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An In-depth Statistical Analysis of Driver Speeding Attitudes and Behavior

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Abstract

Speeding, which encompasses driving above the speed limits, is an aggravating factor in the severity of crashes. It has also serious consequences on the environment and energy consumption.

This paper aims to thoroughly investigate the speeding behavior of Jordanian drivers through a comprehensive statistical analysis of driver speeding attitudes and behavior reaching to the most effective interventions and strategies that would mitigate this phenomenon. Data were collected through distributing a pre-designed questionnaire and receiving a total of 1,049 responses. The Public Security Directorate (PSD) provided the speed-related data.

The collected data were subjected to rigorous statistical analysis including factor analysis, bivariate Pearson's correlation test, bivariate analysis, and multivariate logistic regression analysis.

Based on the outcome of the study, potential measures for reducing speeding that would be both effective and personally acceptable in Jordan are recommended. The dominant measures were mainly law enforcement actions since it is believed that financial disincentives are most effective.

Keywords

speeding, driver behavior, driver attitudes, traffic crashes, statistical analysis, logistic regression

1 Introduction

Speeding is considered one of the most significant contributors to road traffic crashes (RTC) and their consequences. A variety of approaches were used to address this problem and a substantial amount of research has been conducted in different parts of the world on the causes of speeding or speed-related crashes without producing a significant reduction in speed-related fatalities (NHTSA, 2006). Most of the effective speeding countermeasures focus on enforcement or punishment to reduce speeding which may not be as effective with some driver groups such as young men. In addition, several engineering-based countermeasures were also proposed but these can be expensive and address speeding at specific locations.

WHO reports that an estimated 40–50% of drivers speeding (WHO, 2018). However, speeding behavior has not been properly addressed in Jordan calling for the need to identify countermeasures which specifically target the speeders and effectively address the reasons for their speeding.

RTCs constitute a significant health problem in Jordan being the second leading cause of death. Road safety in Jordan falls behind many developed and developing countries. Crash statistics show that 161,511 crashes occurred in 2019 resulting in 643 deaths, and 17,013 injuries. The death rates were 1.8 fatalities per day, 3.8 fatalities per 10,000 vehicles, and 6.1 fatalities per 100,000 population. The estimated cost of these crashes was about US $ half billion (PSD, 2020).

Human-related factors constitute the primary cause of RTCs in Jordan as they contribute to around 97% of total crashes (PSD, 2020) with speed being identified as a key risk factor in both the frequency and severity of these crashes.

Driving at excessive speed means that such a behavior plays a major role in crash occurrence. Atieh et al. (2020) carried out a preliminary analysis of speeding behavior of Jordanian drivers. However, the magnitude of the problem in Jordan is large and calls for the need for a detailed

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investigation to understand drivers' mental factors, their motivations towards this anomie behavior i.e., speeding and to identify interventions and strategies to reduce this behavior.

2 Literature review

A significant amount of work has been carried out on speeding and it's causes. The results showed that a multitude of factors are associated with speeding or speed-related crashes. However, there is still uncertainty regarding the relative importance of these factors, and their use to develop action plans and strategies that effectively target specific types of drivers (Smith, 2013).

Richard et al. (2013) examined the speeding behavior of drivers in their vehicles throughout three to four weeks of naturalistic driving in the urban setting of Seattle, WA and rural setting of College Station, TX. The purpose of the study was mainly to identify interventions/countermeasures and strategies for reducing speeding behaviors. The results identified the main reasons for drivers' speeding together with the proposed countermeasures through predicting travel speed using a developed regression model that incorporated the speeding factors (demographic properties, personal factors, and situation factors).

Dinh and Kubota (2013) carried out research in Japan that aimed to address information regarding drivers' opinions, attitudes and behaviors concerning speeding and driving on urban residential roads with a 30 km/h speed limit. The research involved distribution of a questionnaire to a sample of 367 Japanese drivers. The results indicated that drivers are aware of the positive benefits by abiding with the 30 km/h speed limit and recognize the negative consequences of speeding. However, most of the drivers considered breaking the speed limit as a way to reduce their travel time. While the extent of speeding was found to be very serious, some drivers still braced the use of a 30 km/h speed limit in a residential area and favored protecting the right of vulnerable street users.

Magableh (2016) studied human factors that influence driver behavior and traffic law enforcement in Jordan. He carried out two separate surveys to identify the factors associated with receiving traffic fines and related crashes. He also investigated the perceptions of drivers and traffic Police concerning traffic law enforcement and driver behavior.

The findings of the study revealed that crashes involving males were highly associated with factors such as previously receiving traffic fines (mainly distraction), being fined by police, being intimidated by other drivers. Crashes involving females were highly associated with violating traffic signs, being intimidated by other drivers and previously receiving traffic fines. More than 50% of drivers reported a sense of unfair treatment by traffic police who enforce the traffic law selectively. These factors might deeply affect many Jordanian drivers' motivation to violate traffic rules.

The second part of the study dealt with the police officers' work environment, enforcement perceptions, and practices. Many police officers reported unsatisfactory work conditions and pressures besides unkind/impolite treatment when dealing with drivers. The results of the study revealed underestimation of the importance of road safety and an undervaluing of the risk level of some driver behavior. Some factors related to the driver's social status/position, post networking, authority, and nepotism were found to affect Police enforcement decisions. The study concluded that the role of religion along with Jordanian social culture can be utilized to improve road safety in Jordan.

3 Methodology

A mix of qualitative methodology, based primarily on the outcome of a comprehensive literature review, and a tested, well-structured quantitative data collection methodology were employed. The main source of data for this study was a pre-designed questionnaire which was constructed guided by other countries' experience. The PSD provided all crash-related statistics and details of all crashes that occurred in Amman over an eight year period (June-2011 to August-2018).

Several tools were used to carry out the statistical analysis of the collected data. Microsoft Excel software was used to transform the collected responses to coding numbers to facilitate the use of the data by the statistical analysis programs. Various computer programs were also employed to provide a comprehensive statistical data analysis. These include the Statistical Package for Social Sciences (SPSS) program V20 (IBM, 2018b), Analysis of moments structural equation modeling software (AMOS) SPSS program V19 (IBM, 2018a) and the FACTOR V9.2 (Rovira i Virgili University, 2018).

During the data analysis stage, descriptive and inferential statistics together with various tests were used including means and standard deviations, the Pearson's correlation test, the *t*-test of independent groups, Chi-square test and the Welch's and other One-way ANOVA tests, the Levene's test of equal variance. In addition, the factor analysis in the SPSS Program and the parallel analysis (PA) in the stand-alone FACTOR program were also used to provide a more comprehensive statistical data analysis.

4 Description of the statistical analysis

A comprehensive statistical data analysis was performed to achieve the study goals. Means and standard deviations were used to describe the continuous metric scores (speeding attitudes, behaviors) and the frequencies and percentages for binary and multilevel categorical factors.

