Road Casualties and Changes in Risky Driving Behavior in France Between 2001 and 2004 Among Participants in the GAZEL Cohort

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Objectives. We investigated behavioral changes in a large cohort of drivers to identify underlying causes of the decline in road casualties in France.

Methods. In 2001 and 2004, 11 240 participants used self-administered questionnaires to report attitudes toward road safety and driving behaviors. Injury road traffic collisions were recorded from 2001 to 2005 through the cohort's annual questionnaire.

Results. Between 2001 and 2004, speeding and cell phone use decreased concomitantly with a decrease in injury road traffic collision rates among participants. Reported driving while sleepy remained unchanged and driving while alcohol intoxicated was reported by a higher proportion in 2004 than in 2001. Decreases in speeding between 2001 and 2004 were strongly linked with positive attitudes toward road safety in 2001.

Conclusions. In this cohort, speeding and using a cell phone while driving decreased over the 2001 to 2004 period concomitantly with increases in traffic law enforcement and a dramatic decline in road mortality in France. However, the deterrent effect of traffic enforcement policies may have been reduced by negative attitudes toward traffic safety and having had a history of traffic penalty cancellations. (*Am J Public Health.* 2009;99:1247–1253. doi:10.2105/AJPH.2007.126474)

A very significant decline in the number of road casualties has been observed recently in France.[1,2] Road safety strategy to reduce road traffic collisions usually combines road safety engineering, prevention campaigns, and law enforcement measures. Traffic law enforcements were significantly enhanced in 2002, with an increased crackdown on road violations.

More specifically, speed control efficiency has dramatically improved with the widespread use of laser binocular and automatic speed radars, which were partly responsible for a 145% increase in speeding tickets between 2001 and 2004. During the same period, cell phone use while driving was forbidden,[3] penalties for drunk driving were enhanced, and a 52% increase in infringements for driving while alcohol intoxicated (DWI) was recorded by authorities. In addition, police forces were ordered in 2002 to put an end to traffic penalty cancellations[4] (to "fix the ticket" in US parlance), which tended to occur frequently in France when the offender had connections in the public administration or police force.[5,6]

One of the major conceptual frameworks underlying traffic enforcement is the deterrence theory, which focuses on increasing the individual's perceived expected cost of engaging in illegal activities.[7,8] The deterrence theory specifies 3 key factors that influence individuals' involvement in law violation, namely the celerity, certainty, and severity of punishment, reflected by a significant effect of increased speed enforcement on both speeding and collision occurrence.[9–11] Accordingly, measures taken by the French government between 2001 and 2004 might be partly responsible for reductions in speeding and in mean driving speed observed during this period,[2] but no data are available on whether they affected other risky behaviors.

The deterrent effect of law enforcement might be attenuated among drivers who share characteristics that have been repeatedly associated with risky behavior, such as male gender,[12,13] a higher annual driving mileage,[13–15] a higher occupational category,[14,16] and driving powerful vehicles.[17] Drivers with a history of having their penalties cancelled are also more prone to drive illegally than are others, given that such practice diminishes the certainty of punishment.[6] Psychological and motivational factors such as perceived driving ability, sensation seeking, and perceived safety skills have also been found to influence drivers' behavior,[18–21] and according to social cognition approaches,[22,23] variables such as attitudes, perceived risk, social norms, and perceived behavioral control are also significant determinants of behavior. In particular, attitudes toward traffic safety have been found to correlate with aggressive driving behavior, speeding, and self-reported accident involvement.[24–26]

In a previous study, we showed that opinions in favor of road restrictions increased between 2001 and 2004 in our study population, concomitantly with increased traffic law enforcement in France.[27] In light of recent road safety successes, it was of interest to assess behavioral changes that occurred during this period among the same participants, which could help identify the underlying causes behind the rapid decline in road mortality and contribute to the evaluation of traffic regulation initiatives.

We conducted a prospective study in a large cohort of French employees and retirees to describe behavioral changes that occurred between 2001 and 2004. The 3 specific objectives were to (1) identify which risky behaviors reported in 2001 were associated with traffic collisions resulting in injuries in the subsequent 5-year period, (2) assess how drivers' self-reports of these risky behaviors changed between 2001 and 2004, and (3) determine predictors of these changes.

