Profiling drivers with speed-related contributory factors assigned in collisions. Lessons from UK

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Abstract

Speed is one of the key behavioral risk factors in road traffic safety alongside drink-driving, non-use of motorcycle helmets, seat-belts and child restraints. Changing road user behavior on these five factors is a critical component in reducing road traffic injuries and represents an important issue on international organizations' agenda. The objective of this study is the identification of drivers 'exceeding speed limit' in the UK who are more likely to be involved in collisions, for designing targeted speed compliance campaigns. To profile drivers with speeding factors assigned in collisions, an extensive dataset was used, comprising all reported injury collisions between 2011 and 2015 in the UK (police records), merged with the Experian Mosaic database. Using multilevel mixed-effects logistic regression analysis, the finding is that some driver profiles are more likely to exceed speed limits and contribute to crashes. Speed-related crashes are more common in some circumstances or for some driver groups rather than others. For instance, drivers using single or dual carriageways are significantly more likely to contribute to a speed-related crash, as are male or younger drivers. Speed-related crashes were found to be strongly associated with low speed limits: as the level of speed limit increases, the propensity to be involved in a speed-related crash significantly decreases. Using Experian Mosaic database and dividing the UK population into 66 Types based on demographic, lifestyle, and behavior characteristics, the finding is that some Mosaic Types are significantly more likely (e.g. *Streetwise Singles*, *Asian Heritage*) and other are significantly less likely to contribute to a speed-related crash (e.g. *Metro High-Flyers*, *Inner City Stalwarts*). The outcome is a more nuanced understanding of drivers contributing to speed-related crashes in UK. The study concludes by discussing the implications for Governments and other co-interested bodies for better targeting and delivery of public education campaigns and interventions.

Keywords

Contributory Factors; Speeding; Collision; Driver Profiling

1. Introduction

Speed is one of the key behavioral risk factors in road traffic safety alongside with drink-driving, non-use of motorcycle helmets, seat-belts and child restraints [1]. Changing road user behavior on these five factors is a critical component in reducing road traffic injuries which, currently, take the lives of more than 1.2 million people every year, and injure up to 50 million more [2]. Worldwide, road traffic injuries are the leading cause of death among young people, and the main cause of death among those aged 15-29 years [3]. With fatality rates per 100,000 population varying from 7.2 in high-income Western Pacific countries and 7.9 in high-income European countries up to 32.2 in African countries and 35.8 in middle-income Eastern Mediterranean countries, road traffic crashes are currently estimated to be the ninth leading cause of death across all age groups globally, and predicted to become the fifth leading cause of death across all age groups by 2030 [2]. In these circumstances, road safety more generally and speed-related road traffic injuries in particular represent an important issue on international organizations' agenda, with focus on enforcing and laws on one hand [1] but also on the quality of road safety data and the analysis of it, with direct impact on the national and supranational strategies and action plans [4].

The relations between speed and road safety have been largely debated and modelled over time. It has been argued that speed not only affects the severity of a crash, but is also related to the risk of being involved in a crash [5]. Absolute speed at individual vehicle level or at road section level was found to affect crash rates based on an exponential or a power function [6] Speed dispersion is also an important factor in determining crash rate. Larger differences in speed between vehicles are related to a higher crash rate [6]. Reducing the speed limits at intersections and at road sections has been found to have favourable effects on traffic safety, especially on severe crashes [7]. Speed is generally regarded as one of the main traffic related crash contributory factors [8] but research findings do not confirm this unanimously [9]. The relationship between speed and crash frequently depends on the actual road and traffic characteristics, including road width, junction density, number of lanes, gradient and horizontal curvature, traffic volume, and traffic flow [6, 9] but also on vehicle characteristics and vehicle

occupancy [10, 11]. Whilst crash severity is found to be positively correlated with driving speed [12, 13], the relationship between crash frequency and speed is not always straightforward [6].

Early studies on the link between speed and crash frequency suggest a U-shaped relationship, implying that only extremely low and extremely high speed conditions trigger crashes [14]. Later studies found speed to be linearly or exponentially related to crashes [15]. Nevertheless, there are studies contradicting these findings, few of them finding a negative speed-crash relationship [16] and others finding that the relationship is not statistically significant [17]. Recent studies also did not found statistically significant relationships between speed and crashes and suggested that the relationship estimated by different models depends on the selected measure of exposure, with negative relationship for distance-based exposure but positive for time-based exposure [13, 18], or that the inconsistencies can come from the lack of details in link-based models which are very likely to have limited explanatory potential [9]. However, latest research, some based on more representative, condition-based approaches, found speed as a significant contributory factor for the number and the consequences of crashes [9], the effect on collisions of a given relative change in speed being largest when initial speed is highest [19]. Moreover, the positive relationship between speed and crash consequences or severity [5, 7] has been reconfirmed in many recent studies [7, 20, 21] and the phenomenon of speeding is increasing and constantly changing patterns [22]. All these aspects urge, in parallel with the investigation of the relationship speed-crashes, for further research and investigations of the speeding drivers, of their reasons and their characteristics.

Over time, research investigated various aspects and characteristics of speeding drivers, of the context of speeding and speed choices. Significant links and relationships were found between speeding and several demographic, psychological, and situational characteristics. Age is a very common demographic characteristic that influence speeding choices and behavior; younger drivers being found to be more likely to speed or intend to speed, compared to other age categories [21, 23, 24]. Gender is another demographic characteristic with a strong link to speeding choices and behavior; males being found to be more likely to speed in most studies [21, 23], although there are cases where gender did not manifest a significant influence on speeding behaviour [25]. Peer influence and peer pressure are also an important and significant psychological and situational influencer for speed and speed choices [26]. The status or type of job was found to significantly differentiate drivers in terms of speeding and speed choices; non-manual workers and managerial drivers being found most likely to speed whilst retired drivers and manual-unskilled workers least likely to speed [25]. Drivers who have a provisional and motorcycle license, have committed previous criminal offences, or have a criminal history are also more likely to speed [21]. Comparing work vehicles to personal vehicles, research has found, opposite to the initial assumptions, that drivers speed less and have lower intention to speed, in a work vehicle, compared to a personal vehicle [25].