The Pearson's correlation test was employed to assess the bivariate association between continuous scores while the Chi-squared (χ^2) test of independence was used to evaluate the association between the categorical variables such as the association between speeding above the posted speed limits, respondents' gender, and other demographic factors.

The *t*-test of independent groups and the One-way ANOVA tests were used to assess the levels of binary, and more than two groups' certain factors for statistically significant differences in respondents' mean perceived driving behaviors score. The adjusted *p*-values were quoted where violations to the statistical assumptions of these tests were observed, e.g., the Welch's One-way ANOVA test was used where equal variance assumption violation was noted.

The Levene's test of equal variance was employed to assess the similar variance assumption and the Kolmogorov–Smirnov test of normality while the P-P plots was used to determine the normality assumption of the analyzed variables.

Next, the factor analysis in the SPSS program and the parallel analysis (PA) in the stand-alone FACTOR program as described by Ferrando and Lorenzo-Seva (2013) were used to analyze the factorial structure of the indicators of driving attitudes and the speed driving behaviors for factorability. The scale was used for the first time in the Middle east and confirmed the analyzed concepts using the (FACTOR) and the AMOS structural equation modeling programs to help estimate the factor weights for the indicators. The factor weights were then used to compute weighted factor scores for people's speed driving behaviors and for drive attitudes via multiplying the factor weights by their corresponding raw measured indicators, then adding up the yielded products resulting in weighted attitudes and behavior scores which were used in further analysis. Reverse coding was carried out to negatively worded statements before analyzing these measured indicators of driving attitude and behaviors.

The speeding above road speed limits on the highways and residential roads were of particular interest to the study objectives because they have characterized people's actual speed driving above speed limits. As such the two measures of speeding above road speed limits on highway and residential roads were dummy coded by grouping those who confirmed exceedance of these limits into one group coded as (1) and those who never speed beyond the limit into another group coded (0). The multivariate logistic regression analysis was then used to assess the combined and individual association between people's demographic characteristics, driving attitudes, behaviors and practices, and their odds of speeding above road speed limits on highways with more than 20 km/h, and residential roads with more than 15 km/h. The alpha significance level was set to 0.05 throughout the analysis.

5 Results

5.1 Demographic characteristic

A total of 1,049 persons responded to the survey with complete questionnaires. The yielded analysis of the respondents' demographic and daily travel characteristics are shown in Table 1. It can be seen that the majority of the respondents (56%) were male drivers and the remainder were female drivers. The age of the respondents was distributed as follows: 4% were aged twenty years or lower, most of them were aged between (21–30 years), another 28.3% of them were aged between (31–40 years), another 8.9% aged between (41–50 years) and the rest (7.1%) were aged above fifty years.

Table 1 Respondents' demographic and travel characteristics (n = 1049)

Demographic and travel characteristics		Frequency	Percentage
Gender	Female	462	44
	Male	587	56
Age	= < 20 years	42	4
	21–30 years	543	51.8
	31–40 years	297	28.3
	41–50 years	93	8.9
	> 50 years	74	7.1
Educational level	Lower or equal high school	90	8.6
	Secondary-diploma level	101	9.6
	Bachelor degree	646	61.6
	Master's degree	183	17.4
	Doctorate (PhD) degree	29	2.8
Owned vehicle's engine size	Do not own a vehicle	123	11.7
	< 1500 CC	208	19.8
	1500–2000 CC	511	48.7
	> 2000 CC	207	19.7
Daily travelled distance	= < 30 km/day	341	32.5
	31–80 km/day	458	43.7
	81–120 km/day	157	15
	> 120 km/day	93	8.9

In Table 1 the analysis of the educational level of the respondents showed that 8.6% had high school education or lower, another 9.6% had finished their secondary diploma level. However, most of them (61.6%) were university graduates with another 17.4% holders of master's degree, and 2.8% were PhD holders. 11.7% of the respondents did not own a private vehicle, 19.8% had a vehicle with an engine size smaller than 1,500 CC. Most of them (48.7%), however, had vehicles with engine sized between (1500–2000) CC and the rest (19.7%) owned vehicles equipped with engines sized more than 2000 CC. The daily travelled distance was measured for all respondents, and the yielded results showed that 32.5% of the respondents travelled 30 km per day or less. Most of them (43.7%) travelled between 31–80 km per day, with another 15% travelled between 81–120 km per day and the rest of them (8.9%) travelled more than 120 km per day.

5.2 Factor analysis of drivers' perceived driving attitudes and behaviors

The factor analysis in the SPSS program and the standalone FACTOR program and the SPSS AMOS structural equation modelling program were used to explore the driving attitudes and speeding behavior items and to confirm their dimensionality. The purpose of the factor analysis was to assess these items for dimensionality and in order to help us extract a smaller number of simple meaningful and interpretable scores that were employed in the analysis. The resulting factor analysis (PCA) of people's attitudes toward driving suggested the factorability of the correlation matrix between these items, as evident with a substantive number of correlations between the indicators with magnitudes above 0.30 and the Kaiser-Meyer-Olkin (K-M-O = 0.85) index of sampling adequacy signaled to adequate sample size for the factor analysis, besides the Bartlett's test of sphericity was significant, $\chi^2(78) = 2374.7$, $p < 0.001$, indicating that the factor analysis was supported on the correlations of these items, also the determinant (determinant value = 0.103) indicated the absence of collinearity between these eleven indicators, moreover the parallel analysis test using the FACTOR program indicated the presence of two extractable scores among the items measuring people's attitudes. Table 2 shows pattern matrix factor analysis of people's perceived driving attitudes and behaviors. The items measuring people's attitudes toward recklessness, speed driving, hurried driving, indeliberate speed driving and joy driving fast coalesced under the

Table 2 Maximum likelihood promax rotated loading pattern matrix factor analysis of drivers' perceived driving attitudes and behaviors (n = 1049)

	Items	Rotated factors		
		Reckless driving attitude	Law abiding attitude	Speed driving
Attitudes toward driving	I enjoy driving fast.	0.711		
	I try to get to my destination as fast as I can.	0.687		
	I often get impatient with slower drivers.	0.648		
	The faster I drive, the more alert I am.	0.603		
	Speeding is something I do without thinking.	0.490		
	It is unacceptable to exceed speed limits by more than 30 km/h.		0.608	
	Everyone should obey the speed limits because it's a law.		0.570	
	People should keep pace with the flow of traffic.		0.430	
	If it is your time to die, you'll die, so it doesn't matter whether you speed or not.		−0.409	
	Driving over the speed limit is not dangerous for skilled drivers.		−0.398	
	I worry a lot about having a vehicle crash.		0.378	
Speed driving behavior	I consider myself a risk taker while driving.			0.604
	How often do you get involved in 'races' with other drivers?			0.595
	How often do you honk your horn or make an obscene gesture to indicate your annoyance at another driver?			0.302
	How often do you disregard the speed limits late at night or early in the morning?			0.599
	How often do you drive especially close to a vehicle in front as a signal to the driver to go faster or get out of the way?			0.621
	How often do you become angered by a driver, and indicate your hostility in whatever way you can?			0.460

first factor which was named reckless driving attitude, and higher scores on this factor denote more reckless driving, joy speed driving, more content to fast driving and hurried driving. Also, the items measuring respect to speed limits, compliance with road speed limits, adapting to road traffic level with driving speed, fear from serious crashes and unsafety of speed driving to one's life coalesced under the second factor which was named as traffic-law abiding concept, higher score on this factor denotes greater compliance, respect, safe, and careful driving attitudes. Moreover, the reckless driving and traffic-law abiding were negatively and significantly correlated with $r = -0.50$, denoting that people who scored higher on the traffic law abiding factors scored significantly less on the reckless driving attitudes. The two-factor solution explained 40% of the variations in people's responses to these indicators of driving attitudes and the correlations between these indicators.

