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# Validation of the Dula Dangerous Driving Index: Insights into Risky Driving Behaviors

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**Abstract**

A major safety concern in Pakistan's traffic system is the growing number of drivers who are ignorant of the laws. This research has three primary objectives. Its primary objective is to assess the Dula Dangerous Driving Index (DDDI) for relevance and dependability in the Pakistani setting. Second, it aims to investigate how driving instruction, seat belt use, sociodemographic characteristics, and DDDI affect the frequency of traffic crashes. Finally, it contrasts the driving habits of Chinese and Pakistani drivers. There were 623 Pakistani and 630 Chinese people that filled out a survey for the study. The study asked about dangerous driving habits, sociodemographic information, seat belt use, driving lessons, and been in a traffic collision. The study verified the DDDI's validity by comparing it to self-reported road crashes and seat belt use. We utilized generalized linear models to find predictive factors in the DDDI categories and binary logistic regression to look at the elements that affect traffic crashes. The study looked at DDDI, sociodemographic factors, seat belt use, and driving education. The study's findings indicated that the utilization of a seat belt while driving reduced the probability of a crash by 25%. Aggressive driving and risky behaviors increased the likelihood of traffic crashes by 36% and 20%, respectively. Moreover, the likelihood of involvement in a crash diminished by 21% as the driver's age increased. The study revealed that Pakistani drivers exhibit greater aggression and a higher propensity for unsafe driving than their Chinese counterparts, who are often more disciplined. The findings indicate that the deficient road safety in Pakistan is due to insufficient driving education programs, uneven enforcement of traffic regulations, inadequate road infrastructure, and a lack of public awareness campaigns.

**Keywords:** Traffic Crash; Aggressive driving; Risky driving; Seat belt; DDDI

## 1. Introduction

The most significant threat being faced by humanity is of road traffic crashes (RTAs), that can cause injuries, disabilities and loss of lives among people of all ages. The number of yearly fatalities from road traffic crashes has climbed to 1.35 million, which equates to nearly 3,700 people dying on the world's roads every day [1]. RTAs are rated as the twelfth most common cause of deaths among all causes [2]. The increasing rate of road traffic fatalities can be associated with a variety of factors, including increased urbanization, insufficient safety standards and enforcement, distracted or fatigued driving, impaired

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driving due to drugs or alcohol, speeding, and failure to wear a seat belt or wear a helmet [1]. Researchers, around the globe believe that about 70% of crashes occur due to human factors [3]. The human factors responsible for causation of traffic crashes as reported by Bucsuházy, Matuchová [4] are lack of concentration; tiredness and brief intervals of inadvertent sleep; misjudging the situation; driving too fast without adapting to the conditions; willfully violating traffic laws, lack of experience; weakened mental and physical capacities owing to age; the impact of alcohol and drugs; risky overtaking maneuvers ; reacting out of panic; health concerns; impaired visibility; being affected by luminous lights; and willful self-harm. In road safety research, driver conduct is of paramount importance compared to the various human elements. Among driving behaviors, dangerous driving is an empirical and practical concern that includes behaviors such as aggressive driving, driving while under the influence of negative emotions, and getting involved in risky actions while operating a vehicle [5]. It is commonly acknowledged that this phenomenon is one of the leading causes of traffic crashes on a global scale [5-7]. Pakistan Beaurau of Statistics [8], reported 94,358 crashes from 2011 to 2020. These crashes killed 49,801 and wounded 114,942. In Pakistan, careless driving (55%) and driver tiredness (11%), are the leading causes of road crashes [9]. Over speeding, dangerous driving, reckless overtakes, a lack of situational awareness, and poor driving habits are the primary causes of careless driving. When compared to Western countries, Pakistan has a higher rate of unforeseen incidents while driving. According to a recent study in Pakistan, lack of proper training before driving is major cause of crashes. Moreover, in Pakistan 45% drivers do not possess driving licenses, 75 % drivers have learnt driving from friends and family members and more than 30% are involved directly or indirectly in road traffic crashes over a period of last 3 years [10]. Therefore, it can be argued that compared to drivers with license and proper training the risk of deaths from injuries is high in drivers without license and proper training. Drivers without license and training are more vulnerable to commit dangerous driving behaviors. Due to Pakistan's peculiar social and traffic situations, there is an urgent need for precise approaches to assess dangerous driving behaviors.

Dangerous driving behaviors comprises of reckless driving (driving while under the influence of unpleasant emotions such as rage, frustration, or rumination), aggressive driving (driving while under the influence of thoughts or feelings that increase the danger of the road), [5, 6, 11]. The Dula Dangerous Driver Index (DDDI) serves as a multifaceted tool designed to assess a driver's propensity for hazardous behavior, encompassing negative emotions and risky driving tendencies. In contrast, other assessments tools focus exclusively on the measurement of anger related factors. Additionally, the transcribed variants of DDDI exhibit strong internal consistency. i.e., the US [6], the French [12] and Romanian [13] versions support the three-factor structure while the Flemish [11] and the Chinese [5], supports a four-factor structure. As far as our understanding goes, the DDDI has not undergone adequate validation in Pakistan thus far.

Dula and Ballard [6] report that aggressive driving is a major factor in dangerous driving incidents and contributes significantly to motor vehicle crashes. This phenomenon has been the subject of an abundance of scientific investigations. The deliberate actions of the driver with the aim to cause bodily or psychological harm to other people are what distinguish aggressive driving from unsafe driving. According to Deffenbacher, Lynch [14], an aggressive driver might show their anger in a number of ways: verbally (by shouting or swearing), physically (by getting into a fight or altercation), or by utilizing their car to intimidate others. Aggressive drivers are more likely to be involved in traffic accidents and receive traffic fines. Negative thoughts and feelings that might arise while driving include anger, irritation, provocation, and aggravation. These can manifest in a variety of ways, including being offended or viewing the actions of other drivers as improper or

stupid. Crash rates and traffic tickets are both increased when drivers exhibit aggressive driving habits. These behaviors can be exacerbated by negative thoughts and emotions like rage, annoyance, incitement, or impatience, which might be sparked by feelings of distress or by judging the conduct of fellow motorists as unacceptable or silly [5, 6, 13]. The relationship between negative emotions and driving behaviors has been extensively researched, with one study finding a positive association between negative emotional driving and speeding [12]. Studies have consistently found a link between negative emotions and increased instances of aggressive driving and traffic offences [7]. Negative emotions can distract drivers, thinning their focus and increasing the likelihood of an crash [11]. Risk-taking behaviors are classified into two types: socially unacceptable activities with potentially bad effects due to a lack of precautions, and socially acceptable but risky behaviors [5]. Rushing red lights, cutting through traffic, and violating speed limits are all examples of risky driving behavior. Risky drivers do not want to do harm to others and may not be experiencing negative emotions or thoughts [11]. Drivers with higher self-reported risky driving scores are more commonly engaged in traffic crashes than those with lower scores [15].

