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Injury severity analysis of accidents involving young male drivers in Great Britain

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Abstract

Introduction: Young male drivers are over-represented in traffic accidents; they were involved in 14% of fatal accidents from 1991 to 2003 while holding only 8% of all drivers licenses in the UK. In this study, a subset of the UK national road accident data from 1991 to 2003 has been analyzed. The primary aim is to determine how to best use monetary and progressive resources to understand how road safety measures will reduce the severity of accidents involving young male drivers in both London and Great Britain. *Method:* Ordered probit models were used to identify specific accident characteristics that increase the likelihood of one of three categorical outcomes of accident severity: slight, serious, or fatal. *Results:* Characteristics found to lead to a higher likelihood of serious and fatal injuries are generally similar across Great Britain and London but are different from those predicted to lead to a higher likelihood of slight injuries. Those characteristics predicted to lead to serious and fatal injuries include driving in darkness, between Friday and Sunday, on roads with a speed limit of 60 mph, on single carriageways, overtaking, skidding, hitting an object off the carriageway, and when passing the site of a previous accident. Characteristics predicted to lead to slight injuries include driving in daylight, between Monday and Thursday, on roads with a speed limit of 30 mph or less, at a roundabout, waiting to move, and when an animal is on the carriageway. *Impact on Industry:* These results aid the selection of policy options that are most likely to reduce the severity of accidents involving young male drivers.

Keywords: Young male drivers; Severity of accidents; Ordered probit models; Safety targets; Safety policy

1. Introduction

In 2000, the UK government set up a new national road safety strategy and outcome-based road safety targets to achieve reductions by 2010. The goals were to reduce the number of people killed or seriously injured (KSI) by 40%, reduce the number of children KSI by 50%, and reduce the number of slightly injured per unit of vehicle distance by 10% in relation to the 1994-1998 average. In addition, *London's Road Safety Plan* was created by Transport for London (TfL) in 2001, and this extended the national targets to specifically cover the number of pedestrians, pedalcyclists, and powered two-wheeler riders who are KSI in London by 2010.

In order to achieve the national and London targets, considerable developments need to be made across all aspects of the road system, such as: (a) roads, which are generally the responsibility of the government but could also be the responsibility of other parties (e.g., land developers); (b) vehicles, which are both the manufacturer's responsibility and the responsibility of the individual/organization who owns it; and (c) users, who are generally responsible for themselves and who may be travelling for various reasons such as personal choice or out of necessity due to work.

This study will concentrate upon selected *users* of the road system - *male car drivers* in the 17 to 25 year age group inclusive (henceforth termed "young male drivers") – as this group is over-represented in accidents (Clarke, Ward, Bartle, & Truman, 2006; Clarke, Ward, & Truman, 2005; Moller, 2004). According to the STATS19 (the UK traffic accident reporting system), 54,516 accidents occurred on Great Britain's roads in

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2003 that resulted in at least one individual being KSI. Of these, 6,291 (12%) involved young male drivers. In 2003, young male drivers held only 7% of all drivers licenses and were therefore over-represented in KSI accidents.

Mathijssen (2005) finds that young males have a relatively high accident risk compared to the rest of the population (e.g., while forming less than 5% of the Dutch population, males aged 18-24 formed nearly 25% of all alcohol intoxicated drivers who were involved in serious injury crashes). Vaez and Laflamme (2005) examine the socio-economic differences (age, gender, class of origin, and educational attainment) of Swedish youth (aged 16-30) involved in accidents. They find that there are significant risks among males, persons aged 18-19, those from households classified as “workers” and “others” (e.g., long term unemployed and those on sick leave) as opposed to “salaried employees” or “self-employed,” and those with low educational attainment. Ward, Shepherd, Robertson, and Thomas (2005) find that young male drivers aged 17-20 are up to seven times more likely to die in night-time road accidents than older motorists, and up to 17 times more likely to be involved in a fatal accident between the hours of 0200 and 0500, while female drivers in the same age group are two to three times more likely to be killed than older women, regardless of the time of day. One of the most revealing points to arise from this study is how many young males like to test themselves and their cars to the limit and then joke about it afterwards when things go wrong; little concept of risk is apparent, yet the data in the study indicate that the risk is high for this group. Ulleberg (2002), however, concludes that not all young drivers should be treated in the same way with respect to road safety policy. The study identifies six subtypes of young drivers (aged 18-23), identifying two as “high risk” groups in traffic. The first consists of mostly men, characterized by low levels of altruism and anxiety and high levels of sensation seeking, irresponsibility, and driving related aggression; the second reported high sensation seeking, aggression, anxiety, and driving anger.

Progress toward the national 2010 casualty reduction targets has been analyzed in various studies. Broughton and Buckle (2005) found that before 1994, fatality and KSI rates tended to fall in parallel, but since then the fatality rate has fallen more slowly than the KSI rate. This rise in the severity proportion between 1994 and 2003 has risen faster for car occupants than for other road user groups. Broughton and Buckle go on to state that declining driving standards may have contributed to the increased severity proportion for car occupants, indicating factors such as loss of control, careless/thoughtless/reckless behavior, and aggressive driving. However, the analysis by age cohorts was not conducted for car occupants.

A number of studies used ordered probit models to examine the likelihood of various severity levels sustained under different accident scenarios (e.g., Duncan, Khattak, & Council, 1998; Kockelman & Kweon, 2002; O'Donnell & Connor, 1996; Quddus, Noland, & Chin, 2002). It is therefore the purpose of this study to take the lines of research reviewed above further by examining a large subset of British accident data (between 1991 and 2003) and identifying what types of characteristics increase the likelihood of various accident severity levels for accidents involving a specific age group using ordered probit models. This study is the first of its kind to incorporate accident data for the whole of Great Britain and could aid future research associated with young male drivers by identifying different courses of action aimed at reducing the likelihood of accidents that lead to fatalities, serious injuries, and slight injuries. Therefore, the primary objectives of this study are: (a) to examine the factors that affect the injury severity of accidents involving young male drivers using ordered probit models, in both London and Great Britain as a whole and to investigate any differences; (b) to identify key characteristics to aid London and Great Britain as a whole to improve their records on young male drivers by using appropriate road safety measures. Note that this study will consider both those young male drivers who are themselves killed or injured and those accidents involving young male drivers who kill or injure others.

The rest of the paper is organized as follows. A brief discussion on the sources of data and the statistical models used to achieve the study objectives are described in the next section. This is followed by the presentation of the results obtained from the models for both London and Great Britain as a whole; this section also describes some key characteristics most likely to lead to injuries from accidents involving young male drivers. The paper ends with a conclusion and avenues for further research.