The factor analysis of the speeding behavior items comprised a one factor structure, which was also simple meaningful and interpretable. Bartlett's test was significant denoting the adequacy of the correlation matrix between these indicators for factor analysis, $\chi^2(28) = 1082.91$, $p < 0.001$, K-M-O = 0.73, and the determinant value was equal to 0.325, indicating the suitability of factor analysis. The items in the last column of Table 2 show the factor loadings (i.e., correlations) between their single factor which was named Speeding behavior, since most of the items measured people's fast, risky, and furious driving. The one-factor solution explained a total of 30% of the shared variance between the indicators of speeding behaviors.

5.3 Bivariate Pearson correlations test

The Pearson's correlations test was used to assess the bivariate association between people's measured speed driving behavior with the attitudes and the other metric scores measuring speed limit bypassing and driving practices, the Pearson's test showed that people's law abiding driving attitudes correlated significantly and negatively with their perceived speed driving, $r = -0.44$, $p < 0.010$, suggesting that people with greater driving law-abiding attitudes converged significantly on less speed driving behaviors. Also, the people's measured reckless driving attitudes correlated significantly and positively with their self-reported perceived speedy driving behaviors, $r = 0.57$, $p < 0.010$, indicating that people with greater reckless driving attitudes tended to report more vigorous and speedy driving behaviors on average. Next, the law-abiding and reckless driving correlated significantly and negatively, $r = -0.50$, $p < 0.010$, indicating that people with more law-abiding and respecting attitudes tended to score lower on reckless driving attitudes on average. As well, people's self-reports of over-riding the highway and residential road speed limits correlated positively with their self-report of speedy driving behavior, $r = 0.45$, and $r = 0.37$, $p < 0.010$, respectively, indicating that people who tended to exceed roads' speed limits on average tended to report greater speeding behaviors as well. Moreover, people's perceived driving law abiding attitudes correlated negatively and significantly with their self-reports of exceeding the highway and residential roads' speed limits, $r = -0.37$, and $r = -0.35$, $p < 0.010$, respectively, denoting that people with greater law-abiding driving attitudes tended to report less violation of road speed limits on average. However, the score of people's self-reported driving over the speed limit for highways correlated significantly and positively with their self-report of driving over the speed limits in residential roads as well, $r = 0.60$, $p < 0.010$, suggesting that those who over-ride the speed limits on residential roads tend to incrementally exceed highway speed limits on average as well. Also, people's self-report of reckless driving attitudes/manners converged significantly and positively with more reports of driving above and over road speed limits, $r = 0.44$, and $r = 0.36$, $p < 0.010$ for highways and residential roads, respectively.

Table 3 shows the results of bivariate Pearson's correlations test between people's driving practices, attitudes and behavior.

The meaning of the items in Table 3 are:

- Item 1: Speeding Driving Behavior (SDB);
- Item 2: Law Abiding Driving attitude (LAD);
- Item 3: Reckless Driving Attitude (RDA);
- Item 4: How many times did you exceed speed limit with more than 20 km/h on highways?
- Item 5: How many times did you exceed speed limit with more than 15 km/h on residential roads?
- Item 6: How often do you check traffic conditions before you drive somewhere?
- Item 7: How often do you become impatient and pass on the right?

5.4 Bivariate analysis

In order to better understand people's speeding behavior, their demographic, educational, driving practices and habits factors were explored for statistically significant differences on their mean respective perceived behavior of speed driving, as such the independent groups *t*-test and the One-way ANOVA test were employed and adjusted tests and associated *p*-values were quoted for those tests where statistical

Table 3 Results of bivariate Pearson's correlations test between people's driving practices, attitudes and behavior

#	1	2	3	4	5	6	Mean (SD)
1	1						2.21 (0.85)
2	−0.438**						3.95 (0.71)
3	0.571**	−0.495**					2.83 (0.88)
4	0.451**	−0.365**	0.44**				2.44 (0.95)
5	0.367**	−0.347**	0.364**	0.63**			2.41 (0.95)
6	0.02	0.01	−0.04	−0.011	−0.021		2.96 (1.62)
7	-0.03	0.04	−0.072*	−0.01	−0.015	0.05	3.41 (1.28)

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

assumption violations were noted. The yielded analysis results are shown in Table 4. To untangle the findings of the analysis, an independent groups *t*-test showed that male drivers tended to report significantly greater speed driving (M = 2.32, SD = 0.87) than female drivers (M = 2.1, SD = 0.82), $t = 4.53$, $p < 0.001$, indicating that male drivers tend to behave more variously, competitively and speedy than female drivers. Moreover, a Welch's adjusted One-way ANOVA test indicated that people's age groups differed significantly on their mean perceived speed driving, $F(2,241.9) = 53.13$, $p < 0.001$, and a post-hoc Games-Howell pairwise comparison between people's age groups on their mean perceived speed driving behavior showed that people aged below thirty years had significantly greater

Table 4 Bivariate analysis of respondents' demographic and travel characteristics levels for statistical difference on their mean self-rated speed driving behaviors

	Items	Mean (SD) speeding behavior	Test statistic	*p*-value
Gender	Female	2.10 (0.82)	$t(1047) = 4.53$	< 0.001
	Male	2.32 (0.87)		
Age	Below 30 years	2.40 (0.91)	$F(2,241.9) = 53.13$ (Welch's One-way ANOVA test)	< 0.001
	31-50 years	2.02 (0.72)		
	> 50 years	1.73 (0.511)		
Educational level	Less than secondary education	2.084 (0.92)	$F(4,1044) = 1.90$	0.110
	Secondary diploma level	2.30 (0.97)		
	University degree	2.24 (0.84)		
	Master's degree	2.19 (0.82)		
	Higher education	1.90 (0.70)		
Owned vehicle engine size	Do not own a vehicle	2.12 (0.86)	$F(3,1045) = 0.880$	0.451
	< 1500 CC	2.23 (0.85)		
	1500–2000 CC	2.21 (0.81)		
	> 2000 CC	2.27 (0.97)		
Daily travelled distance	= < 30 km daily	1.99 (0.82)	$F(3,307.75) = 13.20$ (Welch's One-way ANOVA test)	< 0.001
	31–80 km/day	2.28 (0.87)		
	81–120 km/day	2.38 (0.90)		
	> 120 km/day	2.40 (0.98)		
On the road, how do you drive generally?	Another vehicle tends to pass me more often than I pass them.	1.83 (0.70)	$F(2,585.9) = 99.13$ Welch's One-way ANOVA test	< 0.001
	Both I and other vehicles pass each other equally.	2.15 (0.80)		
	I tend to pass other vehicles more often than other vehicles pass me.	2.79 (0.91)		

speed driving behavior (M = 2.41, SD = 0.91) than those aged between thirty to fifty years (M = 2.02, SD = 0.72), $p < 0.001$, also those younger than thirty years had significantly greater speed driving behavior than those aged above fifty years (M = 1.73, SD = 0.51), $p < 0.001$, but also those people aged between thirty to fifty years had perceived significantly greater speed driving than those older than fifty, $p = 0.015$, so it is clear that a significant downward trend in speed driving behaviors is evident as people's age tend to rise incrementally, see Fig. 1.

