Criminology, Brussels
[3] Dept. of Clinical Chemistry - Toxicology, Academic Hospital -VUB, Brussels
[4] Laboratory of Clinical Biology - Toxicology, University Hospital, Ghent

Keywords
Traffic law, driving under the influence (DUID), impairment, illicit drugs

Abstract
This article summarizes the first experiences of the application of the new law on DUID in Belgium. Results of the field sobriety test performed by the Police Officer, the on-site urine test and the blood analysis are presented.

Introduction
In March 1999 a new law on driving under the influence of illegal drugs was introduced in Belgium (1). This law was completed by the RD of June 1999 and can be considered as an extension of the traffic code from March 1968. The number of drug classes mentioned in the law is limited to amphetamines and the designer amphetamines (MDMA, MDEA, MBDB), cocaine (benzoylecgonine), morphine and cannabis (THC), drug groups for which a urine screening test was available on the Belgian market. Police Officers had waited for a very long time for a procedure to demonstrate that drivers were not only under the influence of alcohol, but also of other products that impaired their driving skills.

The original law of 1968 had one article (art. 35) stating it is forbidden to drive when drunk or a in similar state due to the use of drugs (both legal and illegal). Another traffic law (RD 01/12/75) article 8.3 mentions that every driver must at all times be able to perform all maneuvers and possess the necessary ability and skills to drive. However, as no detailed testing method was defined, the Officer needed a decision from the prosecutor in each separate case. As far as the authors could check, no one has ever been convicted for trespassing on these articles.

This study presents the results of the field sobriety tests performed by the Police Officer, the on-site urine tests and the blood analyses for the period of 2001-2002.

Methods

Subject selection

The target population in this study consists of drivers apprehended by the police in Belgium during 2000-2001, under suspicion of driving under the influence of drugs, sometimes in combination with alcohol. The selection procedure is a three-step-process:

1) A standardized test battery (checklist) to check the drivers' level of impairment. The first part of this test battery mentions all physical signs of influence, the second part consists of four psychomotor tests: the Romberg, the one leg stand, the walk and turn, and the finger to nose. In order to decide whether a person might be impaired, at least one parameter in each part of the test battery has to be clearly positive.

2) If signs of impairment are detected, the Officer proceeds to the second step of the procedure, the urine test. If there are no clear signs of "being under the influence", the procedure stops at this point. There is a toilet available on the spot, and if not, the person has to be taken to the Police Station for collecting a urine sample. The law clearly states that all measures have to be taken to respect the privacy of the person. On the other hand, the Court Circular for the Police proceedings also says that the Police Officer has to take all measures necessary to avoid adulteration of the urine sample.

   To screen the urine, a rapid immunoassay test is applied on-site. Theoretically, there is a choice between a single-drug test ("pipette" system) and a multi-drug panel-test ("dip" system) but in practice, all Officers use the panel-test. The on-site urine test Dipro drug screen 5 panel (VanDePutte group, Boechout, Belgium) provides results for five products: cannabinoids (cut-off 50 ng/mL), morphine (cut-off 300 ng/mL), cocaine (cut-off 300 ng/mL), methamphetamines (cut-off 500 ng/mL), and amphetamines (cut-off 1000 ng/mL). The paneltest was extensively evaluated in the laboratory (2) and showed an excellent cross-reactivity for MDMA and MDA.

3) If this urine test is positive for at least one drug class, a physician is summoned to take a blood sample. At least 14 ml of blood will be taken and sent to a certified laboratory as soon as possible. The cut-off values for the plasma analysis are also mentioned in the law: THC (tetrahydrocannabinol) 2 ng/mL, free morphine 20 ng/mL, amphetamine, MDMA (ecstasy), MDEA, MBDB, benzoylecgonine (BE) or cocaine 50 ng/mL. After receiving the requisition from Court, the laboratory then has 15 days to report the results. Within 30 days the driver has to be notified about the results of the analysis, and he then has again 14 days to decide about an eventual counterevaluation.

   A driver can refuse the test battery, the urine test or the blood sampling. However, refusal is punishable and the penalty is equal for both refusal and positive result. The fine can vary between 1.000 and 10.000 Euro (or imprisonment from 15 days to 6 months) in addition to the costs of the analysis and the Court case and an eventual retreat of the driving license.

Sample selection

The Toxicology laboratory of the National Institute of Criminalistics and Criminology (NICC) detected illicit drugs above the legal cut-off in 763 DUID plasma samples during 2000 - 2001.

The results of the other labs were not yet available, but as the NICC received the majority of the blood samples, the data can be used for a first evaluation.

Analytical method
The concentrations of the target drugs in plasma were determined by GC-MS techniques with deuterated internal standards; the LOQ for the different compounds was largely sufficient to meet the cut-off values stated in the law of March 1999.

Results

Field sobriety test
Before the publication of the law, the first training sessions had already been organized for the Federal Police. About 200 Officers from all over the country, local drug-experts and teachers (with experience in drug teaching) from Police-Academies, were trained for one week. The theory was put to practice during a roadside control. During these practical exercises some minor errors appeared, and the training curriculum was immediately adapted. Some problems appeared with the screening tests and were solved by the manufacturer. It was up to these newly trained Officers to pass the training to the rest of the Police.

Most of the control activities are focused on the spots where it is likely to find positive drivers: in the neighborhood of discotheques or after-clubs. Another part of the control activity is focused on the roads and highways coming from the northern borders of the country ('coffee shop' visitors). Best practice seems to be a control action with a spotter on the road (experienced officer) who acts as first filter. The second filter is the first step of the procedure, the standardized test battery. This procedure has proven its efficiency: on several Sunday-morning controls, positive results were obtained on one or two out of three stopped cars.

Analytical Results

Urine
During 2000-2001, the NICC has registered a total of 896 DUID cases. Based on the on-site test results of the urine screening, the corresponding plasma samples were confirmed for one or more legally relevant target analytes. In 121 cases (13.5 % of total), no urine sample was provided. The results of the on-site screening indicate a high prevalence of cannabis users and users of stimulants (both amphetamines and cocaine) in this population (Table 1). Combinations of several drugs are quite common.

Table 1: On-site urine test results of all cases registered as DUID where a urine sample was available

Drug groups / U	N (= 775)	%
Cnb	304	39.2
Amph/Cnb	160	20.6
Amph	100	12.9
Amph/Cnb/Coc	54	7.0
Amph/Coc	36	4.6
Cnb/Coc	30	3.9
Cnb/Opt	21	2.7
Amph/Cnb/Opt	20	2.6
Coc	11	1.4
Cnb/Coc/Opt	10	1.3
Opt	9	1.2
Amph/Cnb/Coc/Opt	6	0.8
Amph/Coc/Opt	5	0.6
Coc/Opt	5	0.6
Amph/Opt	4	0.5

Plasma

In 763 of the corresponding plasma samples the punishable presence of the drugs mentioned in the law was demonstrated. Figure 1 gives an overview of the different combinations of illicit drugs that were detected in plasma. Concentration median and range of the most prevalent analytes are shown in Table 2.

