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Title: Aggressive/hostile personality traits and injury accidents: An eight-year prospective study of a large cohort of French employees: The GAZEL cohort.

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Abstract

Background: Aggressiveness on the roads and / or anger behind the wheel are considered to be a major traffic safety problem in several countries. However, the psychological mechanisms of anger and/or aggression on the roads remain largely unclear. This study examines a large cohort of French employees followed over the 1994-2001 period to establish whether psychometric measures of aggression/hostility were significantly associated with an increased risk of injury accidents (I-A).

Methods: A total of 11 754 participants aged from 39 to 54 in 1993 were included in this study. Aggression/hostility was measured in 1993 using the French version of the Buss-Durkee Hostility Inventory (BDHI). Driving behaviors and I-A were recorded in 2001. Sociodemographic and alcohol consumption data were available from the cohort annual follow-up. The relationship between aggression/hostility scores and I-A was assessed using Negative Binomial regression models with time-dependent covariates.

Results: The overall BDHI scoring was not statistically predictive of subsequent I-A: adjusted rate ratios (aRR) = 1.02, 95% confidence interval (CI) 0.81-1.28 for participants with intermediate scores and 1.25, 95% CI 0.98-1.61 for those with high scores, both compared to those with low scores. The only BDHI subscales found to be associated with I-A were “irritability” (aRR = 1.33, 95% CI 1.02-1.75 for participants with high scores) and “negativism” (aRR = 1.32, 95% CI 1.01-1.71 for participants with high scores).

Conclusion: Overall aggression/hostility personality traits did not predict injury accidents in this large cohort of French employees, suggesting that aggressiveness on the roads and/or anger behind the wheel extends beyond the individual’s general propensity for aggression.

Keys words: aggression / hostility; BDHI; cohort study; negative binomial regression; injury accident.

The phenomenon of “road rage” has in recent years emerged as a new traffic safety issue in some English-speaking countries, including the United States (US), Canada, the United Kingdom (UK) (Harding *et al.* 1998; Smart & Mann, 2002; Joint, 1995; Wells-Parker *et al.* 2002). Despite a lack of consensus, “road rage” was described to be associated with a range of anti-social driving behaviors and/or acts of aggression which occur on the road (Elliot, 1999). According to the US National Highway Traffic Safety Administration (NHTSA), substantial numbers of American drivers report that they have experienced hostile, unsafe or aggressive acts on the part of other drivers (NHTSA, 1999). A survey conducted in the UK (Joint, 1995) in 1995 revealed that 90% of 526 motorists sampled reported having experienced in the past year aggressive acts such as tailgating (close following), and 48% of them reported being a victim of obscene gestures in the same period. In turn, 60% admitted that they themselves had lost their temper while driving at least on occasion.

Although these data suggest that aggressiveness and/or anger behind the wheel in drivers are widespread, it has been argued that dispositional factors like personality traits make some individuals more prone to these behaviors than others (Deffenbacher *et al.* 2003; Arnett, Offer & Fine, 1997; Mayer & Treat, 1987; McMillen *et al.* 1992). An aggressive personality trait or trait aggressiveness has been defined as “a general propensity to engage in acts of physical and verbal aggression, a proneness to anger, and a proneness to hold hostile beliefs about other people across situations” (Buss & Perry, 1992; Baron & Richardson, 1994; Berkowitz, 1993; Bushman, 1996).

Although a large body of the literature demonstrates that aggressive driving is associated with an increased risk of traffic accidents (Lajunen & Parker, 2001; Donovan & Marlatt, 1982; Wilson & Jonah, 1988; Furnham & Saipé, 1993; Parry, 1968; Conger *et al.* 1959; Mizell, 1997), the relationships between aggressiveness as a personality trait, aggressive driving and traffic

accidents remain largely unknown. Earlier and recent studies produced inconsistent findings. In the 1974-1988 period, two studies using the Buss-Durkey Hostility Inventory (BDHI) found a significant association between scores of BDHI, crash involvement, violations and driving-related aggression (Donanan & Marlatt, 1982; Wilson & Jonah, 1988). Other studies conducted (Beirness, 1993) in the same period reported that crash rates were associated with the expression of hostile feelings, increased aggression and with high scores of the Driver Behavior Inventory (DBI). However, further studies carried out in the 1989-1998 period failed to find any significant association between traffic-related injuries, minor accidents and hostility, self-rated irritability, ease of anger arousal, and other aggression factors (Furnham & Saipe, 1993; Karlberg *et al.* 1998; Romanov *et al.* 1994; Novaco, 1989).

