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An investigation of the effects of Motorcycle-Riding Experience on Aberrant Driving Behaviors and Road Traffic Accidents-A Case study of Pakistan

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Abstract: This study investigates the effects of motorcycle-riding experience on aberrant driving behaviors and road traffic accidents (RTAs). Pakistan is one of the countries where motorcycle usage is very high. It can be supposed that the aberrant riding behaviors (improper U-turn, wrong overtaking, stopping anywhere on the road, etc.) while riding a motorcycle might be memorized when motorcycle rider switch to vehicle driving, which ultimately cause RTAs. A self-reported web-based questionnaire survey was conducted in Pakistan, and 396 valid responses were received. The 23-item Driver Behavior Questionnaire (DBQ) was designed to measure aberrant driving behaviors. Proportional Odds (PO) model and binary logistic regression model were employed to examine the effects of motorcycle-riding experience on aberrant driving behaviors and RTAs, respectively. Principal component analysis with varimax rotation confirmed a three-factor solution of aberrant driving behaviors of Pakistani drivers; self-willed violations/errors, distracted violations, and risky violations/errors. Distracted violations were found to be significantly influenced by motorcycle-riding experience. In addition to this, some demographic and socio-economic variables were attributable to aberrant driving behaviors. Surprisingly, no direct relationship was found between motorcycle-riding experience and RTAs. However, a significant association was evident between distracted violations and RTAs. A one-unit increase in distracted violations increased the probability of being involved in RTA by 54%. These results offer a new connection of aberrant driving behaviors to motorcycle use that could be valuable for RTAs reduction.

Keywords: Road traffic accidents; aberrant driving behavior; Driver Behavior Questionnaire; Pakistani drivers; motorcycle-riding experience.

1. Introduction

There is a consensus that safe mobility is a fundamental human right [1]. However, with the increase in urbanization and globalization, safe mobility on road traffic has become a significant concern throughout the world. Failure in safe mobility on road traffic can lead to road traffic accidents (RTAs), which are considered as the leading cause of injuries, disabilities, and fatalities of people. Along with physical damages, RTAs may bring emotional and financial instability in an individual's life. According to the World Health Organization (WHO), RTAs are currently ranked ninth among the various causes of deaths across all age groups and are estimated to reach the seventh position by 2030 [2]. According to a global status report on road safety, the number of fatalities due to RTAs raised to 1.35 million in 2016 [3]. Of all these fatalities, 90% fatalities occur in low and middle-income countries [4]. The global status report on road safety further illustrates that the fatality rate due to RTAs is 14.2 (per 100,000 populations) in Pakistan, whereas in the United Kingdom (UK), it is 3.1 [3]. The number of motor vehicles in the United Kingdom is 18 times higher as compared to Pakistan, but the rate of RTAs within Pakistan is alarmingly high as compared to the UK Human factors (drivers) have been estimated to be a sole or leading causal factor in approximately 90% of RTAs [5]. The driver's behavior (what the driver chooses to do) has a more significant influence on RTAs as compared to driver performance (what a driver can do) [6]. The driver's behavior, which tends to deviate from the safe driving leads towards aberrant driving behavior.

For the last few decades, aberrant driving behavior has attained significant research attention to understand the phenomenon behind RTAs. For the first time, in the United Kingdom, three aberrant driving behaviors; violations, errors, and lapses were investigated among 520 drivers by using 50-item DBQ [7]. Among three aberrant driving behaviors, violations (deliberate infringement of socially accepted code of behavior) are most

crucial that cause risk to drivers himself as well as other drivers [8]. Later, it was found that the original violations could be divided into ordinary violations (deliberate deviations from highway code) and interpersonally aggressive violations (containing an interpersonally aggressive component) [9]. Another crucial aberrant driving behavior is an error (an act or condition of ignorant or imprudent deviation from a code of behavior). Many studies investigated the relationship between demographic and socio-economic variables aberrant driving behavior and RTAs involvement [10, 11]. Globally, it has been well-documented that DBQ is a well-accepted tool to assess driving behaviors [12, 13]. For the last two decades, DBQ has been updated, modified, or even adapted for a variety of traffic cultures and different populations [12-14]. A comprehensive literature review indicates that most of the research regarding aberrant driving behaviors had been conducted in developed countries [12, 14]. As a result, the number of injuries, as well as the fatality rate, has declined over the years due to vibrant safety culture as well as successful law implementation. In contrary to developed countries, the rate of RTAs with fatal consequences is alarmingly high in developing countries [15]. The primary reason is a lack of research culture along with weak law enforcement policies. Therefore, it is not feasible to transfer the research findings of developed countries to developing countries because of considerable differences in traffic conditions, driving behaviors, road conditions, law enforcement strategies, socio-economic levels, and attitudes of road users.