Figure 1: Prevalence of different illicit drugs in plasma samples obtained from impaired drivers

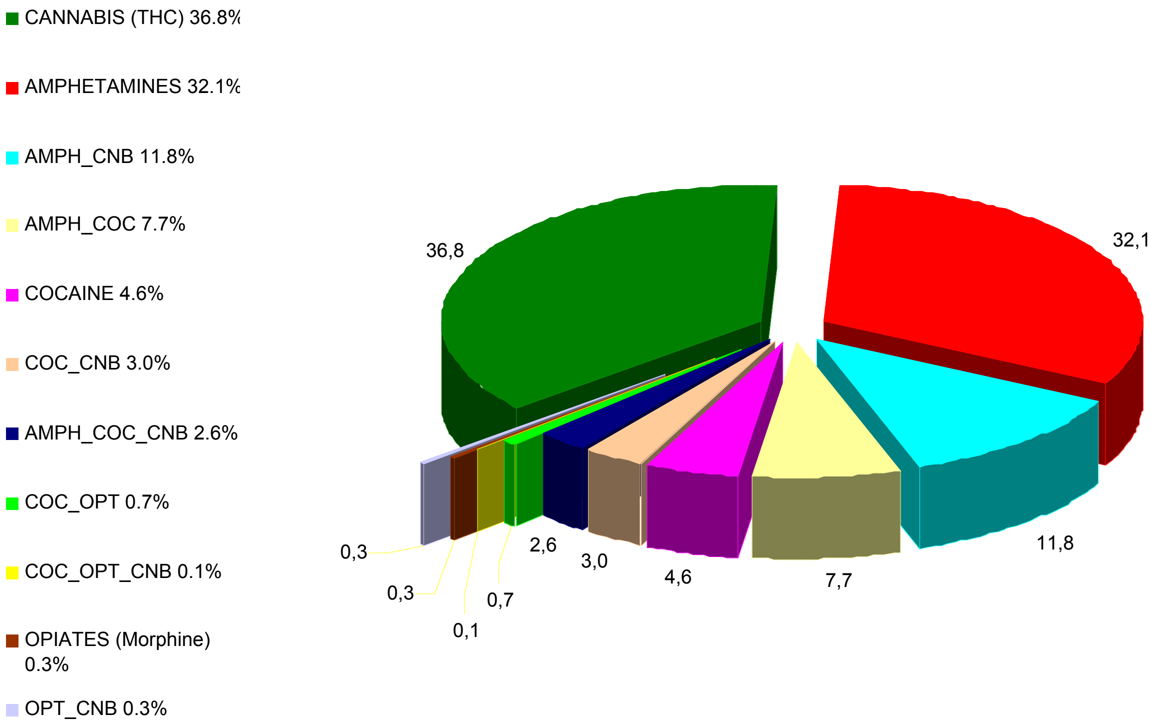


Table 2: Median and range of plasma concentrations (ng/mL) of target analytes in some of the legally positive DUID samples

	THC	***MDMA***	**Amph**	**BE**	***Morphine***
Cnb only	**7.8** (2.0-97.0)				
Cnb/Amph	**4.4** (2.0-27.5)	**279** (27-1582)	**90** (13-980)		
Amph only		**345** (10-5003)	**147** (14-2146)		
Amph/ Coc		**419** (54-1570)	**99** (24-3163)	**325** (53->5000)	
Cocaine only				**448** (66->5000)	
Coc/Opt				**778** (95-2685)	**35** (28-64)
Opt all					**32** (24-64)

Cannabis and amphetamines are obviously the major drugs detected in the impaired driver population. Details of the analytical findings of the cannabis positives are shown in Figure 2. Data on amphetamine, methamphetamine and the designer amphetamines are presented in Figure 3.

Figure 2: Median concentrations (ng/mL) of THC and its metabolites (THC_OH and THC_COOH) in the cannabis-only blood samples

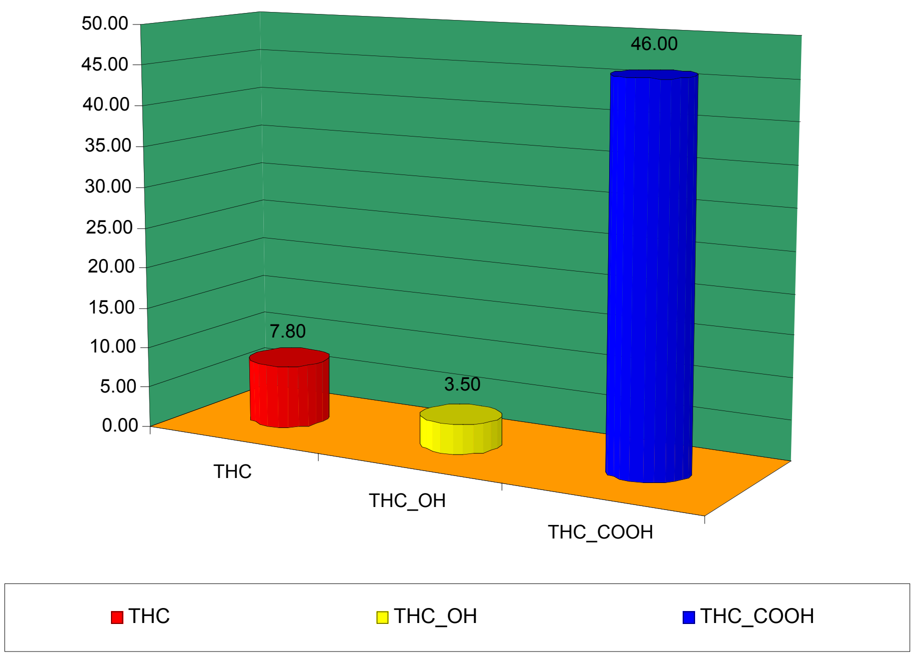
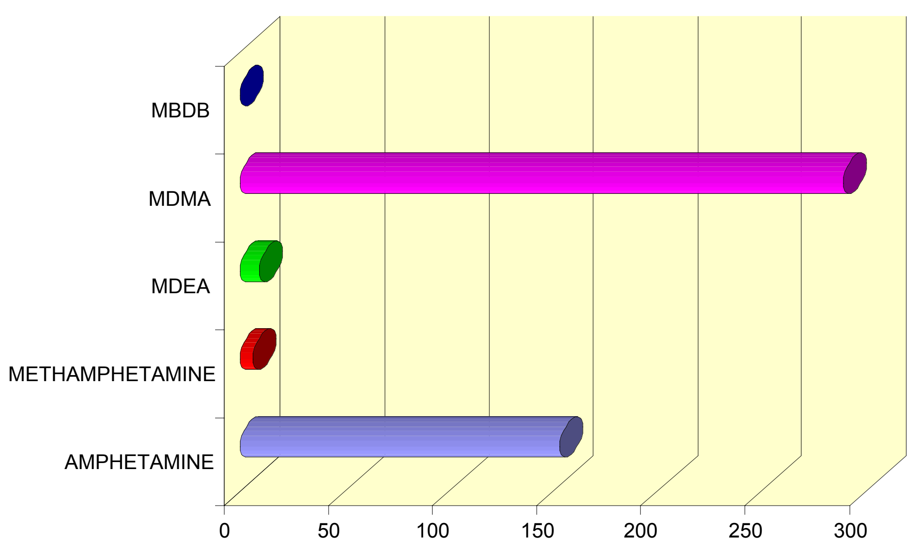


Figure 3: Prevalence of the different amphetamines in the driver population



Discussion

The validity of the new legal procedure for detecting drivers under the influence of illicit drugs is reflected in the number of positive plasma confirmations. As the 15% of not-confirmed cases seemed rather high, Maes et al. (3) investigated the possible reasons for a failed field impairment test, a positive urine test but no illicit drugs above cut-off in the blood.

The total number of DUID cases in the period 2000-2001 was lower than expected from large epidemiological studies about alcohol and drug prevalence in drivers. Some problems were caused by a lack of communication between the Ministry of Justice and the local Courts. Even if the law was applicable since April 1999, many Prosecutors did not sue, as they did not yet receive an explicative circular about this new law. This problem was only solved in December 2000. Only then all Belgian Police-services were able to perform DUID-controls. Coinciding with a massive Police reform in Belgium, it is possible that some of the first applications of the procedure were erratic. The lack of efficient training courses remains a major concern at the moment.

Some local Courts have informed their Police-services that when a positive breath test has been taken, they prefer to prosecute for drunk driving, rather than to continue with drug testing which is more expensive and time-consuming. A National Circular however asks the Police-services to do both procedures and harmonization of the strategy is highly recommended.

Acknowledgements

The authors would like to express their special thanks to B. Laeremans and A. Coppe for their help and participation in the data search, processing and interpretation.