It is noteworthy that the majority of these studies were carried out on small samples with a large spectrum of study designs and measurement tools. Moreover, only one cohort study has been published, on over 21, 000 Finnish participants (Romanov *et al.* 1994). Unfortunately, this latter study suffered from incomplete consideration of confounding factors (no mileage, alcohol consumption as unchanging with time) and from use of unstandardized measures of hostility.

The present study therefore aimed to examine prospectively the extent to which psychometric measures of aggression/ hostility were related to injury accidents in a large cohort of French employees.

METHODS

Participants

The participants are current employees or recent retirees of the French national electricity and gas company, *Electricité de France-Gaz de France* (EDF-GDF), who volunteered to participate in a research cohort, known as the GAZEL cohort. This firm employs approximately 150 000 people of diverse trades and socioeconomic groups throughout France. The GAZEL cohort has been studied since 1989 by the National Institute of Health and Medical Research with the main objective of collecting data about the annual prevalence and incidence of chronic health problems. It initially included 20 625 participants in 1989 (15 011 men aged 40–50 years and 5614 women aged 35–50 years). A comprehensive database has been regularly updated since then with data from the human resources department, the firm's medical insurance program, the occupational medicine department, and an annual questionnaire mailed to participants at the beginning of each year. The objectives and methods of the cohort have been described in detail elsewhere (Goldberg *et al.* 1994).

Materials

Psychosocial questionnaire

In 1993, the members of the GAZEL cohort were mailed a set of questionnaires originally designed to evaluate the role of personality traits in morbidity and mortality from cardiovascular disease and cancer. Questionnaires included the French version of the Buss-Durkee Hostility Inventory (BDHI) which made it possible to evaluate aggression/hostility (Buss & Durkee, 1957). The BDHI contains 75 True-False statements which provide a measure of seven constructs representing general aggression/hostility. The BDHI consists of five assault subscales- Assault (physical violence against others); Verbal Aggression (express negative feelings in content and style, e.g., shouting) Indirect Hostility (devious hostility like gossip); Irritability (quick temper, ready to explode at slight provocation); Negativism (usually

oppositional behavior against authority, refusing to cooperate); - designed to measure aggressiveness; and two hostility subscales; Resentment (jealousy, anger at the world over mistreatment) and Suspicion (projection of hostility onto others). An additional construct captured by the BDHI is Guilt, reflecting the degree of guilt feelings reported by the subject. The sum of the first seven sub-scales leads to a total hostility score. Higher scores indicate that the respondent has endorsed more aggressive/hostile items. There is a substantial body of validation evidence to support this widely used inventory (Buss & Durkee, 1957; Buss, 1961).

Driving behavior and road safety questionnaire

In 2001, a driving behavior and road safety questionnaire was mailed to the 19 894 living members of the GAZEL cohort. This questionnaire was previously pilot-tested on 500 randomly selected participants. The answers and comments of the 330 respondents were used to finalize it. The participants were asked to report all of their injury accidents (I-A) as a 4- or 2-wheel vehicle driver in the cohort follow-up period (1989–2001). An I-A was defined as a traffic accident in which someone was injured, i.e. required medical care. I-A were used instead of accidents with property damage only, because the medical department of EDF-GDF provided reminders that listed dates of the participants' sick leaves for traffic-related injury during the period covered by the questionnaire. These enabled us to improve the exhaustiveness of reported cases and minimize recall bias. Every reported I-A was investigated with a set of 25 questions about the circumstances, injuries, reasons for the accident and the responsibility of the participant.

Risky-driving behaviors were assessed using five questions: The participants were asked to report their maximum speed in built-up areas, on rural roads, and on motorways. Maximum reported speeds were categorized in two groups: under and above the legal limit + 10%. Drinking and driving was assessed with the question: "in the 12 past months, have you ever driven after drinking too much alcohol?" As far as cellular phone use when driving is

concerned, participants were considered to have risky-behavior when they reported answering a phone call whatever the driving circumstances or when they reported not stopping their vehicle before initiating a phone call. Drivers were also asked how many kilometers they drove a 4- or 2-wheel vehicle in the last 12 months, in order to estimate their annual mileage. The type of the principal vehicle owned in January 2001 was coded in five categories. Attitudes towards traffic regulations were assessed by asking participants whether they agreed or disagreed with a set of 12 assertions related to the debate on traffic regulations and enforcement in France in 2001. A score was derived and further categorized in four groups with balanced relative sample sizes.

The annual GAZEL cohort questionnaire

Sociodemographic data from the cohort database included sex, year of birth, occupational categories. Participants were defined as episodic alcohol consumers when they reported drinking alcohol a maximum of 2 days a week. They were also asked to indicate the maximum amount of alcohol drunk during one day and defined as high quantity users when this amount exceeded 3 glasses of wine or 3 pints of beer or 2 measures of spirits. These two indicators were combined to define a composite time-dependent alcohol consumption variable with five categories.