Personal attributes also have an important influence on dangerous driving. Young drivers involved in vehicular crashes take more risks and drive more aggressively than senior drivers [5, 6, 14]. Different translations of the DDDI produce consistent findings as well. Young motorists exhibit more dangerous driving behaviors than elderly, showing an association between dangerous driving and age [12, 13]. Driving expertise and gender also contributes to risky driving [13]. Inexperienced and young drivers are especially vulnerable to the effects of negative emotions [11, 13]. Aside from individual differences, failure to use a seatbelt contributes to dangerous driving behaviors, i.e. risky driving [16]. In 2021, half of the passengers killed in car crashes were not wearing seatbelts in US and in 2017, seat belts saved about 14,955 lives, and an additional 2,549 lives may have been saved if they had been wearing seat belts [16].

The main aim behind selecting Pakistan for this study is that driving in Pakistan is difficult because drivers don't obey the traffic rules and regulations properly. Over speeding, violation of one-way zones, tail gating, over loading, over seating in public transport vehicles, emotional driving non adherence to seat belt laws etc., are a few examples of dangerous driving which eventually lead to road traffic crashes [9]. The seatbelt law has been documented in Pakistan through Motor Vehicle Ordinance (MVO) since 1965 [17] but the implementation level is very low. Drivers in Pakistan wear seat belts only while travelling on Motorways and National highways just to avoid fines as the enforcement level on these roads is high and fines are imposed if caught driving without seat belt [18]. The enforcements levels to seatbelt usage are high in national capital, the provincial capitals and the highways which are in control of National Highway & Motorway (NH&MP) while on rural roads the enforcement level is very rare. The non-adherence to seat belt usage is very dangerous and can cost one's life in case of crashes.

Driver training is another issue which promotes dangerous driving behaviors if not handled properly. In Pakistan it is very common to learn driving from friends, relatives or family members instead of proper driving institutes being operated by traffic enforcement agencies [18]. Reason behind such a trend is the lack of availability of driving institutes at grass root levels within the country. If the instructor (anyone from friends, family members or relatives) is himself not fully aware of traffic rules and regulations cannot train properly others. As a result of which the newly trained drivers behave similarly as their trainers. When discussing the ineffectiveness of driver education in creating safer drivers,

Williams [19] also stated that "safety messages communicated through education can be overshadowed by continuous parental, peer, individual, and various societal factors that mold driving behaviors and involvement in crashes." For instance; Hussain and Shi [10] reported that lack of driving education and permit influences the abnormal driving habits. In the United States, typical driver training programs (comprising 30 hours in the classroom plus 6 hours of on-the-road teaching) are anticipated to result in a 5% reduction in crash rates per newly licensed driver within the first 6 to 12 months of driving [20].

Because existing research in the context of Pakistani drivers have mostly investigated aberrant driving behavior i.e., [10, 21-23]. As a result, there is a great need in Pakistan for adequately created or updated research methods for analyzing dangerous driving behaviors. The DDDI used in this study to assess drivers' self-reported likelihood of engaging in dangerous driving, is motivated by three distinct factors. First and foremost, the DDDI spans a broader scope by addressing negative cognitive processes and emotional sensations related with driving, as opposed to the DBQ [24], which exclusively tackles aggressive driving. Second, while this instrument assesses aggressive and risky driving using independent subscales, there is a widespread propensity in many research to mix up these two distinct traits [11]. Third, DDDI has never been validated in the context of Pakistani drivers. Analyzing dangerous driving behaviors displayed by Pakistani drivers is critical for understanding the core determinants and devising efficient methods to promote the adoption of safer driving practices. The main objectives of the present study were as follows:

- To identify the factor structure and verify the internal consistency and convergent validity of DDDI among Pakistani drivers.
- To find the predictors of dangerous driving behaviors among Pakistani drivers.
- To determine the factors behind the road traffic crashes among Pakistani drivers based on dangerous driving behaviors, demographic variables, seat belt usage etc.

In Pakistan, a self-report questionnaire survey was conducted in order to meet the precise objectives. The survey was designed to assess the sociodemographic, driving-related characteristics, and involvement in dangerous driving behaviors of the participants. The individuals' propensities for dangerous driving were assessed using the 27-item Dula dangerous Driving Index (DDDI). Principal component analysis with varimax rotation was performed to determine the factor structure of dangerous driving behaviors among Pakistani motorists. The influence of demographic variables, seatbelt utilization, and driving education on hazardous riding habits and road traffic crashes (RTAs) among motorists in Pakistan was analyzed through the application of a non-normal model (GLM) along with binary logit model.

## 2. Materials and Methods

**Participants**

Using digital surveys and physical interviews, 796 Pakistani participants in all completed the questionnaire voluntarily and confidentially. Upon necessary data screening and filtration 623 responses came out to be valid and were selected for further analysis. The age group of people who took part varied from eighteen to sixty-five years (M: 3.25, SD: 1.39), with the dataset comprising 80% male (N: 499) and 20% female (N: 124) participants. Seventy-two percent of the participants possessed a valid driving license. The majority of participants, comprising 50%, consisted of students at all levels, as well as workers from various educational institutions. The remainder were

motorists sourced from multiple locations i.e., transport terminals, commercial hubs, and neighborhoods. Refer to table 1 for a comprehensive overview of the sample's descriptive statistics.

**Measures**

***The DDDI:*** In this study, The Dula Dangerous Driving Index (DDDI), a self-report instrument developed by Dula and Ballard in 2003 to assess individual predispositions towards unsafe driving, was utilized. The initial scale comprises 28 parts categorized into three distinct factors: risky driving, encompassing 12 parts; negative emotions experienced during driving, consisting of 9 parts; and aggressive driving, which includes 7 parts. Due to the prohibition of alcohol consumption in Pakistan, discarded one factor associated with driving while intoxicated. A twenty-seven item DDDI instrument was employed to gather data in this study. Respondents assessed the repetition of every item on a 5-point Likert scale, where 1 indicated "never" and 5 signified "always," providing their responses voluntarily.

**Table 1:** Descriptive Statistics

| **Participant Demographics** | **N** | **Percent (%)** |
|---|---|---|
| **Gender** | | |
| Male | 499 | 80% |
| Female | 124 | 20% |
| **Age** | | |
| 18-24 years | 236 | 37.87 |
| 25-34 years | 130 | 20.85 |
| 35-44 years | 107 | 17.17 |
| 45-54 years | 78 | 12.51 |
| 55-64 years | 60 | 9.63 |
| 65 years & above | 12 | 1.92 |
| **Education** | | |
| PhD | 35 | 5.6 |
| Masters | 96 | 15.4 |
| Undergraduate | 181 | 29.1 |
| HSSC ($12^{th}$ Grade) | 186 | 29.9 |
| SSC ($10^{th}$ Grade) | 57 | 9.1 |
| Below SSC | 47 | 7.6 |
| No Formal Education | 21 | 3.4 |
| **Driving Experience** | | |
| Less than 1 year | 30 | 4.8 |
| 1-5 years | 228 | 36.6 |
| 6-10 years | 175 | 28.1 |
| 11-15 years | 86 | 13.8 |
| 16-20 years | 54 | 8.7 |
| More than 20 years | 50 | 8.0 |

The current study utilized a Pakistani version of the DDDI, which is distinctive to Pakistan. The original English version was translated to accommodate the bulk of individuals (drivers) who, due to poor education, have difficulty grasping the English language. The translation of the original version of DDDI into Urdu was done by adopting the procedure explained as follows. Firstly, we requested four professors from the language department to interpret the DDDI into Urdu

individually at the same time. Upon completion of translation, a consolidated single draft was formulated by through discussion on the individual translations. Secondly, five experienced drivers were hired to check and discuss the draft to make sure that items have no ambiguity. Finally, based upon the feedback and group discussion with five probable participants (drivers) that were hired to pretest the translated draft, the scale was modified and finalized.

