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Exploring the Factor Structure of a Modified Motorcyclist Behavior Questionnaire: Croatian Context

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Abstract

Road crashes, particularly those involving vulnerable road users, such as motorcyclists, are a major public concern worldwide, especially on rural roads. To understand the factors contributing to the heightened risk experienced by motorcyclists, a survey was conducted among motorcycle riders. The Motorcycle Rider Behavior Questionnaire (MRBQ), a widely used self-report instrument, was employed to gather insights into motorcyclists' perspectives, behaviors, and attitudes regarding road safety. This study focused on the factor structure of the MRBQ within the context of Croatia. Principal component analysis (PCA) with varimax rotation was performed to examine the underlying factors of motorcyclist behavior. Five distinct factors were identified: violations (e.g., speeding and reckless riding), errors (e.g., risky maneuvers and inattention), stunts (e.g., wheelie), safety equipment (e.g., use of protective gear), and substance use (e.g., riding under influence). These factors explained 40.44% of the variance among the analyzed items. These findings contribute to the understanding of motorcycle rider behavior patterns. Future research will explore the relationship between these factors and motorcyclists' involvement in risky situations and crashes.

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Keywords: Motorcycle; motorcyclist safety; rider; behavior questionnaire

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1. Introduction

Road crashes pose a significant global public health concern, resulting in approximately 1.3 million of fatalities each year, according to the World Health Organization's report (2022). Vulnerable road users, including pedestrians, cyclists, and motorcyclists, account for a substantial proportion of these fatalities. According to the Global Status Report on Road Safety 2018 (2018), motorcyclists account for approximately 23% of global road traffic deaths. In the European Union (EU27) alone, motorcyclists accounted for 16% of all road fatalities in 2019. While the number of motorcycle fatalities exhibited a reduction of 14% between 2010 and 2019, the overall decrease in total road fatalities was 23%. Consequently, the relative proportion of motorcycle fatalities among the total number of road fatalities increased from 14% in 2010 to 16% in 2019. Analysis of the data revealed that rural roads consistently recorded the highest number of motorcycle road fatalities, followed by urban roads and motorways. Specifically, road stretches accounted for the majority of motorcycle fatalities (71%), with fewer incidents occurring at junctions (19%) or roundabouts (2%), as listed in Facts and Figures – Motorcyclists and Moped Riders - 2021 (2021). These statistics emphasize the urgent need for comprehensive research and evidence-based strategies to improve the road safety of motorcyclists and reduce their vulnerability to different types of road sections.

Road safety is a multidimensional concern that requires scientific examination and targeted interventions to address the distinctive risks faced by motorcyclists. With their inherent vulnerability and exposure to various environmental and traffic factors, motorcyclists experience higher crash rates and injury severity than other road users. To address this critical issue, this study aimed to investigate the factors contributing to the heightened risk experienced by motorcyclists. By conducting a survey among motorcyclists, this research seeks to gather valuable insights into their perspectives, behaviors, and attitudes regarding road safety. Numerous studies have shown that examining rider behavior and factors that affect their decision-making is necessary to determine the directions of interventions and strategies that can be used to improve the safety of motorcyclists.

The motorcycle rider behavior questionnaire (MRBQ) has become a common self-report instrument for investigating the factors influencing motorcyclist safety and risk-taking tendencies on the road. Its development followed the driver behavior questionnaire, a widely used instrument for investigating driving behaviors in four-wheeled vehicles utilized by Reason et al. (1990). The authors categorized deviant car driving behaviors based on a system of errors and violations, defining errors as "failure of planned actions to achieve their intended consequences" and violations as "deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system". Further, errors were divided into slips and errors ("the unwitting deviation of action from intention") and mistakes ("the departure of planned actions from some satisfactory path towards a desired goal"). After a principal component analysis with varimax rotation and a scree plot applied to the 43 MRBQ items, Elliott et al. (2007) concluded that the data were best fitted by a 5-factor solution, indicating that there were five main behavior types supporting the MRBQ. A similar approach has been used over the past 15 years by other authors worldwide. Some of the researchers used the same questionnaire items, like Özkan et al. (2012), Sakashita et al. (2014), and Stephens et al. (2017), but some authors have added additional items, for instance, Motevalian et al. (2011) and Setoodehzadeh et al. (2021).