Statistical analysis

We divided the general BDHI scale and subscales scores into three distinct levels using the percentiles (scores at or below the 25th percentile constituted the low level, the intermediate level consisted in scores ranging between the 25th and 75th percentiles, scores at or above the 75th percentile constituted the high level, defined here as individuals who endorsed more aggressive and / or hostile items). Chi-square tests were used first to assess differences in proportion for categorical variables and a negative binomial regression model (Cameron & Trivedi, 1998) with time-dependent covariates was fitted to assess the risk of I-A in the 1994–2001 period in relation to aggression/hostility scores and subscores measured in 1993. Negative

binomial regression (Miaou, 1994; Poch & Mannering, 1996) was used because the distribution of I-A among participants was significantly skewed leading to over dispersion.

In order to assess the effect of potential confounders on the relationship between aggression/hostility on the risk of I-A, rate ratios (RRs) were computed using univariate and multivariate negative binomial models. In the univariate model, the associations of overall BDHI scores and subscores with the risk of I-A were assessed separately. In the multivariate model, RRs were adjusted for age (a time-dependent covariate), gender occupational category each year (a time-dependent covariate of 3 categories), exposure (mileage in 2001; as recommended by Janke (1991) a logarithm transformation was applied to annual mileage). When a significant association was observed after the first adjustment, RRs were further adjusted for alcohol consumption (a five-category time-dependent covariate) maximum speed greater than $\pm 10\%$ legal limits in built-up areas, on rural roads and on motorways, risky use of cell phone. When a significant association persisted after this adjustment, RRs were additionally adjusted for vehicle categories (4 categories) and scores of negative attitudes towards traffic regulation (4 categories).

RESULTS

In 1993, 15 049 participants out of 20 624 returned their BDHI questionnaire. We received responses to the 2001 Driving Behavior and Road Safety (DBRS) questionnaire from 14 226 participants out of 19 894. Some were excluded ($n=26$) because of data discrepancies with the general cohort database. Data on occupational category or mileage were missing for another 376 participants leaving 13 824 participants with a DBRS questionnaire. Among them, 11 754 participants had also returned their BDHI questionnaire and were included in the analyses. In the 1994–2001 period, 548 participants had one I-A, 47 two I-A and 6 three I-A.

Overall aggression/hostility scores and sociodemographic variables

The BDHI scores and subscores were significantly correlated and correlation coefficients ranged from 0.08 to 0.85 (Table 1).

Women, younger participants, participants from lower occupational categories and participants with lowest reported mileage in 2001 scored higher on the general BDHI (Table 2). This means that these groups were more likely to self-report aggressive/hostile items. Similarly, those who reported having less powerful vehicles (except for utilitarian cars), driving faster on motorways and on rural roads, and those with high scores of negative attitudes towards road traffic regulations scored higher on general aggression/hostility measures. Participants who reported low quantity regular alcohol consumption and high quantity regular and episodic alcohol consumption scored higher on the general BDHI.

Relation between overall aggression/hostility scores and subscores and injury accidents

Table 3 shows unadjusted and adjusted rate ratios determined by negative binomial models fitted to assess the impact of BDHI and its subscales on the risk of I-A. In univariate analysis, high irritability, high negativism, and high suspicion BDHI subscores were significantly

associated with I-A. Compared to low scores, unadjusted RRs for high irritability, high negativism and high suspicion scores were respectively 1.29 (95% CI: 1.00-1.68), 1.29 (95% CI: 1.00-1.66), and 1.27 (95% CI: 1.02-1.59). In multivariate negative binomial analysis, when rate ratios were adjusted only for sex, age, occupational category, mileage per year, only RR for high irritability and high negativism slightly increased and remained significant. When adjusted further for behavioral variables, for category of vehicle and for attitudes towards traffic regulations, RR did not change notably.

DISCUSSION

Overall aggression/ hostility-related personality traits as measured by Buss-Durkey Hostility Inventory (BDHI) did not predict injury accidents in this large cohort of French employees. However, a relatively weak but significant association was found between high irritability, high negativism and I-A risk after major confounding factors were controlled for.

These data were consistent with the most recently published studies of this relationship, suggesting that general aggression/hostility was not systematically associated to road traffic accidents (Lajunen & Parker, 2001; Donovan & Marlatt, 1982; Karlberg *et al.* 1998, Romanov *et al.* 1994; Nonaco, 1989). Contrary to previous studies, we were able to assess incident I-A as outcomes and to include in the analysis a wide range of potential confounders. The exhaustiveness of I-A reports was enhanced by the use of reminders from the medical department, which listed sick leaves for traffic accidents during the period covered by the questionnaire. The large sample size of our prospective study rules out the possibility that the absence of associations observed was due to lack of power. More precisely, with an error of first kind (α) of 0.05 and a power ($1-\beta$) of 0.80, we calculated that the fraction detectable rate ratio was 1.29.