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Effectiveness of The Use and Lose Law

[1]R.P. Compton, [2]R.G. Ulmer, [2]V.I. Shabanova

[1]Chief, Research and Evaluation Division, National Highway Traffic Safety Administration, Washington, D.C., USA;
[2]Preusser Research Group, Inc., Trumbull, Connecticut, USA.

Keywords
Use and Lose laws, license suspension, subsequent driver records, underage drinking

Abstract
The term AUse and Lose≅ describes laws that authorize driver licensing actions against persons found to be using or in possession of illicit drugs, and against young persons found to be drinking, purchasing or in possession of alcoholic beverages. Logistic regression and survival analyses were used to assess the highway safety effects of AUse and Lose≅ in Pennsylvania in terms of subsequent motor vehicle crashes and violations of underage persons arrested for alcohol/drug violations. Drivers under the age of 21 suspended for drinking, purchasing or in possession of alcohol or illicit drugs were less likely to have subsequent traffic convictions and crash involvements than young drivers similarly charged but not suspended. License suspension is recommended for these Ahigh-risk≅ young drivers.

Introduction
The term AUse and Lose≅ has been coined to describe laws that authorize driver licensing actions against persons found to be using or in possession of illicit drugs, and against young persons found to be drinking, purchasing or in possession of alcoholic beverages. Use and Lose laws generally began to appear during the mid-1980s. The basic premise of these laws was that teens highly value obtaining a driver=s license and that the threat of losing their license, or delaying when one could be obtained, would deter many from substance abuse. Information compiled by NHTSA indicates that in 2000 there were 36 states and the District of Columbia that specifically authorized driver license denial or withdrawal for underage alcohol purchase, consumption or possession.

Use and Lose laws generally have been enacted to combat alcohol/drug abuse irrespective of possible highway safety benefits. That is, as it came to be recognized that young persons were not very likely to be jailed or otherwise substantially sanctioned by the criminal justice system for alcohol/drug offenses, states sought a meaningful sanction to deter these offenses. Driver license removal, or denying licensure, was seen as a sanction that could be readily imposed and would be meaningful to youth.

While the focus of Use and Lose laws has been on deterring substance abuse, presumably they should also have highway safety effects. License denials, suspensions and revocations under these laws range from 30 days to as much as five years for repeat offenders. The persons convicted are likely to be a sample of individuals who are Aat risk≅ for alcohol/drug impaired driving. Of special relevance from the highway safety point of view, are those Use and Lose laws which include alcohol violations since youth have very high crash rates and alcohol is the one drug most often associated with highway crashes.

Information from several states has indicated that the actual implementation of Use and Lose can vary from case to case. This circumstance creates the possibility of a naturally occurring Aexperiment≅ where the driving records of youth arrested on a Use and Lose charge who underwent a license action can be compared with the records of youth arrested who did not receive a license action.

Methods

Use and Lose Law

Pennsylvania was chosen because of its longstanding Use and Lose law. The Pennsylvania law calls for license suspension or delay in licensing of persons under the age of 21 convicted of: 1) purchase, consumption, possession or transportation of liquor, malt or brewed beverages; or 2) misrepresenting age to obtain alcohol; 3) or carrying a false identification card. The suspension period or delay in licensing is 90 days for a first offense, one year for a second offense and two years for subsequent offenses.

Data

The Pennsylvania Commission on Crime and Delinquency provided data on Use and Lose cases filed in the District Courts during 1995, 1996 and 1997. This file was transmitted to the Bureau of Driver Licensing of the Pennsylvania Department of Transportation which did a name/date of birth search of its driver record files to obtain data on the crashes and motor vehicle law violations of the persons involved. Driver records for 5,690 individuals were available for analyses.

Analytical approach

All cases were categorized into 4 groups based on specific driver's license suspensions, following an arrest for a Use and Lose- related charge. Using logistic regression and odds-ratios (OR), two specific outcomes, crashes and traffic violations, were used to evaluate subsequent driving performance of those who did and did not undergo license suspensions. Significance of parameter estimates was tested with -2 log likelihood statistic and of the odds ratios with chi-square statistic (p-value <.05). Survival analysis was then used to estimate the likelihood of a subsequent violation or crash over time between different groups of license actions. In the survival analysis models, subjects were tracked until their subsequent traffic event or until the last date available in the driver history file, but limited to 48 months. Survival was computed by the Kaplan-Meier method. Differences in the survival parameters were tested for significance using the log-rank test. The statistical significance of each parameter was first tested in univariate Cox regression analysis, then significant predictors were entered into Cox proportional hazards multiple regression models.

Results

Sample Characteristics

Study population consisted of 5,690 individuals who were arrested between December 31, 1994, and December 31, 1997, on Use and Lose- related charges for whom a driver history record could be found. (In Pennsylvania, persons under the age of 18 are usually processed in the juvenile court system. These cases were not available for the study.) The majority of subjects were males with the mean age of 19.5 years (SE=0.86). Over two thirds had at least one previous traffic violation prior to the input arrest, about one in four had a previous motor vehicle crash, and about 40 percent had at least one previous driver=s license suspension (Table 1).

Table 1: Study Population Characteristics, Pennsylvania (N=5,690)

Characteristic	N (%)	Characteristic	Yes, N (%)
Age:		Previous Traffic	
Under 18	45 (0.8)	Violations	3,882 (69.2)
18	1,766 (31.0)		
19	1,972 (34.7)	Previous Crashes	1,413 (24.8)
20	1,907 (33.5)		
Gender:		Previous	
Male	4,849 (89.2)	License Suspensions	2,266 (39.8)
Female	585 (10.8)		

Almost all (5,607) of the arrest charges were for purchase, consumption, possession or transportation of alcohol (Section 6308). The remaining charges were for misrepresenting age to purchase alcohol or carrying false identification (83). One-half (2,851) of all of the Use and Lose charges were coincidental with a DWI arrest that had led to a DWI licensing action; of these, one-half also underwent a Use and Lose license suspension. (Such suspensions are applied sequentially.) For the purposes of the analysis, this group of drivers was considered as having a DWI-related license suspension. Among the remaining cases, 1,821 had no license action associated with the input arrest, 784 had undergone only a Use and Lose Suspension, and 234 had undergone a license action for another reason such as point count (Table 2).

Table 2: Four Driver's License Action Groups Following Input Arrest, Pennsylvania (N=5,690)

Suspension	N (%)
DWI-related	2,851 (50.1)
Only Use/Lose-related	784 (13.8)
Other	234 (4.1)
None	1,821 (32.0)

About 60 percent of the study population committed at least one subsequent traffic violation and about one fifth were involved in at least one subsequent motor vehicle crash (Table 3).

Table 3: Subsequent Violations, Crashes, and License Actions, Pennsylvania (N=5,690)

Subsequent Event	N (%)
Traffic Violation	3,464 (60.9)
Automobile Crash	1,021 (17.9)
Use and Lose License Suspension	652 (11.5)
DWI License Suspension	114 (2.0)

Probability of A Subsequent Traffic Violation or Crash
Age, gender, and driver=s license action group after the input arrest were each evaluated separately and together in association with the odds of having a subsequent violation or a subsequent crash.

The bivariate and adjusted associations showed that those who underwent a license action, and especially a DWI-related action, were less likely to commit a subsequent traffic violation than were those who had no action taken against their license. Generally, younger subjects and male subjects were more likely to commit a subsequent traffic violation (Table 4).

Table 4: Associations Between Age or Gender or Driver=s License Action Group with a Subsequent Violation, Pennsylvania (N=5,690)

Characteristic	Proportion with Event (%)	Adjusted OR (95%CI)	p-valueη
Age		0.78 (0.73, 0.83)	0.000
Gender			
Male	3044/4849(62.8)	1.90 (1.60, 2.27)	0.000
Female	268/585 (45.8)		
License Action Group			
None	1290/1821(70.8)		
Use/Lose Related	469/784 (59.8)	0.61 (0.51, 0.73)	0.000
DWI Related	1559/2851(54.7)	0.52 (0.46, 0.60)	0.000
Other	146/234 (62.4)	0.65 (0.49, 0.88)	0.004

η2*[LL(N)-LL(0)]=229.090, p=0.000 (Model included age, gender, and license action group)

Only the type of a driver=s license action received for the input arrest statistically affected the odds of being involved in a subsequent crash (Table 5). The difference based on age or gender was not found to be statistically significant ($p>0.050$).