2. Data sources and statistical models

STATS19 National Road Accident data for Great Britain were obtained for the period 1991 to 2003. For every accident reported, data are recorded on the accident, the casualties, and the vehicles involved. A large subset of accidents involving *young male drivers* was extracted from this dataset and used in the analysis. The variable of interest (i.e., dependent variable) is the severity of injury due to an accident involving a young male driver. This is categorized as fatal, serious, or slight and accounts for 2%, 15%, and 83% of all accidents nationally and 1%, 15%, 84% in London, respectively over the period 1991 to 2003. The STATS19 data suggest that the proportion of accidents that involve young male drivers has fallen over the period 1991 to 2003 for both Great Britain as a whole and for London only.

Every observation contained within the dataset represents one accident that involves a young male driver. With the severity of injury caused by the accident, details on factors (independent variables) such as the road, the driver, and the environment are also available. Of the 49 independent variables available in the dataset, 21 were hypothesized to have a potential relationship with severity level (includes an additional variable referring to location for the Great Britain dataset only). These variables have been coded for analysis; the coding system is presented in Table 1.

An ordered probit model is used to examine factors that affect the probability of sustaining one of three injury severities for all accidents involving young male drivers (i.e., the model assumes that an accident has occurred). This model is briefly presented below.

Table 1
STATS19 variables used in the analysis (* denotes reference case)

Variables	Categories	Coding of variable
Time trend	-	Year of accident (assuming that 1991* = 1 to 2003 = 13)
Towing and articulation	no tow/articulation*	If accident involved no tow/articulation = 1, otherwise = 0
	tow/articulation	If accident involved tow/articulation = 1, otherwise = 0
Vehicle manoeuvre	reversing	If accident involved reversing vehicle = 1, otherwise = 0
	parked	If accident involved parked vehicle = 1, otherwise = 0
	waiting to move	If accident involved vehicle waiting to move = 1, otherwise = 0
	stopping	If accident involved stopping vehicle = 1, otherwise = 0
	u-turn	If accident involved vehicle conducting u-turn = 1, otherwise = 0
	going ahead*	If accident involved vehicle going ahead = 1, otherwise = 0
	overtaking	If accident involved overtaking vehicle = 1, otherwise = 0
	changing lane	If accident involved vehicle changing lane = 1, otherwise = 0
Vehicle location - road	leaving main road	If leaving main road = 1, otherwise = 0
	entering main road	If entering main road = 1, otherwise = 0
	on the main road*	If on the main road = 1, otherwise = 0
	on minor road	If on minor road = 1, otherwise = 0
Skidding and overturning	no volatile movement*	If no volatile movement = 1, otherwise = 0
	volatile movement	If volatile movement = 1, otherwise = 0
Hit object off carriageway	hit none*	If hit none = 1, otherwise = 0
	hit object	If hit object = 1, otherwise = 0
Damage	no damage*	If no damage = 1, otherwise = 0
	damage	If damage = 1, otherwise = 0
Age of driver	17-19	If driver 17-19 = 1, otherwise = 0
	20-22	If driver 20-22 = 1, otherwise = 0
	23-25*	If driver 23-25 = 1, otherwise = 0
Breath test	negative	If negative = 1, otherwise = 0
	postitive	If positive = 1, otherwise = 0
	other*	If other = 1, otherwise = 0
Regions	SW	If accident in SW = 1, otherwise = 0
	Scotland	If accident in Scotland = 1, otherwise = 0
	SE	If accident in SE = 1, otherwise = 0
	Wales	If accident in Wales = 1, otherwise = 0
	East	If accident in East = 1, otherwise = 0
	E Midlands	If accident in E Midlands = 1, otherwise = 0
	W Midlands	If accident in W Midlands = 1, otherwise = 0
	NE	If accident in NE = 1, otherwise = 0
	NW	If accident in NW = 1, otherwise = 0
	London*	If accident in London = 1, otherwise = 0
Seasonal effects	January*	If accident in January = 1, otherwise = 0
	February	If accident in February = 1, otherwise = 0
	March	If accident in March = 1, otherwise = 0
	April	If accident in April = 1, otherwise = 0
	May	If accident in May = 1, otherwise = 0
	June	If accident in June = 1, otherwise = 0
	July	If accident in July = 1, otherwise = 0
	August	If accident in August = 1, otherwise = 0
	September	If accident in September = 1, otherwise = 0
	October	If accident in October = 1, otherwise = 0
	November	If accident in November = 1, otherwise = 0
	December	If accident in December = 1, otherwise = 0
Day of week effect	Monday*	If accident on Monday = 1, otherwise = 0
	Tuesday	If accident on Tuesday = 1, otherwise = 0
	Wednesday	If accident on Wednesday = 1, otherwise = 0
	Thursday	If accident on Thursday = 1, otherwise = 0
	Friday	If accident on Friday = 1, otherwise = 0
	Saturday	If accident on Saturday = 1, otherwise = 0
	Sunday	If accident on Sunday = 1, otherwise = 0
Time of day effect	0000-0659	If accident between 0000-0659 = 1, otherwise = 0
	0700-0959	If accident between 0700-0959 = 1, otherwise = 0
	1000-1559	If accident between 1000-1559 = 1, otherwise = 0
	1600-1859	If accident between 1600-1859 = 1, otherwise = 0
	1900-2359*	If accident between 1900-2359 = 1, otherwise = 0
Road category	A*	If A road = 1, otherwise = 0
	A(M)	If A(M) road = 1, otherwise = 0

(continued on next page)

Table 1 (*continued*)

Variables	Categories	Coding of variable
	B	If B road = 1, otherwise = 0
Road category	C	If C road = 1, otherwise = 0
	motorway	If motorway = 1, otherwise = 0
	unclassified	If unclassified road = 1, otherwise = 0
Road type	roundabout	If roundabout = 1, otherwise = 0
	one way street	If one way street = 1, otherwise = 0
	dual carriageway	If dual carriageway = 1, otherwise = 0
	single carriageway*	If single carriageway = 1, otherwise = 0
Speed limit	30*	If speed limit is = 30 = 1, otherwise = 0
	40	If speed limit is 40 = 1, otherwise = 0
	50	If speed limit is 50 = 1, otherwise = 0
	60	If speed limit is 60 = 1, otherwise = 0
	70	If speed limit is 70 = 1, otherwise = 0
Junction detail	not at junction or within 20 metres*	If accident not at junction or within 20 metres = 1, otherwise = 0
	roundabout	If accident at roundabout = 1, otherwise = 0
	mini-roundabout	If accident at mini-roundabout = 1, otherwise = 0
	t, y or staggered junction	If accident at t, y or staggered junction = 1, otherwise = 0
	slip road	If accident on slip road = 1, otherwise = 0
	crossroads	If accident at crossroads = 1, otherwise = 0
	multiple junction	If accident at multiple junction = 1, otherwise = 0
	private drive or entrance	If accident at private drive or entrance = 1, otherwise = 0
	other junction	If accident at other junction = 1, otherwise = 0
Light conditions	daylight*	If daylight = 1, otherwise = 0
	darkness	If darkness = 1, otherwise = 0
Weather conditions	fine no high winds*	If fine no high winds = 1, otherwise = 0
	raining no high winds	If raining no high winds = 1, otherwise = 0
	snowing no high winds	If snowing no high winds = 1, otherwise = 0
	fine + high winds	If fine + high winds = 1, otherwise = 0
	raining + high winds	If raining + high winds = 1, otherwise = 0
	snowing + high winds	If snowing + high winds = 1, otherwise = 0
	fog or mist	If fog or mist = 1, otherwise = 0
	other	If other = 1, otherwise = 0
Road surface conditions	dry*	If dry = 1, otherwise = 0
	wet or damp	If wet or damp = 1, otherwise = 0
	snow	If snow = 1, otherwise = 0
	frost or ice	If frost or ice = 1, otherwise = 0
	flood over 3 cm deep	If flood over 3cm deep = 1, otherwise = 0
	mud (from 1999)	If mud = 1, otherwise = 0
	oil or diesel (from 1999)	If oil or diesel = 1, otherwise = 0
Carriageway hazards	none*	If none = 1, otherwise = 0
	object on road	If object on road = 1, otherwise = 0
	previous accident	If previous accident = 1, otherwise = 0
	animal on road	If animal on road = 1, otherwise = 0