In accordance with the literature, in the present study younger participants and unskilled workers were more likely to score higher on overall aggression/hostility (Deffenbacher *et al.*, 2003; Deffenbacher *et al.*, 2000; Deffenbacher *et al.* 2002). Also consistent with previous findings, participants who exceeded road speed limitations scored higher on overall aggression/hostility measures. Deffenbacher *et al.* (2003) in their experimental study on anger and aggression found that, in “the familiarization and open road simulations”, high anger drivers drove faster and more erratically than low anger drivers. According to Ulleberg (2001), this suggests that emotional factors and probably lack of control over these are related to risky-

driving style. Ulleberg (2001) considers that becoming frustrated and angry in traffic situations can easily trigger responses such as speeding and rule violations. Surprisingly, women in our study were relatively more likely to endorse aggressive/hostile items than men. This is not unlikely, because according to the aggression literature, the role of gender in aggressive behavior and anger is a very complex issue (Lajunen & Parker, 2001; Ulleberg (2001); Lajunen et al. (2001)).

Another surprising result, inconsistent with results reported in the literature (Wilson and Jonah, 1988), was that there was no clear significant association between high frequency and high quantity alcohol consumption and high aggression/hostility scores. Alcohol consumption rate is, however, moderate among the participants of the GAZEL cohort as high alcohol consumers were less willing to become members of the cohort. As a consequence, there are almost no heavy drinkers in the cohort (Goldberg *et al.* 1994). However, some researchers have suggested that demonstrating a clear relationship between alcohol intake and aggression is difficult, because alcohol consumption increases aggressiveness in some individuals but decreases it in others (Dougherty, Cherek & Bennett, 1996; Lipsey, Wilson, Cohen & Derzon, 1997, Winslow, Ellingboe & Miczek, 1988; Zhang, Wiczorek & Welte, 1997).

Like a recent study conducted in Greece (Chliaoutakis *et al.* 2002), we found that high irritability was significantly associated with I-A. Theoretically, individuals with high irritability are more prone to lose their temper quickly, and are ready to explode at slight provocation (Buss & Durkee, 1957). Drivers are confronted with wide ranging sources of irritability on roads. A study conducted by EOS Gallup Europe (2003) among 13 673 driving-license holders in 23 countries around the world in the 2002-2003 period reported that the vast majority of respondents (55% to 87%) confirmed that they are sometimes irritated by other drivers. These irritating situations included: *aggressive flashing lights, obscene gestures, tailgating, verbal*

abuse ... (EOS Gallup Europe, 2003). A strong relation was also noted between getting irritated and being irritated by other drivers. Highly irritable individuals may run an increased risk of traffic accidents because they are more prone to react negatively to the numerous irritating road situations. A strong reaction could affect the decision-making process (Chliaoutakis *et al.* 2002), or contribute to the deficit in driving performance because of an increased level of tension or stress (Perry, 1986).

Similarly, individual with high negativism subscore were also slightly more likely to have I-A. Negativistic people tend to be unconventional and individualistic in their response to the world. They have been described as quick to challenge rules or authority deemed arbitrary and unjust. They may also harbour resentment without expressing it directly and may revert to passive-aggressive behaviour to make their feelings known (Strack, 1997). It has been already described that the relationship between mild social deviance and accident involvement was partly mediated by propensity to commit driving violations (Meadows, Stradling & Lawson, 1998). Although the trait could explain why these individuals were slightly at risk of I-A, it is also possible that the finding was due to chance given the large number of statistical tests performed in the study. This caveat could be applied to irritability.

Among the limitations of our study, it should be noted that the sample, despite its large size, was not representative of French drivers as a whole. Although the participants were of diverse trades and socioeconomic groups throughout France, some demographic characteristics were specific. However, previous studies producing results in line with this study were carried out among students aged from 17 to 25, adults aged 25 to 59 years old, and men and women from different socioprofessional categories (Karlberg *et al.* 1998, Romanov *et al.*, 1994, Novaco, 1989, Magnavita *et al.* 1997).

It is possible that some accidents might be more closely related to hostility or aggression than others. Because detailed information's on each recorded injury accident were available, we were able to assess accident's characteristics associated with the overall BDHI scores. Results did not provide however further interesting insight. Surprisingly, the only significant result was that high overall BDHI scores were associated with a higher proportion of accidents reportedly due to vehicle's failures. (28.6%, 17.9% and 53.6% for participants with low, intermediate and high overall BDHI scores respectively, $p=0.004$). It is noteworthy that the power of the analysis was often insufficient when splitting accidents into further categories.