Pakistan, along with several developing countries, has witnessed unprecedented motorization and urbanization in recent years. The continuous ill-planned road infrastructure development, along with the lack of government concerns, has aggravated the situation. Currently, there is very little information available within Pakistan regarding the driver's behavior except for the study [16], which was just focused on violations. The study concluded that drivers in Pakistan are usually involved in aggressive, unlawful, risky, and egoistic driving patterns [16]. Furthermore, Pakistani drivers are involved in driving without proper driving training and driving license, which ultimately leads to aberrant driving behaviors and RTAs [17]. The most frequently occurring aberrant driving behaviors of Pakistani drivers are deliberate encroachment of traffic laws, over-speeding, rude gestures with cursing, physically and mentally incapacitated driving under the intoxicating drugs, and driving without a license [18].

Generally, within Pakistan, the motorcycle is considered as the common mode of transportation. Overall in the world, Pakistan is ranked at fifth position with 35% motorcycle usage, following Vietnam (79%), Indonesia (67%), Taiwan (48%), and India (40%) [19]. Motorcycle riders are responsible for a significant number of RTAs in Pakistan. In 2014, Karachi, Pakistan, 30,274 injuries were reported in RTAs in which 25,855 injuries were caused by motorcycles, and among them, 565 were fatal [20]. In the case of Pakistan, motorcycle riders extensively indulge in aberrant riding behaviors due to weak law enforcement policies and lack of awareness about the safety regulations. Certain aspects of aberrant riding behaviors of motorcycle riders have some relevance with the aberrant driving behaviors of vehicle drivers such as speeding, running red lights, recklessly over-taking, using any direction on the service road, most substantial accessibility on a highway anywhere and anytime, improper U-turn, giving way and stopping anywhere on the road. These above-mentioned traffic-related behaviors opted by motorcycle riders cause self-willed pattern designed in their minds and might be memorized when they switch from motorcycle-riding to vehicle driving. Besides, there are no separate lanes for motorcycle riders on urban highways in major cities of Pakistan. Therefore, motorcycle riders behave violently by merging into any lanes, unnecessary honking, and cutting-in vehicle to force it to leave. Consequently, these drivers having previous motorcycle-riding experience can cause serious concerns and create risky situations for themselves as well as other road users. Hence, identification of the effects of motorcycle-riding experience on aberrant driving behaviors and RTAs involvement of general vehicle driving population when driving a vehicle themselves is interesting to focus on countries having high motorcycle usage.

The literature shows a handful of studies that examined the effects of driving experience on aberrant driving behaviors and identified potential risk factors contributing to RTAs. However, there is no study found in the literature in which the effects of motorcycle-riding experience on aberrant driving behaviors and RTAs in vehicle driving is investigated. To the best of our knowledge, this study is among the first in its nature. Furthermore, there is a genuine need to study aberrant driving behaviors among Pakistani drivers by focusing on both violations and errors. However, the previous study conducted in Pakistan [16] was just based on violations. To accomplish the aim, as mentioned above, we conducted a web-based questionnaire survey in Pakistan to assess demographic and socio-economic characteristics, motorcycle-riding experience, and aberrant driving behaviors. The 23-item DBQ was devised to measure aberrant driving behaviors. Principal component analysis with varimax rotation was conducted to reveal the factors structure (aberrant driving behaviors) among Pakistani drivers. PO model and binary logistic regression model were employed to investigate the effects of motorcycle-riding experience on aberrant driving behaviors and RTAs.

2. Methodology

2.1. Procedure and respondents

The data collection was carried out from February to March 2018 in Pakistan using a web-based self-completion questionnaire survey. It was ensured that the sample must include all age group drivers, both male and female drivers, public transport drivers, and the drivers with high education levels (having graduate or Ph.D. level). It was also ensured that the sample must represent the whole range of all socio-economic and geographic background that exists within the country. The questionnaire was created using a *google form* and sent to different automobile companies (Suzuki, Toyota, Hyundai, Honda) and online forums. In order to get reliable data, e-mail invitations having the survey link were also sent to acquaintances and were requested to take part in the survey. Drivers (respondents) were provided with the option to navigate back/forth of the survey. It was ensured to the drivers that this data would be used only for research purposes. In the above-mentioned time, 409 drivers completed the questionnaire survey. Data screening and filtration were carried out to remove ambiguous data based on two criteria; firstly, missing data in rows (any case having more than 10% questions with blank responses was removed from the dataset), and secondly, unengaged responses (if a driver answered "Never" or "Always" on each question, his/her questionnaire was removed from the dataset). After data screening and filtration, 13 cases were removed, and finally, 396 responses were retained for further analysis.

2.2. Questionnaire structure

The questionnaire is structured into four sections; demographic and socio-economic measures, inquiry about motorcycle-riding experience, the DBQ for the measurement of aberrant driving behaviors, and self-reported RTAs.

2.2.1. Demographic and socio-economic characteristics

This section included items about demographics and socio-economic characteristics of drivers. All variables were measured as categorical variables. Driver's gender (Male=1, Female=2), marital status (Single=1, Married=2), age in years (18-24=1, 25-32=2, 33-39=3, 40-49=4, 50-60=5, 60+=6), education level (Up to Secondary School Certificate (SSC)=1, Undergraduate level=2, Graduate level=3, Ph.D. level=4), and average annual income (Unemployed=1, Less than average annual income=2, Equal to average annual income=3, More than average annual income=4) were recorded in the first section of questionnaire. It is worth mentioning that the average annual income mentioned in the questionnaire was 300,000 Pakistani Rupee/ approximately US$ 2300 (suggested by the expert group).