METHODS

Participants

Study participants were current employees or recent retirees of the French national electricity and gas company, Electricité De France–Gaz De France, who volunteered to participate in a research cohort known as the GAZEL cohort. The GAZEL cohort was established in

1989 and originally included 20 624 persons working at Electricité De France–Gaz De France, with men aged 40 to 50 years and women aged 35 to 50 years at baseline. Since 1989, this cohort has been followed by means of yearly self-administered questionnaires. The objectives and methods of the cohort have been described in detail elsewhere.[28] All participants received a letter describing the objectives of our study.

Traffic Safety–Related Data

Questions on mobility and accidents of the past year were added to the Annual GAZEL Cohort questionnaire sent each January from 2002 to 2006, providing data respectively for the years 2001 to 2005. Drivers were asked how many kilometers they had driven a 4- or 2-wheel motorized vehicle in the past 12 months. The participants were also asked to report whether they had been involved in 1 or more traffic collisions in the same period. An collision with an injury was defined as a collision that required at least a medical consultation.

Driving Behavior and Road Safety Questionnaire

A Driving Behavior and Road Safety questionnaire was administered twice, in February 2001 and February 2004. The drivers who participated in the first survey received the second questionnaire in 2004. This questionnaire was previously pilot-tested on 500 randomly selected participants. The answers and comments of the 330 respondents were used to finalize it. We assessed attitudes toward traffic safety—namely "relaxing existing regulations," reflecting the opinion that current traffic regulations are too restrictive and therefore should be relaxed, and "increasing enforcement and stricter regulations," reflecting the opinion that current traffic regulations and law enforcement are not severe enough and therefore should be reinforced—by asking participants whether they agreed or disagreed with a set of 12 statements, referring to topics related to traffic safety and currently debated in France. Agreement was assessed by summing up the number of affirmations with each topic in a summary score (range: 0–6) and grouped into 3 categories: low (0–2), intermediate (3–4), and high (5–6). Statements reflecting attitudes toward road traffic safety have been described in detail elsewhere.[27]

Behavioral data from the 2001 and 2004 Driving Behavior and Road Safety questionnaires included the report of several drivers' behaviors in the past 12 months, namely, DWI frequency (never, few times a year, once a month or more), frequency of driving while sleepy (never, few times in a year, once a month or more), and answering the phone while driving (always, it depends on circumstances, or never). Participants also reported their maximum speed on the 3 road types usually taken into account in French National Statistics to describe road behaviors and traffic collisions; built-up areas, rural roads, and highways, where the speed limits are 50 km/h (31 mph), 90 km/h (56 mph), and 130 km/h (81 mph), respectively.

Sociodemographic data from the cohort database included gender, year of birth (1939–1943, 1944–1948, 1949–1953), marital status (living alone, living with a partner), occupational category (unskilled worker, skilled worker, manager), educational status (college or high school degree), housing income per month in 1989 converted into euro (1 French franc=0.152 euro; <1600, 1600–2591, >2591), and alcohol consumption. Light drinkers of alcohol were defined as reporting 1 to 13 (men) and 1 to 6 (women) drinks over 1 week, as opposed to heavy drinkers reporting 14 to 27 (men) and 7 to 20 (women) drinks over the same period. Regular drinkers were defined as those who reported consuming alcohol on 3 or more days in the week, as opposed to episodic drinkers who reported drinking alcohol on fewer than 3 days a week.

Psychological data from the 2001 Driving Behavior and Road Safety questionnaire included several perceptions regarding driving: experiencing fear while driving, reporting caution when driving, and driving skills, with these 3 variables being rated on a 6-point scale, ranging from never or very low (1) to always or very high (6). Other potential predictors, as recorded from the 2001 Driving Behavior and Road Safety questionnaire, included annual driving mileage (<10 000 km, 10 000–20 000 km, >20 000 km), type of vehicle owned (compact or economy, vs sedan, family, or sport), history of traffic ticket fixing (yes or no).

There are strong elements pointing to a fair reliability of self-reports on behaviors and attitudes in our survey. First, significant trends between the risk of a traffic collision and self-reported well-known behaviors were found in the GAZEL cohort (speeding,[24] DWI,[24] driving while sleepy,[29] using a cell phone while driving[24]). Moreover, we observed a fair consistency between answers to the same questions in 2001 and in 2004, as shown by weighted κ coefficients between behavioral self-reports (driving while sleepy=0.42; using a cell phone while driving=0.49; DWI=0.52) and by intraclass correlations between reported speeds (in built-up areas=0.63; on rural roads=0.59; and on highways=0.76).