***Sociodemographic:*** The demographics part comprised items regarding age, gender, education, and driving experience, among others. Respondents, additionally were required to respond to questions related to driving license (if they had a valid driving permit), seatbelt usage (if they utilized a seatbelt while driving?), driving training (from where they learnt to drive), their preferred time of travel (morning, evening, midnight etc.) and crashes in last three years (if they have experienced an automobile crash within the last three years).

**Procedure**

Data collection was accomplished in two steps, first by running an online survey and second through physical data collection using a self-report and anonymous questionnaire. Google Forms facilitated the creation of web survey and then disseminated through various media platforms. Whereas the offline data gathering was accomplished by recruiting willing drivers from transport terminals, parking's of shopping malls, restaurants, and other commercial places. Everyone who took part were informed that all data would remain confidential and would be used solely for purposes of research. All the respondents were drivers representing different profession in Pakistan. Once the data collection was completed the data screening and sorting was performed to remove the unwanted data. Data analysis was performed using SPSS version 26.0. The descriptive statistics were determined as shown above in table 1, followed by principal component analysis to find the factor structure of DDDI. Once the factor structure was determined, the reliability (internal consistency) and convergent validity of the DDDI factors was determined using the reliability analysis i.e., Cronbach alpha coefficients and Pearson bivariate correlation analysis. Generalized linear models were used to find the predictors of dangerous driving behaviors among Pakistani drivers. A versatile statistical framework called the Generalized Linear Model (GLM) expands on the linear model to manage outcome variables that lack normal distribution, developed by Robert Wedderburn and statistician Sir John Nelder in 1972 [25]. GLM offers a well-established method applicable to various response modeling challenges, particularly in cases where outcome variables deviate from normal distribution either variance is dependent on the average for multiple scale variables. Generalized linear models might be utilized for qualitative data as well. GLM consists of twin parts: the stochastic element in the probabilistic function, that accounts for the variability in the outcome variable, and the integral element of the probabilistic function, that links the average of outcome variable to the input values [26]. The DDDI factors were incorporated in the model as dependent variables (DVs) while the demographic factors, the seatbelt usage, driving training and driving license variables were used as independent variables (IV). The DVs and IVs coding used in the analysis is shown in table 2 respectively. Similarly, the effect on dangerous driving behavior dimensions, demographics and other study variables on occurrence of traffic crashes was also determined using binary logistic regression model as the dependent variable has two outcomes i.e., either involved in a traffic crash or not involved in a traffic crash (yes/No). The variables mentioned in table including the DVs were used as independent variables to predict traffic crashes among Pakistani drivers.

## 3. Results

### *3.1. Factor structure of DDDI*

To obtain the factor structure of DDDI, Principal component analysis (PCA) with varimax rotation was performed using SPSS statistical software (version 25). Prior to completing PCA, the Kaiser-Meyer-Olkin (KMO) measure of sample adequacy and Bartlett's Test of Sphericity (BTS) were used to assess the suitability of the data. The data set's KMO ratio of 0.821 indicates that it is

sufficient for testing. Likewise, the BTS was also significant for the data (p<0.000) thus, after meeting the pre-requisites the data was factor analyzed with varimax rotation. The PCA analysis revealed three families of DDDI dimensions which represent a vivid picture of dangerous driving behaviors amongst drivers in Pakistan. Each dangerous driving dimension was named based on the dominating contributing factor to that dimension; Risky driving, Aggressive driving and Negative emotions while driving. The items extracted in PCA analysis are shown below in table 2 respectively.

**Table 2:** Dependent and Independent variables used in GLM models

| Variable Name | DVs/IVs | Variable type | Range |
|---|---|---|---|
| **AD** | DV | Ordinal | Never, Rarely, Sometimes, Often, always |
| **RD** | DV | Ordinal | Never, Rarely, Sometimes, Often, always |
| **NE** | DV | Ordinal | Never, Rarely, Sometimes, Often, always |
| **Age** | IV | Ordinal | 18-24, 25-34, 35-44, 45-54, 55-64, 65+ |
| **Gender** | IV | Nominal | Male, Female |
| **Education** | IV | Ordinal | PhD, MS, Bachelor, HSSC, SSC, Middle, Primary, No education |
| **Driving Experience** | IV | Ordinal | <1 year, 1-5, 6-10, 11-15, 16-20, 20+ |
| **Driving License** | IV | Nominal | Yes, No |
| **Driving Training** | IV | Ordinal | From a police training school, Private school, Friend, Family member/relative, No training |
| **Travel Time** | IV | Ordinal | 6am-12pm,12pm-6pm,6pm-12am, 12am-6am |

The first extracted factor, “Risky driving,” has four items and 17.80% variance. on order to avoid traffic, I shall drive on the shoulder lane or median. Five questions made up the second category, “negative emotions while driving,” which explained 16.75% of variance. Pakistani drivers' bad feelings when driving dominate the negative emotions aspect, such as getting annoyed when a car/truck brakes down for no reason. This factor was dubbed "Aggressive driving" since it involved tailgating, hostile gestures, flashing lights, etc. Three items (Whenever a passenger vehicle gets under my skin, I blink headlamps.) constitute 17.01% of variance. See table 3 for detailed information.

3.1.1. Internal Consistency

To assess the validity of the driving index, reliability coefficients (α) were analyzed. All subcategories and the overall DDDI metric demonstrated excellent internal coherence. The α coefficient of the overall DDDI metric was 0.771. All subscale α readings were under permitted limits: unsafe driving ($\alpha = 0.702$), negative emotion while driving ($\alpha = 0.698$), and aggressive driving ($\alpha = 0.716$). See table 4 for detailed information.

3.1.2. Convergent Validity

Pearson’s bivariate correlation was utilized to explore the interactions among the dimensions of the Dula Dangerous Driving Index (DDDI), the overall DDDI score, demographic variables such as age and driving experience, crash involvement, possession of a driving license, and seat belt usage. A positive and significant correlation exist among the three DDDI dimensions and DDDI score ($p < 0.01$). Age was negatively related with risky and aggressive driving DDDI subscales and DDDI score ($p < 0.01$), which shows that the Novice motorists tend to take part in riskier riding habits when contrasted to their seasoned counterparts. The road experience negatively related with

aggressive driving (AD) ($r = -0.093$, $p < 0.01$), risky driving (RD) ($r = -0.153$, $p < 0.01$) and DDDI score ($r = -0.049$, $p < 0.01$), which suggest that novice drivers tend to commit dangerous and reckless driving in contrast to seasoned ones. Furthermore, a significant correlation was evident between crashes and aggressive driving ($r = 0.151$, $p < 0.01$), crashes and reckless driving ($r = 0.142$, $p < 0.01$), crashes and negative emotional driving ($r = 0.119$, $p < 0.05$) crashes and DDDI score ($r = 0.102$, $p < 0.05$), which describes a direct association among these variables. See table 5 for detailed information.

