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Which unsafe riding behaviours are associated with traffic offences and crashes? A study of young Indonesian motorcyclists

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Abstract

Indonesia has high motorcycle dependence, especially among young riders who rely on them for access to education. The number of young riders aged 15-19 involved in crashes is higher than in any other age group. Despite this, there have been limited attempts to comprehensively understand the behaviour of these road users. This study is the first to use the Motorcycle Rider Behaviour Questionnaire (MRBQ) to determine which rider behaviours may predict crash risk in an Indonesian population. In addition, the impact of demographic variables such as age, gender, licensing status (licensed or unlicensed) and area of residence (urban or rural) on young Indonesian riders (N= 7,081) crash risk was also examined. Negative binomial regression analysis revealed that crash risk was positively associated with both intentional and unintentional unsafe behaviours, including “errors”, “speed”, and “unsociable riding”. Interestingly, a common theme in the “errors” identified involved the participant not paying attention to their surroundings. This suggests that even though these errors may be unintentional, there is a possibility to develop targeted safety interventions, such as combined rider awareness and riding skills training. Finally, the results revealed that many of those surveyed were riding on public roads before they reached the legal age for riding, and failed to obtain a license even when they could legally do so. Overall, this study provides valuable insights into the factors affecting the safety of young motorcyclists in Indonesia, taking into account the culture and environmental considerations unique to this country.

Keywords

Motorcycle Rider Behaviour Questionnaire; Young Rider; Developing Country; Motorcycle Crash; Traffic Offence.

1. Introduction

As reported in the Global Status Report on Road Safety (World Health Organization, 2023), there have been slight reductions in the number of annual road traffic deaths, from 1.35 million to 1.19 million between 2018 and 2023. However, among children and young people aged 5 to 29, traffic-related injuries remain to be the major cause of death. Indonesia is the largest country in the region of South-East Asia (Zain et al., 2021) and the fourth most populated country in the world (World Bank Group, 2023) with a population of around 270 million in 2020 (Indonesia Central Bureau of Statistics, 2021). In 2018, the 15-19 years old group was the most crash-involved age group (see Figure 1), while motorcyclists were the most involved user group (see Figure 2).

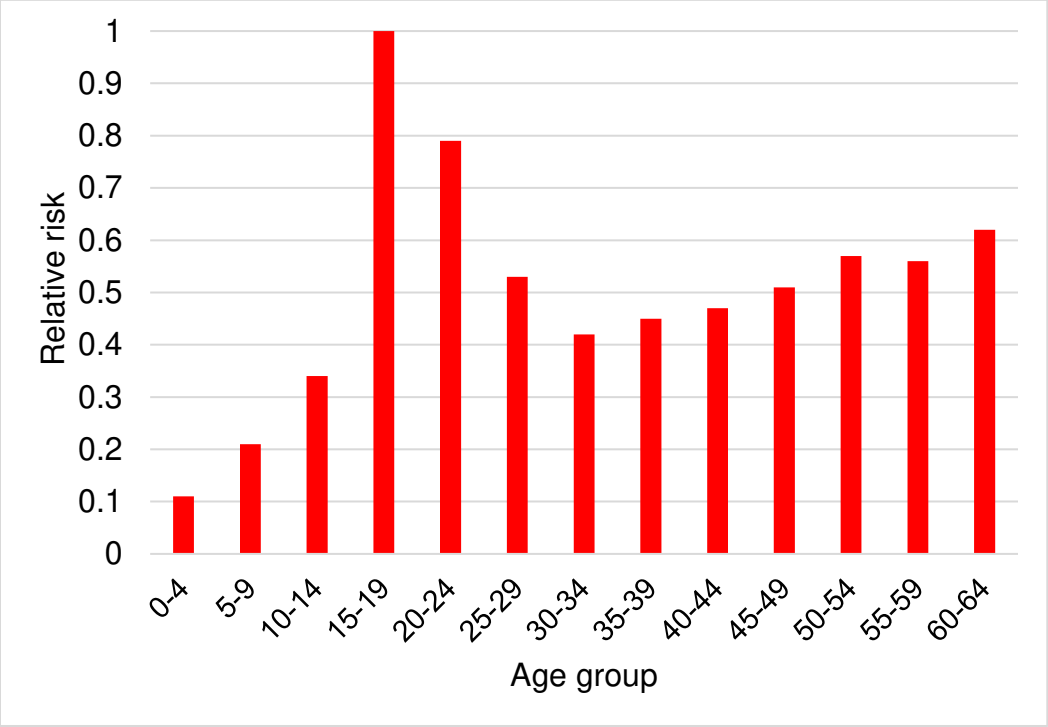

Figure 1: Relative risk of crashes by age group in 2018 with 15-19 as reference (Indonesia National Traffic Police, 2019)