Different interventions aimed at reducing speed and preventing speed offences were designed and evaluated in recent years. Reducing the speed limit was found to have a favourable effect on traffic safety, especially on severe crashes by reducing the overall average speed [7]. The effect of police presence alongside with speed limit and warning signs was also shown to increase the positive effect of decreasing the speeding behavior occurrence for at least nine weeks after the intervention [27]. Intelligent Speed Adaptation (ISA) systems, that bring feedback about speeding behavior into the vehicle, were found to be effective over long time periods [28] being predicted to lead to savings of 30% in fatal crashes and 25% in serious crashes over a 60-years period modelled [28]. Using ISA as a penalty system for serious speed offenders was shown to have the potential to improve road safety by reducing the level of speeding, mean speed, as well as the standard deviation of speed [29]. Auditory speeding warnings were also found to be effective for commercial passenger vehicles, with the drivers tending to reduce the speed when the system is operating [30].

Psychological theory derived interventions were found to be effective and to produce behavioural change; anti-speeding messages are shown to be effective [31], and more effective than roadside messages [31, 32]; interventions addressing motivation, habit and intentions were also found to be effective when addressed in the appropriate manner [33]. Publicity campaigns, although helpful alongside enforcement [34], are less likely to realise sustainable behavioral change in themselves [35].

Linking speed related interventions to speed offenders and to their location outside the roads is a very difficult task, since the reasons or motivations for engaging or not in exceeding the speed limits, or other risky behaviors, can vary from perceived time savings [36], peer pressure and exposure to role models [26], to beliefs about speed and risk perception [37]. Hence, profiling the target audience, identifying the communication preferences, media use and other characteristics of the speed drivers, and linking all together in campaigns and interventions is a very difficult process, but in the same time essential for ensuring effectiveness and efficiency of the actions [38, 39].

This paper aims firstly to reinforce, based on an analysis of a comprehensive database, results from previous studies regarding the profile of speeding drivers, and to also investigate other significant factors. Secondly, the paper aims to provide specific characteristics of the communities most likely to develop, maintain or encourage speeding behaviors within their members. These result can enable practitioners to better understand who they need to target in their campaigns (speeding driver profiles), where to find them and what methods are more likely to be effective in communicating with them.

2. Methodology

To profile drivers with speeding factors assigned in collisions, we here use an extensive dataset, comprising all reported injury collisions between 2011 and 2015 in the UK (police records), where a police officer attended. This involved 612,221 collisions for which a contributory factor (CF) was assigned (e.g. following too close, failed to look properly, fatigue, exceeding speed limit etc.). Given the objective of this paper, the analysis only considered records with factors that contributed to the collision. Using the driver home postcode, the database with reported injury collisions was merged with the Experian Mosaic database, which divides the UK population into 15 Groups and 66 more detailed Types, based on demographic, lifestyle, and behavior characteristics (details in Table A1 in Appendix).

The hypothesis is that the probability to exceed speed limits and contribute to crashes varies according to Mosaic Types (some drivers being more likely than others to be involved in collisions and assigned the 'exceeding speed limit' contributory factor). To analyze this, a multi-level mixed logistic regression analysis is conducted, utilizing the hierarchical nature of the data, namely individuals/drivers within Mosaic Types. The dependent variable measures whether drivers exceed speed limits and contribute to crashes and is based on a dummy variable with recoded value 1 if the driver was assigned the exceeding speed limit contributory factor and 0 otherwise. The independent variables used to analyze which conditions and populations are more likely to contribute to speed-related collisions are divided into (a) collision related variables, (b) crash condition variables and (c) vehicle and driver related variables. Akin to previous studies on road safety investigating speed-related collisions [e.g. 9-11, 33-35], various characteristics are considered (details in Appendix).

To analyze the results, firstly a descriptive analysis is provided, and secondly a multi-level mixed logistic regression analysis is conducted, according to the following logit random intercept model specification [40]:

$$\log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \beta_1 X_{ij} + u_j \quad (1)$$

Where, β_0 is the overall intercept, β_1 is the cluster specific effect, X_{ij} is the vector with explanatory variables, and u_j is the group (random) effect.

Thirdly however, the regression models are used to graphically display whether significant variations between Mosaic Types exist in the propensity to exceed speed limits and contribute to crashes, after controlling for collision related variables, crash condition variables and vehicle and driver related variables. As a robustness check, a logistic regression clustered by Mosaic Type is then conducted.

Below we report the findings.

3. Analysis and Results

Of the 612,221 reported injury collisions between 2011 and 2015 in the UK for which a police officer attended and a CF was assigned collision, 26,051 had 'exceeding the speed limit' as a CF (4.26%). Extrapolating from this, one in 23 injury collisions with CFs include drivers exceeding the speed limit.

As Table 1 displays, the distribution of speed-related crashes is uneven across road types, traffic conditions, vehicle types and driver characteristics. Although exceeding the speed limit as a CF prevails in all investigated variables (collision related variables, crash condition variables and vehicle and driver related variables), it is more common in some. For instance, as Table 1 displays, with 5.18%, 5.11% and 4.78% of collisions having assigned 'exceeding the speed limit' as a CF, speed-related crashes are more likely to happen on secondary, tertiary and unclassified roads, compared with 2.09%, 3.15% and 3.80% for motorways, upgraded main roads and main roads. Moreover, although just 46% of the collisions with assigned CFs were on secondary, tertiary and unclassified roads, more than a half (54%) of speed-related crashes in the UK happened on these roads, displaying how these crashes are therefore heavily concentrated on these classes of roads. Similarly, Table 1 displays descriptive statistics for collision related variables, crash condition variables and vehicle and driver related variables where speed-related crashes are more prevalent.

To evaluate whether variations exist across Mosaic Types, Table 2 reports the percentage of drivers exceeding speed limits and contributing to crashes, by each of the 66 Mosaic Types. It is similarly the case that the prevalence of the speed-related crashes is uneven distributed across Mosaic Types in UK.