**Table 3:** Factor analysis of Dula Dangerous Driving Index (DDDI)

| Factors | Item No | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|---|
| **Risky Driving (RD)** | 26. I regard myself as somebody who takes risks. | 0.742 | | |
| | 21. I'll drive if I'm just a little hummed or slightly drowsy | 0.736 | | |
| | 19. I shall compete against a sluggish train to reach the railway junction. | 0.707 | | |
| | 27. I believe that the majority of traffic regulations may be regarded as mere guidelines. | 0.706 | | |
| **Negative Emotions while driving (NE)** | 11. Traffic congestion causes me considerable irritation. | | 0.763 | |
| | 12. Whenever I have to drive and I am late, I become angry and agitated. | | 0.738 | |
| | 16. If the vehicle ahead of me suddenly pulls over, this annoys myself | | 0.712 | |
| | 15. I sense that I might become quite irate should I find myself in a confrontation with another motorist. | | 0.492 | |
| | 10. I find the conduct exhibited by different motorists to be unprofessional or "foolish." | | 0.491 | |
| **Aggressive Driving (AD)** | 5. When I'm annoyed with a motorist, I might follow them. | | | 0.744 |
| | 4. I intentionally position my vehicle to obstruct those who follow too closely behind me. | | | 0.705 |
| | 6. When an individual interrupts my path, I find myself compelled to consider a form of retribution. | | | 0.631 |
| | 7. If I sense a motorist is being hostile toward me, I believe it is my privilege to take action. | | | 0.567 |
| | 2. I exhibit vulgar actions (e.g., displaying an obscene hand signal, uttering profanities). | | | 0.610 |
| | 3. I express my disdain directly towards motorists who frustrate me. | | | 0.459 |

**Table 4:** DDDI Reliabilities (n=623)

| Items | | Cronbach's Alpha | Mean | SD |
|---|---|---|---|---|
| **Risky Driving (RD)** | 4 | 0.702 | 1.659 | 1.12 |
| **Negative Emotions (NE)** | 5 | 0.698 | 3.134 | 1.74 |
| **Aggressive Driving (AD)** | 6 | 0.716 | 2.277 | 1.68 |
| **Total** | 15 | 0.771 | 2.398 | 1.55 |

**Table 5:** Pearson's bivariate correlation between DDDI and Demographics

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **1. AD** | - | | | | | | | | |
| **2. NE** | 0.276** | - | | | | | | | |
| **3. RD** | 0.385** | 0.087* | - | | | | | | |
| **4. DDDI metric** | 0.816** | 0.357** | 0.443** | - | | | | | |
| **5. Age** | -0.111** | 0.122 | -0.129** | -0.063* | - | | | | |
| **6. Experience** | -0.093** | -0.040 | -0.153** | -0.050** | 0.466** | - | | | |
| **7. Crashes** | 0.151** | 0.119* | 0.142** | 0.102* | 0.071 | -0.021 | - | | |
| **8. Seat belt** | -0.058** | -0.111* | -0.091* | -0.128** | -0.060 | 0.018* | -0.086* | - | |
| **9. License** | -0.007 | -0.034 | 0.130** | -0.006 | 0.118** | 0.154** | 0.042 | 0.039 | - |

### *3.2. Indicators of unsafe driving habits*

The predictive modelling was applied to quantify the influence of socioeconomic determinants, seatbelt utilization, and driving education on dangerous driving behaviors. Our aim was to assess, whether demographics, Seat belt usage and driving training predict the dangerous driving behaviors". A generalized linear model (GLM) was utilized to achieve this objective. Generalized Linear Models (GLM) offer a well-established approach to various response modeling challenges, particularly when response variables deviate from normal distribution either variance is dependent on the average for multiple scale variables. These techniques might be applied to grouped data. The model consist of two elements: the random element, which represents the variability in the outcome parameter, and the structural element, that links the average of outcome variable to the input values [27].

Three GLM models were utilized in regression analysis to investigate the association between seat belt usage, driving training and DDDI dimensions along with demographics. The first GLM The model investigates the relationship between all predictor variables and reckless. The outcomes showed that drivers who got training from government driving centers (β: -0.398, odds ratio [OR]: 0.672, $p < 0.05$), from an exclusive training academy (β: -0.229, odds ratio [OR]: 0.795, $p < 0.01$), through a mate (β: -0.352, odds ratio [OR]: 0.747, $p < 0.01$), and from a relative (β: -0.242, odds ratio [OR]: 0.785, $p < 0.05$) indicated an opposite relationship with reckless driving actions, suggesting that trained drivers exhibit a lower incidence of such behaviors compared to their untrained counterparts. Seat belt usage (β: -0.093, odds ratio [OR]: .911, $p < 0.05$) emerged as a strong indicator of unsafe driving actions, suggesting that drivers who utilize seat belts are more reluctant to engage in unsafe driving in contrast with motorists that do not wear seat belts. Furthermore, drivers aged 18-24 years (β: 0.260, odds ratio [OR]: 1.540, $p < 0.01$) and 25-34 years (β: 0.139, odds ratio [OR]: 1.230, $p < 0.05$) emerged as key indicator of risky driving in contrast to motorists ≥ 65 years. Male drivers (β: 0.136, odds ratio [OR]: 1.348, $p < 0.05$) were found to be more risk takers in

contrast to opposite gender. Drivers having an experience of < 1 year (β: 0. 61, odds ratio [OR]: 1.321, $p < 0.01$) and motorists up to five years expertise (β: 0.258, odds ratio [OR]: 1.586, $p < 0.01$) exhibited greater risky driving habits in contrast to motorists with experience of more than 20 years. See table 6 for detailed information.