Table 5: Associations Between Age or Gender or Driver=s License Action Group with a Subsequent Crash, Pennsylvania (N=5,690)

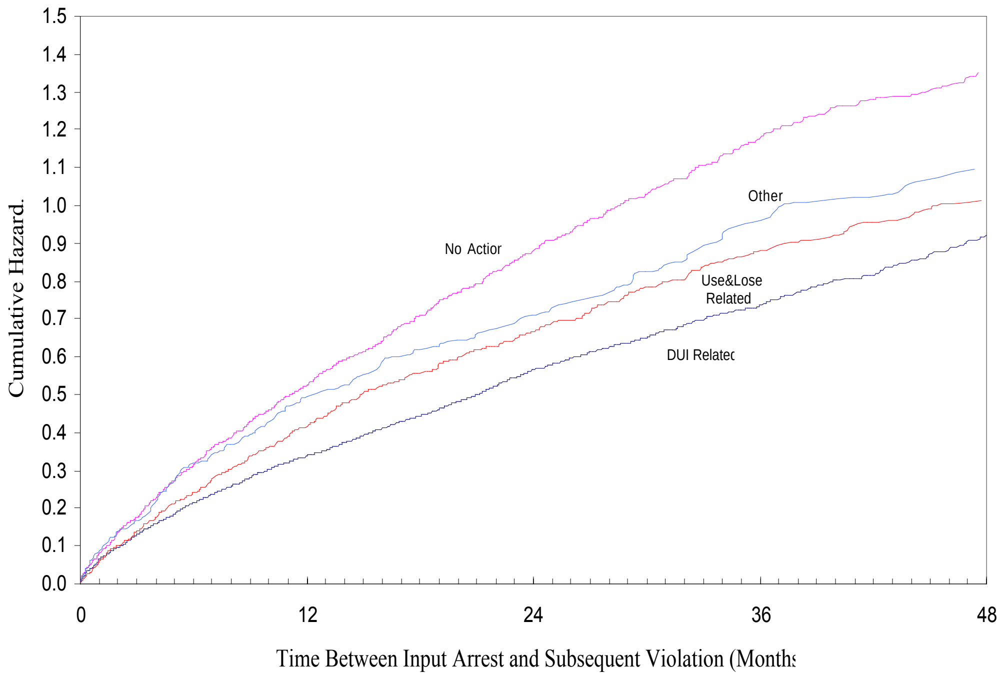
Characteristic	Proportion with Event (%)	Adjusted OR (95%CI)	p-valueη
License Action Group			
None	386/1821 (21.2)		
Use/Lose Related	113/784 (14.4)	0.64 (0.50, 0.80)	0.000
DWI Related	485/2851 (17.0)	0.79 (0.68, 0.92)	0.003
Other	37/234 (15.8)	0.69 (0.47, 1.01)	0.057

η2*[LL(N)-LL(0)]=23.431, p=0.000 (For the model with Alicense action group≅ variable only)

Rate of Incidence of Subsequent Violation or Subsequent Crash
On average, the subjects were followed for 3.4 years (25^{th} percentile=2.7 years, 95^{th} percentile=4.8 years). Overall, the cumulative rate of a subsequent violation per month after the input arrest was higher than the one for a subsequent crash.

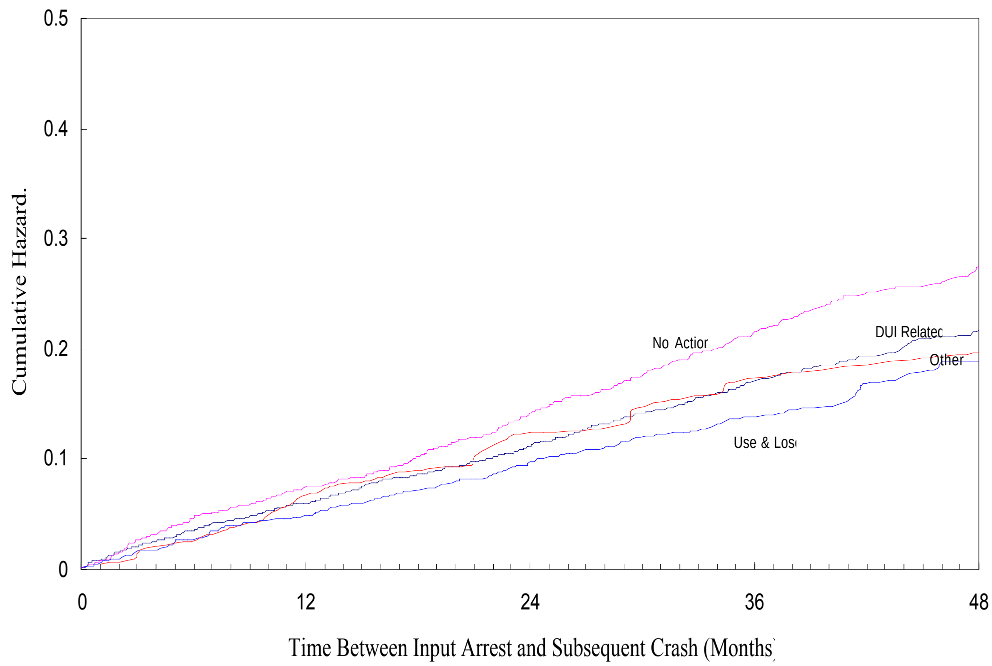
Using Cox proportional hazards regression model, age, gender, and license action group were found to be significant predictors of the rate of incidence of a subsequent traffic violation. Older offenders had a lower rate of incidence than the younger offenders: HR=1.25 (95% CI, 1.19-1.32) for the 25^{th} percentile age (18.8 years) vs. the 75^{th} percentile age (20.3 years); males committed subsequent traffic violations at 1.52 times the rate of females (95% CI, 1.35-1.73); and, compared to the group with no license actions after the input arrest, those with a DWI-related license action had the smallest rate of incidence (HR=0.68, 95% CI, 0.63-0.74), those with a Use and Lose-related license action had the second smallest rate (HR=0.75, 95% CI, 0.68-0.84), and those with other license actions had the third smallest rate (HR=0.81, 95% CI, 0.68-0.96). Figure 1 graphically depicts the cumulative rates of having a subsequent traffic violation between the four license action groups.

Figure 1: Cumulative Hazard Rate for Subsequent Violation, By License Action Groups, Pennsylvania (N=5,690)



After controlling for all three independent variables, only age and driver=s license action group were significantly associated with the rate of incidence of a subsequent crash. Those who committed an input offense at the 25th percentile age (18.8 years) had 1.12 times the rate of the 75th percentile age (20.3 years) (95% CI, 1.00-1.25). Compared to the group with no license actions applied, the group with Use/Lose-related license actions had the lowest rate (HR=0.66, 95% CI, 0.53-0.82), and the group with DWI-related license actions had the second lowest rate (HR=0.83, 0.72-0.95). There was no statistically significant difference between those who received other license actions and those with no license actions applied (HR=0.74, 0.52-1.04). Figure 2 depicts the plots of the rates of incidence of a subsequent crash after the input arrest for the four license action groups.

Figure 2: Cumulative Hazard Rate for Subsequent Crash, By License Action Groups, Pennsylvania (N=5,690)



Discussion

The young persons examined in the present study had been arrested on charges of alcohol and substance abuse, often including DWI. The majority of these persons had traffic violation convictions prior to the input arrest and a large minority had a previous action taken against their driver=s license. Also, about one in four had a previous motor vehicle crash. These circumstances suggest that the study population was high risk from the highway safety point of view.