Table 2 reveals that 6.83% of *Asian Heritage*, 5.52% of *Disconnected Youth* and *Streetwise Singles*, 5.50% of *Local Focus*, 5.49% of *Budget Generations*, 5.43% of *Families with Needs*, 5.34% of *Low Income Worker* and 5.03% of *Seasoned Survivors* exceeded speed limits and contributed to crashes in UK, compared, for instance, with just 1.85% of *Aided Elderly*. Therefore, some drivers' profiles turn out to be more likely to exceed speed limits and contribute to crashes. Analyzing these descriptive statistics therefore, the tentative finding is that, although ubiquitous across all investigated variables, speed-related crashes are more common in some circumstances or for some driver groups rather than others.

Table 1: Distribution of speed-related crashes by collision related variables, crash condition variables and vehicle and driver related variables (N = 612,221)

Variables		CF: exceeding speed limit	Percent of all collisions – exceeding speed limit – CF	Percent of all collisions with assigned CFs
		(%)	(%)	(%)
ALL collisions		4.26	100	100
Road class	Motorway	2.09	2.25	4.58
	Upgraded main road	3.15	0.27	0.36
	Main road	3.80	43.53	48.70
	Secondary road	5.18	15.57	12.80
	Tertiary road	5.11	10.21	8.50
	Unclassified road	4.78	28.18	25.06
Road type	Roundabout	3.14	5.09	6.90
	One way street	3.27	1.20	1.57
	Dual carriageway	3.61	13.82	16.27
	Single carriageway	4.56	79.03	73.81
	Slip road/ Unknown	2.52	0.86	1.45
Speed limit (Permanent)	Below mean (≤ 40mph)	4.51	74.26	70.13
	Above mean (>40mph)	3.67	25.74	29.87
Crash severity	Fatal	14.48	4.27	1.26
	Serious	6.44	21.75	14.37
	Slight	3.73	73.98	84.38
Road surface condition	Dry	4.39	70.09	67.99
	Wet/ Damp	4.14	28.61	29.42
	Snow	1.23	0.15	0.53
	Frost/ Ice	2.37	1.02	1.84
	Flood (surface water over 3cm deep)	2.07	0.09	0.18
	Unknown	2.85	0.03	0.05
Light conditions	Daylight	3.49	59.92	73.07
	Darkness: street lights present and lit	6.53	29.85	19.46
	Darkness: street lights present but unlit	5.55	0.70	0.54
	Darkness: no street lighting	6.01	8.43	5.97
	Darkness: street lighting unknown	4.80	1.09	0.97
Vehicle type	M/cycle 50cc and under	3.70	1.05	1.21
	M/cycle over 50cc and up to 125cc	5.52	4.62	3.56
	M/cycle over 125cc and up to 500cc	7.02	1.65	1.00
	Motorcycle over 500cc	10.62	8.55	3.42
	Car	4.52	77.05	72.55
	Minibus (8-16 passenger seats)	2.74	0.14	0.22
	Bus or coach (17 or more passenger seats)	0.51	0.19	1.60
	Van - Goods vehicle 3.5 tones mgw and under	2.87	3.55	5.26
	Goods vehicle over 3.5 tones and under 7.5 tones mgw	1.69	0.27	0.68
	Goods vehicle 7.5 tones mgw & over	1.11	0.54	2.07
	Other	1.20	2.38	8.42
Sex of driver	Male	5.03	80.70	68.26
	Female	1.98	12.80	27.55
	Not known	6.59	6.49	4.19
Age of driver	-15 years	0.62	0.15	1.06
	16-20	7.65	18.59	10.34
	21-25	6.95	21.66	13.25
	26-35	4.78	23.26	20.72
	36-45	3.29	13.15	16.99
	46-55	2.44	8.15	14.23
	56-65	1.79	3.46	8.25
	66-75	1.26	1.34	4.51
	76+	0.68	0.58	3.63
	Not known	5.87	9.66	7.01
Journey purpose	Journey as part of work	2.47	9.67	16.69
	Commuting to/ from work	3.52	8.72	10.55
	Taking school pupil/ Pupil riding to/ from school	2.16	0.66	1.29
	Other	4.82	80.95	71.47

Table 2: Drivers with speeding factors assigned in collisions, by Mosaic Type (N = 612,221)

Mosaic Group	Mosaic Type	CF* (%)	Mosaic Group	Mosaic Type	CF* (%)	Mosaic Group	Mosaic Type	CF* (%)
Country Living	Rural Vogue	4.61	Prestige Positions	Empty-Nest Adventure	3.15	City Prosperity	World-Class Wealth	2.18
	Scattered Homesteads	4.02		Bank of Mum and Dad	3.79		Penthouse Chic	2.64
	Wealthy Landowners	3.81		Alpha Families	3.76		Metro High-Flyers	2.53
	Village Retirement	3.62		Premium Fortunes	3.31		Uptown Elite	2.57
				Diamond Days	2.85			
Domestic Success	Cafés and Catchments	3.16	Suburban Stability	Dependable Me	3.64	Senior Security	Legacy Elders	2.88
	Modern Parents	3.88		Fledgling Free	4.28		Solo Retirees	3.89
	Mid-Career Convention	3.84		Boomerang Boarders	3.46		Bungalow Haven	2.99
	Thriving Independence	4.03		Family Ties	4.29		Classic Grandparents	3.19
Rural Reality	Far-Flung Outposts	4.59	Aspiring Homemakers	Affordable Fringe	4.26	Urban Cohesion	Cultural Comfort	4.03
	Outlying Seniors	4.79		First-Rung Futures	4.03		Community Elders	3.82
	Local Focus	5.50		Flying Solo	4.48		Asian Heritage	6.83
	Satellite Settlers	4.14		New Foundations	4.72		Ageing Access	3.12
				Contemporary Starts	4.25			
				Primary Ambitions	3.79			
Rental Hubs	Career Builders	3.81	Modest Traditions	Self-Supporters	4.19	Transient Renters	Disconnected Youth	5.52
	Central Pulse	3.07		Offspring Overspill	4.44		Renting a Room	4.80
	Learners & Earners	4.14		Down-to-Earth Owners	4.77		Make Do & Move On	4.93
	Student Scene	3.17					Midlife Stopgap	4.39
	Flexible Workforce	3.63						
	Bus-Route Renters	4.24						
Family Basics	Budget Generations	5.49	Vintage Value	Seasoned Survivors	5.03	Municipal Challenge	Low Income Workers	5.34
	Childcare Squeeze	4.67		Aided Elderly	1.85		Streetwise Singles	5.52
	Families with Needs	5.43		Pocket Pensions	3.11		High Rise Residents	4.21
	Solid Economy	4.47		Dependent Greys	4.06		Crowded Kaleidoscope	3.73
	Not classified	*4.91*		Estate Veterans	4.86		Inner City Stalwarts	2.74