2.2.2. Motorcycle-riding experience

In this section, drivers were enquired about the motorcycle-riding experience in a number of years (No experience=1, 1-3 years=2, 4-8 years=3, 9-14 years=4, 15-20 years=5, above 20 years=6).

2.2.3. The Driver Behavior Questionnaire (DBQ)

In this study, DBQ was designed based on a preliminary study and pilot study with the help of an expert group. Initially, twenty-five items were incorporated in DBQ, in which seventeen items were from the three previous versions of DBQ [7, 10, 16]. The remaining new eight items were derived from a preliminary study based on road safety issues in the country conducted under the supervision of an expert group. These eight new items were in accordance with the social and cultural characteristics of the Pakistani driving context. Expert group included professors of the transportation engineering department from public sector universities in Pakistan, government officials of National Highway Authority [21], general car drivers, motorcycle riders, and public transport drivers. Based on the opinions of the expert group and keeping in mind the typical driving behaviors of Pakistani drivers, newly designed items were incorporated in DBQ. The new DBQ provides the item's relevance to the motorcycle-riding experience. Motorcycle riders within the expert group validated all the items. Our investigations were only focused on violations and errors as these aberrant driving behaviors are directly related to RTAs [8, 22].

To provide a clear understanding of the public and obtain a useful DBQ, we conducted a pilot study in order to remove ambiguous items from DBQ. A group of ten people (professors, transportation officials, local experience drivers, motorcycle riders, and students) were recruited for the pilot study. After a careful pilot study, two more items were removed from the eight newly developed items which do not directly relate to motorcycle-riding. Finally, the 23-items DBQ was developed, which sought to measure aberrant driving behaviors.

To eliminate any chance of confusion or error, we recruited a group of thirty participants (students, vehicle drivers, motorcycle riders) on a trial basis and requested them to complete the questionnaire. No complaint was received at that time. Therefore, after a trial run, the link was opened for the public. Drivers were required to respond, how often they committed each of the twenty-three driving behaviors while driving vehicles, and report on a 5-point Likert scale (1= never, 2= hardly ever, 3= often, 4= frequently, 5= nearly all the times). The high score on any item indicates high aberrant driving behaviors/risk-loving behaviors and vice versa.

2.2.4. Self-reported RTAs

Drivers were required to respond the history of RTAs in the last three years. A substantial debate can be found in the literature that DBQ has been used as a predictor of RTAs, but there are different opinions of researchers on its predictive ability. The relation between DBQ responses and RTAs is an artifact of common method variance and social interest biases [23]. It was also demonstrated that the self-report of RTAs involvement history could be the systematic bias that may alter the correlations between driving behaviors and RTAs involvement. In order to reduce inadequacies and complications arise due to the above-mentioned conflicts, we modified the question and made it more simple: have you ever involved in RTAs in the last three years or not? The response was then recoded into a dichotomous variable (No=0, Yes=1) for subsequent analysis. The high proportion of drivers involved in RTAs in the previous year depicts the road safety concerns of Pakistani drivers.

2.3. Statistical Analysis

The validity of the questionnaire is an essential requirement to achieve reliable statistical results. Kaiser-Meyer-Olkin (KMO) and Barlett's test of sphericity are used to determine the validity of the data. The valid value of KMO (0.798) and the significant result of Bartlett's test of sphericity revealed that the data is suitable for principal component analysis. To determine the dimensional structure of the sample, principal component analysis with varimax rotation and number of iterations were employed on the newly designed 23-items DBQ data. Factor loadings less than 0.4 were omitted to retain factors. All extraction communalities were restricted to greater than 0.5 [24]. Eigenvalue greater than 1 (Kaiser rule) [25], and Scree cut-off points [26] rules were followed to retain the number of factors. The analysis generated a six-factor solution through the Kaiser rule. An inspection of the scree plot revealed a clear break after the third factor. Finally, a three-factor solution was retained from scree cut-off points that provide a vivid picture of aberrant driving behaviors among Pakistani drivers. Cronbach's alpha was calculated to investigate the internal consistency and reliability of the scale. Spearman bivariate correlation analysis was conducted to explore the correlations among motorcycle-riding experience, demographic and socio-economic variables, and aberrant driving behaviors. In this study, all the variables are categorical; therefore, the PO model is used to investigate the influence of motorcycle-riding experience on aberrant driving behaviors. In the PO model, aberrant driving behaviors are introduced as dependent variables (DVs), whereas motorcycle-riding experience, as well as demographic and socio-economic variables, were used as independent variables (IVs). DVs and IVs were introduced in the PO model in two different layers to investigate the effect of motorcycle-riding experience on aberrant driving behaviors. In the first layer, only the motorcycle-riding experience was introduced in the PO model as IV to predict the DVs. The basic idea for incorporating motorcycle-riding experience into the model separately to investigate the sole contribution of motorcycle-riding experience, without the influence of demographic and socio-economic variables on aberrant driving behaviors (DVs). In the second layer, all IVs (motorcycle-riding experience as well as demographic and socio-economic variables) were introduced simultaneously to conclude the influence of these IVs on DVs. Lastly, binary logistic regression was employed to investigate the effects of motorcycle-riding experience and aberrant driving behaviors on RTAs. All the statistical analysis is carried out using SPSS 25.0.