This paper represents the first phase of wider research that deals with the behavior and perception of motorcyclists in Europe. For this reason, only an MRBQ part of the survey will be analyzed. In future phases, a connection between self-assessed behavior and involvement in risky situations and crashes will be investigated. The objective of this paper is to examine and analyze the factor structure of the MRBQ specifically within the context of Croatia, where the questionnaire was administered. By exploring the underlying factors and dimensions of motorcyclist behavior as captured by the MRBQ, this research aims to contribute to the understanding of motorcycle rider behavior patterns. The findings will shed light on the psychometric properties and structure of the MRBQ instrument when applied to a sample of motorcyclists from Croatia, providing valuable insights into the factors influencing motorcycle rider behavior and facilitating targeted interventions for enhancing road safety in the region.

2. Methodology

A questionnaire specifically designed for motorcycle riders was developed to gain insights into further research on motorcycle rider safety. An online survey was conducted to collect data from the participants. Additionally, principal component analysis (PCA) was performed to examine the underlying factors of the questionnaire items.

2.1. Questionnaire design

This study was based on a questionnaire consisting of four major sections: sociodemographic characteristics, Motorcycle Rider Behavior Questionnaire (MRBQ), road perception, and past crash involvement. The present article focuses on the analysis of the section pertaining to motorcycle rider behavior (MRBQ). The MRBQ was developed based on a study conducted by Elliot et al. (2007), which incorporated 40 questions of 43 questions used in the original MRBQ. An additional 15 new items were added to expand the original questionnaire and to gain new insights. The questionnaire was originally composed in English and translated into Croatian for the purposes of research conducted in Croatia. All questionnaire items were formulated as declarative statements, and respondents rated their agreement with each statement on a Likert scale ranging from one to six.

2.2. Participants and data collection

The inclusion criteria for participant selection required that individuals be of legal age and possess a valid motorcycle driver's license. These criteria ensured that participants had the necessary legal qualifications and experience to engage in motorcycle riding activities, thus enabling them to provide valuable insights into motorcycle rider behavior and perceptions.

The data used in this paper were collected in Croatia between January and May 2023. Participants were recruited from various motorcycle clubs and online platforms, utilizing link sharing as a means of participation. The recruitment strategy aimed to obtain a diverse and representative sample of motorcycle riders in Croatia. Each participant received a unique link to access and complete the questionnaire, which had an average completion time of 33,84 minutes (SD = 126,14). The use of a unique link for participation allowed the management of participant responses, ensuring data integrity and privacy.

The sample consisted of 906 participants who answered all the questions regarding their riding behavior. Among them, 125 (13.8%) were female, 775 (85.5%) were male, and six (0.7%) preferred not to declare their gender. After excluding three participants with invalid responses, the ages of the participants ranged from 18 to 75 years, with a mean of 37.44 years (SD = 11.04).

2.3. Data analysis

Principal component analysis (PCA) with varimax rotation was conducted to examine the structure of different types of motorcycle rider behavior. Prior to analysis, the number of factors that best explained the data structure was explored using several criteria. Principal component analysis (PCA) is a widely used statistical technique used to examine the underlying structure of a dataset. According to various researchers, like Campos et al. (2020) and Watkins (2018), it aims to reduce the dimensionality of the data while preserving as much information as possible by transforming the original variables into a new set of uncorrelated variables called principal components. Varimax rotation is a rotation method applied to the principal components obtained from the PCA. Rotation helps to obtain a simpler and more interpretable factor structure by maximizing the variance of squared loadings within each factor while minimizing correlations between factors. The final factor structure was assessed based on the item loadings. Each item was evaluated to determine its factor membership by examining the loading values. Factor loading represents the strength of the relationship between a questionnaire item and a factor. Items with higher loadings for a particular factor indicated a stronger association with that factor. A factor loading close to 1 indicates a strong positive relationship, a factor loading close to -1 indicates a strong negative relationship, and factor loadings close to 0 suggest a weak or negligible relationship. Item loading values of 0.3 were used as a cut-off point.

3. Results and discussion

Questionnaire responses were collected from a sample of participants who were asked to rate their driving behaviors on a 6-point Likert scale, which is commonly used in similar studies made by Elliott et al. (2007), Motevalian et al. (2011), Sakashita et al. (2014) and Uttra et al. (2020). To analyze the data, PCA was performed to identify the underlying factors that explain the patterns of responses across the questionnaire items.