Consider the case where the dependent variable Y takes the value 1, 2, or 3. Then the unobserved index function Y* is defined as:

$$Y^* = \beta\mathbf{X} + \varepsilon \qquad (1)$$

where Y* is a latent and continuous measure of injury severity faced by an individual involved in an accident, **X** is a vector of explanatory variables describing the driver, vehicle, and accident, **β** is a vector of parameters to be estimated, and ε is a random error term (assumed to follow a standard normal distribution). Assume:

$Y = 1$ if $Y^* < k1$ Slight injury
$Y = 2$ if $k1 \leq Y^* < k2$ Serious injury
$Y = 3$ if $k2 \leq Y^*$ Fatal injury

where k1 and k2 are thresholds to be estimated, and k1 < k2. This assumes that if the risk of injury is high then it is reasonable to expect that this will actually be translated into a high level of observed injury. The parameters of the ordered probit model, k1, k2, and **β**, will be measured via maximum likelihood.

Injury severity probabilities for accidents involving young male drivers are also predicted using the estimated ordered probit models as suggested by O'Donnell and Connor (1996), Duncan et al. (1998), and Quddus et al. (2002).

3. Model estimation results

The parameters of the ordered probit models for Great Britain as a whole and London only were estimated by the method of maximum likelihood. Table 2 present the estimation results. In order to determine which characteristics among the independent variables are most likely to lead to each of the three severity levels, the probability of each outcome of the dependent variable (i.e., slight, serious, or fatal injury) is estimated based upon changes in each of the independent variables in turn, all other things being equal (see Tables 3 and 4). For ease of comparison, a reference case has been constructed while calculating the change in predicted probability for each outcome of the dependent variable. The reference case is an observation in which all dummy variables are set equal to zero and the variable *time trend* is set equal to 1 (i.e., 1991).

Creating such a reference case allows us to show how different accident scenarios vary from the reference case by setting each variable in turn to each of its possible coded values, while setting all other variables equal to zero and the time trend equal to 1 (1991) (i.e., it shows how changes in one independent variable, *ceteris paribus*, affect the severity level). Note that when percentages are stated in the text below (e.g., α%/δ%), the first percentage (α%) applies to Great Britain as a whole while the second (δ%) refers to London only.

Table 2 shows that the *time trend* variable is statistically significant with a negative sign. This indicates that something that has changed over the study period has led to a downward trend in injury severity. Therefore, it is suggested that, *ceteris paribus*, some other unmeasured factors is influencing the relative severity of accidents involving young male drivers. From Table 3, a fatality is 45% less likely in 2003 in Great Britain than it was in the reference case (1991) and 38% less likely in London (see Table 4), serious injuries are 26%/22% less likely than in the reference case, while slight injuries are 9%/5% more likely than in the reference case. As the model is intended to capture factors that affect the severity of injuries, the changes in probabilities shown in the time trend are assumed to be caused by some other exogenous factors. Noland and Quddus (2003) analyzed the impact of improvements in medical treatment and technology and found that medical technology improvements are associated with reductions in traffic-related fatalities over time. This therefore could be one source of the time trend effect shown.

When considering *time of day effects*, it can be seen that more severe injuries occur earlier in the morning, with less severe injuries during the day. Overall, accidents occurring between 0000-0659 are 23%/20% more likely to result in a fatality than the reference case (1900-2359), while all other time periods are less likely to result in a fatal accident than the reference case. A reason for this could be that alcohol use is likely to be most prevalent at this time of day. The model includes a variable, *breath test,* indicating a proxy measure for alcohol consumption. The reference case for this variable is "others" representing the cases where the driver either did not request the breath test or was not present at the scene of the accident. The results of the model for this variable do not confirm the hypothesis that a positive breath test leads to a higher probability of a fatal accident; in fact the results show that both the positive and negative tests (compared with the "others" category) are associated with high injury severity. The differential coefficient for the negative breath test is higher than that of the positive breath test, indicating that the negative breath test is more likely to be connected to a fatal accident. However, as the young male driver may not be the person that the breath test is related to, it is not possible to ascertain the full effects of young male drivers' alcohol consumption on injury severity probabilities via this variable. In addition to this, the variables *day of the week* and *time of the day* might capture some of the effects of alcohol consumption.

Looking at *day of the week effects*, it can be seen that relative to the reference case (Monday) less severe accidents are predicted on Tuesdays and Wednesdays (and Thursdays in London), but more severe accidents are predicted on Thursdays (excluding in London), Fridays, Saturdays, and Sundays (e.g., a fatality is 14%/19% more likely on a Saturday). This is logical as young people tend to go out more toward the end of the week, especially the weekend, and again this result is assumed to have some connection to alcohol consumption at this time. The high result for Sunday is assumed to be caused by the large amount of young males still out in the early hours of Sunday morning driving home after a Saturday evening. A possible policy recommendation from this finding is that a curfew needs to be imposed on young male drivers to prevent them from driving between the hours of 0000-0659 on Fridays to Sundays. This would entail enforcement issues, would be viewed as a very strict rule, and could be discriminatory if only applied to males.

The variable *light conditions* allows us to consider the effect of the level of light. Tables 3 and 4 show that more severe injuries are predicted during darkness, with fatalities 30%/23% more likely and serious injuries 13%/11% more likely than in the reference case (daylight). This result concurs with the results of various studies, including Ward et al. (2005) and Clarke et al. (2006). Reasons for this result may include higher levels of tiredness and alcohol consumption and the associated slower reactions and reduced hazard awareness, but also factors such as the different set of people that use the road at night and their reasons for doing so (e.g., driving for social purposes and driving for pleasure, both of which younger drivers do more than other groups of drivers; Ward et al., 2005).