* CF - contributory factor: exceeding speed limit

To evaluate firstly, whether the variations across investigated variables are significant when other characteristics are taken into account and held constant, and secondly, to graphically display the variations between Mosaic Types in the propensity to exceed speed limits and contribute to crashes, after controlling for other variables, we here report the results of a staged multi-level logistic regression analysis (Table 3). This utilizes the hierarchical nature of the data (drivers within Mosaic Types).

To analyze which groups are more likely to be associated with speed-related crashes, an additive model is used. The first model examines collision related factors, the second model examines the crash condition factors together with collision related factors and the third model examines the influence of each factor on the propensity to exceed speed limits and contribute to crashes when collision related factors, crash condition factors and vehicle and driver related factors are all included. Table 3 reports the results.

Model 1 in Table 3 reveals that speed-related crashes are more common for drivers using certain categories of roads. Not only are those using any class of road except motorways significantly more likely to be involved in a speed-related crash, but so too are those who are using single or dual carriageways. Moreover, Model 1 reveals that speed-related crashes are strongly associated with low speed limits: as the level of speed limit increases, the propensity to be involved in a speed-related crash significantly decreases. In addition, Model 1 shows that these kinds of collisions are more likely to be fatal than serious or slight severity crashes. When adding road surface and lighting conditions in Model 2, the finding is that drivers travelling on dry roads are significantly more likely to be involved in speed-related crashes than those travelling on roads covered with snow, ice (frost) or flood roads, as are those travelling in darkness conditions relative to those travelling in daylight conditions. Adding vehicle type and drivers' gender and age in Model 3, meanwhile, reveals that, motorcyclists riding motorcycles over 50cc, car, minibus or van drivers are significantly more likely while bus or coach drivers and drivers of goods vehicles over 7.5 tones are significantly less likely to contribute to a speed-related crash. Male drivers are also significantly more likely to exceed speed limits and contribute to crashes than women, as are younger drivers (16-55 years). Nevertheless, with drivers over 66 years old significantly less likely to contribute to a speed-related crash, Model 3 reveals a pattern: after 16 years old, the propensity to exceed speed limits and contribute to crashes decrease with age. Moreover, according to Model 3, drivers having another journey purpose than driving as part of work (except commuting to/ from work or taking school pupil/ pupil riding to/ from school) are significantly more likely to contribute to a speed-related crash. The same results, however, are obtained if running a logistic regression clustered by Mosaic Type (details in Table A2 in Appendix).

Table 3: Multilevel logistic regressions of the propensity to exceed speed limits and contribute to crashes

	Model 1			Model 2			Model 3		
Fixed part	β	se(β)	Exp(β)	β	se(β)	Exp(β)	β	se(β)	Exp(β)
Road class (CG: Motorway)									
Upgraded main road	0.407 ***	0.129	1.503	0.415 ***	0.129	1.515	0.336 **	0.130	1.399
Main road	0.483 ***	0.047	1.621	0.525 ***	0.047	1.690	0.393 ***	0.048	1.482
Secondary road	0.772 ***	0.051	0.109	0.821 ***	0.051	2.273	0.665 ***	0.051	1.945
Tertiary road	0.783 ***	0.052	2.189	0.837 ***	0.052	2.310	0.692 ***	0.053	1.997
Unclassified road	0.658 ***	0.050	1.931	0.720 ***	0.050	2.054	0.579 ***	0.051	1.784
Road type (CG: Roundabout)									
One way street	-0.097	0.064	0.907	-0.094	0.064	0.911	-0.064	0.065	0.938
Dual carriageway	0.361 ***	0.034	1.434	0.348 ***	0.034	1.416	0.319 ***	0.035	1.375
Single carriageway	0.271 ***	0.029	1.311	0.286 ***	0.029	1.331	0.218 ***	0.030	1.243
Slip road/ Unknown	-0.041	0.074	0.960	-0.037	0.074	0.964	-0.096	0.075	0.909
Speed limit (Permanent)	-0.007 ***	0.001	0.993	-0.005 ***	0.001	0.995	-0.009 ***	0.001	0.991
Crash severity (CG: Fatal)									
Serious	-0.960 ***	0.036	0.383	-0.904 ***	0.036	0.405	-0.891 ***	0.037	0.410
Slight	-1.534 ***	0.034	0.216	-1.442 ***	0.034	0.236	-1.380 ***	0.036	0.252
Road surface condition (CG: Dry)									
Wet/ Damp				-0.202 ***	0.015	0.817	-0.191 ***	0.015	0.826
Snow				-1.393 ***	0.160	0.248	-1.294 ***	0.160	0.274
Frost/ Ice				-0.792 ***	0.063	0.453	-0.728 ***	0.064	0.483
Flood (surface water over 3cm deep)				-0.867 ***	0.212	0.420	-0.871 ***	0.213	0.419
Unknown				-0.673 *	0.361	0.510	-0.661 *	0.364	0.516
Light conditions (CG: Daylight)									
Darkness: street lights present and lit				0.665 ***	0.015	1.944	0.451 ***	0.015	1.569
Darkness: street lights present but unlit				0.510 ***	0.077	1.666	0.400 ***	0.079	1.491
Darkness: no street lighting				0.630 ***	0.026	1.877	0.395 ***	0.026	1.484
Darkness: street lighting unknown				0.315 ***	0.062	1.371	0.119 *	0.063	1.126
Vehicle type (CG: M/cycle 50cc and under)									
M/cycle over 50cc and up to 125cc							0.490 ***	0.069	1.632
M/cycle over 125cc and up to 500cc							0.932 ***	0.081	2.540
Motorcycle over 500cc							1.561 ***	0.068	4.764
Car							0.899 ***	0.063	2.456
Minibus (8-16 passenger seats)							0.579 ***	0.180	1.784
Bus or coach (17 or more passenger seats)							-1.096 ***	0.156	0.334
Van - Goods vehicle 3.5 tones mgw and under							0.389 ***	0.072	1.476
Goods vehicle over 3.5 tones mgw and under 7.5 tones mgw							0.020	0.137	1.020
Goods vehicle 7.5 tones mgw & over							-0.192 *	0.108	0.825
Other							-0.601 ***	0.075	0.548
Sex of driver (CG: Male)									
Female							-0.990 ***	0.020	0.371
Not known							0.079 *	0.041	1.082
Age of driver (CG: -15 years)									
16-20							1.583 ***	0.164	4.868
21-25							1.474 ***	0.164	4.365
26-35							1.134 ***	0.164	3.108
36-45							0.798 ***	0.164	2.221
46-55							0.486 ***	0.165	1.625
56-65							0.155	0.167	1.168
66-75							-0.305 *	0.172	0.737
76+							-1.014 ***	0.183	0.363
Not known							1.039 ***	0.167	2.828
Journey purpose (CG: Journey as part of work)									
Commuting to/ from work							0.012	0.031	1.012
Taking school pupil/ Pupil riding to/ from school							-0.082	0.081	0.921
Other							0.259 ***	0.024	1.296
Constant	-2.365 ***	0.078	0.094	-2.710 ***	0.079	0.067	-4.074 ***	0.192	0.017
N			612,221			612,221			612,221
Random part									
Mosaic-level variance			0.0487***			0.0486***			0.0247***
(Standard error)			0.0096			0.0097			0.0053
Mosaic Types			67			67			67