Statistical Analyses

Because the mean and variance of the number of collisions with injuries in the 2001 to 2005 period were similar in our study,[30] we fitted generalized linear Poisson regression models[31] with time-dependent covariates to estimate the rate ratios (RRs) of collisions with injuries from 2001 to 2005 associated with reported risky driving behaviors in 2001. We included a logarithmic transformation of the time between 2001 and 2004 questionnaires (in months) in the model as the offset term. We adjusted rate ratios for potential confounders, namely, demographic characteristics usually associated with risky road behaviors: age, gender, occupational category in 2001, the type of vehicle owned in 2001, and annual mileage (a time-dependent covariate). As recommended by Janke,[32] a logarithmic transformation was applied to annual mileage.

We then estimated the fraction of collisions with injuries attributable to risky behaviors under study (speeding, DWI, using a cell phone while driving, and driving while sleepy) in 2001 and in 2004. We defined attributable fraction of collisions with injuries as:

$$(1)\quad AF = Pd(RR - 1/RR),^{33}$$

where Pd was the proportion of cases (participants having reported at least 1 collision with an injury) exposed to risky behavior in 2001 or in 2004 and RR was the adjusted rate ratio, as estimated from the adjusted risks of collisions with an injury from 2001 to 2005 between those who reported the risky behavior in 2001 and those who did not.

The risk of collisions with injuries attributable to speeding in built-up areas, on rural roads, and on highways decreased markedly between 2001 and 2004; we therefore investigated the determinants of such behavioral changes. Demographic and psychological variables usually associated with increased risky road behaviors and attitudes toward road safety were all entered in a regression model including the baseline values (E [$\Delta Y/Xs$, Y_{2001}]). However, when the association between the explanatory variable and the speed in 2001 was significant, then the association between the explanatory variable and the mean change in speed (i.e., E[$\Delta Y/X$]) was considered to be confounded by the correlation between Y_{2001} and X (which could be caused by a "regression to the mean" effect).[34]

To investigate associations between the true change in speed and a set of predictor variables, an estimate of the intraindividual variability (i.e., measurement error) in self-reports is necessary. We obtained this estimate from an ancillary survey recently performed among 70 individuals through a short e-mail questionnaire about their speed in built-up areas, on rural roads, and on highways, administered twice at a 3-month interval. Mean reported speeds in kilometers per hour in built-up areas, on rural roads, and on highways were 60.6 (SD=9.1), 100.1 (SD=9.7), and 138.2 (SD=9.4), respectively, in the first survey, and 61.3 (SD=9.3), 100.5 (SD=9.1), and 138.7 (SD=10.1) 3 months later. Measurement errors in self-reports of speed were estimated by computing intraindividual variances between the 2 surveys, namely, 17.6 for built-up areas, 4.4 for rural roads, and 6.3 for highways.

We further adjusted multivariate models on measurement error in the SAS macro Biasfix (version 9.1; SAS Institute Inc, Cary, NC) to obtain unbiased estimates of the change in speed on each road surface by using a method-of-moment correction.[35,36]

RESULTS

Population

Among the 13 447 participants (10 300 men, 3147 women) who had sent back the 2001 Driving Behavior and Road Safety questionnaire, 87% (n=11 706) returned the 2004 questionnaire. Those who reported having stopped driving either in 2001 or 2004 were excluded from the analysis. The final study population comprised 11 240 respondents. Comparisons at baseline showed that participants in the study population reported more excessive speed on rural roads than did excluded or nonresponding participants (76.4% vs 73.5%; P=.002). No other significant difference in road behavior between groups was found.

Respondents were managers (26.5%), skilled workers (58.1%), and unskilled workers (15.3%); the highest level of education attained for most of them was a high school diploma (81.7%). In 2001, the majority of respondents reported having driven fewer than 20 000 km in the past 12 months (62.1%). Support for relaxing existing regulations in 2001 was low in 77.8% of participants, intermediate in 19.2%, and high in 3.0%. Support for increased enforcement and stricter regulations in 2001 was low in 28.5% of participants, intermediate in 42.4%, and high in 29.1% (Table 1).

At least 1 injury RTC was reported by 1.19% of respondents in 2001, 0.90% in 2002, 0.95% in 2003, and 0.81% in 2004. This represents a 31.9% decrease in rates on average from 2001 to 2004. In 2005, however, 1.15% of respondents reported at least 1 injury RTC.