There are several implications that need to be considered in view of the fact that the present study failed to find a significant relation between overall aggression/hostility measures and I-A. Our results suggest that the phenomenon of aggressiveness on the roads and/or anger behind the wheel extend beyond individual's general propensity toward aggression. Recent studies on the causes of aggressive driving on the roads tend to support this claim. Deffenbacher *et al.* (2000, 2003) in their studies suggested that a person's disposition to anger interacts with some irritating road situations, rather than high anger drivers being "ubiquitously angry behind the wheel". They added that while there is a degree of correlation between anger behind the wheel and general or trait anger, this relationship was not so important as to suggest that anger behind the wheel should be subsumed within general or trait anger (Deffenbacher *et al.* 2003). In their study of the relationship between general aggressiveness, driver anger and aggressive driving, Lajunen and Parker (2001) also suggested that driver anger and behavioral reaction to the anger seemed to depend partly on situational characteristics. Taking into account that their study failed to find an association between physical aggression and driver anger, they suggested that anger as an emotion state did not always precede aggressive driving behavior.

While much remains to be learned about the factors contributing to anger behind the wheel and / or aggressive driving, it is interesting to note the difficulty of determining one profile of the so-called “aggressive driver”. Mizell (1997) reports that today’s aggressive driver could be “male or female, young or old, educated or uneducated, rich or poor, white or black, Hispanic, or Asian”.

It reasonable however, to suggest that aggressiveness and/or anger behind the wheel may be a phenomenon shared by all road users and that messages on the dangers of aggressive driving and how to deal with it should not be reserved for drivers with aggressive tendencies. It is important in future studies to consider aggression in driving across cultures in order to determine which societal characteristics trigger these behaviors.

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CONFLICT OF INTEREST: None

REFERENCES

- Arnett, J.J., Offer, D. & Fine, M.A.** (1997). Reckless driving in adolescence: 'State' and 'Trait' factors. *Accident Analysis and Prevention* **29**, 57-63.
- Baron, R., Richardson, D.** (1994). *Human Aggression*. Plenum Press, New-York.
- Berkowitz, L.** (1993). *Aggression: its causes, consequences, and control*. McGraw-Hill, New-York.
- Beirness, D.J.** (1993). Do We Really Drive As We Live? The Role of Personality Factors in Road Crashes. *Alcohol, Drugs and Driving* **9**(3-4), 129-143.
- Bushman, B.J.** (1996). Individual difference in the extend and development of aggressive cognitive-associative networks. *Personality and Social Psychology Bulletin* **22**, 811-819.
- Buss, A.H.** (1961). *The psychology aggression*. Wiley, New York.
- Buss, A.H. & Durkee, A.** (1957). An inventory for assessing different kinds of hostility. *Journal of Consulting and Clinical Psychology* **21**, 343-349.
- Buss, A.H. & Perry, M.** (1992). The aggression Questionnaire. *Journal of personality and Social Psychology* **63**, 452-459.
- Cameron, A.C & Trivedi, P.K.** (1998). *Regression Analysis of Count Data*. Cambridge University Press.
- Chliaoutakis, J.E., Demakakos, P., Tzamalouka, G., Bakou, V., Koumaki, M. & Darviri, C.** (2002). Aggressive behavior while driving of self-reported car crashes. *Journal of safety Research* **33**(4), 431-43.
- Conger, J.J., Gaskill, H.S, Glad, D.D., Hassel, L., Rainey, R.V., Sawrey, W.L. & Turrell E.S.** (1959). Psychological and psychophysiological factors in motor vehicle accidents. *Journal of the American Medical Association* **169**(14), 1581-1587.
- Deffenbacher, J.L., Deffenbacher, D.M., Lynch, R.S. & Richards, T.L.** (2003) Anger, aggression, and risky behavior: a comparison of high and low anger drivers. *Behavioural Research and Therapy* **41**(6), 701-718.
- Deffenbacher, J.L., Deffenbacher, D.M., Lynch, R.S. & Richards, T.L.** (2003) Anger, aggression, and risky behavior: a comparison of high and low anger drivers. *Behavioural Research and Therapy* **41**(6), 701-718.
- Deffenbacher, J.L., Lynch, R.S., Filetti, L.B., Dahlen, E.R. & Oetting, E.R.** (2003). Anger, aggression, risky behavior, and crashes-related outcomes in three groups of drivers. *Behavioural Research and Therapy* **41**(3):333-349.
- Donovan, D.M. & Marlatt, G.A.** (1982). Personality subtypes among driving-while-intoxicated offenders: relationship to drinking behavior and driving risk. *Journal of Consulting and Clinical Psychology* **50**, 241-249.