Seasonal effects, as captured by the variable *month of the year*, while not statistically significant, show that January and May (and April and August for Great Britain as a whole) tend to be the months where the more severe accidents will occur. Although the changing of the clocks is sometimes argued to have an effect on road safety, this is unlikely to be causing the effect here as the clocks move forward one hour at the end of March, potentially making it darker in the morning and lighter in the evening, and move backward one hour at the end of October, potentially making it lighter in the morning and darker in the evening. Therefore, according to the results shown above for variable *month of the year*, the month of April may be expected to have more severe injuries in the darker mornings and the month of November to have more severe injuries in the darker evenings. This, however, is not supported by the results.

Weather conditions also have an effect on the predicted severity of injury; however, the effect is very different for Great Britain as a whole and for London only. For Great Britain as a whole, the weather condition most likely to lead to the most severe injuries is *fine no high winds*, whereas in London it is

Table 2
Ordered probit estimates - injury severity of accidents involving young male drivers (Great Britain and London)

Variables	Categories	Great Britain		London	
		Coeff	*t*-stat	Coeff	*t*-stat
Time trend	-	-0.0204	-30.51	-0.0143	-7.32
Towing and articulation	no tow/articulation (Reference)	-	-	-	-
	tow/articulation	0.0315	0.79	-0.0414	-0.12
Vehicle manoeuvre	reversing	-0.1704	-7.50	-0.1167	-2.03
	parked	-0.0633	-4.00	0.0534	1.39
	waiting to move	-0.5138	-49.33	-0.4601	-18.60
	stopping	-0.4786	-37.42	-0.3376	-8.66
	u-turn	-0.1560	-6.51	-0.1624	-3.57
	going ahead (Reference)	-	-	-	-
	overtaking	0.0943	11.05	0.0521	1.54
	changing lane	-0.0503	-2.62	-0.1527	-3.40
Vehicle location - road	leaving main road	-0.0247	-2.64	-0.0481	-2.11
	entering main road	-0.0930	-11.36	-0.0842	-4.18
	on the main road (Reference)	-	-	-	-
	on minor road	-0.0768	-9.17	-0.0475	-1.50
Skidding and overturning	no volatile movement (Reference)	-	-	-	-
	volatile movement	0.0682	14.04	0.2250	11.06
Hit object off carriageway	hit none (Reference)	-	-	-	-
	hit object	0.1212	21.24	0.2311	11.48
Damage to vehicle	no damage (Reference)	-	-	-	-
	damage	-0.0605	-8.61	0.0189	1.15
Age of driver	17-19	-0.0247	-4.86	0.0275	1.94
	20-22	0.0028	0.56	0.0285	2.17
	23-25 (Reference)	-	-	-	-
Breath test	negative	0.0489	11.23	0.1202	9.62
	postitive	0.0275	2.61	0.1015	2.89
	other (Reference)	-	-	-	-
Police force (Reginal effects)	SW	-0.1141	-11.92	-	-
	Scotland	0.1283	13.78	-	-
	SE	-0.1064	-12.66	-	-
	Wales	-0.1245	-11.28	-	-
	East	-0.0032	-0.36	-	-
	E Midlands	-0.0082	-0.87	-	-
	W Midlands	0.0101	1.16	-	-
	NE	-0.0437	-5.34	-	-
	NW	-0.1259	-15.32	-	-
	London (Reference)	-	-	-	-
Seasonal effects	January (Reference)	-	-	-	-
	February	-0.0343	-3.33	-0.0475	-1.70
	March	-0.0046	-0.45	-0.0304	-1.11
	April	-0.0011	-0.10	-0.0202	-0.73
	May	0.0049	0.47	0.0087	0.31
	June	-0.0022	-0.21	-0.0169	-0.61
	July	-0.0117	-1.12	-0.0031	-0.11
	August	0.0068	0.67	-0.0374	-1.33
	September	-0.0109	-1.07	-0.0386	-1.41
	October	-0.0157	-1.59	-0.0044	-0.16
	November	-0.0195	-2.03	-0.0458	-1.71
	December	-0.0144	-1.49	-0.0738	-2.74
Day of week effect	Monday (Reference)	-	-	-	-
	Tuesday	-0.0098	-1.21	-0.0073	-0.34
	Wednesday	-0.0031	-0.39	-0.0095	-0.44
	Thursday	0.0045	0.57	-0.0042	-0.19
	Friday	0.0255	3.41	0.0376	1.80
	Saturday	0.0571	7.65	0.0657	3.17
	Sunday	0.0467	6.02	0.0370	1.73
Hour of accident	0000-0659	0.0902	12.49	0.0663	3.44
	0700-0959	-0.1071	-12.21	-0.0465	-1.83
	1000-1559	-0.1044	-14.15	-0.0539	-2.47
	1600-1859	-0.0719	-11.23	-0.0669	-3.53
	1900-2359 (Reference)	-	-	-	-
First road class	A (Reference)	-	-	-	-
	A(M)	-0.2964	-5.82	-0.2755	-2.13

Table 2 (*continued*)

Variables	Categories	Great Britain		London	
		Coeff	*t*-stat	Coeff	*t*-stat
First road class	B	-0.0161	-2.55	0.0148	0.75
	C	-0.0390	-5.21	0.0004	0.02
	motorway	-0.1883	-12.19	-0.1254	-2.03
	unclassified	-0.0755	-13.81	-0.0519	-3.22
Road type	roundabout	-0.1808	-9.71	-0.0639	-1.15
	one way street	-0.0880	-6.15	-0.0257	-0.85
	dual carriageway	-0.0782	-9.92	-0.0058	-0.31
	single carriageway (Reference)	-	-	-	-
Speed limit	30 (Reference)	-	-	-	-
	40	0.1363	17.50	0.1252	5.46
	50	0.1839	11.35	0.0973	2.34
	60	0.2690	48.63	0.1832	4.33
	70	0.2256	17.77	0.0730	1.38
Junction detail	not at junction or within 20 metres (Reference)	-	-	-	-
	roundabout	-0.3649	-22.04	-0.3082	-6.27
	mini-roundabout	-0.2435	-7.80	-0.1700	-2.88
	t, y or staggered junction	-0.1415	-26.75	-0.0874	-6.01
	slip road	-0.1971	-11.12	-0.1193	-2.13
	crossroads	-0.1638	-21.79	-0.0841	-4.75
	multiple junction	-0.1747	-16.25	-0.1562	-3.77
	private drive or entrance	-0.2382	-21.78	-0.1524	-4.78
	other junction	-0.2245	-14.45	-0.1797	-3.12
Light conditions	daylight (Reference)	-	-	-	-
	darkness	0.1144	17.81	0.0786	4.10
Weather conditions	fine no high winds (Reference)	-	-	-	-
	raining no high winds	-0.1201	-17.26	-0.0911	-4.15
	snowing no high winds	-0.1047	-3.00	0.0728	0.59
	fine+high winds	-0.0058	-0.36	0.1038	1.79
	raining+high winds	-0.0564	-3.41	0.0353	0.49
	snowing+high winds	-0.0877	-1.42	-0.0321	-0.11
	fog or mist	-0.0047	-0.25	-0.1262	-1.39
	other	-0.0861	-5.91	0.0436	0.78
Road surface conditions	dry (Reference)	-	-	-	-
	wet or damp	-0.0274	-4.86	0.0195	1.08
	snow	-0.2510	-6.47	-0.3334	-2.05
	frost or ice	-0.2693	-17.15	-0.1355	-2.36
	flood over 3cm deep	-0.1804	-3.63	-0.6940	-2.70
	mud (from 1999)	-0.3339	-2.88	-5.6272	0.00
	oil or diesel (from 1999)	0.0351	0.35	0.2476	0.61
Carriageway hazards	none (Reference)	-	-	-	-
	object on road	-0.0824	-4.52	-0.2423	-2.52
	previous accident	0.1807	5.38	0.1478	1.08
	animal on road	-0.2675	-13.50	-0.4370	-3.60
Summary statistics					
Ancillary parameters					
cut-point1 (k1)		0.6527		0.8999	
cut-point 2 (k2)		1.9130		2.3716	
Log-likelihood at convergence		-267,706.85		-33665.05	
Observations		549,178		73,253	