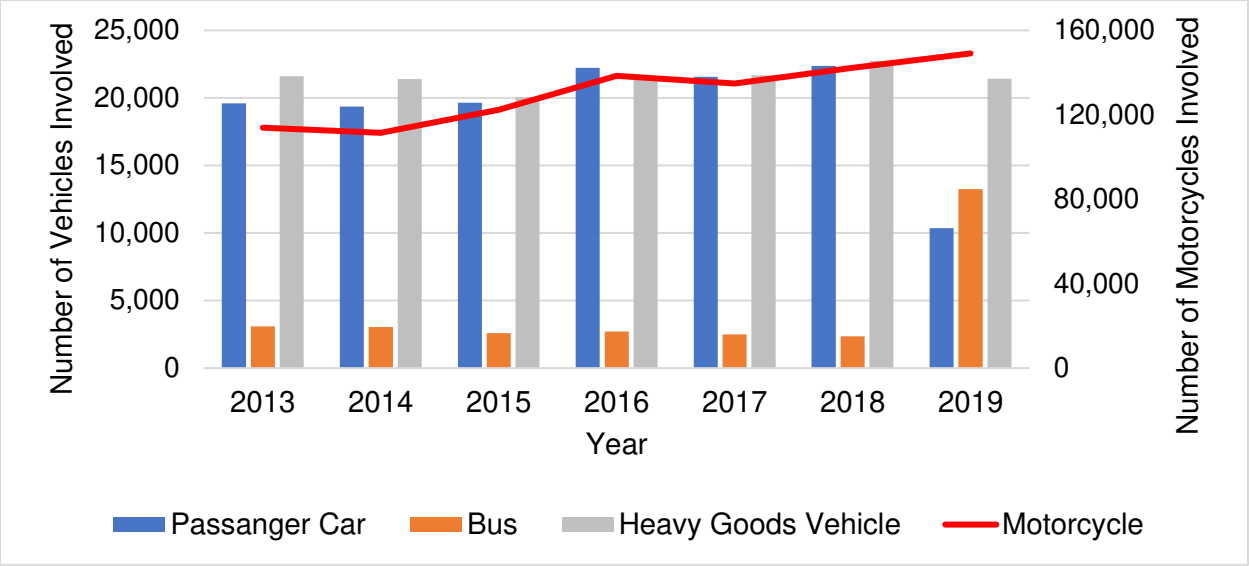

Figure 2: Number of vehicles involved in a crash by vehicle category (scale for passenger cars, buses, and heavy goods vehicles on the left of the figure, while the scale for motorcycle involvement is on the right)

Young people's extensive involvement in crashes is a complex problem that requires a comprehensive approach (Cassarino & Murphy, 2018). However, developing a comprehensive approach for young Indonesian riders has unique challenges. Generally, the contributory factors to road crashes are categorised into three main factors: (1) road environment factors, (2) vehicle factors, and (3) human factors (Indriastuti and Sulistio, 2010 and Setyowati et al., 2018). The Republic of Indonesia Police Regulation (PERPOL) No.5 of 2021 Article 8 verse A states that 17 is the minimum age to apply for a motorcycle license in Indonesia (PERPOL, 2021). However, insufficient public transport infrastructure, school environments / access to education, and family factors means that young, unlicensed riders are frequently present on public roads (Yeh et al., 2008; Nurlia et al., 2017; Anggraeni, 2019). Based on Legislation No. 22 of 2009 Article 77 verse 1 about Traffic and Road Transport (Republic of Indonesia, 2009), it is stated that every person driving a motorised vehicle on the road is required to have a driving license

following the type of motor vehicle being driven. In reality, although riders aged 17 and above are eligible for a license, many riders do not apply for various reasons, including a belief that it is a complicated procedure (Siswantoro, 2018).