Parallel analysis indicated that there are seven components that can be extracted from the data. However, the eigenvalues of the sixth and seventh factors were very close to those of the simulated data and the Velicer MAP criteria indicated six factors. In the seven-factor solution, only two items were loaded on one of the factors, and in the six-factor solution sixth factor was not interpretable; therefore, results were obtained for the five-factor solution. The total variance of the items included in the analysis explained by the five factors was 40.44%. In the rotated solution, the variances explained by the first, second, third, fourth, and fifth factors were 13.38%, 8.82%, 7.69%, 6.16%, and 4.39%, respectively.

The loadings for these five factors are listed in Table 1. Each of the factors had several items loaded on it, making them stable. In the case of the first three factors, there were items that loaded highly only on them, but there were also items with relatively high cross-loadings. According to the obtained item loadings, 12 items were loaded onto Factor 1, 12 items were loaded onto Factor 2, five onto Factor 3, four onto Factor 4, and five onto Factor 5. Nine analyzed factors loaded onto two or more factors, while there were six items without high loadings on any of the extracted factors. The fourth and fifth factors had a clear structure, with items that loaded highly only on each of them.

Table 1. Factor loadings from principal components analysis with varimax rotation

Questionnaire item	1	2	3	4	5
Q25_2 Exceeding the speed limit on a country/rural road/outside the urban area.	**0.82**	0.10	-0.02	-0.04	-0.15
Q25_1 Exceeding the speed limit on a motorway/highway.	**0.80**	0.06	0.07	0.01	-0.09
Q25_3 Exceeding the speed limit on an urban/city road/residential area.	**0.76**	0.08	-0.06	-0.12	-0.01
Q25_5 Opening up the throttle and "going for it" on rural/country roads.	**0.74**	0.11	0.21	-0.09	0.05
Q25_4 Disregarding the speed limit late at night or in the early hours of the morning.	**0.74**	0.09	0.04	-0.12	0.05
Q22_6* Start overtaking a slower vehicle in front, even though this is prohibited.	**0.70**	0.13	0.20	-0.05	0.08
Q22_7* Start overtaking a slower queue of three or more vehicles in front.	**0.66**	0.08	0.21	0.02	0.15
Q24_5* Overtaking another vehicle at a short distance/slalom riding.	**0.58**	0.10	**0.48**	-0.06	0.15
Q22_10* Turning onto the main road from a side road without stopping at the "Stop" sign.	**0.52**	0.22	0.05	-0.14	0.10
Q25_6* Disregarding the speed limit during rainy conditions.	**0.52**	0.11	0.12	0.00	0.20
Q22_9* Merging from a side road onto the main road while seeing vehicles approaching on the lane I am merging to.	**0.47**	0.18	0.03	-0.08	0.26
Q24_7 Ride between two lanes of fast-moving traffic.	**0.46**	0.10	**0.31**	-0.01	**0.31**
Q22_8 Attempt to overtake someone that you had not noticed to be signaling a right turn.	**0.46**	0.20	0.11	-0.03	0.19
Q24_6 Race away from traffic lights with the intention of beating the driver/rider next to you.	**0.45**	0.17	**0.32**	-0.09	0.14
Q23_7 Riding so close to the vehicle in front that it would be difficult to stop in an emergency.	**0.44**	**0.35**	0.24	-0.03	0.10
Q22_1* Not maintaining a sufficient safety distance between vehicles.	**0.40**	0.14	0.19	-0.01	0.09
Q23_5 Slipping on a wet road, manhole covers, road markings, etc.	**0.32**	0.29	**0.32**	0.07	-0.06
Q22_3* Not using direction indicators (so-called blinkers) when turning or changing lanes.	0.28	0.23	0.19	-0.15	0.11
Q23_6 Changing gear around a curve/corner.	0.18	0.15	0.10	0.12	0.14
Q22_20 Not notice someone stepping out from behind a parked vehicle until it is nearly too late.	0.11	**0.68**	-0.03	0.00	0.08
Q22_19 Fail to notice that pedestrians are crossing when turning into a side street from a main road.	0.14	**0.65**	-0.04	-0.03	0.06