3. Results

3.1. Characteristics of the sample

The univariate descriptive analysis was performed to depict characteristics of the sample, which indicated several prominent demographic and socio-economic as well as behavioral characteristics of Pakistani drivers (Table 1). The results show that the majority of drivers were male (80.6%), and a little proportion was female (19.4%). However, according to census data of Pakistan, the proportion of the male and female population is 51.23% versus 48.77% [27]. This variation in the sample might be attributed to the fact that females are very less in number as compared to males. The age of most of the drivers (82.3%) in our sample lay in the range of 18-32 years. The sample was dominated by a majority of drivers having undergraduate education level (67.7%).

However, overall, people having undergraduate education within Pakistan is only 28.64%, according to the census data of Pakistan [27]. This might be attributed to survey hosting facilities, which favors only highly educated people. More than 70% of drivers reported that they are either unemployed or getting less income as compared to average annual income. Furthermore, the results also indicated that 61.4% of drivers were having past motorcycle-riding experience. Public transport drivers are inadequately educated in Pakistan and mostly unaware of the internet, so it was not possible to expect a large population of public transport drivers in our sample. Overall, the sample is dominated by young unmarried male drivers having age between 18 to 39 years with education level up to undergraduate.

Table 1. Sample composition by various characteristics

Variables	Categories	Percentages (%)
Age groups (Number of years)	>60	2.3
	50-60	2.3
	40-49	3.5
	33-39	9.8
	25-32	36.6
	18-24	45.5
Education level	PhD	6.1
	Graduate	23.5
	Undergraduate	67.7
	Under SSC	2.8
Marital status	Married	35.4
	Unmarried/ Single	64.6
Average annual income	More than the average annual income	8.3
	Equal to the average annual income	20.7
	Less than the average annual income	51.3
	Unemployed	19.7
Motorcycle-riding experience (Number of years)	>20	2.8
	15-20	5.1
	9-14	14.9
	4-8	25.3
	1-3	13.4
	No experience	38.6

3.2. Aberrant driving behaviors

In this study, the three-factor solution provides a vivid picture of the aberrant driving behaviors among Pakistani drivers (Table 2). Each factor was given a name that reflects the dominating contributing items to this behavior.

The first factor was “self-willed violations/errors” which contains five items and accounts 12.534% variance with moderate internal consistency. Items with the highest loading within this factor were a mixture of violations and errors. Only one item; “drive with only 'half-an-eye' on the road while looking at a map, changing a cassette” within this factor came from the Manchester DBQ [7], and the remaining four items were from the previous study conducted in China [10]. These items consist of high-risk violations and affected by self-willingness, along with errors.

The second new factor, “distracted violations” contains five violations items. One item within this factor came from the previous DBQ conducted in Pakistan [16]. The other four items were from our newly designed items, which were in accordance with the local Pakistani cultural environment. These items were incorporated in the current DBQ from a preliminary study in which interviewees suggested that these are the most common behaviors observed in Pakistan such as, “distraction in driving by using the phone” and “distraction in driving while talk with other passengers” and “distraction in driving while drinking water.” This factor accounts for 11.992% of the variance and with moderate internal consistency. Due to high loading (0.624) of the item, i.e., “how often do you use a status profile or personal connection to get rid of fines, penalties,” falls in distracted violations. Other, all items in this factor were violations caused by distraction.

The third factor, “risky violations/errors” have 8.928% of the variance with moderate internal consistency. Within this factor, three items were extracted, and most were violations that cause risk to the driver himself as

well as for other drivers. This factor includes items from Manchester DBQ [7], which consists of violations and errors involving risk to some extent. Self-willed violations/errors and risky violations/errors look similar, containing a combination of violations and errors, but the severity of risk could be the differentiating aspect between these two.

Table 2. Factor analysis and reliability analysis of DBQ items

Extracted Factors	Item No	Factor1 α=.679	Factor 2 α=.643	Factor 3 α=.501
Self-willed violations/errors	10**. Drive fast when in a bad mood.	.748		
	8**. Drive fast to pass a yellow light turning to red	.596		
	9** Distracted, misjudge interval and narrowly miss collision	.593		
	11** Fail to notice a pedestrian crossings	.563		
	4* Drive with "half-an-eye" on the road while looking at a map, changing a cassette, or radio channel.	.475		
Distracted violations	19**** Get distracted when using a mobile phone while driving?		.658	
	18****. Get distracted when drinking water while driving		.652	
	16*** Use status profile or personal connection to get rid of fines, penalties,		.624	
	20**** Get distracted when talking with passengers while driving		.573	
	21****. Forget to apply hand brake when parking the vehicle.		.501	
Risky violations/errors	3*. Take a chance and cross on lights that have turned left.			.762
	5*. Deliberately disregard the speed limit late at night or very early in the morning.			.531
	2*. Lost in thought and forget that lights are full beams until flashed by other motorists.			.505

(Extraction method: Varimax, Principal Components Analysis), Rotation converged in 6 iterations. (*) Items from [7], (**) items from [10], (***) items from [16], (****) newly inducted items designed in this study.