While 57% of two-vehicle crashes involving a motorcycle are caused by car drivers (Shaheed et al., 2013), research has also shown that motorcyclist risk-taking behaviour has been found to play a major role in motorcycle crashes (Lin and Kraus, 2009). Risk-taking behaviour in general increases during adolescence as a result of biological changes in the brain's socio-emotional system, exhibiting a greater reward-seeking desire, especially in the presence of peers, environmental exposures, and cultural and familial influences (Steinberg, 2008).

Understanding what causes crashes amongst young riders can be key in improving traffic safety strategies (Dobson et al., 1999; Lin et al., 2003). However, there has been little research on the safety of young motorcyclists in Low- and Middle-Income Countries (Akasreku et al., 2023). The necessity for a tool that enhances knowledge of the significance of human factors in motorcycle crashes led to the development of the Motorcycle Rider Behaviour Questionnaire (MRBQ). The MRBQ was first developed by Elliott et al. (2007) in the UK to measure and determine which rider's behaviour may predict crash risk, along similar lines to the Driver Behaviour Questionnaire developed by Reason et al. (1990). Since the development of MRBQ for UK riders in 2007, many researchers have used it to study motorcyclist behaviour. The research has ranged from testing its applicability in different countries (Ozkan et al., 2012; Trung Bui et al., 2020; Uttra et al., 2020), predicting the occurrence of crashes, near-crashes and traffic offences

(Sakashita et al., 2014; Stephens et al., 2017; Schreurs et al., 2023), and exploring the risky riding behaviour of the riders (Chouhan et al., 2021).

However, mixed findings about which MRBQ factors can better predict crash involvement were found (Stephens et al., 2017; Sakashita et al., 2014; Sunday and Akintola 2011). The diverse MRBQ findings across regions reflects the significant differences among socio-economic and demographic factors in traffic safety (Chakraborty and Maitra, 2024). Furthermore, several studies have facilitated the idea of adopting the MRBQ to analyse the behaviour of riders in countries with high motorcycle dependence (Hsu et al., 2003), between countries with different cultures (Özkan et al., 2012) and with large samples (Chouhan et al., 2023).

To our knowledge, there are only three studies which have applied the MBRQ in the Indonesian context (Setyowati et al, 2024; Putranto et al. 2014; Putranto and Anjaya 2014). However, all these three previous studies only used the MRBQ to assess rider's attitude and behaviour and did not attempt to discover the relationship between MRBQ factors and crash involvement. Therefore, in the Indonesian context, it is still unknown which factors can best predict crash involvement.

Gaining a deeper understanding about this relationship is important for Indonesian practitioners and policymakers to enhance the safety of young motorcyclists, an area which has consistently been a road safety issue in Indonesia. Additionally, previous research argued for additional validation of the MRBQ in other geographic settings due to the cross-national discrepancies that have been recorded in the previous studies (Schreurs et al., 2023). With this background, the aims of current study are to: (a)

investigate the most appropriate factor structure of the modified MRBQ among young riders from Indonesia; and (b) investigate whether or not the extracted factors are associated with traffic offences, near crash, and crash experience among young Indonesian riders.

2. Methodology

2.1. Development of the questionnaire

The first MRBQ contained 43 items that measure aberrant riding behaviours and the use of safety equipment. The most recent study concluded that the MRBQ has its merits in terms of both construct and predictive validity (Schreurs et al., 2023). Indeed, a recent meta-analysis study by Chouhan et al. (2023), which argued that MRBQ has a low predictive ability for crashes, still found that the *"speed violation"* factor could significantly predict self-reported crashes.

Because the original MRBQ study was designed to investigate rider behaviour in a developed country (UK), it was anticipated that there would be some characteristics of riders in developing countries that were not mentioned in the original survey. Two items from the original study were not included in the present study. The item "exceed the speed limit on a motorway" was excluded because the speed limit and the definition of motorway in UK road is similar to the toll road in Indonesia where motorcycles (regardless of their engine capacity) being prohibited to enter the road, and the item "wear a leather one-piece suit" was also removed because it is highly unlikely for students to wear such safety equipment due to the climate in Indonesia. Items related to wearing leather suits were also not considered in India's MRBQ study due to the weather (Chouhan et al., 2021).

Furthermore, 13 additional items were included in the final survey - nine items from a previous Indonesian MRBQ study by Putranto and Anjaya (2014); and four items gathered from informal conversations with Indonesian traffic police. In total, for the present study, 54 items were used. There were three items that could pose difficulty in interpretation due to them being unusual in the Indonesian riding context. These were re-worded to be more easily understood (see Table 1). The list of 54 items is presented in Table 8 in the appendix. The items were first translated from English to Bahasa (Indonesia language) and back-translated to English by another person who was fluent in both languages to check for correct translation.