**Table 6:** GLM model outcomes for Reckless driving

| Variable | B | SE | Wald | P (Sig) | OR | 95% C I | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| **Risky Driving (RD)** | Chi-square: 86.385, $p < 0.01$ | | | | | | |
| **Age (18-24)** | .260 | .1594 | 3.366 | .008 | 1.540 | .850 | 1.587 |
| **Age (25-34)** | .0139 | .1601 | 2.053 | .017 | 1.230 | .758 | 1.420 |
| **Age (over 65)** | 0[a] | | | | | | |
| **Gender (male)** | .136 | .0546 | 1.065 | .012 | 1.348 | .951 | 1.177 |
| **Gender(female)** | 0[a] | | | | | | |
| **Experience (< 1 year)** | .061 | .1287 | .172 | .009 | 1.321 | .820 | 1.358 |
| **Experience (1-5 years)** | .258 | .0911 | 2.762 | .007 | 1.586 | .973 | 1.391 |
| **Experience (> 20 years)** | 0[a] | | | | | | |
| **Driving Training (Government driving centers)** | -.398 | .1303 | 9.315 | .022 | .672 | .520 | .867 |
| **Driving Training (Individual driving centers)** | -.229 | .1099 | 4.349 | .037 | .795 | .641 | .986 |
| **Driving Training (from a mate)** | -.352 | .1103 | 7.023 | .008 | .747 | .601 | .927 |
| **Driving Training (from a relative)** | -.242 | .1015 | 5.308 | .021 | .785 | .639 | .965 |
| **Driving Training (No training at all)** | 0[a] | | | | | | |
| **Seat Belt (yes)** | -.093 | .0504 | 3.378 | .046 | .911 | .826 | 1.006 |
| **Seat Belt (No)** | 0[a] | | | | | | |
| **Driving license (yes)** | -.101 | .0483 | 4.416 | .036 | . 904 | .822 | .993 |
| **Driving license (No)** | 0[a] | | | | | | |

Likelihood Chi squared: 86.385, df: 27, Significance: $p < 0.01$

Akaike's Information Criterion (AIC): 1403.212, Bayesian Information Criterion (BIC): 1531.814

B: Coefficient, SE: Standard Error, OR: Odds ratio, CI: Confidence Interval

[a] This parameter is set to be zero because it is redundant.

The subsequent GLM model was executed to examine the relationships between forecasting variables and the negative emotion (NE) category of DDDI. The findings indicated that solely age and driving expertise emerged as the key indicators of negative emotion factor. Drivers aged 18-24 years (β: 0.235, odds ratio [OR]: 1.369, $p < 0.05$), and 25-34 years (β: 0.413, odds ratio [OR]: 2.356, $p < 0.05$) emerged as the significant positive predictors of negative emotion factor whereas motorists up to 64 years age (β: -0.475, odds ratio [OR]: .356, $p < 0.05$) emerged as negative indicator of negative emotion factor. Drivers having an expertise up to 20 years (β: -0.165, odds ratio [OR]: .880, $p < 0.05$) emerged as key indicator of negative emotions factor indicating motorists

having greater driving expertise exhibit lower levels of negative emotions ridden riding when contrasted with those who are less experienced. See table 7 for detailed information.

**Table 7:** GLM model outcomes for Negative Emotions

| Variable | B | SE | Wald | P (Sig) | OR | 95% C I | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| **Negative Emotions (NE)** | Chi-squared: 56.068, p < 0.01 | | | | | | |
| **Age (18-24)** | .235 | .1194 | 4.750 | .027 | 1.369 | 1.014 | 1.240 |
| **Age (25-34)** | .413 | .1209 | 5.746 | .046 | 2.356 | 1.273 | 1.380 |
| **Age (55-64)** | -.475 | .1209 | 1.029 | .030 | .356 | 0.698 | 1. 121 |
| **Age (over 65)** | 0[a] | | | | | | |
| **Experience (16-20 years)** | -.165 | .0.0772 | 4.594 | .032 | 0.880 | 0.941 | 1.372 |
| **Experience (> 20 years)** | 0[a] | | | | | | |
| Likelihood Chi squared: 58.369, df: 25, Significance: p < 0.01 | | | | | | | |
| Akaike's Information Criterion (AIC): 1842.639, Bayesian Information Criterion (BIC): 1478.232 | | | | | | | |
| B: Coefficient, SE: Standard Error, OR: Odds ratio, CI: Confidence Interval | | | | | | | |
| [a] This parameter is set to be zero because it is redundant. | | | | | | | |

Final GLM model predicted the associations of forecasting factors with DDDI's Aggressive driving category. The outcomes indicated that gender had a significant association with aggressive driving (β: 0.258, odds ratio [OR]: 1.863, p < 0.01) which suggest that males exhibit a higher involvement in aggressive driving habits in contrast to their female counterparts. Age also emerged as the key indicator of aggressive driving. The motorists aged 18-24 years (β: 0.358, odds ratio [OR]: 1.260, p < 0.01), motorists aged 25-34 years (β: 0.123, odds ratio [OR]: 1.343, p < 0.05) and drivers aged 35-44 years (β: 0.245, odds ratio [OR]: 1.222, p < 0.01) emerged to be a key indicator of aggressive driving in contrast to motorists ≥ 65 years. Drivers with < 12 months expertise (β: .217, odds ratio [OR]: 1.346, p < 0.05) and drivers having an experience of up to five years (β: 0.122, odds ratio [OR]: 1.130, p < 0.05) emerged as key indicator of aggressive driving in contrast to motorist in possession of > 20 years expertise. Moreover, seat belt usage (β: -0.423, odds ratio [OR]: 0.872, p < 0.05) was identified as a pertinent inverse indicator of aggressive driving relative to individuals which do not utilize seat belts. Drivers who got training from government driving centers (β: -0.242, odds ratio [OR]: 0.785, p < 0.05) also emerged as a pertinent indicator of aggressive driving behaviors in contrast to untrained drivers. See table 8 for detailed information.

### *3.3. DDDI and demographics as predictor of road traffic crashes*

This subsection intends to examine the impact of the Dula Dangerous Driving Index (DDDI) dimensions, seat belt utilization, driving education, and sociodemographic factors on involvement in vehicle crashes. Binary logistic regression modelling technique was implied to uncover the variables accountable for crashes. The model included the characteristics of dangerous driving behaviors (DDDI) as independent variables (IV) and crashes while driving (RTA) as dependent factors (DV). The model's dependent variable coding is as follows: never engaged in an automobile crash: 0 and ever engaged in an automobile crash: 1. Several logit models were utilized to find the factors accountable for crash engagement. The primary logit model was utilized by combining the hazardous driving habits (DDDI) jointly to analyze their effect on crash engagement (refer to table 9 for further details).

**Table 8:** GLM model outcome for Aggressive driving (AD)

| Variable | B | SE | Wald | P (Sig) | OR | 95% C I | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| **Aggressive Driving (AD)** | Chi-squared: 57.153, p < 0.01 | | | | | | |
| **Age (18-24)** | .358 | .1540 | 7.636 | .006 | 1.260 | 1.132 | 2.070 |
| **Age (25-34)** | .123 | .1549 | 5.414 | .020 | 1.343 | 1.058 | 1.942 |
| **Age (35-44)** | .245 | .1519 | 7.372 | .007 | 1.222 | 1.122 | 2.035 |
| **Age (over 65)** | 0[a] | | | | | | |
| **Gender (Male)** | .258 | .0528 | 7.156 | .007 | 1.863 | 1.038 | 1.277 |
| **Gender (Female)** | 0[a] | | | | | | |
| **Driving Training (from traffic police driving school)** | -.242 | .1012 | 5.720 | .017 | .785 | 0.644 | 0.957 |
| **Driving Training (No training at all)** | 0[a] | | | | | | |
| **Seatbelt (yes)** | -.423 | .0487 | 3.155 | .044 | .872 | .834 | .1.009 |
| **Seatbelt (No)** | 0[a] | | | | | | |
| **Driving Experience (<1 year)** | .217 | .1221 | 3.158 | .046 | 1.340 | .975 | 1.226 |
| **Driving Experience (1-5 year)** | .122 | .0868 | 1.988 | .039 | 1.130 | .953 | 1.340 |
| **Driving Experience (>20 year)** | 0[a] | | | | | | |

Likelihood Chi squared: 57.153, df: 27, Significance: p < 0.01

Akaike's Information Criterion (AIC): 1737.092, Bayesian Information Criterion (BIC): 1865.693

B: Coefficient, SE: Standard Error, OR: Odds ratio, CI: Confidence Interval

[a] This parameter is set to be zero because it is redundant.