- Dougherty, D.M., Cherek, D.R. & Bennett RH.** (1996). The effects of alcohol on the aggressive responding of women. *Journal of Studies on Alcohol* **57**, 178–186.
- Elliott, B.J.** (1999). *Road rage: media hype or serious road safety issue?* Third National Conference on Injury Prevention & Control, Brisbane, Australia.
- EOS Gallup EUROPE.** (2003). *Aggressive behavior behind the wheel.* Responsible Young Drivers, Belgium.
- Furnham, A. & Saipe, J.** (1993). Personality, Correlates of Convicted Drivers. *Personality and Individual Difference* **14**(2), 329-336.
- Goldberg, M., Leclerc, A., Bugel, I., Chastang, J.F., Trand, P.D., Kaniewski, N., Marne, M.J., Morcet, J.F., Schmaus, A., Zins, M.** (1994). *Cohorte GAZEL 20 000 volontaires pour la recherche médicale: Bilan 1989-1993.* (In French). Les Editions INSERM, Paris, France.
- Harding, R.W., Morgan, F.H., Indermaur, D., Ferrante, A. & Blagg, H.** (1998). Road rage and the epidemiology of violence: something old, something new. *Studies on Crime and Crime Prevention* **7**, 221–38.
- Janke, M.K.** (1991). Accidents, mileage, and the exaggeration of risk. *Accident Analysis and Prevention* **23** (2-3), 183–188.
- Joint, M.** (1995) *Road rage.* American Automobile Foundation for Traffic Safety, Washington, DC.
- Karlberg, L., Unden, A.L., Elofsson, S. & Krakau, I.** (1998). Is there a connection between car accidents, near accidents, and type A drivers? *Behavioral Medicine* **24**, 99–106.
- Lajunen, T. & Parker, D.** (2001). Are aggressive people aggressive drivers? A study of the relationship between self-reported general aggressiveness, driver anger and aggressive driving. *Accident Analysis and Prevention* **33**, 243–255.
- Lajunen, T., Praker, D. & Stradling, S.** (1998). Dimensions of driver anger, aggressive and Highway Code violations and their mediation by safety orientation in UK drivers. *Transportation Research Part F* **1**, 107–121.
- Lipsey, M.W., Wilson, D.B., Cohen, M.A. & Derzon, J.H.** (1997). Is there a causal relationship between alcohol use and violence? A synthesis of evidence. *Recent Developments in Alcoholism* **13**, 245–282.
- Magnavita, N., Narda, R., Sani, L., Carbone, A., De Lorenzo, G. & Sacco A.** (1997). Type A behaviour pattern and traffic accidents. *British Journal of Medical Psychology* **70** (Pt 1), 103–107.
- Mayer, R.E. & Treat, J.R.** (1987). Psychological, social, and cognitive characteristics of high-risk drivers: a pilot study. *Accident Analysis and Prevention* **9**, 1–8.

- McMillen, D.L., Pang, M.G., Wells-Parker, E., Anderson, B.J.** (1992). Alcohol, personality traits, and high risk driving: A comparison of young, drinking driver groups. *Addictive behaviour* **17**, 525–532.
- Meadows, M.L., Stradling, S.G., Lawson, S.** (1998). The role of social deviance and violations in predicting road traffic accidents in a sample of young offenders. *British journal of psychology* **89**(Pt 3):417-31.
- Miaou, S.** (1994). The relationship between truck accidents and geometric design of road section: Poisson versus Negative Binomial regression. *Accident Analysis and Prevention* **26**(4).
- Mizell, L.** (1997). *Aggressive driving in Aggressive Driving: Three Studies*. American Automobile Association Foundation for traffic Safety, Washington, DC.
- National Highway Traffic Safety Administration** (1999). *Traffic Safety Facts 1998: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, National Center for Statistics and Analysis, U.S. Department of Transportation, Washington, D.C.
- Novaco, R.W.** (1989). *Aggression on Roadways*. Reprint N° 16. The University of California Transportation Center, California.
- Parry, M.** (1968). *Aggression on the Road*. Tavistock, London.
- Perry, A.R.** (1986). Type A behavior pattern and motor vehicle driver's behavior. *Perceptual and Motor Skills* **63**, 875–8.
- Poch, M., Mannering, F.** (1996). Negative binomial analysis of intersection accident frequencies, *Journal of Transportation Engineering* **122**(2).
- Romanov, K., Hatakka, M., Keskinen, E., Laaksonen, H., Kaprio, J., Rose, R.J. & Koskenvuo, M.** (1994). Self-reported hostility and suicidal acts, accidents, and accidental deaths: a prospective study of 21,443 adults aged 25 to 59. *Psychosomatic Medicine* **56**(4), 328–36.
- Smart, R.G. & Mann, R.E.** (2002). Deaths and injuries from road rage: cases in Canadian newspapers. *Canadian Medical Association Journal* **167**(7), 761–762.
- Strack, S.** (1997). The PACL: Gauging normal personality styles. In T. Millon (Ed.), *The Millon inventories: Clinical and personality assessment*. New York: Guilford.
- Ulleberg, P.** (2001). Personality subtypes of young drivers. Relationship to risk-taking preferences, accident involvement, and response to a traffic safety campaign. *Transportation Research Part F* **4**(4), 279–297.
- Wells-Parker, E., Ceminsky, J., Hallberg, V., Snow, R.W., Dunaway, G., Guiling, S., Williams, M. & Anderson, B.** (2002). An exploratory study of the relationship between road rage and crash experience in a representative sample of US drivers. *Accident Analysis and Prevention* **34**, 271–278.