Behavioral Predictors of Collisions With Injuries

The adjusted risk of collisions with injuries from 2001 to 2005 increased significantly, with 2001 self-reported excessive speed on all roads (built-up areas, rural roads, and highways), always answering the phone while driving, and with self-reported frequency of DWI and driving while sleepy a few times a year or more (Table 2). Although not significant, the risk of collisions with injuries associated with a maximum speed of more than 100 km/h on rural roads was nonetheless included in further analyses, because most collisions with injuries (81.4%) and fatal crashes (75.3%) occurred on these types of roads in 2005 in France.[37]

Between 2001 and 2004, the prevalence of excessive speed significantly decreased by 52.8% in built-up areas, 39.2% on rural roads, and 65.2% on highways (Table 3). Cell phone use decreased by more than half (52.1%) during the same period, but was already low in 2001 (4.2%). The prevalence of driving while sleepy did not change, whereas DWI remained marginal despite a 115% increase. During the same period, fractions of collisions with injuries attributable to excessive speed and driving while sleepy decreased, whereas those attributable to cell phone use and DWI increased (Table 3).

Factors Associated With Change in Maximum Reported Speed

Between 2001 and 2004, mean reported speed decreased by 6.7% in built-up areas (from 59.8 km/h [SD=9.3] to 55.8 km/h [SD=7.2]; P<.001), 5.1% on rural roads (from 102.3 km/h [SD=10.4] to 97.1 km/h [SD=8.9]; P<.001), and 4.1% on highways (from 137.9 km/h [SD=12.8] to 132.3 km/h [SD=9.7]; P<.001).

The decrease in reported maximum speed between 2001 and 2004 in built-up areas (Table 4) was lower among respondents who were born between 1949 and 1953, who had higher educational status and perceived driving ability, who reported traffic ticket fixing in 2001, and who had a high support for relaxing existing regulations. It was greater among women, respondents with a high level of cautiousness while driving, and those with a high support for increased enforcement and stricter regulations.

The decrease in reported maximum speed between 2001 and 2004 on rural roads was lower among respondents who were born between 1949 and 1953, who reported traffic ticket fixing, and who had a high support for relaxing existing regulations. It was greater among women, respondents living with a partner, those with a high level of cautiousness while driving, and those with a high support for increased enforcement and stricter regulations. The decrease in reported maximum speed between 2001 and 2004 on highways was lower among respondents born between 1949 and 1953, those with a higher occupational category, those with a higher perceived driving ability, those who reported traffic ticket fixing in 2001, and those with a high support for relaxing existing regulations. It was greater among women and among respondents with a high support for increased enforcement and stricter regulations.

DISCUSSION

We estimated that, between 2001 and 2004, the prevalence of excessive speed and

TABLE 1—Baseline Sample Characteristics: GAZEL Cohort, France, 2001

Variables Assessed in 2001	% (No.)
Year of birth (n = 11 240)	
1939–1943	39.7 (4463)
1944–1948	52.0 (5846)
1949–1953	8.3 (931)
Gender (n = 11 240)	
Men	77.7 (8736)
Women	22.3 (2504)
Marital status (n = 10 766)	
Living with partner	88.4 (9518)
Single, divorced, widow, or widower	11.6 (1248)
Occupational category (n = 11 191)	
Managers	26.6 (2969)
Skilled workers	58.1 (6505)
Unskilled workers	15.3 (1717)
Highest level of education (n = 11 055)	
College/university	18.3 (2018)
High school	81.7 (9037)
Monthly income in 1989, converted into euro (n = 10 893)	
< 1600	20.7 (2250)
1600–2591	47.0 (5121)
> 2591	32.3 (3522)
Alcohol intake[a] (n = 11 012)	
None	16.4 (1810)
Light regular	17.1 (1888)
Light episodic	28.4 (3123)
Heavy regular	37.4 (4122)
Heavy episodic	0.6 (69)
Type of vehicle (n = 10 636)	
Compact or economy	54.2 (5766)
Family	35.6 (3785)
Sport or sedan	10.2 (1085)
Annual mileage, km (n = 11 020)	
< 10 000	21.2 (2337)
10 000–20 000	40.9 (4509)
> 20 000	37.9 (4174)
Reported fear when driving (n = 11 194)	
Never	24.0 (2685)
Sometimes to always	76.0 (8509)
Reported cautiousness while driving (n = 11 167)	
Poor to medium (1–4)	27.9 (3114)
High (5–6)	72.1 (8053)
Perceived driving ability (n = 11 170)	
Poor to medium (1–4)	48.7 (5436)
High (5–6)	51.3 (5734)
History of traffic ticket cancellations (n = 11 098)	
No	73.1 (8114)
Yes	26.9 (2984)