Furthermore, the One-way ANOVA test showed that no statistically significant differences in mean perceived speed driving exist between the levels of people's educational attainments, $p = 0.110$, neither was a statistically significant association between people's own vehicle's engine sizes with their perceived speed driving behaviors according to the One-way ANOVA test, $p = 0.451$. However, another Welch's One-way ANOVA showed that there was a statistically significant difference between people with various daily travelled distances on their respective mean perceived speed driving, $F(3,307.75) = 13.20$, $p < 0.001$, and a Games-Howell post-hoc pairwise comparison between people's travelled daily distances on their mean speed driving score showed that people who travelled less than or equal 30 km per day had significantly lower mean perceived speed driving than those who travel 31–80 km per day, $p < 0.001$, also they (those who travel less than 30 km) had significantly lower speed driving behavior perception than those who travelled between 81–120 km per day, $p < 0.001$, as well as a significantly lower speed driving behavior than those who travelled more than 120 km per day, $p = 0.002$, indicating that those who travel less than 30 km per day have significantly lower perceived mean speed driving than those who travel 31 km or more per day, however the post-hoc pairwise comparison analysis showed that those who travel between (31–80 km per day) also had significantly lower mean speed driving behavior perception than those who travelled between (80–120 km per day), $p < 0.001$. Also, the Welch's One-way ANOVA test showed that there was a statistically significant difference between people with various competitive road driving practices on their speed driving behavior perceptions, $F(2,585.9) = 99.13$, $p < 0.001$, and a Games-Howell adjusted pairwise comparison between people's competitive driving levels on their respective mean perceived speed driving showed that people who reported being passed more often by other vehicles had significantly lower perceived speed driving behavior, (M = 1.83, SD = 0.7), than those who reported passing other vehicles (M = 2.15, SD = 0.8), $p < 0.001$. Also, those who are passed by other drivers perceived significantly lower speed driving behaviors than those who reported to always pass other drivers (M = 2.8, SD = 0.91), $p < 0.001$, however those in the latter group (who always pass others) had significantly greater perceived speed driving than those who are mutually passing others, $p < 0.001$, see bottom part of Table 4 for the means and standard deviations of those groups.

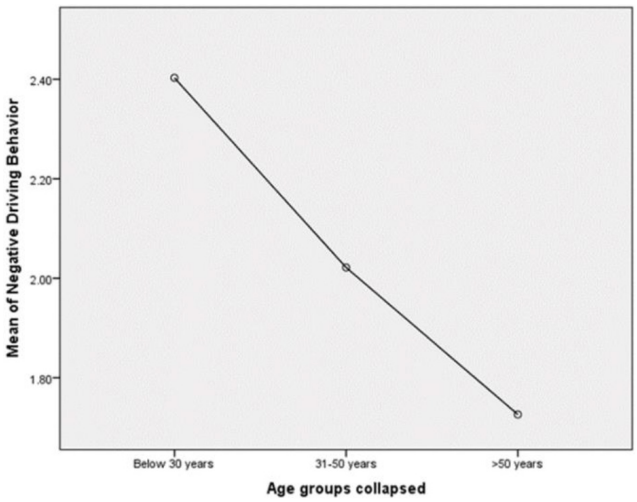

Fig. 1 Driving behavior – age group relationship

Next, bivariate analysis was used to explore the profiles of people for their speed above highway speed limits with > 20 km/h, as such their demographic-educational factors, driving practices, habits, behavior and attitude scores were explored for statistical association with exceeding the speed limits on highways, the resulting analysis results are shown in Table 5. The χ^2-test of independence and the independent groups tests were used to analyze the variables for bivariate correlation. In order to put the results from the analysis simply, the χ^2-test of independence showed that male and female respondents differed statistically significantly on their likelihoods of speeding above highway speed limit, $p < 0.0.001$, males were more likely to exceed speed limits on highways than females (65% vs. 35%), indicating that male respondents are significantly more inclined to exceed speed limits. Also, people's age was significantly and positively associated with their road speed limit compliance, older people in general were less inclined to exceed the highway speed limits than younger people, $p < 0.001$, clearly people aged with 30 years or below were significantly more inclined to agree on their violation to the highway road speed limits with 20 km/h and above than those aged older than thirty years on average, see Table 5.

Similarly, people's educational level was significantly associated with violating highway speed limits, $p < 0.001$,

Table 5 Bivariate analysis of respondents' demographic and travel characteristics for statistical differences on exceeding the speed limit on highways with above 20 km/h

Items		Speeds > = 20 km on highway		Test statistic	*p*-value
		No	Yes		
		n = 526	*n* = 523		
Gender	Female	279 (53%)	183 (35%)	$\chi^2(1) = 34.70$	< 0.001
	Male	247 (47%)	340 (65%)		
Age	= < 20 years	16 (3%)	26 (5%)	$\chi^2(4) = 44$	< 0.001
	21–30 years	227 (43.2%)	316 (60.4%)		
	31–40 years	170 (32.3%)	127 (24.3%)		
	41–50 years	63 (12%)	30 (5.7%)		
	> 50 years	50 (9.5%)	24 (4.6%)		
Educational level	Less than secondary education	43 (8.2%)	47 (9%)	$\chi^2(4) = 20.36$	< 0.001
	Secondary diploma level	47 (8.9%)	54 (10.3%)		
	University degree	305 (58%)	341 (65.6%)		
	Master's degree	107 (20.3%)	76 (14.5%)		
	Higher education	24 (4.6%)	5 (1%)		
Owned vehicle's engine size	Do not own a vehicle	74 (14.1%)	49 (9.4%)	$\chi^2(3) = 7.45$	0.059
	< 1500 CC	110 (20.9%)	98 (18.7%)		
	1500–2000 CC	245 (46.6%)	266 (50.9%)		
	> 2000 CC	97 (18.4%)	110 (21%)		
Daily travelled distance	= < 30 km daily	213 (40.5%)	128 (24.5%)	$\chi^2(3) = 30.89$	< 0.001
	31–80 km/day	200 (38%)	258 (49.3%)		
	81–120 km/day	70 (13.3%)	87 (16.6%)		
	> 120 km/day	43 (8.2)	50 (9.6%)		
Which of the following statements best describes your driving behavior?	Other vehicles tend to pass me more often than I pass them.	208 (39.85%)	101 (19.3%)	$\chi^2(2) = 85.1$	< 0.001
	Both/about equally	245 (46.6%)	238 (45.5%)		
	I tend to pass other vehicles more often than other vehicles pass me.	73 (13.9%)	184 (35.2%)		
	Speeding Driving Behavior (SDB), mean (SD)	1.87 (0.7)	2.55 (0.87)	t (988.7) = 14.03	< 0.001
	Law Abiding Driving attitude (LAD), mean (SD)	4.2 (0.611)	3.72 (0.73)	t (1012.6) = 11.23	< 0.001
	Reckless Driving Attitude (RDA), mean (SD)	2.49 (0.81)	3.17 (0.83)	t (1047) = 13.40	< 0.001
	On residential roads, how often do you drive 15 km/h over the speed limit? mean (SD)	1.9 (0.80)	2.92 (0.80)	t (1047) = 20.80	< 0.001
	How often do you check traffic conditions before you drive somewhere? mean (SD)	2.96 (1.61)	2.96 (1.62)	t (1047) = 0.021	0.983
	How often do you become impatient and pass on the right? mean (SD)	3.45 (1.33)	3.38 (1.21)	t (1038.9) =0.914	0.361