The findings in Pennsylvania, that license actions taken against this group do lead to fewer subsequent violations and crashes, provide additional evidence that the withdrawal of driving privileges is an effective driver control measure. While the study findings do not comment on the possible deterrent effects of Use and Lose laws on substance abuse by young persons, the application of license actions do lead to fewer violations and crashes by this high risk group.

Does Graduated Driver Licensing Reduce Drinking and Driving?: An Examination of California's Teen Driving Restrictions

[1]S.A. Bloch, [2]H-C. Shin and [2]S.N. Labin

[1] Public Affairs A131, Automobile Club of Southern California
3333 Fairview Road, Costa Mesa, CA 92626
[2]Institute for Survey Research, Temple University
4646 40th Street, NW, Washington, DC 20016

Keywords
Drinking and driving, graduated driver licensing

Abstract
In July 1998, California passed one of the U.S.'s toughest graduated driver licensing (GDL) laws. This study evaluates the effect of the state's GDL provisions—a strict teen passenger restriction and nighttime driving limitation—on alcohol-related crashes. While prior studies do not clearly demonstrate that GDL leads to alcohol-related crash reductions among teens, results in California show sharp reductions in had been drinking crash rates of 16-year-olds, especially in comparison to crash rates for a control series of 19-year-old drivers. The reduction in the had been drinking driver crash rate (per 100,000 drivers) for 16-year-olds from pre-GDL to one year post GDL is 16.0%; during the second post GDL year, it is 13.1%. When crash rates are standardized to control for crash trends of 19-year-olds, reductions are 21.0% and 22.0% in post GDL periods.

Introduction
In recent years, teen nighttime driving restrictions and passenger limitations have become common in the U.S. and elsewhere (New Zealand, Australia, Canada) as part of graduated driver licensing (GDL) systems. Research has clearly shown that teen crashes occur disproportionately at night (1-3), when drinking and driving is greatest, and that crashes rise significantly when teens drive with other teens in the vehicle (4,5)—presumably because teens are more likely to involve themselves in risky activities like drinking and driving when other teens are present. Taken together, these findings suggest that, when graduated licensing systems are instituted, they should result in reductions in teen drinking and driving.

Despite this logic, the relationship between GDL and alcohol-related crashes has not been well examined. Reasons for this include that most GDL laws are quite recent, localities generally have insufficient alcohol-related teen crashes to test the hypothesis, and localities often impose drinking and driving restrictions (particularly lower BAC laws) as a component of GDL laws, confounding potential analyses. Still, two recent studies reported findings on this subject (6,7).

Shope found that the rate of 16-year-old Michigan drivers in crashes declined in nearly every category (day, night, single vehicle, nonfatal injury, etc.) after GDL, especially after adjusting for populationwide trends (drivers 25 and older). The notable exception was, however, alcohol-related crashes. Shope reports that, after controlling her alcohol-related crash indicator for populationwide trends, alcohol-related crashes showed no change at all (that is, her relative risk indicators were almost exactly 1). (It should be noted that Shope also found an exception for fatal crashes; this finding, however, was "likely due to the relatively small numbers of such crashes.")

Foss reported that North Carolina crash rates of 16-year-olds declined sharply after GDL for all severities and types of crashes—including alcohol-related crashes. The alcohol-related crash finding is, however, somewhat questionable. While population-adjusted crash rates for 25-54-year-olds increased for every other subgroup studied, they *decreased* for alcohol-related crashes. Foss, therefore, showed that his results were conservative for all subgroups of crashes—except alcohol-related collisions. For that one subgroup (rate ratio=0.62; 95% CI=0.44-0.88), reported results overstated the effect. Because the sample size for alcohol-related crashes was small and the 95% confidence interval very large, it is quite possible that the statistical significance of the crash rate decrease would have disappeared if population controls had been formally examined. In brief, then, the two studies examining GDL's effects on alcohol-related crashes produced equivocal results. No decrease was found in Michigan, while suggestive, but inconclusive, findings were reported in North Carolina.

California implemented a teen licensing law in July 1, 1998, covering all young drivers less than 18 years of age. In imposing one of the U.S.'s toughest GDL laws, the state instituted the country's first, and still perhaps most stringent, passenger restriction (provisional license drivers cannot drive any passengers under age 20 for their first six months) and restricted teens from driving between midnight and 5 a.m. for their first year. Prior to receiving a provisional license, teens were also required to hold an instruction permit for at least six months.

Given the strength of the provisions of California's GDL law and the fact that preliminary evidence found that the state's law was effective in reducing crashes (8), it will be interesting to determine whether effects of California's GDL law on alcohol-related collisions are different from, or more clear than, in other localities. In brief, this study evaluates whether California's GDL provisions reduced teen alcohol-related crashes.

Methods

Crash data have been obtained from the California Highway Patrol's Statewide Integrated Traffic Records (SWITRS) system. Data for the following crash types were gathered: had been drinking (HBD) (all alcohol levels), "day" (5 am-11:59 p.m.), "night" (midnight to 4:59 am), non-injury "property damage only" (PDO), and had not been drinking (HNBD).

Data cover nine and one-half years, from January 1992 through June 2001. In this analysis, the pre-GDL period is April 1997-March 1998, and the post GDL period is April 1999-March 2001. An intermediate year (April 1998-March 1999) is omitted because of the unusual levels of licensing activity taking place during much of the period, particularly during the three months (April through June, 1998) just prior to GDL.

Because new drivers had to hold instruction permits for six months before receiving provisional licenses, no 16-year-old received a license under the new law until January 1999. As a result, the post GDL period could not be begun until at least January 1999. In actuality, April 1999 was selected for use in this study because it was one year after the April 1998 cutoff and it allows comparisons of comparable one-year periods (such as, April, 1997-March, 1998 and April, 1999-March, 2000). This approach eliminates the confounding effects of seasonal factors.

Using April 1999 as the beginning of the post GDL period is not without complications. A number of 16-year-olds who had been licensed under the old system still held licenses through June 1999. Therefore, some 16-year-old non-GDL drivers are included in the GDL group. Still, April 1999 is considered the best alternative for two reasons. First, the bias of this cutoff was in a conservative direction, tending to reduce, rather than increase, the effect of GDL. Second, any effect introduced by this approach is eliminated during the second post GDL year when all 16-year-old drivers would have passed through the GDL system.

Analysis in this study is in two parts. In the first, Table 1, crash rates (per 100,000 population) of 16- and 19-year old drivers are compared before and after GDL. In the second analysis, Table 2, controls for societal trends (varying levels of enforcement, economic factors, special traffic safety initiatives) are introduced by standardizing crashes of 16-year-olds by those of a control series for 19-year-olds.

It is worth noting that use of 19-year-old drivers as a control group differs somewhat from the control often used elsewhere, where 16-year-olds are typically compared to drivers 25 years of age or above. It is believed that, while analysis of crashes of drivers over 25 may control well for many general societal trends, the data ignore effects that can arise within the teen subculture such as changes in drinking patterns or risk-taking.

California has experienced a rapid rise in its teen population in recent years. As a result, all crashes in the analysis are examined as rates, derived by dividing crashes monthly by the number of those 16 and 19 years of age. Monthly population data were obtained from the California Department of Finance.

Results

This analysis focuses on the period from 1997-2001. Longitudinal changes are, however, also important to examine in determining if any unusual long-term trends exist that would alter the analysis. The Figure (below) presents 12-month moving averages of had been drinking driver crashes for 16- and 19-year olds for the period from 1993-2001. The Figure shows that crashes for 19-year-olds generally declined from 1993 through 1997, and then began to increase. For 16-year-olds, the Figure shows that crashes, in general, declined mildly throughout the period.

Crash rates (per 100,000 population) for 16- and 19-year-old drivers before and after GDL are presented in Table 1. Data in the table demonstrate that:

- Fatal and injury crashes have declined more than property damage only crashes. This finding holds for both HBD and HNBD crashes.
- Nighttime crashes have declined more than daytime crashes. Again the finding holds for both HBD and HNBD crashes.