3.3. Spearman correlations between DBQ factors and study's variables

Spearman's bivariate correlation coefficients showed that self-willed violations/errors (r (396) = .754, p >.01), distracted violations (r (396) = .735, p >.01), and risky violations/errors (r (396) = .634, p >.01) were significantly associated with the total DBQ score. Higher-income was associated with less reported distracted violations (r (396) = -.143, p >.01) and less risky violations/errors (r (396) = -.165, p >.01). Single/ unmarried drivers were more likely to report distracted violations (r (396) = .175, p >.01) and risky violations/errors (r (396) = .153, p >.01) than married drivers. Males were more likely to report distracted violations as compared to female (r (396) = .194, p >.01). Drivers having high education level were reported less self-willed violations/errors (r (396) = -.175, p >.01), distracted violations (r (396) = -.108, p >.05), and risky violations/errors (r (396) = -.144, p >.01). The significant correlations among all scales shows that the new DBQ has a good content validity. In this study, no multiple correlations with sufficient magnitude (> 0.7) are achieved which has the potential to affect regression estimates adversely. This advocates that there is no collinearity issue in this sample.

Table 3. Spearman's bivariate correlation analysis between DBQ factors and study's variables[a]

Variables	1	2	3	4	5	6	7	8	9
1. Self-willed violations/errors	_								
2. Distracted violations	.377**	_							
3. Risky violations/errors	.445**	.351**	_						
4. DBQ score	.754**	.735**	.634**	_					
5. Income	-.085	-.143**	-.165**	-.155**	_				
6. Marital status	.028	.175**	.153**	.178*	-.433*	_			
7. Gender	.021	.194**	-.024	.075	-.053	.016	_		
8. Education	-.175**	-.108**	-.144**	-.154	.698**	-.338**	-.070	._	
9. Motorcycle-riding experience	.035	-.157**	.004	-.075	.025	-.135**	.150**	.049	_

*Correlation is significant at 0.05 level (1-tailed)

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

[a]Variables used in this study, such as demographic and socio-economic variables and motorcycle-riding experience.

3.4. Predictors of aberrant driving behavior by PO model

In this section, the PO model was employed to quantitatively explore the effects of motorcycle-riding experience and demographics as well as socio-economic variables in causing aberrant driving behaviors. PO model is commonly named as a cumulative odds model [28], which is used for the analysis of categorical data in the regression analysis. In the PO model, each of the three extracted aberrant driving behaviors (DBQ dimensions) was predicted by motorcycle-riding experience as well as different demographic and socio-economic variables. Table 4 portrays the variables involved in the PO model and the nature of these variables.

Table 4. Variables involved in model

Variable Name	DV/IV	Valid Range	Variable type
Self-willed violations/errors	DV	Never, Hardly ever, Often, Frequently, Nearly all the time	Ordinal
Distracted violations	DV	Never, Hardly ever, Often, Frequently, Nearly all the time	Ordinal
Risky violations/errors	DV	Never, Hardly ever, Often, Frequently, Nearly all the time	Ordinal
Gender	IV	Male, Female	Nominal
Marital status	IV	Single, Married	Nominal
Education	IV	Up to Secondary School Certificate (SSC), Undergraduate level, Graduate level, Ph.D. level	Ordinal
Age (Number of years)	IV	<18, 18-24, 25-32, 33-39, 40-49, 50-60, >60	Ordinal
Income	IV	Unemployed, Less than average annual income, Equal to average annual income, higher than the average annual income	Ordinal
Motorcycle-riding experience	IV	No exp, 1-3, 4-8, 9-14, 15-20, +20	Ordinal

3.4.1. Layer-1: Prediction of aberrant driving behaviors (DVs) based on motorcycle-riding experience (IV):

To facilitate interpretation, we reported only significant results in this section. Table 5 presents the results of fitting the PO model accounting for motorcycle-riding experience predicting aberrant driving behaviors. It is revealed that motorcycle-riding experience had a significant effect on distracted violations (Model X^2=20.083, p<0.01). Drivers having no motorcycle-riding experience (β=2.571, OR=13.07, p<.01) were found to be more involved in distracted violations as compared to drivers with motorcycle-riding experience over 20 years. Drivers having experience of 1-3 years in motorcycle-riding (β=1.734, OR=5.66, p<.01) are also more involved in distracted violations as compared to drivers with motorcycle-riding experience over 20 years. By comparing the drivers having no or little motorcycle-riding experience, the results showed that drivers without motorcycle-riding experience were more likely to commit distracted violations as compared to drivers having less riding experience. However, as the driver getting more experience in motorcycle-riding, the distracted violation increases. The results further reveal that motorcycle-riding experience is not found to be a significant predictor of self-willed violations/errors and risky violations/errors.