however by evaluating the percentages of people who violate the speed limits on highways suggested that people with a university degree were significantly more inclined to speed drive past the highway speed limits than the other educational groups, and those educated with a master degree or higher were significantly less inclined to exceed road speed limits, $p < 0.001$. Moreover, people's own vehicle's engine sizes correlated slightly positively with speeding past the speed limits on highways with or above 20 km/h, however by investigating the contingency matrix for the percentage of those who exceed the limits it was clear that those who do not own private vehicles tend to not exceed road speed limits, $p = 0.059$, and other people with own vehicles with various engine sizes may not necessarily differ with their speed limit violation/compliance. Also, the chi-squared test of association indicated that people with various daily travelled distances may differ significantly on their highway speed limit violation, $p < 0.001$, those who travel (= < 30 km/day) were found to be significantly less inclined to speed past the highway road speed limits with above 20 km/h, but people who travelled

between (31–80 km/day) were significantly more inclined to speed past the highway speed limits, and the other people with higher daily travelled distances were equally likely to speed or not speed above highway limits. None the less, people's habitual competitive vehicle driving was significantly associated with their violation of highway speed limits, those who reported being very competitive (passing all vehicles) were significantly more inclined to override the highway speed limits with > 20 km/h, $p < 0.001$. Nonetheless, according to an independent groups *t*-test, those who drive above highway speed limits scored significantly higher on the speeding behavioral score (M = 2.55, SD = 0.9) than those who do not exceed highway speed limits (M = 1.9, SD = 0.7), $p < 0.001$. Similarly, those who exceeded the speed limits on highways score significantly less on the law-abiding score (M = 3.72, SD = 0.73) than those who do not drive faster than the road speed limits (M = 4.20, SD = 0.611), $p < 0.001$, according to an independent groups *t*-test. Moreover, another independent groups *t*-test indicated that those who exceeded the highway road speed limits had significantly greater reckless driving attitude (M = 3.17 m, SD = 0.83) than people who do not exceed the highway road speed limits (M = 2.49, SD = 0.81), $p < 0.001$. Likewise, those who exceeded the speed limits on highways scored higher speeding on residential roads (M = 2.92, SD = 0.8) than those who do not speed past highways' speed limits (M = 1.9, SD = 0.8), $p < 0.001$. The analysis, however, showed that people's practices of checking road conditions for jams and practicing patience while driving did not correlate with their highway speed limit violation with above 20 km/h, $p > 0.050$. Next, in order to explain why people may or may not speed above highway speed limits the respondents' factors and co-variates were analyzed using the multivariate binary logistic regression analysis as will show in Section 5.5 for their multivariate association with the odds of speeding above the highway's speed limits.

Next, people's speeding above residential roads' speed limits was also analyzed (with > = 15 km/h) for statistically significant association with their demographic, habits, attitudes and behaviors plus their practices and travel and vehicle characteristics. The yielded analysis results are shown in Table 6. To put simply, the analysis again showed that males are significantly more inclined to speed above residential roads' speed limits than females, $p < 0.001$ according the χ^2-test, also older people were found to be significantly less predicted to speed past the residential roads' speed limits, $p < 0.001$, in particular those older than thirty years were less predicted to speed on residential roads than those younger than thirty years as such. Next, people holding a university degree were significantly more predicted to speed on residential roads than other people with various educational levels, $p < 0.001$. Unexpectedly, people's own vehicle engine sizes did not correlate significantly with their speeding on residential roads, $p = 0.128$, however the daily travelled distance in kilometers converged significantly on the speed driving above limits in suburbs, $p < 0.001$, according to the χ^2-test, in particular those who travel between (31–120 km per day) tended to report speeding above residential road speed limits significantly more often than the other respondents who travel various distances per day.

Next, people's competitive driving correlated significantly with speeding above residential roads' speed limits, $p < 0.001$, those who reported being always ahead of the other travelling vehicles were predicted to have significantly more speeding in suburbs than those who do dual bypassing or do not bypass other vehicles at all, $p < 0.001$, see middle part of Table 6. Moreover, the *t*-test of independent groups suggested that those people who speed above residential roads' speed limit had significantly greater speeding behavior score (M = 2.55, SD = 0.9) than those who do not speed on residential roads, (M = 1.92, SD = 0.7), $p < 0.001$, also those who speed above limits on residential roads had significantly lower road law-abiding attitudes (M = 3.70, SD = 0.73) than those who do not speed on residential roads (M = 4.16, SD = 0.62), $p < 0.001$, Nonetheless those who speed above road speed limits on residential roads had significantly greater reckless driving attitudes (M = 3.14, SD = 0.85) than those who do not speed above residential road speed limits (M = 2.56, SD = 0.83) according to another independent groups *t*-test, $p < 0.001$, also those who reported speeding above road speed limits on the residential roads had significantly greater frequency exceeding the speed limits on highways too, $p < 0.001$, as shown in Table 6. However, the bivariate analysis indicated that people's patience with other drivers and routine checking of road traffic jams before driving did not converge significantly on their habitual speeding above residential roads' speed limits with more than 15 km/h.

Next, to help to understand better the inter-arched nature of people's demographic, habits, attitudes, behaviors and road manners and practices with their odds of speeding on residential roads, with > 15 km/h, it was determined to analyze these people's covariates and factors for their combined and individual association with speeding on residential roads via regressing them against people's odds of committing such speeding behavior in smaller cities on small roads.