Table 1: Modified MRBQ items

Original MRBQ	**Modified Indonesian MRBQ**
Wear bright/fluorescent clothing	Wear bright/fluorescent clothing when riding at night
Another driver deliberately annoys you or puts you at risk	You get annoyed when other road users put you at risk
Ride when you suspect you might be over the legal limit for alcohol	Ride after having an alcohol drink

Besides the MRBQ items, the questionnaire also included items regarding rider's demographics, riding activity, traffic violation, near crash and crash involvement in the past 12 months. The questions included demographic variables such as age, gender, licensing status (licensed or unlicensed) and area of residence (urban or rural). The information about the area of residence was used as a proxy for where the riders mostly rode their motorcycle, based on the premise that the Minister of Education and Culture of the Republic of Indonesia Regulation (PERMENDIKBUD) Number 14 of 2018 states that 90% of a school's capacity should consist of students who live in the proximity (PERMENDIKBUD, 2018). For the details related to their riding activity, participants were

asked to provide information about their motorcycle, the main purpose of riding, average riding hours per week and average kilometres per week. Information about how long they have been riding actively on public roads was also obtained to estimate riding experience.

Moreover, participants were also asked to provide information about their traffic violations that received a fine from the traffic police, as well as near crash and crash experiences in the past twelve months measured as 0 (never), 1 (once), 2 (twice), and 3 or more. The occurrence of crashes is limited, and previous studies found that there is an association between reported traffic offences and reported crashes (Lawton et al., 1997a; Parker et al., 1995) as well as strong frequency relationship between crashes and near- crashes (Guo et al., 2010; Wu et al., 2014). Therefore, separating these three aspects could provide a more comprehensive understanding of the factors contributing to road safety among young people. A crash in this study refers to a situation where the rider hit something (including single-vehicle crashes where no-one else was involved), whilst a near-crash refers to where the rider was able to just avoid a crash. The description of crashes and near-crashes were provided in the questionnaire.

2.2. Participants and procedure

Data collection was conducted in three different provinces on Java, Indonesia. Java was chosen as the study location because more than 56% of the total Indonesian population lives there (Indonesia Central Bureau of Statistics, 2021). Among the six provinces in Java, the provinces of East Java, DKI Jakarta, and Central Java were selected as research locations because of the following characteristics: (a) East Java has the highest crash rates based on 2019 Indonesia National Traffic Police data; (b) DKI Jakarta has the

highest motorcycle ownership based on the latest Electronic Registration and Identification data, and; (c) Central Java has the highest number of motorcycle traffic violations based on 2020 Indonesia National Traffic Police data (Indonesia National Traffic Police, 2020). Thus, these provinces provide a representative sample of the at-risk Indonesian population.

Ethical approval for this study was obtained from the University of Leeds Business, Earth and Environment and Social Sciences Joint (AREA) Faculty Research Ethics Committee (reference number AREA 21-172). Participants were senior high school students, and the eligibility criteria were (a) aged between 17 to 19 years old and (b) currently ride a motorcycle. A convenience sampling technique was used to recruit young motorcyclists from various senior high schools in the three chosen provinces. The researcher approached the prospective participants in their school, gave an explanation about the study and the questionnaire was distributed to the participants in the form of an online survey link through the student's WhatsApp group. The survey was filled out by the participants themselves in the own time at their convenience within a one-week timeframe.

To maintain confidentiality and anonymity no names were recorded. Of those approached, 7,340 students met all the eligibility criteria. To ensure data reliability, unobtrusive methods of detecting low quality data were implemented. The methods involve recording response time (Berry et al., 1992) and consecutive identical responses or "long string" (Meade and Craig, 2012). After deletion of missing data, the final dataset includes 7,081 samples. The data collection took place between December 2022 and February 2023.

193 *2.3. Data handling and analysis*

194 There were 259 responses that did not pass the data quality check, and these were
195 excluded from the analysis, leading to a total of 7,081 responses. Exploratory Factor
196 Analysis (EFA) was selected as the most appropriate analysis to determine factor
197 structure in the present study due to the exploratory nature of the study. As previously
198 stated, 13 new items were included in this study, and one of the objectives was to
199 investigate the most appropriate factor structure of this modified version of the MRBQ for
200 young Indonesian riders. The analysis was completed using IBM's statistical package
201 SPSS version 26 (for Exploratory Factor Analysis) and R Studio version 2022 (for
202 Negative Binomial Regression Analysis).