fine weather with *high winds*. Overall, for Great Britain any weather condition different from *fine no high winds* is generally predicted to increase the likelihood of slight injuries and reduce the likelihood of serious and fatal injuries. In London, however, the pattern is generally reversed. It is possible then that the less frequent occurrence of weather of types other than fine no high winds means that individuals in London are less experienced at driving in them and hence are more likely to be involved in serious accidents when they do occur.

The condition of the *road surface* also has an effect on predicted injury severity. Compared to the reference case (dry), oil or diesel (and wet or damp in London) is predicted to lead to more severe injuries, with oil or diesel resulting in an 8%/91% higher likelihood of a fatality. It appears that perhaps more obvious hazards such as snow, frost or ice, or floods or mud cause the driver to make compensatory measures, such as slowing down, whereas factors such as oil or diesel (which may only be an isolated spill so that the driver has no warning of it) or water (where if it has been raining, the driver becomes accustomed to the rain and forgets that the surface will be affected) may not cause the driver to compensate. This is also supported by the fact that any road condition other than the reference case (dry) is generally

Table 3
Injury severity probabilities for accidents involving young male drivers, Great Britain

Variables	Categories	Estimated probability			Percent change relative to reference case (%)		
		Slight	Serious	Fatal	Slight	Serious	Fatal
-	Reference case	0.7496	0.2238	0.0266	-	-	-
Time trend	2003	0.8207	0.1646	0.0147	9%	-26%	-45%
Towing and articulation	no tow/articulation (Reference)	-	-	-	-	-	-
	tow/articulation	0.7394	0.2320	0.0286	-1%	4%	8%
Vehicle manoeuvre	reversing	0.8005	0.1818	0.0177	7%	-19%	-33%
	parked	0.7693	0.2078	0.0229	3%	-7%	-14%
	waiting to move	0.8824	0.1104	0.0072	18%	-51%	-73%
	stopping	0.8753	0.1168	0.0079	17%	-48%	-70%
	u-turn	0.7965	0.1852	0.0183	6%	-17%	-31%
	going ahead (Reference)	-	-	-	-	-	-
	overtaking	0.7187	0.2484	0.0330	-4%	11%	24%
	changing lane	0.7653	0.2111	0.0236	2%	-6%	-11%
Vehicle location - road	leaving main road	0.7574	0.2175	0.0251	1%	-3%	-6%
	entering main road	0.7782	0.2004	0.0214	4%	-10%	-20%
	on the main road (Reference)	-	-	-	-	-	-
	on minor road	0.7734	0.2044	0.0222	3%	-9%	-17%
Skidding and overturning	no volatile movement (Reference)	-	-	-	-	-	-
	volatile movement	0.7274	0.2415	0.0311	-3%	8%	17%
Hit object off carriageway	hit none (Reference)	-	-	-	-	-	-
	hit object	0.7095	0.2555	0.0350	-5%	14%	32%
Damage to vehicle	no damage (Reference)	-	-	-	-	-	-
	damage	0.7684	0.2085	0.0231	3%	-7%	-13%
Age of driver	17-19	0.7574	0.2175	0.0251	1%	-3%	-6%
	20-22	0.7487	0.2245	0.0268	0%	0%	1%
	23-25 (Reference)	-	-	-	-	-	-
Breath test	negative	0.7338	0.2365	0.0298	-2%	6%	12%
	postitive	0.7408	0.2309	0.0283	-1%	3%	7%
	other (Reference)	-	-	-	-	-	-
Police force	SW	0.7844	0.1953	0.0203	5%	-13%	-24%
	Scotland	0.7071	0.2574	0.0355	-6%	15%	34%
	SE	0.7822	0.1971	0.0207	4%	-12%	-22%
	Wales	0.7875	0.1927	0.0198	5%	-14%	-26%
	East	0.7506	0.2230	0.0264	0%	0%	-1%
	E Midlands	0.7522	0.2217	0.0261	0%	-1%	-2%
	W Midlands	0.7464	0.2264	0.0272	0%	1%	2%
	NE	0.7633	0.2127	0.0240	2%	-5%	-10%
	NW	0.7879	0.1924	0.0197	5%	-14%	-26%
	London (Reference)	-	-	-	-	-	-
Seasonal effects	January (Reference)	-	-	-	-	-	-
	February	0.7603	0.2151	0.0246	1%	-4%	-8%
	March	0.7510	0.2227	0.0263	0%	-1%	-1%
	April	0.7499	0.2236	0.0265	0%	0%	0%
	May	0.7480	0.2251	0.0269	0%	1%	1%
	June	0.7503	0.2233	0.0265	0%	0%	-1%
	July	0.7533	0.2208	0.0259	0%	-1%	-3%
	August	0.7474	0.2256	0.0270	0%	1%	2%
	September	0.7530	0.2210	0.0259	0%	-1%	-2%
	October	0.7545	0.2198	0.0256	1%	-2%	-4%
	November	0.7558	0.2188	0.0254	1%	-2%	-4%
	December	0.7541	0.2201	0.0257	1%	-2%	-3%
Day of week effect	Monday (Reference)	-	-	-	-	-	-
	Tuesday	0.7527	0.2213	0.0260	0%	-1%	-2%
	Wednesday	0.7506	0.2230	0.0264	0%	0%	-1%
	Thursday	0.7481	0.2250	0.0269	0%	1%	1%
	Friday	0.7414	0.2304	0.0282	-1%	3%	6%
	Saturday	0.7311	0.2386	0.0303	-2%	7%	14%
	Sunday	0.7345	0.2359	0.0296	-2%	5%	11%
Hour of accident	0000-0659	0.7200	0.2473	0.0326	-4%	10%	23%
	0700-0959	0.7824	0.1970	0.0206	4%	-12%	-22%
	1000-1559	0.7816	0.1976	0.0208	4%	-12%	-22%
	1600-1859	0.7719	0.2057	0.0225	3%	-8%	-16%
	1900-2359 (Reference)	-	-	-	-	-	-