Figure: Crash rates for 16- and 19-year-old drivers: Had been drinking driver crashes, 12-month moving average

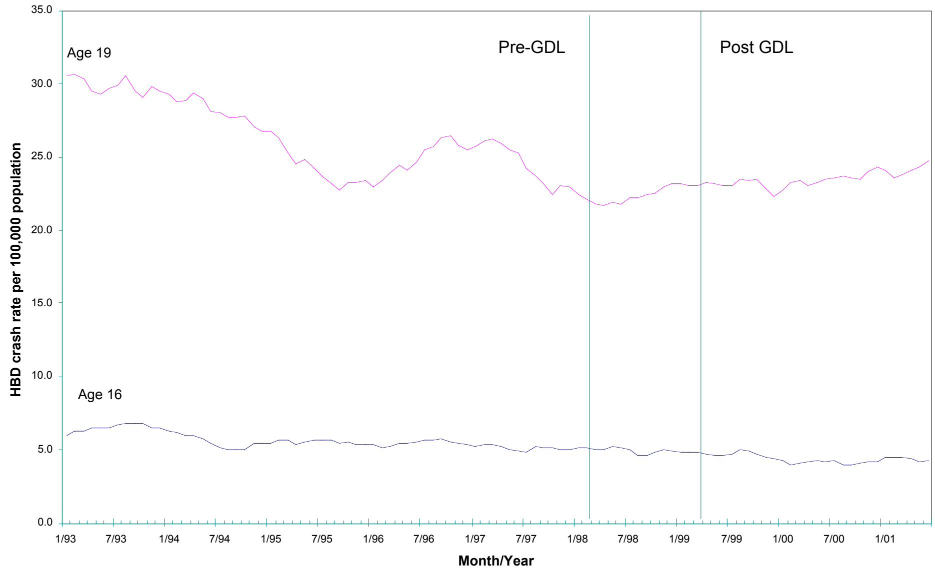


Table 1: Crash rates of 16- and 19-year-old drivers one year pre-GDL (4/97-3/98) and

		Drivers Involved in Crashes, No. (Rate Per 100,000 Population)			Percent Change Post GDL vs 1 y Pre-	
Crash Type	Age	Pre-GDL	Post GDL (4/99 - 3/00)	Post GDL (4/00 - 3/01)	1st y Post vs Pre-	2nd y Post vs Pre-
All	16	12,518 (231.196)	11,212 (199.575)	11,188 (197.255)	-13.7	-14.7
	19	21,818 (422.615)	26,147 (455.607)	28,457 (483.451)	7.8	14.4
All HBD	16	271 (5.001)	236 (4.201)	246 (4.344)	-16.0	-13.1
	19	1,118 (21.667)	1,321 (23.026)	1,421 (24.122)	6.3	11.3
HBD Day Fatal & Injury	16	89 (1.640)	72 (1.282)	76 (1.345)	-21.8	-18.0
	19	288 (5.582)	371 (6.473)	399 (6.772)	16.0	21.3
HBD Day PDO	16	85 (1.569)	82 (1.460)	88 (1.550)	-6.9	-1.2
	19	333 (6.454)	414 (7.214)	411 (6.979)	11.8	8.1
HBD Night Fatal & Injury	16	38 (0.701)	27 (0.481)	31 (0.550)	-31.4	-21.5
	19	230 (4.461)	243 (4.238)	282 (4.790)	-5.0	7.4
HBD Night PDO	16	59 (1.091)	55 (0.979)	51 (0.900)	-10.3	-17.5
	19	267 (5.170)	293 (5.100)	329 (5.581)	-1.4	7.9
All HNBD	16	12,247 (226.195)	10,976 (195.375)	10,942 (192.911)	-13.6	-14.7
	19	20,700 (400.948)	24,826 (432.581)	27,036 (459.329)	7.9	14.6
HNBD Day Fatal & Injury	16	4,946 (91.329)	4,484 (79.816)	4,293 (75.716)	-12.6	-17.1
	19	8,416 (163.051)	9,803 (170.870)	10,837 (184.069)	4.8	12.9
HNBD Day PDO	16	6,953 (128.441)	6,195 (110.271)	6,342 (111.778)	-14.1	-13.0
	19	11,174 (216.374)	13,718 (238.991)	14,732 (250.352)	10.5	15.7
HNBD Night Fatal & Injury	16	139 (2.561)	120 (2.136)	119 (2.099)	-16.6	-18.0
	19	506 (9.820)	523 (9.112)	633 (10.746)	-7.2	9.4
HNBD Night PDO	16	209 (3.864)	177 (3.151)	188 (3.317)	-18.5	-14.2
	19	604 (11.703)	782 (13.608)	834 (14.162)	16.3	21.0

- Crashes of 16-year-olds dropped for all time periods and in all categories. Crashes for 19-year-olds increased in most cases.
- Reductions in HBD crashes were relatively similar to reductions in HNBD crashes for 16-year-olds. Overall reductions are in the 13-15% range.

To control for societal crash changes, Table 2 shows calculated crash rate ratios of 16-year-olds relative to 19-year-olds during one-year pre-GDL and two years post GDL. While findings for this analysis are similar to those in Table 1, there are some notable differences. Findings for this analysis show that:

- Fatal and injury crashes have declined more than property damage only crashes among HDB crashes. Among HNBD crashes, however, the opposite is generally true.
- Fatal and injury HBD crashes, both during the day and at night, showed the greatest reductions for any indicator during the first and second post GDL years—32%-33% during the day and 27%-28% at night.
- Nighttime and daytime crashes have both declined. Findings are mixed as to which declined more.
- Because crashes for 19-year-olds *increased* in most cases in Table 1, relative declines shown in Table 2 are consistently greater for 16-year-olds than in Table 1.
- Reductions in HBD crashes are relatively similar to reductions in HNBD crashes. Reductions for HBD crashes are 21% and 22% for the first and second post GDL years; for HNBD, they are 20% and 26% during those periods.

Table 2: Comparative crash rates of drivers16-years-old vs drivers 19-year-old one year pre-GDL (4/97-3/98) and two years post GDL (4/99-3/01)

	Crash Rate of Drivers 16 y vs 19 y Per 100,000 Population			Percent Change Post GDL vs 1 y Pre-	
Crash Type	Pre-GDL	Post GDL (4/99 - 3/00)	Post GDL (4/00 - 3/01)	1st y Post vs Pre-	2nd y Post vs Pre-
All	0.547	0.438	0.408	-19.9	-25.4
All HBD	0.231	0.182	0.180	-21.0	-22.0
HBD Day Fatal & Injury	0.294	0.198	0.199	-32.6	-32.4
HBD Day PDO	0.243	0.202	0.222	-16.8	-8.6
HBD Night Fatal & Injury	0.157	0.113	0.115	-27.8	-26.9
HBD Night PDO	0.211	0.192	0.161	-9.0	-23.6
All HNBD	0.564	0.452	0.420	-19.9	-25.6
HNBD Day Fatal & Injury	0.560	0.467	0.411	-16.6	-26.6
HNBD Day PDO	0.594	0.461	0.446	-22.3	-24.8
HNBD Night Fatal & Injury	0.261	0.234	0.195	-10.1	-25.1
HNBD Night PDO	0.330	0.232	0.234	-29.9	-29.1

Discussion

Results clearly indicate that California's GDL system was associated with a substantial reduction in both alcohol-related and non-alcohol-related crashes. The reduction in the had been drinking driver crash rate (per 100,000 drivers) from pre-GDL to one year post is 16.0%; during the second post GDL year, it is 13.1%. The reduction in the had not been drinking crash rate during the first post GDL year is 13.6%; during the second year, 14.7%.

As a means of controlling for societal trends (economic activity, etc.) and changes in the teen population (drinking levels, risk-taking), crash rates of 16-year-olds have been standardized by dividing rates for 16-year-olds by those for 19-year-olds. When this is done, crash reductions for 16-year-olds appear consistently greater than before. Reductions in the had been drinking crash rate show declines of 21.0% and 22.0% during post GDL periods; reductions in the had not been drinking crash rate show declines of 19.9% and 25.6% for the two periods.