203 Firstly, the factor structure of the 54 MRBQ items was determined using exploratory factor
204 analysis with Principal Axis Factoring (PAF) and the Direct Oblimin method to ensure that
205 the sample size was adequate and appropriate for data reduction. Items with factor
206 loadings greater than 0.3 were retained as suggested by Hair et al. (2010). The averaged
207 summed items within each factor were used to calculate factor scores. Higher factor
208 scores, with the exception of the *"safety equipment"* factor, imply more frequent aberrant
209 behaviour. Secondly, given the five MRBQ factors were not normally distributed, the
210 difference between MRBQ scores across rider demographics were explored using a non-
211 parametric test (Mann Whitney U Test for two independent groups, Kruskal-Wallis for
212 more than two independent groups). And finally, because the dependent variables of this
213 study (traffic violation, near crash and crash experience in the past 12 months) were found
214 to be not normally distributed and demonstrated over-dispersion, they were predicted

using negative binomial regression (NBR). The cut-off for the p-value was set at 0.05, and the odds ratio for each independent variable was calculated at a 95% confidence interval.

3. Result and discussion

3.1. Sample characteristics

Before investigating the most appropriate factor structure of the modified MRBQ among young riders from Indonesia, this section first gives a brief overview of the study sample in terms of demographics, riding experience and violation, near crash and crash involvement.

The descriptive statistics are mentioned in Table 2. Table 2 shows that the gender ratio of male to female participants is almost equal, with males making up 52.2% and females 47.8%. More than half of the riders (56.9%) mainly rode in urban areas. Half of the sample reported riding for less than 5 hours per week, and almost half (49.4%) rode less than 50 kilometres per week. In terms of traffic violations, the majority (81%) had not received any tickets in the past 12 months. However, 23.5% and 20.9% of the sample reported experiencing at least one near-crash and crash, respectively, in the past 12 months. More than 75% of the participants reported that they had been riding for more than 2 years, suggesting that many of those surveyed were riding on public roads before they reached the legal age for riding. It is worth mentioning that the sample description revealed that the majority of the riders did not hold a motorcycle license (71%), despite being eligible to do so.

Table 2: Sample descriptions

	N	Percentage
Age		
17	1,142	16.1%
18	4,744	67%
19	1,195	16.9%
Gender		
Male	3,697	52.2%
Female	3,384	47.8%
Province		
DKI Jakarta	2,325	32.8%
Central Java	2,268	32.1%
East Java	2,488	35.1%
License Status		
Unlicensed	5,029	71%
Licensed	2,052	29%
Area of residence		
Rural	3,052	43.1%
Urban	4,029	56.9%
Riding experience		
0 - 1 year	1,529	21.6%
2 - 3 years	2,822	39.9%
4 - 5 years	1,662	23.5%
More than 5 years	1,068	15.1%
Average hours riding per week		
Less than 5 hours	3,735	52.7%
5-10hours	2,337	33%
10-20hours	710	10%
More than 20hours	299	4.2%
Average kilometres per week		
Less than 50 km	3,497	49.4%
51-100 km	2,303	32.5%
101-200 km	806	11.4%
201-300 km	251	3.5%
More than 300 km	224	3.2%
Traffic violation in the past 12 months		
None	5,739	81%
One	877	12.4%
Two	239	3.4%
Three or more	226	3.2%
Near-crash in the past 12 months		
None	3,432	48.5%
One	1,667	23.5%
Two	974	13.8%
Three or more	1,008	14.2%
Crash in the past 12 months		
None	4,731	66.8%
One	1,481	20.9%
Two	592	8.4%
Three or more	277	3.9%

3.2. Rider behaviour based on MRBQ items

Individual item scores from the MRBQ were analysed to explore self-reported rider behaviour. When the entire sample from the three different provinces was combined, on the scale ranging from 1 (never) to 6 (almost all the time), the three most frequently reported items were “Brake or throttle-back when going round a corner or bend”, “You get annoyed when other riders put you at risk”, and “Wear shoes” (see Table 3). On the other hand, the least frequent riding behaviours were “Ride your motorcycle after having an alcoholic drink”, “Intentionally do a wheel spin”, and “Attempt to do, or actually do, a wheelie”.