Table 5. Prediction of aberrant driving behaviors based on the motorcycle-riding experience (years)

Variable	B	SE.	Wald	p	OR.	95% C.I	
						Lower bound	Upper bound
Self-willed violations/errors			Not significant				
Distracted violations			Chi-square= 20.083, p<0.01				
Motorcycle-riding experience (No experience)	2.571	.633	16.502	.000	13.07	1.330	3.811
Motorcycle-riding experience (1-3)	1.734	.667	6.749	.009	5.66	.426	3.042
Motorcycle-riding experience (4-8)	2.011	.640	9.887	.002	7.47	.758	3.265
Motorcycle-riding experience (9-14)	2.050	.664	9.547	.002	7.76	.750	3.351
Motorcycle-riding experience (15-20)	2.403	.762	9.935	.002	11.05	.909	3.897
Motorcycle-riding experience (+ 20)	0[a]						
Risky violations/errors			Not significant				

a= this parameter is set to zero because it is redundant, O.R= Odds ratio, C.I.= confidence interval.

3.4.2. Layer 2: Prediction of aberrant driving behaviors (DVs) based on motorcycle-riding experience as well as demographic and socio-economic variables (IVs):

In layer 2, the PO model was employed against each of the DVs, i.e., self-willed violations/errors, distracted violations, and risky violations/errors. It is found that the PO model could not reach significant values when self-willed violations/errors were introduced as DVs, and motorcycle-riding experience, as well as demographic and socio-economic variables, were introduced as IVs.

Table 6 presents the results of the PO model employed against distracted violations (DV) and all other DVs (Model X^2=47.039, p<0.01). These results are in line with the results obtained from the first layer of the PO model in which the same pattern of distracted violations was examined. The result might be biased due to small proportions of drivers having motorcycle-riding experience for more than 20 years (2.8%). The results reveal that males are less involved in distracted violations as compared to females (β=-.631, OR=0.53, p<.05). In addition to that, the results of the model portray that married drivers are less involved in distracted violations as compared to single/unmarried drivers (β=-.564, OR=0.56, p<.05). Drivers having age (25-32) years are more likely to be involved in distracted violations as compared to other drivers.

Table 6. Predictors of distracted violations

Variable	B	SE.	Wald	P	OR.	95% C.I	
						Lower bound	Upper bound
Distracted violations			Chi-square= 47.039, p=.000				
Motorcycle-riding experience (No experience)	2.347	.710	10.938	.001	10.45	.956	3.738
Motorcycle-riding experience (1-3)	1.513	.742	4.180	.041	4.54	.059	2.966
Motorcycle-riding experience (4-8)	1.892	.714	7.019	.008	6.63	.492	3.291
Motorcycle-riding experience (9-14)	1.951	.733	7.082	.008	7.03	.514	3.387
Motorcycle-riding experience (15-20)	2.443	..832	8.614	.003	11.50	.892	4.075
Motorcycle-riding experience (+ 20)	0[a]						
Gender (Male)	-.631	.281	5.035	.025	0.53	-1.183	-.080
Gender (Female)	0[a]						
Marital status (Married)	-.564	.287	3.856	.05	0.56	-1.127	-.001
Marital status (Single)	0[a]						
Age (25-32)	-1.514	.71	4.463	.035	0.22	-2.198	-.109
Age (33-39)	-1.855	.777	5.701	.017	0.15	-3.378	-.332
Age (50-60)	-2.755	1.006	7.499	.006	0.06	-4.728	-.783
Age (+60)	0[a]						

a= this parameter is set to zero because it is redundant, O.R= Odds ratio, C.I= confidence interval.

Table 7 presents the results of the PO model employed between risky violations/errors (DV) and all IVs (Model X^2=32.120, p<0.01). Income was found to be the only significant predictor of risky violations/errors.

Unemployed drivers (β=1.224, OR=3.40, p<.05) are found to be more involved in risky violations/errors than drivers having more than the average annual income. On the other hand, drivers with a higher income show less risky violations/errors. However, results in the PO model could not reach reached significant values with motorcycle-riding experience and other demographic and socio-economic variables like gender, marital status, and education level.

Table 7. Predictors of risky violations/errors

Variable	B	SE.	Wald	P	OR.	95% C.I	
						Lower bound	Upper bound
Risky violations/errors	Chi-square= 32.120, p<0.05						
Income (Unemployed)	1.224	.564	4.711	.030	3.40	.119	2.329
Income (Equal to the average annual income)	1.026	.497	4.266	.039	2.78	.052	2.000
Income (More than the average annual income)	0[a]						

a= this parameter is set to zero because it is redundant, O.R= Odds ratio, C.I= confidence interval.