Notes: Significant at *** p<0.01, ** p<0.05, * p<0.1; All coefficients are compared to the benchmark category (in brackets).

To determine whether significant variations between Mosaic Types exist in the propensity to exceed speed limits and contribute to crashes, after controlling for collision related variables, crash condition variables and vehicle and driver related variables, Figure 1 displays the residual Mosaic-Type effects. A Mosaic-Type whose confidence interval does not overlap the line at zero differs significantly from the UK average at the 5% significance level. At the lower end, *Metro High-Flyers*, *Inner City Stalwarts*, *Uptown Elite*, *World-Class Wealth*, *Central Pulse*, *Cafés and Catchments*, *Flexible Workforce*, *Ageing Access* and *Crowded Kaleidoscope* have a significantly lower propensity to contribute to speed-related crashes. At the upper end, *Satellite Settlers*, *Make Do*

& Move On, Estate Veterans, Down-to-Earth Owners, Disconnected Youth, Families with Needs, Budget Generations, Seasoned Survivors, Low Income Workers, Outlying Seniors, Local Focus, Streetwise Singles and *Asian Heritage* have a significantly higher propensity to exceed speed limits and contribute to crashes. These groups are detailed in the discussion section.

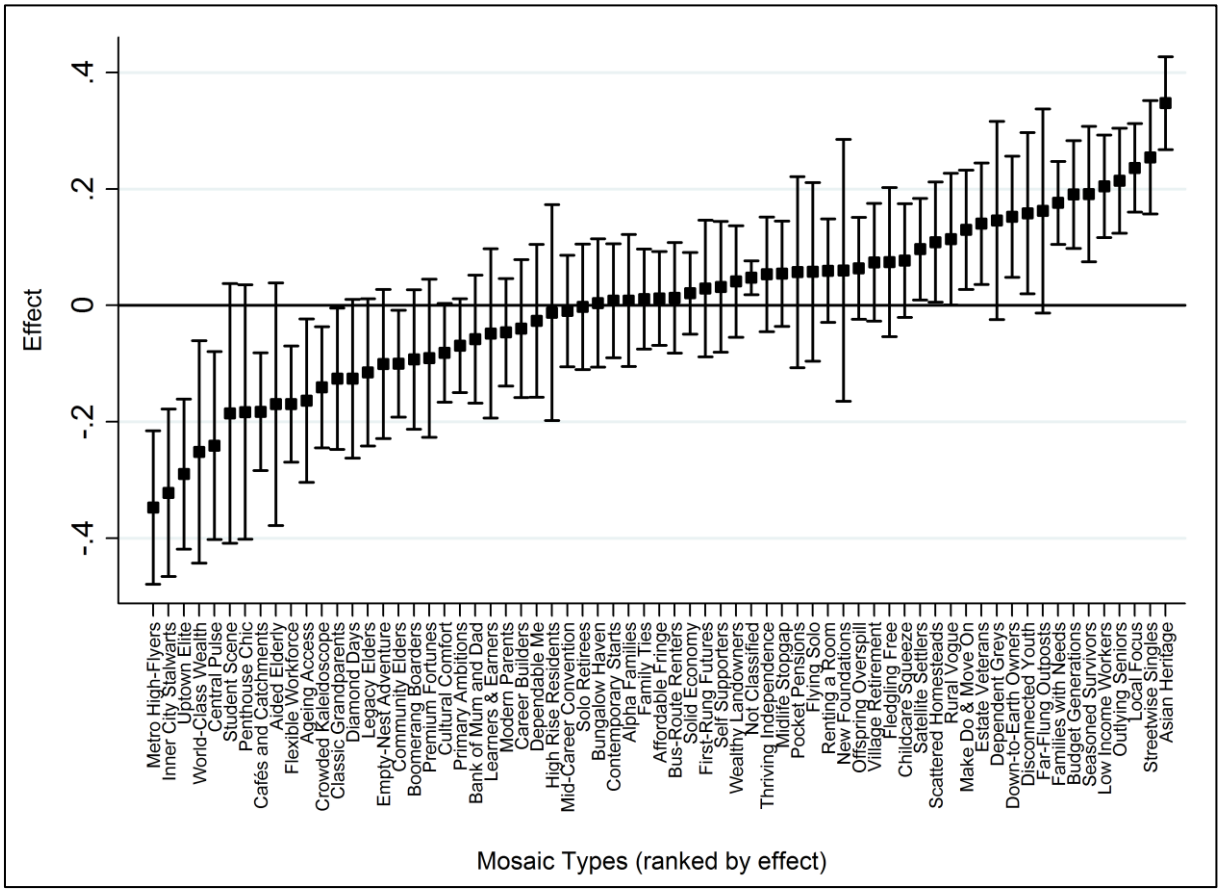

Figure 1: Variations between Mosaic Types in the propensity to cause speed-related crashes in UK: residual Mosaic-Type effects within a 95% confidence interval (N = 612,221)