However, even though the mean scores only differed very slightly, young riders in Central Java reported slightly different behaviour compared to the other two provinces. The 3rd most frequent riding behaviour among Central Java riders was “Change gear when going round a corner or bend” and the 3rd least frequent behaviour was “Get involved in unofficial ‘races’ with other riders or drivers”.

Table 3: Most and least frequent MRBQ items

	Most frequent riding behaviour
1st	Brake or throttle-back when going round a corner or bend (M = 5.18)
2nd	You get annoyed when other riders put you at risk (M = 4.4)
3rd	Wear shoes (M = 3.92)
	Least frequent riding behaviour
1st	Ride your motorcycle after having an alcoholic drink (M = 1.08)
2nd	Intentionally do a wheel spin (M = 1.08)
3rd	Attempt to do, or actually do, a wheelie (M = 1.17)

What stands out from this study is “you get annoyed when other riders put you at risk” was observed to be the second most frequent behaviour among young riders. It could conceivably be hypothesised that young riders can easily be emotionally distracted whilst riding, which further supports the study of Sumit et al. (2021) that found that it can be challenging for teenagers to self-regulate impulsive behaviours because of the maturational gap between their social-affective brain system and the cognitive control system. This may account for young riders performing risky riding behaviour, such as speeding or competing with other riders on the road. The third most frequent behaviour was “wear shoes” and related to the voluntary use of safety equipment. This finding is not surprising because the sample was exclusively senior high school students, and it is mandatory for them to wear shoes in school.

3.3. Exploratory Factor Analysis of the MRBQ

The first research aims were to determine the most appropriate factor structure of a modified version of the MRBQ to be used among young riders in Indonesia. The 54 items of the modified MRBQ were subjected to Exploratory Factor Analysis with Principal Axis Factoring (PAF) and Direct Oblimin method to determine the factor structure. Item interrelationships were examined before the factor analysis and four items were found to have very few significant relationships with other items. These four items were excluded from further analysis. Initially, PAF produced eleven factors with an eigenvalue greater than 1. However, after examining a scree plot, Monte Carlo parallel analysis and Minimum Average Partial test, a 5-factor solution from the Minimum Average Partial test was adopted. Factor scores were created from the average summed items within each factor.

Higher factor scores indicate more frequent aberrant behaviour, except for the safety equipment factor. The final five-factor solution is displayed in Table 4.

The Kaiser-Meyer-Olkin test of sampling adequacy was good (0.895), and Bartlett's test of sphericity was significant (X^2 (496, N = 7,081) = 58542.14 (p < 0.001) showing that the data were suitable for PAF and can be used for further factor analysis, following the recommendation of Field (2013). Fourteen items had factor loadings below 0.3 (item 5, 16, 23, 31, 38, 39, 40, 41, 42, 43, 45, 48, 52, and 53) and so were omitted from further analysis. Four items (item 8, 11, and 17) were found to be cross-loading so were also removed from the analysis.

The final five-factor solution consisted of 32 items and explained 45.61% of the variance. Factor 1 comprised of nine items and accounted for 20.51% of the total variance that seem to reflect mostly speeding behaviour and thus was labelled *"speed*". Factor 2 explained a further 8.6% of the total variance and contained four items all from the original safety equipment factor (Elliot et al., 2007). Therefore, the label "*safety equipment*" was assigned to this factor. Factor 3, accounted for a further 6.4% of the total variance and contained seven items all from the original traffic errors factor. Thus, factor 3 was named "*errors*". There was no evidence to support the inclusion of two separate "*errors"* factors among young Indonesian riders. Factor 4 explained another 5.35% of the total variance. Interestingly, this factor contained five items which were newly included in this study (item 47: carry a passenger who does not wear a helmet, item 36: riding without a helmet, item 46: carry more than one passenger with your motorcycle, item 35: using helmet without chin straps or not fastening it, item 49: riding in the opposite direction of the roadway).

297 This factor was referred as “traffic violation” in the context of Indonesia and is the most
298 different to previous research.