Table 3 (*continued*)

Variables	Categories	Estimated probability			Percent change relative to reference case (%)		
		Slight	Serious	Fatal	Slight	Serious	Fatal
First road class	A (Reference)	-	-	-	-	-	-
	A(M)	0.8339	0.1532	0.0129	11%	-32%	-52%
	B	0.7547	0.2197	0.0256	1%	-2%	-4%
	C	0.7618	0.2139	0.0243	2%	-4%	-9%
	motorway	0.8055	0.1776	0.0169	7%	-21%	-36%
	unclassified	0.7730	0.2048	0.0223	3%	-9%	-16%
Road type	roundabout	0.8034	0.1793	0.0172	7%	-20%	-35%
	one way street	0.7767	0.2017	0.0216	4%	-10%	-19%
	dual carriageway	0.7738	0.2041	0.0221	3%	-9%	-17%
	single carriageway (Reference)	-	-	-	-	-	-
Speed limit	30 (Reference)	-	-	-	-	-	-
	40	0.7043	0.2595	0.0362	-6%	16%	36%
	50	0.6877	0.2722	0.0401	-8%	22%	51%
	60	0.6569	0.2950	0.0480	-12%	32%	81%
	70	0.6728	0.2834	0.0438	-10%	27%	65%
Junction detail	not at junction or within 20 metres (Reference)	-	-	-	-	-	-
	roundabout	0.8504	0.1388	0.0108	13%	-38%	-59%
	mini-roundabout	0.8203	0.1649	0.0147	9%	-26%	-45%
	t, y or staggered junction	0.7924	0.1886	0.0190	6%	-16%	-29%
	slip road	0.8079	0.1755	0.0166	8%	-22%	-38%
	crossroads	0.7987	0.1833	0.0180	7%	-18%	-32%
	multiple junction	0.8017	0.1807	0.0175	7%	-19%	-34%
	private drive or entrance	0.8190	0.1661	0.0149	9%	-26%	-44%
	other junction	0.8153	0.1692	0.0155	9%	-24%	-42%
Light conditions	daylight (Reference)	-	-	-	-	-	-
	darkness	0.7119	0.2537	0.0345	-5%	13%	30%
Weather conditions	fine no high winds (Reference)	-	-	-	-	-	-
	raining no high winds	0.7862	0.1938	0.0200	5%	-13%	-25%
	snowing no high winds	0.7817	0.1976	0.0208	4%	-12%	-22%
	fine+high winds	0.7514	0.2223	0.0262	0%	-1%	-1%
	raining+high winds	0.7672	0.2095	0.0233	2%	-6%	-12%
	snowing+high winds	0.7766	0.2017	0.0216	4%	-10%	-19%
	fog or mist	0.7511	0.2226	0.0263	0%	-1%	-1%
	other	0.7762	0.2021	0.0217	4%	-10%	-18%
Road surface conditions	dry (Reference)	-	-	-	-	-	-
	wet or damp	0.7582	0.2168	0.0250	1%	-3%	-6%
	snow	0.8223	0.1632	0.0145	10%	-27%	-46%
	frost or ice	0.8270	0.1592	0.0138	10%	-29%	-48%
	flood over 3 cm deep	0.8033	0.1794	0.0173	7%	-20%	-35%
	mud (from 1999)	0.8431	0.1453	0.0117	12%	-35%	-56%
	oil or diesel (from 1999)	0.7383	0.2329	0.0288	-2%	4%	8%
Carriageway hazards	none (Reference)	-	-	-	-	-	-
	object on road	0.7751	0.2030	0.0219	3%	-9%	-18%
	previous accident	0.6888	0.2714	0.0398	-8%	21%	50%
	animal on road	0.8266	0.1596	0.0139	10%	-29%	-48%

likely to increase the likelihood of slight injuries and decrease the likelihood of serious or fatal injuries.

The variable *skidding or overturning* shows that if a volatile movement occurs, then a more severe injury is predicted (i.e., a fatality is 17%/80% more likely than in the reference case; no volatile movement). This is logical and is linked to the variable *damage*. The results of this variable for London show that if damage to the vehicle is caused then a more severe injury is predicted (i.e., a fatality is 5% more likely than in the reference case; no damage). The results for Great Britain show the reverse, which is surprising. Also, the variable *hit object off carriageway* shows that hitting an object off the carriageway increases the chance of a fatality by 32%/83% compared to the reference case (hit nothing).

The results of the variable *carriageway hazard* show that compared to the reference case (no carriageway hazards), a previous accident on the road is predicted to lead to more severe injuries, with a fatality 50%/48% more likely. This concurs with the results of various studies that show that "rubbernecking," whereby drivers passing a previous accident slow down to watch, is a real problem. Objects on the road and animals on the road are predicted to lead to less severe injuries, possibly because it causes the driver to slow down and increase his/her concentration.

The variable *speed limit* shows some interesting results. The highest speed limit, 70 mph, does not lead to the most severe accidents; however, this may be because 70 mph is only the speed limit on motorways and dual carriageways. The variable

Table 4
Injury severity probabilities for accidents involving young male drivers, London