Q22_14 Distracted or pre-occupied, you belatedly realize that the vehicle in front has slowed and you have to brake hard to avoid a collision.	0.17	**0.62**	0.06	-0.09	0.03
Q22_21 Not notice a pedestrian waiting to cross at a zebra crossing, or a pelican crossing that has just turned red.	0.22	**0.60**	0.04	-0.11	-0.05
Q22_15 When riding at the same speed as other traffic, you find it difficult to stop in time when a traffic light has turned against you.	0.03	**0.58**	-0.02	-0.03	0.04
Q23_2 Run wide when going round a corner.	0.14	**0.54**	0.12	-0.02	-0.03
Q22_11 Pull out on to a main road in front of a vehicle that you had not noticed, or whose speed you have misjudged.	0.21	**0.54**	0.09	-0.07	0.23
Q22_13 Queuing to turn left on a main road, you pay such close attention to the main traffic that you nearly hit the vehicle in front.	0.05	**0.49**	0.11	0.03	0.06
Q23_3 Having difficulty controlling the motorcycle while riding at high speed (e.g., steering wobble).	0.04	**0.49**	0.21	-0.01	0.13
Q22_12 Miss “Give Way” signs and narrowly avoid colliding with traffic having the right of way.	0.14	**0.47**	0.06	-0.04	0.28
Q23_8* Braking too quickly on a slippery road.	0.19	**0.45**	0.23	-0.04	0.11
Q23_1 Riding so fast into a curve that I feel like I might lose control.	**0.36**	**0.44**	**0.40**	0.00	-0.06
Q22_2 Fail to notice or anticipate that another vehicle might pull out in front of you and have difficulty stopping.	0.02	**0.42**	0.09	-0.08	0.11
Q23_4 Riding so fast into a curve/corner that I have to brake or throttle-back round it.	**0.33**	**0.37**	0.23	0.00	-0.03
Q22_5* Not using mirrors to check the vehicles surrounding me while riding or turning.	0.04	0.29	0.20	-0.11	0.11
Q26_10 Have trouble with your visor or goggles fogging up.	0.01	0.19	-0.03	-0.09	-0.04
Q24_3 Pulling away too quickly, and my front wheel coming off the road (lifts).	0.27	0.06	**0.82**	-0.07	0.09
Q24_1 Attempting to or actually doing a wheelie (a trick or maneuver whereby a bicycle or motorcycle is ridden for a short distance with the front wheel raised off the ground).	0.19	0.02	**0.80**	-0.09	0.05
Q24_2 Intentionally doing a wheel spin.	0.19	0.09	**0.71**	-0.16	0.10
Q24_4* Braking too rapidly with the front brake, and my rear wheel going up in the air.	0.07	0.12	**0.71**	0.05	0.14
Q24_8 Get involved in unofficial ‘races’ with other riders or drivers.	**0.42**	0.15	**0.52**	-0.10	0.20
Q23_9 Unintentionally doing a wheel spin.	0.14	0.24	**0.51**	-0.01	-0.11
Q26_11 Use dipped headlights on your motorcycle.	0.12	0.00	-0.17	0.15	-0.15
Q26_3 Wear protective trousers (leather or non-leather).	-0.11	-0.05	-0.01	**0.80**	0.01
Q26_4 Wear riding shoes / boots.	-0.05	-0.11	0.00	**0.76**	0.01
Q26_2 Wear a protective jacket (leather or non-leather).	0.00	-0.09	-0.13	**0.70**	-0.12
Q26_5 Wear motorcyclist gloves.	0.00	-0.07	-0.14	**0.61**	-0.10
Q26_6 Wear body armor to protect elbows, knees, shoulders, etc.	-0.10	-0.11	0.09	**0.60**	0.03
Q26_8 Wear bright/fluorescent or reflective markings /strips on your clothing or helmet.	-0.26	0.00	-0.01	**0.51**	-0.06
Q26_7 Wear fluorescent clothing / helmet or reflective vest / clothing / helmet.	-0.29	0.03	-0.01	**0.48**	-0.08
Q26_1* Wear a protective helmet.	0.10	0.02	-0.10	**0.34**	-0.20
Q26_9 Wear no protective clothing.	-0.03	0.13	0.02	-0.19	0.03
Q22_18 Ride when you suspect you might be over the legal limit for alcohol.	0.25	0.13	0.01	-0.05	**0.79**
Q22_16* Immediately before driving a motorcycle, I consumed alcohol. Hence, I drove under the influence of alcohol.	0.23	0.10	-0.03	-0.10	**0.78**
Q22_17* I consumed light/heavy drugs, strong medicaments, or other intoxicants and drove under the influence of drugs and strong medicaments.	0.05	0.13	0.14	-0.16	**0.47**
Q22_4* Going through a red light.	0.15	0.18	0.18	-0.17	**0.40**