Table 6 Bivariate analysis of respondents' demographic and travel characteristics for statistical differences on exceeding the speed limit on residential roads with > 15 km/h

Items		Speeds > = 15 km on residential road		Test statistic	*p*-value
		No	Yes		
		n = 564	*n* = 485		
Gender	Female	287 (50.9%)	175 (36.1%)	$\chi^2(1) = 23.19$	<0.001
	Male	277 (49.1%)	310 (63.9%)		
Age	= < 20 years	18 (3.2%)	24 (5%)	$\chi^2(4) = 36.9$	<0.001
	21–30 years	251 (44.5%)	292 (60.2%)		
	31–40 years	179 (31.7%)	118 (24.3%)		
	41–50 years	62 (11%)	31 (6.4%)		
	> 50 years	54 (9.6%)	20 (4.1%)		
Educational level	Less than secondary education	42 (7.4%)	48 (9.9%)	$\chi^2(4) = 5.70$	< 0.001
	Secondary diploma level	57 (10.1%)	44 (9.1%)		
	University degree	327 (58%)	319 (65.8%)		
	Master's degree	112 (19.9%)	71 (14.6%)		
	Higher education	26 (4.6%)	3 (0.6%)		
Owned vehicle's engine size	Do not own a vehicle	72 (12.8%)	51 (10.5%)	$\chi^2(4) = 5.70$	0.128
	< 1500 CC	123 (21.8%)	85 (17.5%)		
	1500–2000 CC	267 (47.3%)	244 (50.3%)		
	>2000 CC	102(18.1%)	105 (21.6%)		
Daily travelled distance	= < 30 km daily	234 (41.5%)	107 (22.1%)	$\chi^2(3) = 45.74$	< 0.001
	31-80 km/day	218 (38.7%)	240 (49.5%)		
	81-120 km/day	68 (12.1%)	89 (18.4%)		
	>120 km/day	44 (7.8%)	49 (10.1%)		
	Other vehicles tend to pass me more often than I pass them.	204 (36.2%)	105 (21.6%)	$\chi^2(2) = 62.99$	< 0.001
	Both/about equally	274 (48.6%)	209 (43.1%)		
	I tend to pass other vehicles more often than other vehicles pass me.	86 (15.2%)	171 (35.3%)		
	Speeding driving behavior, mean (SD)	1.92 (0.70)	2.55 (0.90)	t (909.51) = 12.43	< 0.001
	LAD, mean (SD)	4.16 (0.62)	3.70 (0.73)	t (956.40) = 10.90	< 0.001
	RDA, mean (SD)	2.56 (0.83)	3.14 (0.85)	t (1047) = 11.30	< 0.001
	Drive 20 km/h over the speed limit on highway mean (SD)	1.97 (0.82)	2.99 (0.80)	t (1047) = 20.80	< 0.001
	Check traffic conditions before you drive, mean (SD)	3.01 (1.63)	2.91 (1.6)	t (1047) = 0.995	0.32
	Become impatient and pass on the right? mean (SD)	3.44 (1.32)	3.38 (1.22)	t (1041.4) = 0.80	0.429

5.5 Multivariate logistic regression analysis

The results from the binary logistic regression suggested that the model was overall statistically significant, $\chi^2(13) = 434.11$, $p < 0.001$, indicating that at least one, or more, of the tested predictor variables had a statistically significant multivariate association with the respondents' exceeding the highway speed limits well above 20 km/h, more or less. Also, they are under the receiver operating curve (ROC) showed that the model was statistically significantly specific and sensitive at predicting people's true habitual over-riding the highway speed limits, denoting the overall accuracy of the model at prediction, AUC ROC = 0.848, $p < 0.001$.

To put simply the findings from the multivariate logistic regression analysis, the model showed that male respondents, compared to females, were significantly more inclined to override the highway speed limits (O). $R = 1.45$, $p = 0.029$, males are 45% times more (= (OR−1) × 100 = (1.45−1) × 100 = 45%) predicted to speed beyond the highway speed limits than females on average, by controlling for the other factors and co-variates in the model. Also, the analysis model showed that people aged above thirty years were significantly 29.8% times less inclined (= (1−OR) × 100) = (1−0702) × 100 = 29.8%), than people aged below thirty years, $p = 0.034$, well by

Table 7 Multivariate Logistic Regression of respondents' demographic and travel characteristics for statistical differences in exceeding the speed limit on highways above 20 km/h (n = 1049)

Items	B	S.E.	Wald	Adjusted odds ratio	95% CI for EXP (OR)		p-value
					Lower	Upper	
1	0.371	0.170	4.785	1.450	1.039	2.022	0.029
2	−0.354	0.167	4.484	0.702	0.506	0.974	0.034
3	−0.143	0.102	1.966	0.867	0.709	1.059	0.161
4	0.115	0.093	1.525	1.122	0.935	1.347	0.217
5	−0.060	0.093	0.425	0.941	0.785	1.129	0.515
6			3.486				0.175
7	0.322	0.190	2.872	1.379	0.951	2.001	0.090
8	0.395	0.247	2.570	1.485	0.916	2.408	0.109
9	1.934	0.160	146.134	6.917	5.055	9.465	< 0.001
10	0.011	0.049	0.047	1.011	0.918	1.112	0.828
11	−0.024	0.063	0.153	0.976	0.863	1.103	0.696
12	0.533	0.126	17.876	1.703	1.331	2.180	< 0.001
13	−0.209	0.134	2.451	0.811	0.624	1.054	0.117
14	0.329	0.123	7.194	1.389	1.093	1.767	0.007
Constant	−2.048	0.827	6.135	0.129			0.013

controlling for the other variables in the model, see Fig. 2, the model's predicted probability (adjusted propensity score of speeding above road speed limits) on the (y-axis) against people's age (x-axis), it is evident as people's age rises above thirty years their model's predicted probability of speeding above highway speed limits declines substantively, note also gender as a subgroup analysis, males are significantly at greater risk of speeding above highways' limits of speed across all age groups. As well, the analysis model indicated that those people who exceed the residential roads' speed limits with or above 15 km/h are at 6.97 (597%) time more significantly expected to bypass the highway speed limits, $p < 0.001$, by keeping the other

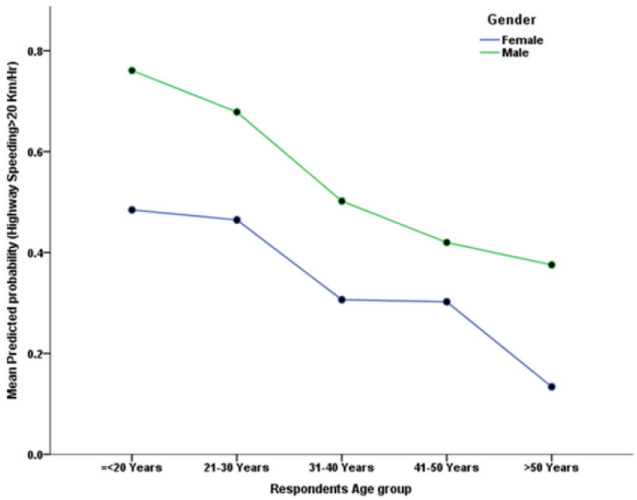

Fig. 2 The relationship between mean predicted probability of highway speeding above 20 km/h and respondents' age group

factors and co-variates similar/controlled. Moreover, people's speeding behavior score correlated significantly with their odds of speed driving above highway speed limits, $p < 0.001$, for each additional one unit in their speed driving behavior score their odds of bypassing the highways' speed limits rises by 1.7 times (i.e., 70%), when controlling for the other factors and covariates in the model. Likewise, people's reckless driving attitude score converged significantly and positively with their odds of having had driven past the highway speed limits well above 20 km/h, $p = 0.007$, for each additional one unit on the score of reckless driving attitude score the odds of people exceeding the highways' speed limits ((> = km/hr) rises by a factor equal to 1.389 times, for example equal 38.9%) more on average, by considering the other variables as controlled for.