Variables	Categories	Estimated probability			Percent change relative to reference case (%)		
		Slight	Serious	Fatal	Slight	Serious	Fatal
-	Reference case	0.8197	0.1718	0.0085	-	-	-
Time trend	2003	0.8612	0.1336	0.0053	5%	-22%	-38%
Towing and articulation	no tow/articulation (Reference)	-	-	-	-	-	-
	tow/articulation	0.8304	0.1620	0.0076	1%	-6%	-11%
Vehicle manoeuvre	reversing	0.8487	0.1451	0.0062	4%	-16%	-28%
	parked	0.8053	0.1849	0.0098	-2%	8%	15%
	waiting to move	0.9153	0.0825	0.0022	12%	-52%	-74%
	stopping	0.8947	0.1021	0.0032	9%	-41%	-62%
	u-turn	0.8592	0.1354	0.0054	5%	-21%	-36%
	going ahead (Reference)	-	-	-	-	-	-
	overtaking	0.8057	0.1845	0.0098	-2%	7%	15%
	changing lane	0.8570	0.1374	0.0056	5%	-20%	-35%
Vehicle location - road	leaving main road	0.8320	0.1605	0.0075	2%	-7%	-12%
	entering main road	0.8409	0.1523	0.0068	3%	-11%	-21%
	on the main road (Reference)	-	-	-	-	-	-
	on minor road	0.8319	0.1606	0.0075	1%	-7%	-12%
Skidding and overturning	no volatile movement (Reference)	-	-	-	-	-	-
	volatile movement	0.7546	0.2300	0.0154	-8%	34%	80%
Hit object off carriageway	hit none (Reference)	-	-	-	-	-	-
	hit object	0.7527	0.2317	0.0156	-8%	35%	83%
Damage to vehicle	no damage (Reference)	-	-	-	-	-	-
	damage	0.8147	0.1764	0.0090	-1%	3%	5%
Age of driver	17-19	0.8124	0.1784	0.0092	-1%	4%	8%
	20-22	0.8121	0.1787	0.0092	-1%	4%	8%
	23-25 (Reference)	-	-	-	-	-	-
Breath test	negative	0.7864	0.2019	0.0117	-4%	18%	38%
	postitive	0.7918	0.1970	0.0112	-3%	15%	31%
	other (Reference)	-	-	-	-	-	-
Seasonal effects	January (Reference)	-	-	-	-	-	-
	February	0.8319	0.1606	0.0075	1%	-6%	-12%
	March	0.8276	0.1646	0.0078	1%	-4%	-8%
	April	0.8249	0.1670	0.0081	1%	-3%	-5%
	May	0.8174	0.1739	0.0087	0%	1%	2%
	June	0.8241	0.1678	0.0081	1%	-2%	-5%
	July	0.8205	0.1711	0.0084	0%	0%	-1%
	August	0.8293	0.1630	0.0077	1%	-5%	-10%
	September	0.8296	0.1627	0.0077	1%	-5%	-10%
	October	0.8208	0.1707	0.0084	0%	-1%	-1%
	November	0.8315	0.1610	0.0075	1%	-6%	-12%
	December	0.8384	0.1546	0.0070	2%	-10%	-18%
Day of week effect	Monday (Reference)	-	-	-	-	-	-
	Tuesday	0.8216	0.1700	0.0084	0%	-1%	-2%
	Wednesday	0.8222	0.1695	0.0083	0%	-1%	-3%
	Thursday	0.8208	0.1708	0.0084	0%	-1%	-1%
	Friday	0.8096	0.1809	0.0094	-1%	5%	11%
	Saturday	0.8019	0.1879	0.0102	-2%	9%	19%
	Sunday	0.8098	0.1808	0.0094	-1%	5%	11%
Hour of accident	0000-0659	0.8017	0.1881	0.0102	-2%	9%	20%
	0700-0959	0.8316	0.1609	0.0075	1%	-6%	-12%
	1000-1559	0.8335	0.1592	0.0073	2%	-7%	-14%
	1600-1859	0.8367	0.1562	0.0071	2%	-9%	-17%
	1900-2359 (Reference)	-	-	-	-	-	-
First road class	A (Reference)	-	-	-	-	-	-
	A(M)	0.8829	0.1132	0.0039	8%	-34%	-54%
	B	0.8158	0.1754	0.0089	0%	2%	4%
	C	0.8196	0.1719	0.0085	0%	0%	0%
	motorway	0.8507	0.1433	0.0060	4%	-17%	-29%
	unclassified	0.8330	0.1596	0.0074	2%	-7%	-13%
Road type	roundabout	0.8360	0.1569	0.0071	2%	-9%	-16%
	one way street	0.8264	0.1657	0.0079	1%	-4%	-7%
	dual carriageway	0.8212	0.1704	0.0084	0%	-1%	-2%
	single carriageway (Reference)	-	-	-	-	-	-

Table 4 (*continued*)

Variables	Categories	Estimated probability			Percent change relative to reference case (%)		
		Slight	Serious	Fatal	Slight	Serious	Fatal
Speed limit	30 (Reference)	-	-	-	-	-	-
	40	0.7849	0.2032	0.0119	-4%	18%	40%
	50	0.7930	0.1959	0.0111	-3%	14%	30%
	60	0.7676	0.2186	0.0138	-6%	27%	62%
	70	0.7999	0.1898	0.0104	-2%	10%	22%
Junction detail	not at junction or within 20 metres	-	-	-	-	-	-
	roundabout	0.8892	0.1073	0.0035	8%	-38%	-59%
	mini-roundabout	0.8609	0.1338	0.0053	5%	-22%	-38%
	t, y or staggered junction	0.8417	0.1516	0.0067	3%	-12%	-21%
	slip road	0.8493	0.1446	0.0061	4%	-16%	-28%
	crossroads	0.8409	0.1523	0.0068	3%	-11%	-21%
	multiple junction	0.8578	0.1367	0.0055	5%	-20%	-35%
	private drive or entrance	0.8569	0.1375	0.0056	5%	-20%	-35%
	other junction	0.8630	0.1319	0.0052	5%	-23%	-40%
Light conditions	daylight (Reference)	-	-	-	-	-	-
	darkness	0.7983	0.1912	0.0105	-3%	11%	23%
Weather conditions	fine no high winds (Reference)	-	-	-	-	-	-
	raining no high winds	0.8426	0.1508	0.0066	3%	-12%	-22%
	snowing no high winds	0.7999	0.1897	0.0104	-2%	10%	22%
	fine+high winds	0.7911	0.1976	0.0112	-3%	15%	32%
	raining+high winds	0.8103	0.1804	0.0094	-1%	5%	10%
	snowing+high winds	0.8280	0.1642	0.0078	1%	-4%	-8%
	fog or mist	0.8509	0.1431	0.0060	4%	-17%	-30%
	other	0.8080	0.1824	0.0096	-1%	6%	12%
Road surface conditions	dry (Reference)	-	-	-	-	-	-
	wet or damp	0.8145	0.1765	0.0090	-1%	3%	5%
	snow	0.8939	0.1028	0.0033	9%	-40%	-62%
	frost or ice	0.8531	0.1411	0.0058	4%	-18%	-31%
	flood over 3 cm deep	0.9461	0.0529	0.0010	15%	-69%	-88%
	mud (from 1999)	1.0000	0.0000	0.0000	22%	-100%	-100%
	oil or diesel (from 1999)	0.7475	0.2363	0.0162	-9%	38%	91%
Carriageway hazards	none (Reference)	-	-	-	-	-	-
	object on road	0.8762	0.1195	0.0043	7%	-30%	-50%
	previous accident	0.7783	0.2091	0.0126	-5%	22%	48%
	animal on road	0.9117	0.0859	0.0024	11%	-50%	-72%

road category shows that motorways are relatively safe, while the variable *road type* shows that a dual carriageway is safer than a single carriageway – this is discussed further below. The speed limit associated with the most severe injuries is 60 mph (which legally applies to single carriageways), where a fatality is 81%/62% more likely than in the reference case (≤30 mph).