Note. Loadings greater than 0.30 are typed in bold.
* - new questionnaire items

Items associated with the first factor refer mainly to speeding and reckless riding, that is, deliberate disregard for riding that would be considered safe. This factor is consistent with the previously defined "Violations". The highest

loadings within Factor 1 are associated with items that are related to exceeding speed limits under various road conditions. Twelve items loaded on Factor 2 mainly represented risky maneuvers, inattention, and the distraction of riders, and well represent situations that can be characterized as "Errors". Items with high positive loadings in Factor 3 include maneuvers with a motorcycle, which can be labeled as "Stunts", for example, wheelie. There are five items with loadings clearly related to the third factor. As mentioned earlier, the fourth and fifth factors had a clear structure according to the analysis performed. Factor 4 relates to the use of protective motorcycle gear, including helmets, jackets, gloves, and additional protective equipment, so it can be labeled as “Safety equipment”. Items with high positive loadings in Factor 5 are associated with risky behaviors such as riding under the influence of alcohol, drugs, or medications. However, one of the items (Q22_4) could not be related to substance misuse.

The five factors accounted for a total variance of 40.44% among the analyzed items, which is a percentage comparable to previous studies: Elliott et al. (2007), Motevalian et al. (2011), and Trung Bui et al. (2020). Further, Motevalian et al. (2011) in a Persian version of the MRBQ showed a six-factor, while structure Hosseinpourfeizi et al. (2018) developed a shortened version of the MRBQ which included 23 questionnaire items showed a three-factor structure. The study from Vietnam by Trung Bui et al. (2020), which utilized 43 items from the original MRBQ, revealed a four-factor structure, with six items displaying low weights that were not associated with any factor, while one item exhibited loading across multiple factors, which is similar to results obtained from a study from Nigeria executed by Sunday (2010). On the other hand, a 43-item MRBQ adapted to the Indian context by Sumit et al. (2021) revealed a five-factor structure, similar to the one in the original questionnaire.

The results presented in this paper are in line with previous research, although they do exhibit slight variations, which was anticipated considering that the existing literature emphasizes the existence of differences among motorcyclists depending on the region under study.

In future research, the identified factors will continue to provide valuable insights into the structure of motorcycle rider behavior, shedding light on the distinct dimensions that influence rider actions and choices. According to the presented values, the final structure of the questionnaire (without items that do not belong to any factor and without items that showed high cross-loadings) contains a total of 41 items in five factors. Of these, 12 are new and 29 items are from the original MRBQ. The refinement process focuses on the most relevant questionnaire items that demonstrate strong associations with the underlying factors. By omitting items with low loading values, the precision and validity of the questionnaire can be improved, thereby facilitating a clearer understanding of motorcycle rider behavior. The next step in the research will involve investigating the relationship between the obtained factors and motorcyclists’ self-reported risky situations, such as involvement in crashes and penalties for traffic violations.

4. Conclusion

In conclusion, this study examined the factors influencing motorcycle rider behavior with the aim of enhancing the road safety of motorcyclists. The analysis of data collected from a sample of motorcycle riders in Croatia revealed a five-factor structure of motorcycle rider behavior, similar to the original motorcycle rider behavior questionnaire (MRBQ). The factors identified could be grouped as “Violations” representing deliberate disregard for safe riding practices; “Errors” encompassing risky maneuvers, inattention, and distractions; “Stunts” related to motorcycle maneuvers such as wheelies; “Safety equipment” reflecting the use of protective gear; and “Substances misuse” associated with riding under the influence of alcohol, drugs, or medications.

These findings contribute to the existing body of research on motorcycle rider behavior by providing insights specific to the Croatian context. The results align with those of previous studies, demonstrating both consistency and slight variations in the factor structure of motorcycle rider behavior across different regions.

The identification of these factors offers valuable insights into the dimensions that influence rider actions and choices. By refining the questionnaire based on the omitting items with low loading values or cross-values, the precision and validity of the MRBQ could be enhanced, facilitating a clearer assessment of motorcycle rider behavior. In future research, the relationship between the identified factors and motorcyclists' self-reported risky situations, such as involvement in crashes and traffic violations, will be explored. This will provide further evidence of the impact of motorcycle rider behavior on road safety outcomes. Overall, this study contributes to the broader goal of reducing the vulnerability of motorcyclists and improving their road safety. By addressing the distinct risks faced by motorcyclists and understanding the factors that influence their behavior, evidence-based interventions can be developed to promote safer riding practices and ultimately reduce motorcycle-related injuries and fatalities.

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