4. Discussion

The first aim of the paper was to reinforce, based on an analysis of a comprehensive database, results from previous studies. In this respect, the study identified several aspects of speed related crashes consistent with the literature but also a small number of slightly different findings. The positive relationship between speed and the severity of crashes [5, 12, 13] is reinforced, the 'exceeding the speed limit' CF being more often reported for fatal (14.73%) and serious (6.46%) crashes, than for slight severity (3.73%) crashes. In the same time, fatal and serious crashes are more prevalent for speed-related crashes than for all crashes (26% compared to 16%). The positive association between speed distribution and crashes [6] is also supported since speed-related crashes are strongly associated with low speed limits, where the dispersion of speed can be larger. A further investigation between these limits and the severity would provide, though, a better image of this relationship. Another supporting finding for the dispersion related hypothesis is that motorways are shown to be the class of road with the lowest propensity of speed-related crashes. The hypothesis that speed is one of the main traffic related contributory factors [8, 9] is supported by the finding that 4.26% (or 1 in 23) of the total crashes with CFs assigned include 'exceeding the speeding limit'. Road characteristics and conditions [6, 9] were also found to be an important factor; drivers on dry roads being significantly more likely to being involved in speed-related crashes compared to other road conditions, as too, drivers driving at night are significantly more likely to be involved in a speed-related crash compared to those driving in the day. Vehicle characteristics [10, 11] are also a significant factor, with motorcyclists riding motorcycles over 50cc and drivers of a car, minibus or van being more likely to have speed-related CFs than other drivers, while bus or coach drivers are the least likely to contribute to crashes with 'exceeding the speed limit' CF.

In terms of demographic characteristics, age, one of the most present factors in the literature [21, 23, 24] was also found in this study to be a significant factor for speed-related crashes. Younger drivers, aged between 16 and 35 years, being more likely to be involved in these types of crashes than drivers over 35 years old. Gender, another heavily investigated factor [21, 24, 25], is also shown to be significant, males being more likely to be involved in crashes with the 'exceeding the speed limit' CF, than women. The hypothesis that drivers speed less and have lower intentions to speed in a work vehicle, compared to a personal vehicle [25] is also supported by the findings that drivers driving as part of work are significantly less likely to be involved in speed-related crashes than the ones with other journey purposes.

The second aim of the paper was to provide specific characteristics of the communities most likely to develop, maintain or encourage speeding behaviours within their members. Looking at the residual effect of the Mosaic Type on the propensity to contribute to crashes with the 'exceeding the speed limit' factor, the study identified several Mosaic Types significantly more likely to exceed the speed limit and contribute to crashes. The top five Types are shortly described using description and characteristics from the original source, Mosaic Public Sector:

Asian Heritage - extended young families with children, in neighbourhoods with a strong South Asian origin, where cultural traditions and faith are important. Most adults are between 18 and 45 years old with the predominant group around 26 to 30 years old. They are generally working in low paid routine occupations in transport or food service. Asian Heritage like new technology and the younger generation leads the way in enjoying the latest gadgets. They are the least likely to drink and participate in sport. Asian Heritage live in areas where the crime rate is higher than average, therefore they have an above average fear of crime, yet also have the most confidence in the criminal justice system;

Streetwise Singles - hard-pressed single people renting very low value social flats and searching for opportunities. Most adults are between 26 and 55 years old with the predominant group around 26 to 30 years old. Education is limited and many have no, or only very low qualifications, and work in low-paid routine and semi-routine jobs. They often spend a good amount of time watching television and reading regional newspapers. Although alcohol consumption is moderate, they are regular smokers. They are more likely to believe that crime in their area is a big problem and to worry about being a victim of crime;

Local Focus - families living in affordable village homes in rural communities. Most adults are aged between 18 and 50 years old, with the predominant group around 36 to 45 years old. Local Focus are often skilled tradespeople working locally across a range of sectors. They are average users of internet and media channels as well as local newspapers. The frequency of alcohol consumption is comparatively low. The crime rate in their rural communities is well below average, hence their fear of crime is also low. They feel speeding traffic is a major problem;

Outlying Seniors - retired people living in inexpensive housing in out of the way locations such as in larger villages or small market towns. Incomes are low and people rely on their state pensions to fund their modest lifestyles. While they are infrequent users of the internet, they do have digital TV. They dislike marketing approaches and are the most likely of all to say they do not wish to be contacted with offers or promotions. In general, they smoke and drink less than the population average. The crime rate in these outlying communities is well below average and the overall fear of crime is also below average. Nevertheless, they have concerns about speeding traffic;

Low income workers - older social renters still of working age, who are settled in low value homes in communities where employment opportunities are hard to find. These communities usually contain older post-family singles and couples aged predominantly between 50 and 65, most likely to work in manual jobs offering low pay. A favourite form of entertainment is television and these are often heavy TV viewers. Many haven't been able to keep up with modern technology. They are heavy smokers but moderate drinkers. Crime in the areas where they live is above average and the level of confidence in police is not particularly high.