3.5. Predictors of self-reported RTAs by the binary logistic regression model

The theme of this section is to explore the effects of motorcycle-riding experience and aberrant driving behaviors on the self-reported RTAs. The effect of demographic and socio-economic variables on self-reported RTAs is also investigated. For this purpose, drivers in this sample are divided into two different categories; one with drivers who were involved in RTAs in the last three years and others who were never involved in RTAs in the last three years. A binary logistic regression model is applied to the sample by inserting involved and not involved in RTAs as DVs and aberrant driving behaviors as IVs. DVs coding in the binary logistic regression model is no=0 and yes=1.

In stage 1 of the binary logistic regression model, the aberrant driving behaviors are put together to quantify the impact on RTAs involvement (Table 8). Distracted violations have a significant result of <.01, which demonstrates that this aberrant driving behavior is the predictor of RTAs. The results reveal that distracted violations have a significant relationship with RTAs involvement (Table 8). In stage 2, all demographic and socio-economic variables, including aberrant driving behaviors were introduced as IVs (Table 8). It was found that income and distracted violations had a significant effect on RTAs involvement. A one-unit increase in income decreased the probability of being involved in RTA by 71%. However, a one-unit increase in distracted violations increased the probability of being involved in RTA by 54%.

Table 8. Predictors of self-reported RTAs (Criterion= RTAs) (Predictor= all variables)

Variable	B	SE.	Wald	p	EXP(B)
RTAs involvement(criterion)	-.809	.109	55.262	.000	.445
Predictors= Aberrant driving behaviors	Nagelkerke R^2= .026, Model Chi-square=7.401, df=3, sig<.01				
Self-willed violations/errors	Not significant				
Distracted violations	.381	.192	3.593	.047	1.463
Risky violations/errors	Not significant				
Predictors= Aberrant driving behaviors and demographic and socioeconomic characteristics	Nagelkerke R^2= .137, Model Chi-square=40.478, df=9, sig<.01				
Income	-.709	.210	11.377	.001	.498
Distracted violations	.534	.212	6.341	.012	1.706

4. Discussions and Conclusions

The current study aimed to investigate the effects of motorcycle-riding experience on aberrant driving behaviors (through the identified DBQ factors) and RTAs among Pakistani drivers. A substantial increase in RTAs involvement of drivers having previous motorcycle-riding experience in the past is the motivation behind this study. When these drivers start vehicle driving, the aberrant riding behaviors (due to past motorcycle-riding experience) already perceived in their mind resulted in aberrant driving behaviors. A potential explanation for such behaviors could be the aberrant riding behaviors of motorcycle riders such as speeding, running red lights, riding on the wrong side of the road, recklessly overtaking, and riding on sidewalks. This study concludes that drivers who had motorcycle-riding experience are found to be involved in aberrant driving behaviors. However,

no direct effect of motorcycle-riding experience on RTA was noticed in this study. There are many studies found in the literature which conclude driving experience as a significant predictor of aberrant driving behaviors [14]. However, we are not familiar with any study in which the effects of motorcycle-riding experience on aberrant driving behaviors of vehicle driving is examined. Therefore, this study is among the first to examine this effect.

The aberrant driving behaviors of Pakistani drivers are also identified in this sample. The study explored a three-factor solution of aberrant driving behaviors; self-willed violations/errors, distracted violation, and risky violations/errors. This study is not in line with some studies in which a four-factor solution [29, 30], five-factor solution [10], and a six-factor solution [31] were explored. However, this study is in accordance with the previously conducted studies in which authors concluded a three-factor solution [7, 8, 22, 32] of aberrant driving behaviors. A high percentage of variations enlightened by the three-factor solution supports the use of the DBQ, which can be used as a measure of aberrant driving behaviors of Pakistani drivers. This study is the continuation of the previous research conducted in Pakistan [16], which was only based on violations. However, this study focused on both violations and errors. Notably, the newly designed 23-items DBQ could be altered to imitate characteristics of driver's community having the motorcycle-riding experience where deployed. In this DBQ, it is also found that out of the five most committed behaviors, three items are newly inducted items based on the observations of the expert group recruited for the preliminary study. Therefore, this paper demonstrates the utilization of this proposed DBQ in the future where similar driving conditions exist.

One of the aims of this study was to investigate the effects of motorcycle-riding experience on RTAs involvement in Pakistani sample. Surprisingly, the motorcycle-riding experience was not found to be a significant predictor of RTAs. However, there might be some indirect relationship between motorcycle-riding experience and RTAs, which will be investigated in the future. A vast number of studies found in the literature which shows that aberrant driving behaviors predict RTAs [10, 11]. Therefore, each aberrant driving behavior was shown to RTAs involvement separately in the binary logistic regression model. Distracted violations were found to be significantly related to RTAs involvement, a result consistent with a wealth of studies [12]. The analysis of the paper elucidates that the risk of RTAs is increased considerably for drivers who involves in distracted violations, which is a new finding as this has never been considered in previous studies of aberrant driving behaviors. This study is the continuation of the previous research conducted in Pakistan [16], which was only based on violations. However, our study focused on both violations and errors. This finding is in accordance with the several previous studies in which a significant effect of violations on RTAs involvement was examined [33-35]. In contrast, self-willed violations/errors and risky violations/errors demonstrated no significant effects on RTAs involvement.