The analysis model, however, indicated that people's (educational level, vehicle engine size, daily travelled distance, competitive driving, patience with other drivers, checking road jams and law-abiding attitudes) did not converge significantly on their odds of speeding above highway speed limits although educational level may have slight negative, $p = 0.161$, association with less speeding above highway speed limits the association, however, was not statistically significantly but rather practicably and maybe managerially important, see Fig. 3.

The meaning of the items in Table 7 are:

- Item 1: Gender = Male;
- Item 2: Age > 30 years;
- Item 3: Educational level;

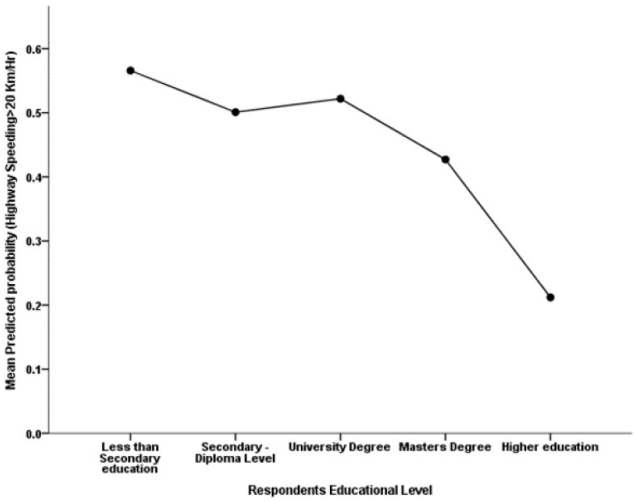

Fig. 3 The relationship between mean predicted probability of highway speeding above 20 km/h and respondents' educational level

- Item 4: Vehicle engine size in CC;
- Item 5: Daily travelled distance;
- Item 6: Competing behavior = Other bypass me;
- Item 7: Competing behavior = Dual bypassing;
- Item 8: Competing behavior = I bypasses others;
- Item 9: How many times you exceeded speed limit with 15 km/h on local roads?
- Item 10: How often do you check traffic Jam conditions before travelling?
- Item 11: How often do you become impatient and pass on the right?
- Item 12: Speed driving behavior self-rating (1–5) score;
- Item 13: Driving law abiding attitude (1–5) score;
- Item 14: Reckless driving attitude (1–5) score.

Also, the multivariate binary logistic regression analysis model of people's odds of speeding on residential roads (with > = 15 km/h) was statistically significant, $\chi^2(13) = 390.1$, $p < 0.001$. This indicated that at least one, or more, of people's tested predictor independent variables had a significant multivariate association with their odds of speed driving above road speed limits in suburbs of the city. The model also had statistically significant predictive power, as evident with great area under the ROC curve, AUC = 0.831, $p < 0.001$, indicating that the model, with the tested predictor independent variables, was generally great at predicting people's true speeding behavior in city residential roads. To untangle the main findings of the analysis model, the binary logistic multivariate analysis indicated that male and female citizens were not statistically significantly different on their odds of speed driving above limit in suburbs on average, $p = 0.724$, when accounting for the other variables as shown in Table 8. Also, the analysis model indicated that in the case of people aged above thirty years the odds of speeding above speed limits on residential roads are 28% times less (OR = 0.72, $p = 0.046$) than in the case of those aged below thirty years, as shown in Fig. 4. Also, the model suggested, contrary to the bivariate analysis findings, that people's educational level and their owned vehicle's engine sizes did not converge significantly

Table 8 Multivariate Logistic Regression of respondents' demographic and travel characteristics for statistical differences in exceeding the speed limit on highways above 15 km/h ($n = 1049$)

Items	B	SE	Wald	Adjusted odds ratio	95% CI for EXP (OR)		*p*-value
					Lower	Upper	
1	0.059	0.169	0.124	1.061	0.763	1.477	0.724
2	−0.329	0.165	3.981	0.719	0.521	0.994	0.046
3	−0.110	0.100	1.213	0.896	0.737	1.089	0.271
4	0.052	0.091	0.320	1.053	0.881	1.259	0.572
5	0.241	0.089	7.263	1.273	1.068	1.517	0.007
6			1.617				0.445
7	−0.185	0.189	0.956	0.831	0.573	1.205	0.328
8	0.021	0.244	0.007	1.021	0.633	1.647	0.933
9	1.939	0.160	147.322	6.949	5.081	9.504	< 0.001
10	−0.067	0.048	1.921	0.935	0.851	1.028	0.166
11	−0.002	0.062	0.002	0.998	0.884	1.126	0.968
12	0.382	0.121	9.979	1.466	1.156	1.858	0.002
13	−0.360	0.131	7.588	0.698	0.540	0.901	0.006
14	0.129	0.121	1.133	1.138	0.897	1.443	0.287
Constant	−0.816	0.816	1.001	0.442			0.317

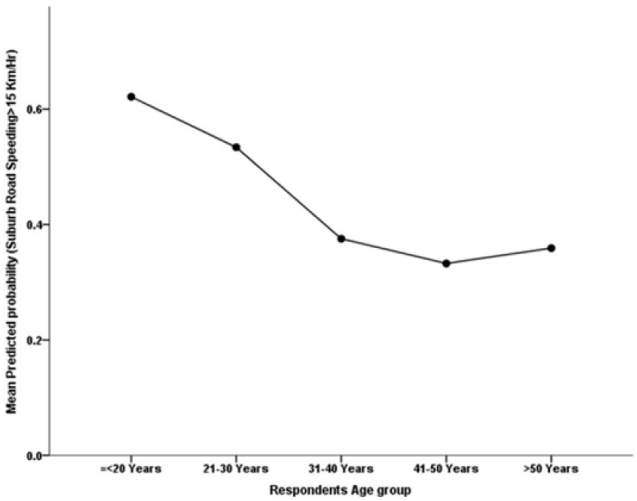

Fig. 4 Relationship between mean predicted probability of sub speeding above 15 km/h and respondents' age group