It is particularly noteworthy that fatal and injury crashes were more affected than property damage only crashes since personal and societal costs of fatal and injury crashes are more substantial. Standardized HBD crash rates show that fatal and injury crashes of 16-year-olds declined 28% (night) and 33% (day) in the first post GDL period and 27% (night) and 32% (day) in the second.

The reasons crashes declined in California after GDL require further analysis, although two possible explanations call for discussion here. The first concerns the effects of long-term crash trends. It is important to assess whether long-term crash trends can explain reductions in crashes of 16-year-olds after GDL. The answer from available data appears to be no. During the three years prior to the (1997-98) pre-GDL period, HBD crash rate reductions for 16-year-olds averaged just 2.4%, far less than reductions demonstrated after GDL. A second crash trend issue that warrants further examination is whether trends for 16- and 19-year-olds were similar before GDL, when they then diverged sharply. The answer is that, in general, these trends were similar. From 1992-93 (April- March) to 1994-95, HBD crash rate reductions averaged 8.6% per year for 16-year-olds and 8.0% for 19-year-olds; from 1994-95 through 1997-98, HBD crash rate reductions averaged 2.4% for 16-year-olds and 4.2% for 19-year-olds.

The second issue requiring further analysis is the degree to which changes in levels of teen licensure affected crash levels of GDL drivers. Clearly, reductions in licensure had an early effect on California teen crashes. During the first post GDL period, provisional licenses dropped 13.4% from their pre-GDL level. This reduction was substantial, although the degree to which it affected exposure (vehicle miles traveled) is not clear since such data are not available. What should be noted is that it is unlikely that a drop in licensure translates into an exact commensurate drop in exposure. Teens who choose not to get a license may well be those who need a car less, and are therefore less likely to drive as much. In any case, by the second post GDL period, the number of provisional licenses granted returned to the same level as before GDL. The 215,127 provisional licenses granted in 2000-2001 was less than 1% fewer than (-0.7%) than that (216,669) before GDL.

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Does Graduated Driver Licensing Reduce Alcohol-Related Crashes?

D.R. Mayhew and H.M. Simpson

Traffic Injury Research Foundation, Suite 200 - 171 Nepean Street,
Ottawa, Ontario Canada K2P 0B4

Keywords
Graduated driver licensing, young drivers, novice drivers, impaired driving, drinking driving, alcohol-related crashes

Abstract
Graduated driver licensing (GDL) has been implemented in numerous jurisdictions in North America and elsewhere to address the elevated crash risk of novice drivers, particularly young ones. Such a system phases in on-road driving, allowing beginners to gain their initial experience under conditions that are less risky. This paper examines the impact of GDL programs in Canada and the United States on alcohol-related crashes. Although every evaluation conducted to date has reported positive benefits overall, evidence for the effectiveness of GDL on alcohol-related crashes has been mixed. Reasons for this apparent inconsistency in the findings are discussed.

Introduction
The elevated crash risk among novice drivers, particularly young ones, has resulted in numerous jurisdictions in North America and elsewhere implementing graduated driver licensing (GDL). This system involves a step-wise introduction to full licensing that imposes restrictions on the new driver so they can gain their initial experience under conditions of low risk. Scientific evidence is mounting that GDL programs are an effective safety measure. Early efforts to implement versions of graduated licensing in Maryland and California were found to reduce the collision involvement of young drivers (1, 2). More recent evaluations of more comprehensive graduated licensing programs implemented in New Zealand in 1987, Ontario in 1994, Nova Scotia in 1994, Quebec in 1997, and Florida in 1996 have also found safety benefits, ranging from about 10% to 37% reductions on some measure of collision involvement (3, 4, 5, 6, 7).

Several evaluations are currently being conducted of graduated licensing programs implemented in Kentucky in 1996, Michigan in 1997, North Carolina in 1997, and California in 1998 (8, 9, 10, 11). Preliminary findings from these studies are consistent with the results of the completed evaluations.

Only a few studies have examined the effects of GDL specifically on alcohol-related crashes, even though an impact could be expected, given that many programs impose a night driving curfew (the time most often associated with alcohol-related collisions) and some even impose a zero tolerance provision. However, evaluations that have examined the impact of GDL programs on alcohol-related crashes in Canada and the United States have produced mixed results. This paper describes these studies and discusses the apparent inconsistencies in their findings.

Method
Scientific papers published in journals, conference proceedings or technical reports on the safety effectiveness of GDL programs in Canada and the United States for drivers of passenger vehicles were identified and critically reviewed. Only four studies examined the impact of GDL programs on alcohol-related crashes. The author(s) and publication dates of each of these evaluations are shown in Table 1.

Table 1: GDL Evaluations

Jurisdiction	GDL Implementation Date	Author(s) and Publication Date
United States		
Michigan	**1997**	**Shope et al. 2001**
North Carolina	**1997**	**Foss et al. 2001**
Canada		
Ontario	**1994**	**Boase and Tasca 1998**
Quebec	**1997**	**Bouchard et al. 2000**

All of these studies used pre-post comparisons with controls to assess changes in collisions among the primary target group. This approach involves comparing the prevalence of collisions among the primary target group prior to the introduction of the program to the collision experience of these groups after the program was implemented. Typically, the year the program was implemented is omitted from the comparisons because of transitional changes in licensing – e.g., a rush to get licensed just prior to implementation to avoid the new requirements (5).

The evaluations also compared per-capita collision rates in the before and after periods to control for fluctuations in population among the primary target group. A few studies compared per-driver collision rates to control for changes in licensing, which could account for changes in the frequency of collisions in the target group.

The two U.S. studies examined the impact of graduated driver licensing on the collisions of 16-year-old drivers, the primary target group for the program. The programs that have been evaluated in Canada examined the impact on all novice drivers, since the graduated licensing systems in Ontario and Quebec apply to all novices, not just those who are young.

The types of outcome measures of alcohol-related crashes examined in these studies have varied -- e.g., crashes in which police-reported the driver as having been drinking (HBD) or a "surrogate" measure such as single-vehicle crashes that occurred at night (SVN).

Results
All four studies consistently reported reductions in crashes of beginners, ranging from 17% in Quebec to 31% in Ontario. However, they did not all find a positive impact on alcohol-related

crashes. A positive impact on alcohol-related crashes was reported in the evaluations of Ontario and Quebec programs; no effect was found in the evaluation of the Michigan or North Carolina programs. The relevant results are shown in Table 2 and discussed below.

Table 2: Impact of GDL

Jurisdiction	Crashes Overall	Alcohol-Related Crashes
The United States		
Michigan	**-25%**	**NS**
North Carolina	**-23%**	**NS**
Canada		
Ontario	**-31%**	**-27%**
Quebec	**-17%**	**-9%**

Michigan

The GDL program was implemented in Michigan in 1997. Shope et al. (9) found that, after adjusting for population-wide trends, the overall per-capita collision rate of 16-year-old drivers declined significantly between 1996 and 1999 by 25%. There were also significant reductions over this period for non-fatal injury crashes (a 24% reduction) as well as for crashes occurring at night (a 53% reduction between midnight and 5 a.m.), during the evening (a 21% reduction between 9 p.m. and 12 a.m.), and during the day (a 24% reduction between 5 a.m. and 9 p.m.). Although the per-capita fatal crash rate also declined from 1996 to 1999, this difference was not statistically significant. Of primary concern to this paper, no significant decline was detected in the alcohol-related crash rate among 16 year olds, relative to those 25 years and older.

North Carolina

In a preliminary evaluation of the GDL program implemented in North Carolina in 1997, Foss et *al.* (10) reported that the per-capita crash rate of 16-year-old drivers declined by 23% (or by 27%, adjusting for the overall crash trend among drivers age 25-54). Per-capita crash rates declined for all levels of severity among 16-year-old drivers after the new program was implemented – fatal crashes by 57%, injury crashes by 28%, and non-injury crashes by 23%. Reductions were also observed for night-time crashes (by 43% between 9 p.m. and 5 a.m.) and daytime crashes (20%). As was the case in the Michigan analysis, the evaluation of the North Carolina program did not find a significant decline in the alcohol-related crash rate among 16 year olds.