Analyzing the specific characteristics of the Mosaic Types of communities more likely to exceed the speed limit and contribute to a crash, some similarities can be easily observed. Most of these communities seem to be characterized by low income and an elevated fear of crime. Also, education levels look more likely to be lower in these types of communities and work is often in low level jobs. Means of information and communication as well as the trust in police and authorities varies within the Types. From the perspective of age groups, an interesting grouping can be observed: on one hand, there are the young communities, consistent with the previous literature and with the finding described earlier in this study, and on another hand, there are the elderly communities, where we wouldn't expect to see the speeding phenomenon. This might suggest that the members of these communities, which are not the majority, such as children or grandchildren, still living inside the communities, might be the ones speeding. Given this limitation of this study, further research, focusing on matching the age with the composition of the communities, could give more clarity to the phenomenon. Another limitation of this study is that speed-related contributory factors were assigned by police officers. Therefore, contributory factors reflect the reporting officer's opinion at the time of reporting and may not be the result of extensive investigation. However, at a universal level, CFs provide a valuable insight as to what the officer believes occurred.

Each Mosaic Type is fully described in detail on the Experian Mosaic Public Sector website, comprising data and statistics around demographics, origins, property, work lives, finances, home lives, community safety, education, health, engagement and communication, and online activity. All that information enables decision makers, such as Governments or Public Health Bodies, to better understand their target, to identify and adopt tailored communication campaigns or interventions. As discussed in the introductory part of this paper, different campaigns and approaches can produce different effects on different categories or types of people. Knowing whom to address the intervention to, where you can find them and what the characteristics of those people are, from various points of view, is the first and maybe the most important step in designing an effective intervention.

5. Conclusions

The study aimed at profiling drivers with speed-related contributory factors assigned in collisions in UK, between 2011 and 2015. The analysis revealed several characteristics of the speeding driver, consistent with and reinforcing previous literature findings. The analysis revealed that, the speeding driver is more likely to be young, male and drives a private car rather than work car. The crash involving the speeding driver is also more likely to occur when driving a car or a motorcycle, in darkness conditions, on dry single or dual carriageway roads, and less likely to occur on motorways. When these crashes occur, they are more likely to result in a fatal or serious collision than other types of crash. Moreover, looking at the Mosaic Types, based on the postcode where the drivers are living, the study revealed nine Mosaic Types that have significantly higher propensity to exceed the speed limit and contribute to crashes. These Types are: *Satellite Settlers*, *Make Do & Move On*, *Estate Veterans*, *Down-to-Earth Owners*, *Disconnected Youth*, *Families with Needs*, *Budget Generations*, *Seasoned Survivors*, *Low Income Workers*, *Outlying Seniors*, *Local Focus*, *Streetwise Singles* and *Asian Heritage*. The specific of these Types enable decision makers to have a better understanding of their target market and to create appropriate and effective public education campaigns and interventions.

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Appendix

- Supplementary material -

Characteristics considered in the analysis

Collision related independent variables:

- *Road class*: a categorical variable for the class of the road where the collision occurred, with value 1 for motorway, value 2 for upgraded main road, value 3 for main road, value 4 for secondary road, value 5 for tertiary road, and value 6 for unclassified road.
- *Road type*: a categorical variable for the type of the road where the collision occurred, with value 1 for roundabout, value 2 for one way street, value 3 for dual carriageway, value 4 for single carriageway, and value 5 for slip road or unknown type of road.
- *Speed limit*: a numerical variable for the permanent speed limit of the road where the collision occurred (up to 70 mph).
- *Crash severity*: a categorical variable for the severity of the crash, with value 1 for fatal crash, value 2 for serious crash, and value 3 for slight crash.

Crash condition independent variables:

- *Road surface condition*: a categorical variable for the surface condition of the road where the collision occurred, with value 1 for dry road, value 2 for wet/ damp road, value 3 for road covered with snow, value 4 for road covered with ice (frost), value 5 for flood road (surface water over 3cm deep), and value 6 for unknown condition of the road surface.
- *Light conditions*: a categorical variable for the light conditions of the street where the collision occurred, with value 1 for daylight, value 2 for darkness – street lights present and lit, value 3 for darkness – street lights present but unlit, value 4 for darkness – no street lighting, and value 5 for darkness – unknown street lighting conditions.

Vehicle and driver related independent variables:

- *Vehicle type*: a categorical variable for the type of the vehicle involved in the collision, with value 1 for motorcycle 50cc (cubic centimeter) and under, value 2 for motorcycle over 50cc and up to 125cc, value 3 for m/cycle over 125cc and up to 500cc, value 4 for motorcycle over 500cc, value 5 for car, value 6 for minibus (8-16 passenger seats), value 7 for bus or coach (17 or more passenger seats), value 8 for van - goods vehicle 3.5 tons maximum gross weight (mgw) and under, value 9 for goods vehicle over 3.5 tons and under 7.5 tons mgw, value 10 for goods vehicle 7.5 tons mgw and over, and value 11 for other type of vehicles.
- *Sex of driver*: a categorical variable, with value 1 for males, value 2 for females, and value 3 for not known sex of the driver.
- *Age of driver*: a categorical variable for the age of the driver, with value 1 for those under 15 years old, value 2 for those aged 16-20, value 3 for those aged 21-25, value 4 for those aged 26-35, value 5 for those aged 36-45, value 6 for those aged 46-55, value 7 for those aged 56-65, value 8 for those aged 66-75, value 9 for those over 76 years old, and value 10 for not known age of the driver.