Continued

fractions of collisions with injuries attributable to excessive speed decreased on all road types, concomitantly with a decrease in rates of collisions with injuries among participants of the cohort. These results were consistent with behavioral changes observed in France from 2001 to 2005, during which the mean observed speed in built-up areas, on rural roads, and on highways decreased by 8.8%, 8.7%, and 5.5%, respectively.[38] The picture is quite different when it comes to other risky behaviors under study, because the prevalence of driving while sleepy remained unchanged and DWI was reported by a higher proportion of drivers in 2004 than in 2001.

Automated controls have been used to increase the likelihood of detecting speeding offenses and preventing speeding in specific locations. Between 2001 and 2004, 1500 radar units (70% fixed and 30% mobile) were deployed and capture more than 1 million images a month, which likely enhanced the perceived probability of being punished and, therefore, improved the level of deterrence to speeding.[11] Similarly, the prevalence of cell phone use while driving decreased (–52.1%) following its ban in 2003, but its attributable fraction of collisions with injuries increased over time, suggesting a high propensity for traffic collisions among those who persist in this dangerous practice.[14,39,40]

Driving while sleepy is not considered a traffic offense in France and is therefore not taken into account in national statistics. Because it was not specifically targeted by police checks and preventive measures, there is no reason to assume that it could have diminished over time. However, as sleepiness in drivers is increasingly recognized as an important factor contributing to the burden of traffic-related morbidity and mortality,[29,41–43] it seems necessary to develop national campaigns to raise the awareness of all road users and to inform them how to avoid driving while sleepy through promotion of "sleep hygiene" or how to deal with sleepiness.[29] It remains unclear why the fraction of collisions with injuries attributable to driving while sleepy diminished between 2001 and 2004. One possible explanation is that feeling sleepy while driving had less severe consequences in 2004 compared with 2001 because of an overall reduction in speed, but this issue warrants further consideration.

TABLE 1—*Continued*

Number of agreements with relaxing existing regulations (n = 10 561)	
Low (0–2)	77.8 (8216)
Medium (3–4)	19.2 (2032)
High (5–6)	3.0 (313)
Number of agreements with increased enforcement and stricter regulations (n = 10 558)	
Low (0–2)	28.5 (3011)
Medium (3–4)	42.4 (4473)
High (5–6)	29.1 (3074)

Note. The GAZEL cohort comprises employees and retirees of the French national electricity and gas company.
[a]Light was defined as 1 to 13 drinks per week for men and 1 to 6 drinks per week for women. Heavy was defined as 14 to 27 drinks per week for men and 7 to 20 drinks per week for women. Regular was defined as drinking 3 or more days per week. Episodic was defined as drinking fewer than 3 days per week.

TABLE 2—Association Between Risky Driving Behaviors and Traffic Collisions With Injuries Among Participants: GAZEL Cohort, France, 2001–2005

Risky Driving Behaviors in 2001	% (No.)	RR[a] (95% CI)
Maximum speed in built-up areas, km/h (n = 11 135)		
20–60 (Ref)	76.2 (8480)	1.00
≥65	23.8 (2655)	1.35** (1.09, 1.67)
Maximum speed on rural roads, km/h (n = 11 123)		
60–95 (Ref)	23.6 (2621)	1.00
≥100	76.4 (8502)	1.17 (0.91, 1.52)
Maximum speed on highways, km/h (n = 11 083)		
80–140 (Ref)	75.5 (8366)	1.00
≥145	24.5 (2717)	1.35** (1.09, 1.68)
Driving while alcohol-intoxicated (n = 11 116)		
Never or a few times a year (Ref)	99.7 (11 084)	1.00
Once per month or more	0.3 (32)	3.53** (1.37, 9.13)
Answering the phone while driving (n = 11 145)		
Never, no cell phone, turned off while driving, or it depends on circumstances (Ref)	95.0 (10 590)	1.00
Always	5.0 (555)	1.88*** (1.35, 2.61)
Driving while sleepy (n = 11 139)		
Never (Ref)	62.8 (6996)	1.00
Few times a year or more	37.2 (4143)	1.44*** (1.18, 1.76)