Regarding demographic and socio-economic variables, the previous researches depicted that these variables could explain aberrant driving behaviors [7, 10, 36]. Male exhibits more violations than female and female commit more errors than male [7]. In this study, some demographic and socio-economic variables were also introduced along with motorcycle-riding experience in the PO model. Gender was found to be a significant predictor of distracted violations; this finding is in line with previous studies [37-39] but in contrary with the results of a recent study conducted in Pakistan, in which gender was not found to be a significant predictor of aberrant driving behaviors [16]. The reason might be due to the lesser number of female drivers on roads in the country and under-representativeness of female drivers (19.4%) in our sample. In this study, the age of the driver was found to be a significant predictor of distracted violations, which demonstrates that younger drivers are more involved in distracted violations. However, involvement in distracted violations decreases as age increases. The finding of this study is in line with the previous studies [36, 40] in which age was found to be significantly related to violations. There might be two reasons; one is the distraction factor which decreases with age and secondly due to the unequal representation of age groups of respondents in this study. The drivers having more than the average annual income are less likely to be involved in risky violations/errors. This finding is consistent with the previous study conducted in Pakistan [16] in which the authors concluded that the middle-income group drivers are more aggressive than other drivers. On the other hand, drivers with a higher income show less risky violations/errors. This result is also in line with the studies conducted in Iran and Israel, in which authors concluded that low-income drivers were related to more risky driving behaviors [41, 42].

One of the main limitations of this study is the self-reported nature of the measurement instrument. For examining the driving behaviors, self-reported data are often considered due to cost-effectiveness. A vast literature has been found in which authors used the same technique [12]. However, it is believed that the study having self-reported nature might be biased. Therefore, we encourage to use some modern techniques such as driving simulator or naturalistic driving technique. Secondly, this DBQ is adopted for the first time in the country based on new items, so more research work is encouraged to validate it for Pakistan. Furthermore, online surveys and using a single data collection tool for a modeling perspective limited the inclusion of drivers

that might have limited access to the internet as well as unaware of the internet and could contribute to the issue of common method bias [43]. Therefore the sample might not be representative of the general driving population of the whole country.

Based on the findings of this study, it is recommended to explore the relationship between motorcycle-riding experience and aberrant driving behaviors more deeply. This study advocates re-thinking the penalties and fines against each non-compliance of traffic law regarding motorcycle-riding as well as the vehicle driving in the country as followed in developed countries. In order to reduce RTAs in the country, the government officials and road safety regulating authorities of Pakistan should set strict rules and regulations according to international standards for motorcycle riders, so when they switch to vehicle driving, the road safety should be maintained. We hope that this study has helped shed some light on the connection between aberrant riding behavior of motorcycle rider and aberrant driving behaviors of vehicle drivers, and we encourage further research on this topic in the future.

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Appendix A: 23-items DBQ used in quantitative measuring to aberrant driving behaviors

No	Items	Mean	SD
22	How often you do not slow on zebra crossing while driving vehicle	3.03	1.24
8	Drive fast to pass a yellow light turning to red*	2.66	1.10
1	Check your speedometer and discover that you are unknowingly traveling faster than the legal limit.	2.66	1.12
19	How often do you get distracted when you use a mobile phone while driving	2.44	.93
14	How often do you use high beam lights during driving at night time in built-up areas	2.35	1.0
10	Drive fast when in a bad mood.	2.30	1.10
4	Drive with only 'half-an-eye' on the road while looking at a map, changing a cassette or radio channel.	2.27	.96
5	Deliberately disregard the speed limits late at night or very early in the morning.	2.23	1.00
9	Distracted, misjudge interval and narrowly miss collision	2.21	.88
12	How often do you manage to drive a vehicle with poor maintenance conditions?	2.14	1.00
15	How often do you speed, blow the horn or overtake to get ahead of female drivers?*	2.08	1.07
6	Forget which gear you are currently in and have to check with your hand.	2.06	1.04
13	How often you do not stop at the stop line while driving	2.03	.95
2	Lost in thought, you forget that your lights are on the full beam until 'flashed' by other motorists	2.02	.91
20	How often do you get distracted when you talk with passengers while driving	2.00	.97
21	How often do you forget to apply a handbrake while parking your car at a certain place?	1.92	1.03
18	How often do you get distracted when you drink water in driving	1.91	.94
11	Fail to notice a pedestrian crossing.	1.88	.95
16	How often do you use your status profile or personal connections to get rid of fines, penalties	1.84	.96
3	Take a chance and cross on lights that have turned red**	1.74	.87
17	How often do you not stop at the call of traffic police wardens?	1.70	1.05
7	Disregard Traffic Light	1.67	.84

*This item is taken from a previous study conducted in Pakistan (Aggressive Violation No 13) [16]. From a cultural perspective, female drivers are not considered as a safe driver as compared to males. Furthermore, female drivers drive the vehicle very slowly due to a lack of confidence, which further reduces the traffic flow. For these reasons, it's a common practice in Pakistan that male drivers speed, blow the horn or overtake to get ahead of female drivers.

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