The results associated with the variable *road category* show that for Great Britain, A roads are predicted to lead to the most severe injuries, whereas in London B roads and C roads are predicted to lead to more severe injuries. For both Great Britain and London, A(M) roads, motorways, and unclassified roads are predicted to lead to less severe injuries. The difference in relative safety of road type between Great Britain and London may be due to the higher volumes of traffic on London A roads and the associated slower speeds relative to A roads in Great Britain as a whole.

The results show that for the variable *vehicle maneuver* overtaking (and being parked in London) is the maneuver that is predicted to lead to more severe injuries. Overall, overtaking is associated with a 24%/15% higher likelihood of a fatality than the reference case (going ahead), suggesting that young male drivers are relatively poor at ascertaining safe overtaking distances and speeds of oncoming traffic.

The variables *vehicle location on the road, road type,* and *junction detail*, all suggest that junctions are not major causes of more severe injuries. For variable *vehicle location on the road*, being on the main road is the scenario most likely to lead to a fatality, as opposed to leaving the main road, entering the main road, or being on a minor road. For variable *road type*, the results show that being on a single carriageway is most likely to lead to a fatality rather than roundabouts, one-way streets, or dual carriageways. For variable *junction detail*, not being at a junction or within 20m of one is associated with the most severe injuries.

For Great Britain as a whole, *towing* something like a caravan or trailer is predicted to lead to more severe injuries (a fatality is 8% more likely than the reference case (no tow or articulation)) whereas in London it is not (fatality is 11% less likely). This discrepancy could be due to the fact that only a very small minority of young male drivers actually tow anything and articulation is not an option as the data only includes car drivers. Again, the results could be related to the level of traffic on the roads; in London, where towing is less likely to result in a fatality, traffic flows are relatively higher and so speeds will also tend to be lower.

The variable *driver age* suggests that for young male drivers in Great Britain, it is those in the age group 20-22 that are most likely to be involved in accidents resulting in more severe injuries and for London it is the age groups 17-19 and 20-22 (e.g., those aged 20-22 are 1%/8% more likely to be involved in a fatal accident than the reference case (23-25)). This finding is consistent with the finding of Clarke et al. (2006).

Finally, the variable *regions* shows, for the Great Britain dataset only, the effect of accident location on severity level. Accidents occurring in Scotland and the West Midlands are predicted to be associated with more severe injuries (e.g., an accident is 34% more likely to be fatal if it occurs in Scotland than if it occurs in the reference case (London)).

Reasons suggested for the over-representation of young male drivers in accidents, as presented in the introduction section, include the higher likelihood of driving while under the influence of alcohol and the overall more risk taking and less law abiding nature of young males (e.g., speeding). Factors such as over-confidence, peer pressure, desire to show off, and higher likelihood of driving at night and with multiple passengers are also considered possible causes of the over-representation of young male drivers in car accidents. While not all of these factors are captured by the STATS19 dataset, it has been possible to summarize the following from the ordered probit modeling for Great Britain as a whole and for London only. The key characteristics predicted to increase the probability of fatal, serious, and slight injuries are shown in Table 5.

According to Golias and Karlaftis (2002) young male drivers tend to fall into the category of "risk takers." Then, as maintained by Ulleberg (2002), if young male drivers' involvement in accidents is to be reduced, it is necessary to *force* those young males that do not already drive safely to do so because they do not respond well to measures designed to encourage safer driving (e.g., safety campaigns). This is an idea corroborated by Tay (2005), who found that enforcement and publicity campaigns produce different results.

It should be noted that the results obtained in this study only refer to the user component of the basic road system, specifically young male drivers; the other two components – roads and vehicles – must also be considered when formulating and implementing road safety policy.

Table 5
Key characteristics most likely to lead to injuries

Great Britain	London only
Fatal and serious injuries	
Between 0000-0659	Between 0000-0659
In darkness	In darkness
Fine no high winds	In fine weather with high winds
On a road with speed limit of 60 mph, most likely a single carriageway and/or A road	On a road with speed limit of 60 mph, most likely a single carriageway and/or B road
Towards the end of the week (Friday-Sunday), particularly on a Saturday (includes early morning Saturday after a Friday night)	Towards the end of the week (Friday-Sunday), particularly on a Saturday (includes early morning Saturday after a Friday night)
On a main road, not at a junction, overtaking	On a main road, not at a junction, either parked or overtaking
When vehicle has skidded, the car has hit an object off the carriageway, but damage has not been caused	When vehicle has skidded, the car has hit an object off the carriageway and damage has been caused
Passing the site of a previous accident	Passing the site of a previous accident
Slight injuries	
Between 1000-1859	Between 1000-1859
In daylight	In daylight
In rain but no high winds	In fog or mist
On a road with speed limit of 30 mph or less, most likely at a roundabout and/or A(M) road	On a road with a speed limit of 30 mph or less, most likely at a roundabout and/or A(M) road
Towards the beginning of the week (Monday-Thursday)	Towards the beginning of the week (Monday-Thursday)
Entering a main road, at a roundabout, waiting to move	Entering a main road, at a roundabout, waiting to move
When vehicle has not skidded, the car has not hit an object off the carriageway, but damage has been caused	When the vehicle has not skidded, the car has not hit an object off the carriageway and no damage has been caused
When there is an animal in the carriageway	When there is an animal in the carriageway

4. Conclusions

This paper investigated the factors affecting the severity of accidents involving young male car drivers. The results demonstrated that young male drivers are over-represented in car accidents relative to their level of exposure as measured by their driver license holding level. Young male drivers were more over-represented in Great Britain as a whole than for London, although it could be argued that exposure levels may be lower in London due to more comprehensive public transport and schemes such as the congestion charge that was implemented in February 2003. The significant factors affecting the severity of accidents involving young male drivers are driving in darkness, trips during early morning and towards the end of the week (Friday and Saturday), on the main roads, during overtaking maneuvers, and on the single carriageway of speed limit 60 mph. Based on these findings, a number of policies were recommended to reduce the severity of accidents involving young male drivers.

STATS19 data has formed the basis of this study. While the STATS19 form does capture a lot of useful information, it does not capture other factors that would be very useful in understanding the nature of accidents involving young male drivers (e.g., number of passengers, mobile phone usage, whether the driver was speeding, and years of driving experience). Since 2005, however, police officers completing STATS19 forms have also been required to note the accident's "precipitating factor" (a choice of 1 out of 15 critical failures or maneuvers that led to the accident) and its "contributory factors" (a choice of up to 4 out of 54 factors that contributed to the critical failure or maneuver). For each, the factors must be categorized as "definite," "probable," or "possible." This type of data will add another dimension to road safety research, especially once data has been collected for a range of years.

It would be interesting to compare the results of this study with similar modeling for young female drivers, or with the driving population as a whole. It would also be interesting to factor into this analysis some measure of traffic flow on the roads on which the accidents occur. This may help explain the reason for some of the different results obtained for the Great Britain and London only datasets via the speed-flow relationship.

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