Table A1: Mosaic Type

Mosaic					
Group/ Type		Group/ Type		Group/ Type	
Country Living	Rural Vogue	Prestige Positions	Empty-Nest Adventure	City Prosperity	World-Class Wealth
	Scattered Homesteads		Bank of Mum and Dad		Penthouse Chic
	Wealthy Landowners		Alpha Families		Metro High-Flyers
	Village Retirement		Premium Fortunes		Uptown Elite
			Diamond Days		
Domestic Success	Cafés and Catchments	Suburban Stability	Dependable Me	Senior Security	Legacy Elders
	Modern Parents		Fledgling Free		Solo Retirees
	Mid-Career Convention		Boomerang Boarders		Bungalow Haven
	Thriving Independence		Family Ties		Classic Grandparents
Rural Reality	Far-Flung Outposts	Aspiring Homemakers	Affordable Fringe	Urban Cohesion	Cultural Comfort
	Outlying Seniors		First-Rung Futures		Community Elders
	Local Focus		Flying Solo		Asian Heritage
	Satellite Settlers		New Foundations		Ageing Access
			Contemporary Starts		
			Primary Ambitions		
Rental Hubs	Career Builders	Modest Traditions	Self-Supporters	Transient Renters	Disconnected Youth
	Central Pulse		Offspring Overspill		Renting a Room
	Learners & Earners		Down-to-Earth Owners		Make Do & Move On
	Student Scene				Midlife Stopgap
	Flexible Workforce				
	Bus-Route Renters				
Family Basics	Budget Generations	Vintage Value	Seasoned Survivors	Municipal Challenge	Low Income Workers
	Childcare Squeeze		Aided Elderly		Streetwise Singles
	Families with Needs		Pocket Pensions		High Rise Residents
	Solid Economy		Dependent Greys		Crowded Kaleidoscope
			Estate Veterans		Inner City Stalwarts

Table A2: Logistic regressions of the propensity to exceed speed limits and contribute to crashes

	Model 1			Model 2			Model 3		
	β	se(β)	Exp(β)	β	se(β)	Exp(β)	β	se(β)	Exp(β)
Road class (CG: Motorway)									
Upgraded main road	0.405 ***	0.136	1.499	0.417 ***	0.137	1.517	0.351 ***	0.129	1.421
Main road	0.488 ***	0.060	1.629	0.538 ***	0.061	1.712	0.421 ***	0.050	1.523
Secondary road	0.792 ***	0.067	2.207	0.854 ***	0.067	2.350	0.715 ***	0.056	2.044
Tertiary road	0.795 ***	0.079	2.215	0.860 ***	0.078	2.362	0.726 ***	0.062	2.067
Unclassified road	0.700 ***	0.091	2.013	0.775 ***	0.091	2.171	0.639 ***	0.072	1.895
Road type (CG: Roundabout)									
One way street	-0.100 *	0.058	0.905	-0.100 *	0.060	0.905	-0.076	0.066	0.927
Dual carriageway	0.364 ***	0.034	1.440	0.345 ***	0.035	1.412	0.303 ***	0.033	1.354
Single carriageway	0.262 ***	0.032	1.300	0.276 ***	0.032	1.318	0.208 ***	0.030	1.232
Slip road/ Unknown	-0.043	0.079	0.958	-0.043	0.079	0.958	-0.110	0.085	0.896
Speed limit (Permanent)	-0.007 ***	0.001	0.993	-0.004 ***	0.001	0.996	-0.008 ***	0.001	0.992
Crash severity (CG: Fatal)									
Serious	-0.962 ***	0.037	0.382	-0.905 ***	0.036	0.404	-0.896 ***	0.034	0.408
Slight	-1.535 ***	0.046	0.216	-1.446 ***	0.043	0.235	-1.397 ***	0.037	0.247
Road surface condition (CG: Dry)									
Wet/ Damp				-0.191 ***	0.016	0.826	-0.180 ***	0.020	0.835
Snow				-1.370 ***	0.174	0.254	-1.274 ***	0.172	0.280
Frost/ Ice				-0.778 ***	0.081	0.459	-0.710 ***	0.085	0.492
Flood (surface water over 3cm deep)				-0.856 ***	0.284	0.425	-0.860 ***	0.286	0.423
Unknown				-0.615 *	0.317	0.541	-0.620 *	0.333	0.538
Light conditions (CG: Daylight)									
Darkness: street lights present and lit				0.675 ***	0.017	1.965	0.446 ***	0.014	1.563
Darkness: street lights present but unlit				0.524 ***	0.067	1.689	0.404 ***	0.068	1.498
Darkness: no street lighting				0.639 ***	0.029	1.894	0.398 ***	0.028	1.488
Darkness: street lighting unknown				0.334 ***	0.064	1.397	0.118 *	0.064	1.126
Vehicle type (CG: M/cycle 50cc and under)									
M/cycle over 50cc and up to 125cc							0.469 ***	0.065	1.599
M/cycle over 125cc and up to 500cc							0.918 ***	0.066	2.505
Motorcycle over 500cc							1.548 ***	0.073	4.702
Car							0.899 ***	0.069	2.456
Minibus (8-16 passenger seats)							0.602 ***	0.200	1.825
Bus or coach (17 or more passenger seats)							-1.116 ***	0.141	0.327
Van - Goods vehicle 3.5 tonnes mgw and under							0.388 ***	0.076	1.474
Goods vehicle over 3.5 tonnes mgw and under 7.5 tonnes mgw							0.029	0.129	1.029
Goods vehicle 7.5 tonnes mgw & over							-0.171	0.199	0.843
Other							-0.621 ***	0.112	0.537
Sex of driver (CG: Male)									
Female							-0.996 ***	0.023	0.369
Not known							0.098	0.079	1.103
Age of driver (CG: -15 years)									
16-20							1.542 ***	0.212	4.674
21-25							1.429 ***	0.208	4.173
26-35							1.081 ***	0.205	2.949
36-45							0.743 ***	0.199	2.101
46-55							0.429 **	0.201	1.535
56-65							0.099	0.209	1.104
66-75							-0.363 *	0.217	0.696
76+							-1.083 ***	0.208	0.339
Not known							0.990 ***	0.179	2.692
Journey purpose (CG: Journey as part of work)									
Commuting to/ from work							0.007	0.054	1.008
Taking school pupil/ Pupil riding to/ from school							-0.082	0.082	0.922
Other							0.254 ***	0.059	1.289
Constant	-2.311 ***	0.100	0.099	-2.693 ***	0.100	0.068	-4.050 ***	0.201	0.017
N		612,221			612,221			612,221	
Pseudo R^2		0.0171			0.0289			0.0936	
Log pseudolikelihood		-105885.62			-104620.96			-97646.63	
χ^2		3063.13			9586.91			47855.25	
p>		0.0000			0.0000			0.0000	

Notes: Significant at *** p<0.01, ** p<0.05, * p<0.1; Robust standard errors; All coefficients are compared to the category shown in brackets.

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