Note. RR = rate ratio; CI = confidence interval. The GAZEL cohort comprises employees and retirees of the French national electricity and gas company. Speed limit in built-up areas is 50 km/h; speed limit on rural roads is 90 km/h; speed limit on highways is 130 km/h.
[a]RRs with 95% CIs were determined with generalized linear Poisson regression. RRs were adjusted for gender, age (covariate of 3 categories), occupational category (covariate of 3 categories), driving mileage per year (a time-dependent covariate logarithmic transformed), and type of vehicle owned in 2001 (covariate of 4 categories).
**$P \leq .01$, ***$P \leq .001$.

Driving while alcohol intoxicated once per month or more was the strongest predictor of collisions with injuries, although it concerned less than 1% of the study population. Drunk drivers represent only 2.5% of French drivers, but they were involved in 30.7% of fatal crashes in 2004 and 28.1% in 2005.[44] This high-risk driving behavior and its attributable fraction of collisions with injuries, however, increased in our study population between 2001 and 2004 and remains unchanged in France despite increased blood alcohol concentration checks on the road and harsher penalties.[44,45] Unlike speeding, detection of DWI offenders cannot be achieved through automated devices, thus limiting the probability of being arrested for DWI.[46] Accordingly, it is likely that the current increased preventive measures were not sufficient to deter drunk drivers.

The multivariate analysis suggests that the decrease in speed was smaller among a specific category of drivers sharing several characteristics in 2001: men with a higher socioeconomic status, who were confident in their ability to drive, who agreed with relaxing existing regulations, and who disagreed with increased enforcement and stricter regulations. Because both repression and regulations have been significantly enforced in recent years, which might have contributed to significant consecutive declines in road mortality, such attitudes toward traffic safety may reflect a strong antagonism to this recent trend. The decrease in reported speed on all road surfaces between 2001 and 2004 was greater among women, among individuals reporting highly cautious driving, and among those who agreed with increased enforcement and stricter regulations, confirming that support for traffic regulations has a significant protective effect against traffic collisions.[24] Because study participants progressed toward such an attitude between 2001 and 2004,[27] further behavioral changes might be expected in the near future.

It is also noteworthy that the decrease in speed was smaller among drivers who reported traffic ticket fixing history in 2001 compared with those who did not. We showed in a previous study that the use of connections who have the authority to cancel traffic penalties is strongly associated with risky behavior and collisions with injuries.[6] Certainty of punishment is ruled out by ticket fixing, thus jeopardizing the deterrent effect of law enforcement. Moreover, participants who reported ticket fixing in 2001 were more likely to support relaxing regulations ($P < .001$) and less likely to support increased enforcement and stricter regulations ($P < .001$), which might indicate a greater tendency to disregard traffic rules among these drivers. Such practice was certainly limited in recent years by government prohibition, but our findings suggest a long-term effect on a driver's behavior.

TABLE 3—Risky Behaviors and Their Attributable Fractions of Traffic Collisions With Injuries in 2001 and in 2004 Among Participants: GAZEL Cohort, France, 2001–2005

Risky Behaviors	2001			2004			Change in Prevalence,[a] %	Change in AF, %
	Prevalence	Pd, %	AF, %	Prevalence	Pd, %	AF, %		
Reporting a maximum speed of more than 65 km/h in built-up areas	0.238	7.70	7.41	0.108	3.63	2.75	–52.8***	–49.4
Reporting a maximum speed of more than 100 km/h on rural roads	0.764	11.50	11.30	0.442	6.99	5.19	–39.2***	–54.1
Reporting a maximum speed of more than 145 km/h on highways	0.245	7.90	8.02	0.081	2.75	2.81	–65.2***	–65.0
Driving while alcohol intoxicated once per month or more	0.003	0.72	0.59	0.006	1.55	1.75	+115.3***	+196.6
Always answering the phone while driving	0.050	4.20	3.37	0.023	2.01	3.95	–52.1***	+17.2
Driving while sleepy a few times a year or more	0.372	14.06	14.28	0.365	13.85	12.0	–0.01	–16.0

Note. Pd = proportion of cases (participants having reported at least 1 injury road traffic collision) exposed to risk behaviors; AF = attributable fraction of traffic collisions with injuries calculated with adjusted rate ratios. The GAZEL cohort comprises employees and retirees of the French national electricity and gas company.
[a]PEs in 2001 and in 2004 were compared with the nonparametric McNemar test.
***$P < .001$.