Winslow, J.T., Ellingboe, J. & Miczek, K.A. (1988). Effects of alcohol on aggressive behavior in squirrel monkeys: Influence of testosterone and social context. *Psychopharmacology* **95**, 356–363.

Wilson, R.J. & Jonah, B.A. (1988). *The Application of Problem Behavior Theory to the Understanding of Risky Driving. The Social Psychology of Risky Driving*, Proceedings of an International Symposium Held in Santa Monica, California.

Zhang, I., Wiczorek, W.F. & Welte, J.W. (1997). The nexus between alcohol and violent crime. *Alcoholism: Clinical and Experimental Research* **21**, 1264–1271.

Table 1. Intercorrelations (Pearson's coefficients) between BDHI scores and subscores

	1	2	3	4	5	6	7	8	9
(1) Assault									
(2) Verbal hostility	.80								
(3) Indirect hostility	.72	.38							
(4) Irritability	.54	.44	.49						
(5) Negativism	.34	.27	.26	.33					
(6) Suspicion	.26	.19	.22	.38	.23				
(7) Resentment	.31	.21	.30	.50	.25	.54			
(8) Guilt	.15	.08	.19	.37	.13	.31	.39		
(9) Total hostility	.85	.68	.67	.78	.51	.59	.65	.34	

All coefficients are significant at $p < 10^{-3}$

Table 2. Univariate comparison of overall BDHI aggression/hostility scores by selected variables among men and women in the GAZEL cohort, 2001.

Overall BDHI aggression/hostility scores				
Variables	Low N (%)	Intermediate N (%)	High N (%)	P for comparison
Sex				$<10^{-4}$
Male	2 520 (80.4)	4 271 (75.4)	2 152 (73.9)	
Female	615 (19.6)	1 396 (24.6)	759 (26.1)	
Age category at the time of BDHI hostility measurement in 1993				$<10^{-4}$
50–54	1 262 (40.2)	2 206 (38.8)	1 249 (38.8)	
45–49	1 657 (52.7)	2 953 (51.9)	1 491 (51.0)	
39–44	223 (7.1)	528 (9.3)	322 (11.2)	
Occupational category in 2001				$<10^{-4}$
Unskilled Workers	233 (7.4)	481 (8.5)	354 (12.1)	
Skilled Workers	1 552 (49.4)	3 026 (53.3)	1 708 (58.4)	
Managers	1 355 (43.2)	2 175 (38.3)	861 (29.5)	
Alcohol consumption				$<10^{-3}$
No drinkers	1 868 (59.7)	3 256 (57.3)	1 603 (54.8)	
Low quantity regular alcohol	114 (3.6)	232 (4.1)	161 (5.5)	
Low quantity episodic alcohol	44 (1.4)	81 (1.4)	31 (1.1)	
High quantity regular alcohol	1 101 (35.0)	2 083 (36.6)	1 112 (38.0)	
High quantity episodic alcohol	15 (0.5)	35 (0.6)	18 (0.6)	
Risky use of cellular phone while driving				0.80
Yes	154 (4.9)	297 (5.2)	151 (5.2)	
No	2 988 (95.1)	5 390 (94.8)	2 774 (94.8)	
Mileage in 2001 (km)				$<10^{-3}$
< 10 000	645 (20.5)	1 301 (22.9)	700 (23.9)	
10 000–20 000	1 459 (46.4)	2 649 (46.6)	1 350 (46.2)	
>20 000	1 038 (33.0)	1 737 (30.5)	875 (29.9)	
Type of vehicle owned in 2001				$<10^{-3}$
City and utilitarian cars	649 (21.7)	1 258 (23.4)	707 (25.7)	
Small family cars	928 (31.1)	1 610 (29.9)	875 (31.8)	
Large family cars, MPVs and 4x4s	1 130 (37.8)	2 064 (38.4)	946 (34.4)	
Executive, luxury cars and sport cars	282 (9.4)	448 (8.3)	222 (8.1)	
Maximum speed on motorways > 145 km/h				$<10^{-3}$
Yes	172 (5.5)	380 (6.8)	222 (7.7)	
No	2 932 (94.5)	5 211 (93.2)	2 661 (92.3)	
Maximum speed on rural roads > 100 km/h				0.02
Yes	58 (1.9)	150 (2.7)	82 (2.8)	
No	3 057 (98.1)	5 478 (97.3)	2 809 (97.2)	
Maximum speed in built-up areas > 55 km/h				0.03
Yes	156 (5.0)	327 (5.8)	191 (6.6)	
No	2 960 (95.0)	5 296 (94.2)	2 707 (93.4)	
Scores for negative attitudes towards traffic regulations				$<10^{-4}$
0 to 2	386 (12.3)	564 (9.9)	270 (9.2)	
3 to 4	1 059 (33.7)	1 845 (32.4)	846 (28.9)	
5 to 6	936 (29.8)	1 703 (29.9)	840 (28.7)	
7 to 12	761 (24.2)	1 575 (27.7)	969 (27.7)	