Ontario

Boase and Tasca (4) conducted an interim evaluation of the Ontario program using a pre-post comparison group design. They found that the overall collision rate per 10,000 licensed novice drivers for 1995 (program group) was 31% lower than the rate observed for 1993 novice drivers (comparison group). The 1995 novice drivers had a casualty collision rate that was 24% lower than the rate of the 1993 novice drivers. They also reported that the 1995 G2 novice drivers (those in the intermediate phase) had an overall collision rate that was 16% lower than the rate for 1993 novice drivers.

The effects of the alcohol, night and freeway restrictions in Ontario were also examined and found to be very effective. Of pertinence to the present paper, reductions were observed in alcohol-related collisions (a 27% decline) as well as collisions between midnight and 5 a.m. (a 62% decline).

Quebec

The GDL program implemented in Quebec in 1997 has also been evaluated and proven effective (6). Bouchard et al. used a pre-post design to compare the crash record of the GDL group (learner and probationary drivers) with that of a non-GDL group composed of young drivers aged 18-24 who held a regular license. The authors found, after adjusting for changes in deaths and injuries among the control group, a 5% reduction in fatalities and a 14% reduction in injuries, attributable to the new program. To control for changes in the number of drivers, they compared per-driver collision rates of the GDL drivers and non-GDL drivers in the periods before and following graduated driver licensing. The per-driver fatality rate declined by 7% and the injury rate by 17%. Again, of particular relevance to the present paper, the analyses showed that alcohol-related fatalities and injuries – indexed in terms of the surrogate measure nighttime single vehicle crashes – declined by 9% among the GDL group, relative to the non-GDL group.

Discussion

Evidence of the effectiveness of GDL on alcohol-related crashes is mixed – a positive impact was found in Ontario and Quebec but not in Michigan and North Carolina. Several factors may explain this disparity.

First, unlike the GDL programs implemented in Canada, most of the GDL programs implemented in the United States do not include a zero BAC restriction because zero tolerance was already in place in these states for several years. Any impact of GDL on alcohol-related crashes in Michigan and North Carolina would have been expected when the zero tolerance law was introduced and not when GDL was implemented.

Second, U.S. GDL programs and studies also focus on the crash experience of teen drivers, typically those aged 16, who drive after drinking less often. Accordingly, alcohol-related crashes among 16 year-old drivers are relatively rare and it would, therefore, be difficult to detect a measurable impact. By contrast, GDL programs in Canada apply to all novice drivers, not just young ones, so it may be more likely to find a positive effect when the zero BAC restriction applies to all novice drivers. Moreover, no zero tolerance laws existed in Ontario or Quebec before the implementation of their GDL program with the zero BAC restriction.

Third, the positive findings in Ontario and Quebec may be overstated, or accounted for by factors other than the implementation of GDL. As mentioned previously, these studies used simple pre-post GDL comparisons with controls to assess changes in collisions among the primary target group. They did not consider the possibility that the reductions in alcohol-related crashes observed after GDL were, in part or totally, accounted for by a pre-existing downward trend in alcohol-related crashes. In this regard, Figure 1 compares trends in the percent of fatally injured 16-19 year old drivers in Canada who tested positive for alcohol with trends among a comparison group of 36-45 year olds. As can be seen, both groups are similar in that during the 1980s they showed a consistent decline in the proportion who were drinking, and showed less dramatic changes in the 1990s. But there are also differences in the trends. There was a much more dramatic decrease in the prevalence of drinking among young drivers who were killed – from 1982 to 1999, the percent of fatally injured drinking drivers aged 16-19 declined by 56%, compared to a 37% decline among fatally injured drinking drivers aged 36-45. A similar pattern occurred in the United States as shown in Figure 2, which compares trends in the percent of 16-20 and 35-44 drivers in fatal crashes who had been drinking. Thus, a pre-existing downward trend in alcohol-related teen crashes may account for at least some of the observed reductions after GDL was implemented in Ontario and Quebec. The studies of the impact of GDL programs in Ontario and Quebec, as well as in North Carolina and Michigan, did not use time-series analysis, so the pre-existing downward trends in alcohol-related crashes would not have been fully taken into account. Further research is needed controlling for the pre-existing trends to determine the actual impact of GDL on alcohol-related crashes.

The above explanations suggest that GDL should only be expected to reduce alcohol-related crashes if the jurisdiction does not already have a zero BAC law and is now introducing one, or if the program targets older novices not just those aged 16 and 17. As well, studies should rule out the possibility that pre-existing trends account for, all or some of, the changes in alcohol-related crashes after GDL implementation. Given these issues, the specific impact of GDL on alcohol-related crashes is as yet unknown, and this needs to be pursued further.

Figure 1 : Percent of 16-19 and 36-45 Year Old Fatally Injured Drivers with Positive BACs: Canada, 1982-1999

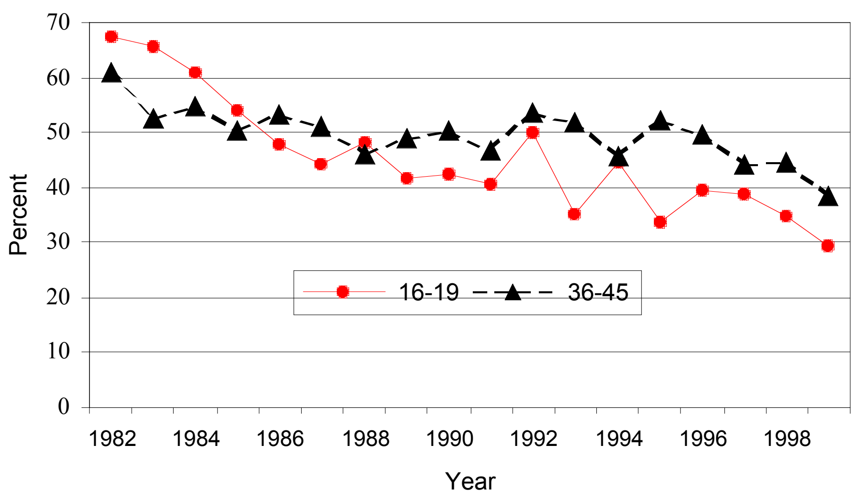
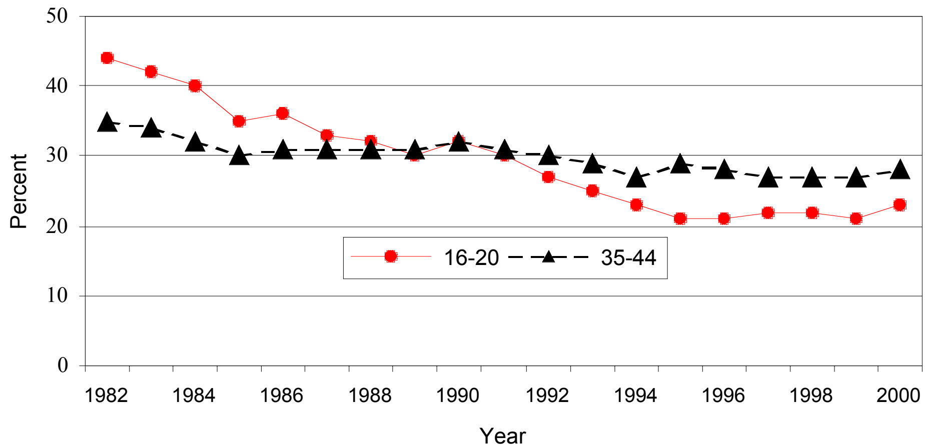


Figure 2 : Percent of 16-20 and 35-44 Year Old Drivers in Fatal Crashes with Positive BACs: U.S., 1982-2000



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