**Table 9:** Binary logistic regression model for predictors of crash involvement (IVs: Dangerous driving behaviors)

| Variable | β | SE | Wald | Sign (p) | Exp. (β) |
|---|---|---|---|---|---|
| **Crash engagement** | .216 | .081 | 7.178 | 0.007 | 1.241 |
| **Aggressive Driving (AD)** | .335 | .084 | 15.833 | .000 | 1.398 |
| **Negative Emotions (NE)** | .014 | .083 | .030 | .862 | 1.014 |
| **Risky driving (RD)** | .198 | .094 | 4.458 | .035 | 1.219 |
| **Nagelkerke $R^2$: .069, goodness of fit: 33.007, sig: p < 0.01, model accuracy: 58.7%** | | | | | |

The outcomes indicated that rash driving (AD) and reckless driving (RD) exhibit direct effects on crash engagement that can be debated as; the drivers engaged in aggressive driving (β: 0.335, p < 0.01) and risky driving (β: 0.198, p < 0.05), have higher probability of crash involvement. In the subsequent model all the IVs (i.e., demographic factors) were utilized jointly to analyze their effect on crash engagement. The results showed that aggressive driving (β: 0.358, p < 0.01), and risky driving (β: 0.196, p < 0.05) had a significant association with crash involvement. seatbelt usage (β: -0.252, p < 0.05) had a significant association with crash involvement. Among demographics only

drivers age (β: -.215, $p < 0.01$) emerged as a key indicator of traffic crashes while driving experience and other factors did not achieve the significance. See table 10 for detailed information.

**Table 10:** Binary logistic regression model for predictors of crash involvement (IVs: Dangerous driving behaviors, driving training, seat belt usage, driving experience & socio demographic variables)

| Variable | β | SE | Wald | Sign (p) | Exp. (β) |
|---|---|---|---|---|---|
| **Crash engagement** | .216 | .081 | 7.178 | 0.007 | 1.241 |
| **Aggressive Driving (AD)** | .358 | .086 | 17.269 | .000 | 1.430 |
| **Negative Emotions (NE)** | .014 | .084 | .027 | .871 | 1.014 |
| **Risky driving (RD)** | .196 | .096 | 4.193 | .041 | 1.217 |
| **Age** | -.215 | .069 | 9.825 | .002 | .987 |
| **Seat belt** | -.252 | .214 | 2.447 | .035 | .957 |
| **Nagelkerke $R^2$: .099, goodness of fit: 48.155, sig: $p < 0.01$, model accuracy: 63%** | | | | | |

### *3.4. Comparative study of DDDI among Chinese and Pakistani motorists*

In order to better understand the cultural disparities in road fatalities, it is imperative to explore how driving habits vary cross cultures. These discrepancies in driving habits are probably caused by important cultural differences. For instance, Lajunen, Corry [28] reported, Australian drivers ended up in greater number of crashes and indicated a lower degree of priority for safety as opposed to Finnish drivers. In another instance, Warner, Özkan [29] showed that motorists in Finland and Sweden register fewer aggressive infractions than motorists in Greece and Turkey. Furthermore, it has been observed that, in comparison to Hellenic and Turks drivers, those from Finnish and Swedish demonstrate a reduced frequency of abnormal driving habits and a diminished rate of crashes. Furthermore, discrepancies in the quality of the road infrastructure may be associated with differences in driver behavior throughout regions.

Traffic safety has been a major concern for both China and Pakistan as a result of increasing motorization and fast urbanization. In 2021, the total road traffic crashes reported in China were 273, 098 resulting in loss of 62,218 precious lives and 281,447 injuries [30]. The deaths due to road traffic crash per 100,000 population as reported by Zhao [31] has increased from 2.1 in year 1980 to 7.60 in year 2005 but the situation has worsen overtime with increased motorization, this fatality rate has reached 18.2 per 100,000 of population in year 2016 [1]. Similarly, in Pakistan the road safety issues are on the rise, which is evident from the fact that the fatality rate is 14.3 [1], which is also on the rise. China and Pakistan have a long friendship history as exemplified by China Pakistan Economic Corridor (CPEC) project. It is anticipated that there would be an uptick in cross-border traffic between Pakistan and China once CPEC is finished. Different driving habits could be a result of cultural norms and customs that are unique to each country. A thorough examination of these variations may shed light on the ways in which cultural norms affect road safety, which in turn may inspire the development of policies that facilitate travel across international borders. However, the fourth objective of this research was to provide an overview of dangerous driving behaviors of Pakistani drivers compared to the Chinese drivers. To achieve this objective, data was gathered from drivers in China using the same questionnaire as was used to collect data from Pakistani drivers. Data collection was performed using the online platform through Wenjuanxing (https://www.wjx.cn/), the widely used Chinese data collection channel. The survey link was disseminated through the Wenjuanxing network and various online forums. Participants completed the questionnaire in a mean time of 17 minutes and were compensated with 10 Chinese Yuan for their participation. A total of 630 valid samples were collected and included in the comparative analysis. The participants' age ranged from 18 to 65 years (M:2.56, S.D: 0.78), the dataset consists

of 65% male (N:410) and 35% female (N: 220) participants. All the participants in sample reported to have a valid driving license and 48% of participants reported of being involved in a traffic crash.