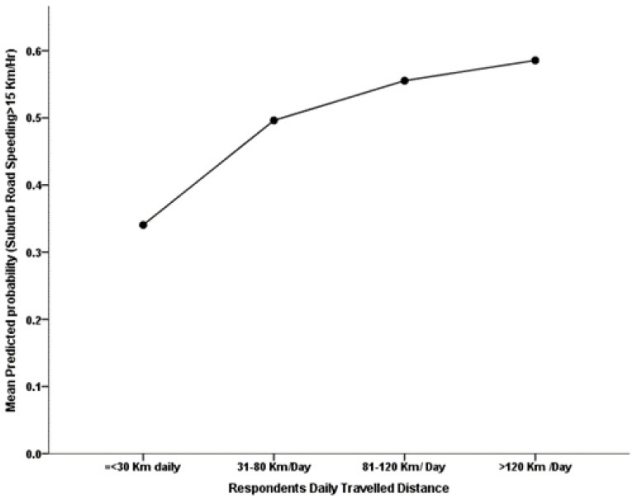

Fig. 5 The relationship between mean predicted probability of highway speeding above 15 km/h and respondents' daily travelled distance

on their odds of having had speeded above residential road speed limits while driving, $p > 0.05$, when controlling for the other variables in the model. Otherwise, people's daily travelled distances (km) converged significantly on their odds of having had speeded above street speed limits within suburbs of the city, $p < 0.001$, as shown in Fig. 5, people's odds of speeding on suburb roads rises by 1.27 times more as their travelled distance rises between less than thirty kilometers per day to higher levels of daily travel, indicating that as people's travelled distance per day tended to rise their odds of speeding on residential roads rised significantly also on average, by considering the other variables as accounted for.

Furthermore, people's habits of checking the road condition before driving and being patient with other road drivers did not coverage significantly on their odds of speeding on city suburb roads, $p > 0.05$. However, people's speeding on highways predicted significantly greater odds (OR = 6.95 times more) of speeding on residential roads with speed above or equal to 15 km/h over the speed limits of those roads, $p < 0.001$, suggesting that speeding drivers on residential roads are significantly greater speeders on highways too. Also, the analysis model suggested that people's speeding behavior score correlated significantly with greater odds of speeding on suburb roads, for each additional unit in their perceived speeding behavior score the odds of their exceeding residential road speed limits rises significantly, $p = 0.002$ by a factor equal to 1.47 times more, i.e. (rises by 47% times) on average and by accounting for the other predictor independent variables in the model. From the other hand, people's perceived driving law-abiding attitudes converged significantly and negatively with their odds of speeding on suburb roads above specified limits, $p = 0.006$, for each additional rise in people's perceived driving law abiding attitudes their odds of exceeding the residential road speed limits declines by 30.2% times on average, by controlling the other factors and covariates in the analysis model. Interestingly as well, people's perceived attitudes toward reckless driving did not converge significantly with their reported odds of speed driving on residential roads greater than specified, $p = 0.287$, suggesting that those who perceived themselves as in favor of reckless driving tended to not speed above speed limits on residential roads, but probably they're more significantly inclined to speed above limits on highways as found in earlier model explaining speeding on highways, as referred to in Table 8. The analysis model suggested that people's patience with other drivers on the road and their habit of checking road condition did not correlate significantly with their odds of fast driving on residential roads above the road speed limits, $p > 0.001$.

The meaning of the items in Table 8 are:

- Item 1: Gender = Male;
- Item 2: Age > 30 years;
- Item 3: Educational level;
- Item 4: Vehicle engine size in CC;
- Item 5: Daily travelled distance;
- Item 6: Competing behavior = Other bypass me;
- Item 7: Competing behavior = Dual bypassing;
- Item 8: Competing behavior = I bypasses others;
- Item 9: How many times you exceeded speed limit with 20 km/h on highways?
- Item 10: How often do you check traffic jam conditions before travelling?

- Item 11: How often do you practice patience while driving and change lane?
- Item 12: Speed driving behavior self-rating (1–5) score;
- Item 13: Driving law abiding attitude (1–5) score;
- Item 14: Reckless driving attitude (1–5) score.

6 Conclusions and recommendations

In order to achieve the study objectives, data were collected using a pre-designed questionnaire with a total of 1,049 responses. The collected data was subjected to a comprehensive statistical analysis. Based on the outcome of the study, its conclusions may be summarized as follows:

1. Factor analysis was carried out to explore the driving attitudes and speeding behavior items and confirmed their dimensionality. Results explored three dimensions; two dimensions of driver attitudes measures; i.e. reckless driving and law abiding with one-dimension driver behavior measure, namely speedy driving.
2. The results of Pearson's correlations test showed the following main findings:
   - Drivers with greater reckless driving attitudes tended to report greater vigorous and speedy driving behaviors.
   - Drivers with greater law-abiding driving attitudes reported less violation to speed limits.
   - Drivers who over-ride the speed limits on residential roads tend to incrementally over ride highway speed limits.
3. Bivariate analysis results revealed a generally significant association between the speed behavior and demographic characteristic and other driving practices. Further findings of the same analysis may be summarized as follows:
   - Males were more likely to exceed speed limits on highways than females, and older drivers in general were less inclined to exceed the road speed limits than younger drivers.
   - Drivers with a Bachelor degree were significantly more inclined to exceed the speed limits than other educational groups.
   - Drivers who travelled between (31–80 km/day) were significantly more inclined to speed past the road speed limit.
   - Speeding drivers on highways scored higher speeding on residential roads too.
4. The results of the multivariate logistic regression analysis and the developed model revealed the following:
   - Male respondents were significantly more inclined to override the road speed limit than females.
   - Drivers aged above thirty years were significantly less inclined than drivers aged below thirty years.
   - Drivers who exceed the residential roads' speed limit more significantly expected to bypass the highway road speed limit.
   - Speeding behavior score correlated significantly with bypassing the roadway speed limit.
   - Drivers who perceived themselves as in favor of reckless driving tended to not speed above speed limits on residential roads, but probably they are more significantly inclined to speed above limits on highways.
   - The analysis model indicated the drivers' (educational level, vehicle engine size, daily travelled distance, competitive driving, patience with other drivers, checking road jam and law-abiding attitudes) did not converge significantly on their odds of speeding above road speed limit.

Based on the results of the study, the following specific potential measures are recommended for reducing the incidence of speeding on Jordanian roads:

- Introduce multi-session "classroom" speed awareness courses to a targeted audience of repeat and/or dangerous speeders while increasing public awareness and education campaigns.
- Apply "automatic enforcement" at random locations with either fixed or truck-mounted cameras and issue tickets by mail. This is coupled with broader application of speed cameras, increased levels of police presence, introducing the idea of speed traps, with increased penalties for habitual (repeat)speeders.
- Apply different types of engineering countermeasures such as rumble/vibration treatments and traffic calming techniques such as chicanes especially in residential areas.
- Proper land use and transportation planning that ensures uniform speed through the entire road network.
- Start moving towards intelligent transportation system ITS) in controlling speed.

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