Table 3. Relationship between overall BDHI scores and subscores, and injury accidents among men and women in the GAZEL cohort in the 1994-2001 period-Negative Binomial regression models.

		N	Rate ratios of injury accidents							
			RR*	95% CI	aRR†	95% CI	aRR‡	95% CI	aRR††	95% CI
BDHI scores and subscores										
Assault	11 879									
low	3 676	1		1						
intermediate	5 544	0.96	(0.77-1.17)	0.95	(0.76-1.16)					
high	2 659	1.23	(0.97-1.56)	1.22	(0.96-1.55)					
Verbal hostility	11 862									
low	3 003	1		1						
intermediate	9 913	1.14	(0.85-1.34)	1.13	(0.89-1.46)					
high	4 946	1.18	(0.90-1.39)	1.17	(0.93-1.49)					
Indirect hostility	11 851									
low	3 721	1		1						
intermediate	5 736	0.99	(0.80-1.20)	0.99	(0.80-1.20)					
high	2 394	1.18	(0.92-1.52)	1.17	(0.92-1.50)					
Irritability	11 853									
low	3 939	1		1		1		1		
intermediate	5 954	0.99	(0.80-1.20)	0.99	(0.81-1.22)	0.99	(0.81-1.23)	0.98	(0.78-1.20)	
high	1 960	1.29	(1.00-1.68)	1.32	(1.02-1.71)	1.32	(1.02-1.73)	1.33	(1.02-1.75)	
Negativism	11,807									
low	3 684	1		1		1		1		
intermediate	5 720	1.05	(0.85-1.29)	1.05	(0.85-1.30)	1.05	(0.85-1.30)	1.06	(0.85-1.32)	
high	2 403	1.29	(1.00-1.66)	1.30	(1.02-1.68)	1.30	(1.01-1.69)	1.32	(1.01-1.71)	
Suspicion	11 842									
low	5 144	1		1		1		1		
intermediate	3 862	1.02	(0.82-1.27)	1.01	(0.81-1.25)	1.04	(0.84-1.29)			
high	2 836	1.27	(1.02-1.59)	1.24	(1.02-1.56)	1.24	(0.98-1.58)			
Resentment	11 849									
low	4 767	1		1						
intermediate	5 139	1.09	(0.90-1.33)	1.08	(0.88-1.32)					
high	1 943	1.27	(0.98-1.64)	1.24	(0.96-1.61)					
Guilt	11 811									
low	3 059	1		1						
intermediate	5 977	0.89	(0.71-1.10)	0.89	(0.71-1.11)					
high	2 775	1.05	(0.82-1.36)	1.05	(0.81-1.34)					
Total hostility	11 754									
low	3 142	1		1						
intermediate	5 687	1.02	(0.81-1.28)	1.02	(0.81-1.28)					
high	2 925	1.27	(0.99-1.63)	1.25	(0.98-1.61)					

* RR= Unadjusted rate ratios

†aRR= rate ratios adjusted for: **sex** (male/female), **age** (a continuous time-dependent covariate), **occupational category** (a time-dependent covariate of 3 categories: unskilled workers/skilled workers/managers) and **driving mileage per year** (logarithmic transformation).

‡ aRR= rate ratios additionally adjusted for: **alcohol consumption** (a five-category time-dependent covariate describing quantity and frequency) **maximum speed greater than ± 10% legal limits in built-up areas** (yes/no), on **rural roads** (yes/no) and **on motorways** (yes/no), **risky use of cell phone** (yes/no)

††aRR rate ratios additionally adjusted for: **vehicle categories** (4 categories) and **scores of negative attitudes towards traffic regulation** (4 categories).