**Table 11:** Mean item score comparison of Dangerous driving behaviors in Pakistan and China

| Item | Description | China | Pakistan |
|---|---|---|---|
| 11 | Traffic congestion causes me considerable irritation. | 2.38 | 3.42 |
| 15 | I sense that I might become quite irate should I find myself in a confrontation with another motorist. | 2.33 | 2.63 |
| 16 | If the vehicle ahead of me suddenly pulls over, this annoys myself. | 2.32 | 3.43 |
| 12 | Whenever I have to drive and I am late, I become angry and agitated. | 2.3 | 3.28 |
| 6 | When an individual interrupts my path, I find myself compelled to consider a form of retribution. | 1.73 | 2.15 |
| 27 | I believe that the majority of traffic regulations may be regarded as mere guidelines. | 1.64 | 1.94 |
| 3 | I express my disdain directly towards motorists who frustrate me. | 1.63 | 2.58 |
| 2 | I exhibit vulgar actions (e.g., displaying an obscene hand signal, uttering profanities). | 1.39 | 2.06 |
| 4 | I intentionally position my vehicle to obstruct those who follow too closely behind me. | 1.35 | 2.12 |
| 22 | Attempting to pass a vehicle that is traveling too slowly has me crossing two sets of yellow markings. | 1.35 | - |
| 28 | I intend to operate a motor vehicle while intoxicated. | 1.3 | - |
| 5 | When I'm annoyed with a motorist, I might follow them. | 1.27 | 2.24 |
| 21 | I'll drive if I'm just a little hummed or slightly drowsy | 1.09 | 1.28 |
| 26 | I regard myself as somebody who takes risks. | 1.04 | 1.36 |
| 7 | If I sense a motorist is being hostile toward me, I believe it is my privilege to take action. | - | 2.51 |
| 10 | I find the conduct exhibited by different motorists to be unprofessional or "foolish." | - | 2.91 |
| 19 | I shall compete against a sluggish train to reach the railway junction. | - | 1.56 |

Table 11 compares the mean scores of dangerous driving behaviors of Pakistani drivers and Chinese drivers determined in this study. The results show that Pakistani drivers commit dangerous driving behaviors more frequently compared to Chinese motorists i.e., the average of item no 16, "If the vehicle ahead of me suddenly pulls over, this annoys myself" for Chinese motorists is 2.32 while, for Pakistani motorists is 3.43. similarly, the average of item no 3, "I express my disdain directly towards motorists who frustrate me." for Chinese motorists is 1.63 while for Pakistani motorists it is 2.58. The item no 11, "Traffic congestion causes me considerable irritation" with a mean score of 2.38 is the most reported dangerous driving behavior drivers while, the item no 26, "I regard myself as somebody who takes risks." is the most least reported driving behavior among the Chinese drivers. Among the Pakistani drivers, the most reported dangerous driving behavior is, item no 16 (mean score: 3.43) and the least reported dangerous driving behavior is, item no 26 (mean score: 1.36). Several items have similar mean scores, for example, item no 21, "I'll drive if I'm just a little hummed or slightly drowsy" have a mean score of 1.09 for Chinese and 1.28 for Pakistani drivers. Figure 1 shows further comparative insights of dangerous driving behaviors of both countries. In summary, the outcomes reveal that Chinese drivers behave less dangerously on

roads compared to Pakistani driver. The reasons for such trend in China can be attributed to the state-of-the-art road infrastructure, traffic management systems in place and governments policies on road safety whereas, in Pakistan, less attention is paid on road safety.

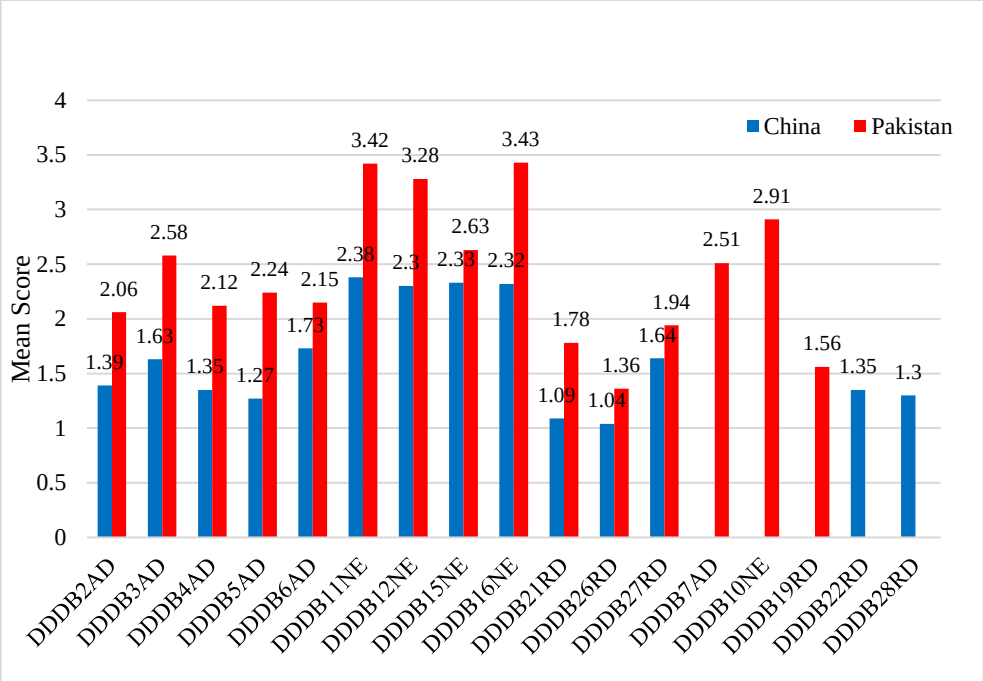


**Figure 1:** Comparison of dangerous driving behaviors

## 4. Discussion

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted. The main purpose of this study was to explore the influence of dangerous driving behaviors, seat belt usage, driving training and demographic determinants on crash engagement in a sample of Pakistani drivers. The DDDI scale has never been used in Pakistan to predict the road crashes or driving behaviors so, the original DDDI scale [6] was translated in to Pakistani language (Urdu) its factor structure, reliability and validity was determined. The results showed that the Pakistani version of DDDI possess reliable psychometric qualities. The Pakistani DDDI version had higher reliabilities and a stable structure which can be compared to other DDDI translated versions;[5, 12, 13]. The Pakistani DDDI supports a three-factor structure i.e., aggressive driving, risky driving and negative emotional driving which were also in accordance with previous studies, Dula and Ballard [6], Richer and Bergeron [12], Iliescu and Sarbescu [13]. Furthermore, to strengthen the empirical validity of Pakistani version of DDDI, traffic crashes and violations (seatbelt usage) were used as criteria. All the DDDI dimensions were positively and strongly correlated with traffic crashes and negatively correlated with seatbelt usage. According to previous studies, both traffic violations and crashes play important roles in predicting dangerous driving behaviors [5, 32]. The present results show that these variables are associated with risky driving, aggressive driving, negative emotional driving and overall DDDI score. The results from this study imply that the DDDI is sensitive in its capacity to identify drivers who exhibit dangerous behavior.

The motivation for selecting Pakistan was the increasing number of road crashes and violation of traffic rules [33-35]. The problem in Pakistan is that people are hesitant to learn driving from the driving institutes either government or private owned. Instead, their preferred choice is to learn driving from friends or family members. This lack of proper training and knowledge prior to driving leads to increase in road traffic crashes. This fact is eminent considering that in this sample 72.5%

participants and 86.7% participants in a previous study [18] learned driving from friends or family members instead of training institutes. The other very common issue is the non-usage of seat belts while driving, although the compulsory seat belt law exists in country but the implementation is very low. According to a previous study in Pakistan only 20% people use seatbelts while driving, 53% of which is on motorways only [35], while in another study, it was reported that 72.2% of drivers use seatbelts just to avoid fines and penalties and 45.6% drivers feel ashamed to wear a seat belt while driving [18]. The results show that Pakistani drivers drive fast when upset or angry, flash headlights when annoyed by other drivers, perform illegal overtaking moves, show aggression towards others while driving on roads and violate the traffic laws. The involvement in these types of behaviors promotes dangerous driving behaviors which results in traffic crashes. These facts encourage us to study the effect of dangerous driving behaviors on crash involvement among Pakistani drivers.