TABLE 4—Determinants of the Decrease in Maximum Reported Speed in Built-Up Areas, on Rural Roads, and on Highways Between 2001 and 2004 Among Participants: GAZEL Cohort, France, 2001–2004

Variables Assessed in 2001	Built-Up Areas		Rural Roads		Highways	
	Unstandardized Estimate	z	Unstandardized Estimate	z	Unstandardized Estimate	z
Reported maximum speed in 2001	0.572	16.339***	0.603	21.760***	0.514	27.069***
Female gender	1.108	4.426***	1.455	4.779***	1.303	4.326***
Agreement with increased enforcement and stricter regulations[a]	0.446	4.005***	0.517	4.112***	0.527	4.240***
Agreement with relaxing existing regulations[a]	–0.342	2.225*	–1.025	–4.745***	–0.643	–3.159***
Born between 1949 and 1953[b]	–0.834	–2.388**	–1.624	–3.693***	–1.391	–3.268***
Higher perceived driving ability[c]	–0.272	–1.730*	–0.301	–1.566	–0.518	–2.779**
Traffic ticket fixing[d]	–0.543	–3.273***	–0.461	–2.206*	–0.473	–2.537*
Higher occupational category[e]	–0.219	–1.025	–0.156	–0.624	–0.556	–2.289*
Higher income	–0.016	–0.133	–0.040	–0.284	–0.227	–1.707
Higher educational status	–0.419	–1.025*	0.236	0.972	0.059	0.268
Heavy episodic alcohol consumption[f]	–2.02	–2.45*	–1.419	–1.110	–0.048	–0.036
Higher reported cautious driving	0.476	2.261*	0.818	3.416**	0.242	1.167
Owning a more powerful vehicle[g]	–0.005	–0.036	–0.218	–1.241	–0.274	–1.614
Higher annual mileage	–0.010	–0.009	–0.105	–0.752	–0.050	–0.357
Living with partner	0.065	0.257	0.677	2.173*	0.326	1.097
Reported fear when driving	0.124	0.736	0.289	1.376	0.009	0.049

Note. The GAZEL cohort comprises employees and retirees of the French national electricity and gas company.
[a]Coded as low = 1, intermediate = 2, high = 3.
[b]Versus 1939 to 1948.
[c]Coded as low to medium = 0; high to very high = 1.
[d]Reported ever used traffic ticket fixing: no = 0; yes = 1.
[e]Coded as unskilled worker = 0; skilled worker or manager = 1.
[f]Coded as heavy episodic alcohol consumption = 1; other = 0.
[g]Coded as compact or economy vehicle = 0; sedan, family, or sport vehicle = 1.
*$P < .05$; **$P < .01$; ***$P < .001$.

Limitations

It should be stressed that our study population included employed or retired middle-aged drivers from a large company, which may limit the generalizability of our results. On the other hand, because French traffic issues do not differ substantially from those in other European countries,[47] the large size of the cohort and the inclusion of diverse trades and socioeconomic groups represent an exceptional strength for the study of road behaviors and may contribute to the evaluation of increased traffic regulation initiatives in industrialized countries.

Conclusions

Overall, our results show that several risk behaviors, such as speeding and cell phone use while driving, decreased over the 2001 to 2004 period, concomitantly with significant increases in traffic law enforcement and support for traffic regulations. However, the deterrent effect of traffic enforcement policies may have been reduced through negative attitudes toward traffic safety and cancellation of traffic penalties, especially in some drivers who share characteristics repeatedly associated with risky road behaviors. Because the deterrence effect of traffic law enforcement seems to depend mostly upon the certainty of punishment, public education campaigns and police interventions might be effective in reducing RTC burden if they actually increase the perceived probability of potential offenders being punished. ■

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Contributors

A. Constant analyzed and interpreted data and wrote the article. L. R. Salmi contributed to the analysis and interpretation of data and to the preparation of the article. S. Lafont and M. Chiron contributed to study design and to the preparation of the article. E. Lagarde originated the study and contributed to the analysis and interpretation of data and to the preparation of the article.

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Human Participant Protection

All participants received an informational letter describing the objectives of the study. The study protocol was approved by the French data protection authority (Commission Nationale Informatique et Liberté).

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