GLM models and binary logistic regression models were employed in the research to identify predictors of dangerous driving behaviors (DDDI) and crash involvement. The results of GLM models indicated that using a seatbelt while driving had a significant effect on risky driving and aggressive driving. This can be concluded as drivers who use seatbelt are less involved in risky and aggressive driving behaviors. Wearing a seat belt raises the risk perception linked with probable crashes. This increased awareness can lead to more cautious driving behavior, such as driving at slower speeds, keeping a safe distance from other vehicles, and following traffic rules. Drivers receiving prior training either from friends, relatives or training institutes negatively influenced the risky driving while, motorists which got training from government driving centers negatively influenced aggressive driving behavior. Whereas, it had no significant influence on negative emotional driving. It can be concluded that drivers who have got training either from a driving school or a friend and relative are not much engaged in risky and aggressive driving habits in contrast to motorists without appropriate training. Driving training can improve abilities, improve perceived risk, promote considerate approach, and build a cautious driving ethos, all of which can have a beneficial and long-term impact on dangerous driving behaviors and improve road safety [36].

Sociodemographic characteristics can potentially be capable to characterize risky driving behaviors, according to prior research [13]. Among sociodemographic variables, age was the significant predictor of risky, negative emotional and aggressive driving. It is believed that younger drivers exhibit more dangerous and risky behaviors as compared to elderly one [5, 6, 13], the outcomes of current research were also intuitive with prior research. The reason could be argued as the higher percentage of young drivers (58.7%) in our sample as compared to elderly ones. Whereas, males emerged key indicator of aggressive and risky driving behaviors only. In our data set female driver representation is very less (18.8%) in contrast to males (81.2%). One possible explanation is that cultural norms make it so that women are not allowed to drive as much as men in the country [37]. Males involvement in aggressive driving behaviors was significantly high with regard to females in the current work, this is also intuitive with prior work of Iliescu and Sarbescu [13]. Driving experience significantly influenced the aggressive and risky driving behavior while having no significant influence on negative emotional driving. It can be concluded that young and inexperienced drivers committed higher aggressive driving traits as reported in previous studies by Ellison-Potter, Bell [38] and Iliescu and Sarbescu [13] as well. Therefore, it could be argued that age, gender, lack of driving training, inexperience and non-usage of seat belt are the significant predictors of dangerous driving traits among Pakistani motorists.

To find the predictors of crash involvement, the dangerous driving behaviors, socio demographic variables, sea belt, driving license and driving training were introduced into binary logistic regression model. Crash involvement was introduced as dependent variable while others (dangerous driving behaviors, socio demographic variables, sea belt, driving license and driver training) as independent variable in the model. Aggressive driving and risky driving emerged as a key metric of crash incidence. Whereas, negative emotional trait showed no prominent effect on crash

involvement. Aggressive and risky driving behavior has been reported as a significant contributor of traffic crash by various previous researches as well [39-41]. Many studies concluded that socio-demographic variables are predictors of traffic crashes [10, 42, 43]. Sociodemographic variables along with seatbelt and driver training variables were also studied to predict the traffic crashes in this study. Using seat belt while driving (as a predictor variable) negatively effects the traffic crashes. It can be argued that people violating the seat belt usage law indulge in traffic crashes (severe injury) in contrast to those who abide by this law which is consistent with the fact that in USA, out of all the vehicle occupants killed 51.1% were not wearing seat belt during year 2020 [16]. The seat belt usage law [17] exists in country but its implementation is limited i.e. is only on highways and motorways under the control of national highway and motorway police (NH&MP) while on local roads or roads with less importance the implementation level is very low [35, 44]. Wearing a seat belt should be a constant reminder to drive responsibly and safely. By associating this crucial safety step with the knowledge that the motorist has already completed it, this mental link may deter them from participating in unsafe activities. Among demographic variables, only drivers age emerged to be a key negative metric of traffic crashes. Which can be argued as the with the increase in drivers age the probability of involvement in traffic crashes reduces as reported by Regev, Rolison [45].

This research set out to do a few things, one of which was to explore the risky driving habits of people from China and Pakistan. In contrast to Chinese motorists' Pakistani motorists emerged to be more aggressive and risk takers which, is also evident from the mean item score comparison between both countries. The possible reason for such a trend can be attributed to the Limited comprehensive and standardized driving instruction and learning initiatives, uneven traffic law enforcement, insufficient road infrastructure, and no public awareness initiatives. The Chinese drivers on the other hand are found to be more disciplined and less aggressive due to the stringent measures being taken in country to improve road safety. Therefore, it can be concluded that Pakistani motorists are more aggressive and reckless, which is a substantial risk to the road safety for cross border travels between both countries after the completion of CPEC project.

## 5. Conclusions

The current study is the first to utilize the Dula dangerous driving index (DDDI) to identify the dangerous driving behaviors in Pakistan. In context of Pakistani drivers dangerous driving behaviors, the DDDI demonstrates good internal consistency and validity. Thus, the DDDI is useful tool for Pakistani researchers examining the driving behaviors. Also, this study used seatbelt and driving training as predictors of dangerous driving behaviors and road traffic crashes first time in context of Pakistani drivers. This study also compared the dangerous driving behaviors of motorists in China and Pakistan to find the differences in driving behaviors. The study also offers important practical suggestions for improving road safety and crash reduction. The road safety agencies and authorities can further improve the road safety in the country by utilizing the findings of this study which provides ample knowledge about the dangerous riding habits of motorists in Pakistan. Based on the findings it is recommended that current policies related to road safety should be revised to promote safer transportation system at the cost of minimal casualties. It is also highlighted that transportation agencies should make interventions in order to give safe and effective transportation system for general public. In order to control dangerous driving behaviors, government officials must get insight from comparable experiences in other nations e.g., China.

## 6. Limitations

This research comes with certain drawbacks. The main limitation is the dependence on motorists' self-reports to determine crashes and illicit driving habits, a cost-effective method but often presumed to be biased. Although, the findings of our study relied upon 623 individuals (80% male) in which female representation is very limited in case of Pakistani sample therefore, it is presumed

that future researches with increased female representation could better implicate the results for whole population. This DDDI measure has been used very little to explore dangerous driving behaviors in Pakistan, and extensive studies are recommended to validate it for the country, focusing particularly on negative emotional driving and commercial vehicle drivers.

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## Abbreviations

The following abbreviations are used in this manuscript:

| | |
|---|---|
| DDDI | Dula Dangerous Driving Index |
| CPEC | China Pakistan Economic Corridor |
| AD | Aggressive driving |
| RD | Risky driving |
| NE | Negative Emotions |
| GLM | Generalized linear model |

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