299 Factor 5 explained a further 4.7% of the total variance and consisted of five items that
300 were originally classified as “stunts” behaviour and two new items. The two new items
301 that loaded onto this factor are item 50 (riding with an unroadworthy motorcycle) and item
302 51 (smoking while riding). Riding unroadworthy motorcycles and smoking while riding are
303 riding behaviours that can easily be observed in Indonesia. However, instead of “*stunt*s”,
304 the addition of these two new items in this factor suggests that “*unsociable riding*” is a
305 more appropriate factor name in the present study.

306 All factors had good reliability with Cronbach’s alpha, ranging from 0.68 to 0.80, and
307 shared weak to moderate Pearson correlations (Table 5), indicating that each factor
308 appears to measure a conceptually distinct construct. The strongest relationship was
309 between “*speed*” and “*unsociable riding*” (r = 0.493) and between “*spee*d” and “*errors*” (r
310 = 0.455) although these relationships were only of moderate strength. In this context, the
311 five-factor structure proved to be reasonably interpretable. Table 4 also shows that the
312 most frequent type of behaviour, albeit still relatively uncommon, were traffic violations
313 (M = 2.05 ± 0.689). Therefore, riders in the current sample, on average, tended to engage
314 in aberrant behaviours very infrequently.
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Table 4: Final results of rotated factor pattern matrix for young Indonesian riders

MRBQ items	Mean	S.D.	Speed	Safety equipment	Error	Traffic violation	Unsociable riding
Item 15: Disregard the speed limit late at night or in the early hours of the morning	2.68	1.45	0.62				
Item 12: Run wide when going round a corner	1.72	1.14	0.58				
Item 54: Riding zig-zag (move between lane quickly) to find road gaps	2.12	1.28	0.58				
Item 18: Open up the throttle and just 'go for it' on country roads	1.48	0.78	0.57				
Item 19: Ride between two lanes of moving traffic	2.90	1.40	0.53				
Item 13: Ride so fast into a corner that you feel like you might lose control	1.44	0.77	0.52				
Item 14: Exceed the speed limit on a country/rural road	1.81	1.07	0.41				
Item 10: Not slow down when approaching a yellow light	2.03	1.27	0.41				
Item 21: Ride so fast into a corner that you scare yourself	1.52	0.86	0.38				
Item 33: Wear bright/fluorescent strips/patches on your clothing	1.33	0.77		0.82			
Item 34: Wear bright/fluorescent clothing when riding at night	1.33	0.78		0.76			
Item 30: Wear body armour (elbow pads, shoulder pads, knee pads, etc)	1.29	0.77		0.57			
Item 26: Wear riding boots	1.27	0.74		0.50			
Item 3: Not notice a pedestrian waiting to cross at a zebra crossing, or a pelican crossing that has just turned red	1.45	0.95			0.71		
Item 2: Not notice someone stepping out from behind a parked vehicle until it is nearly too late	1.50	0.85			0.66		
Item 1: Fail to notice that pedestrians are crossing when turning into a side street from a main road	1.75	1.23			0.55		
Item 4: Pull out on to a main road in front of a vehicle that you had not noticed, or whose speed you have misjudged	1.42	0.86			0.47		
Item 6: Fail to notice or anticipate that another vehicle might pull out in front of you and have difficulty stopping	1.99	1.05			0.47		
Item 7: 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	1.54	0.84			0.46		
Item 9: Attempt to overtake someone that you had not noticed to be signalling a right turn	1.73	0.91			0.34		
Item 47: Carry a passenger who has not worn a helmet	2.74	1.18				0.69	
Item 36: Riding without a helmet	2.26	1.07				0.63	
Item 46: Carry more than one passenger with your motorcycle	1.97	1.01				0.51	
Item 35: Using helmet without chin straps or not fastening it	1.64	1.07				0.36	
Item 49: Riding in the opposite direction of the roadway	1.64	0.84				0.36	
Item 22: Attempt to do, or actually do, a wheelie	1.17	0.62					0.73
Item 20: Get involved in unofficial 'races' with other riders or drivers	1.17	0.61					0.60
Item 24: Intentionally do a wheel spin	1.08	0.43					0.59
Item 44: Ride your motorcycle after having an alcoholic drink	1.08	0.43					0.51
Item 51: Smoking while riding	1.30	0.87					0.48
Item 25: Unintentionally do a wheel spin	1.39	0.74					0.36
Item 50: Riding with unroadworthy motorcycle	1.57	0.93					0.31
Cronbach's Alpha			0.80	0.76	0.75	0.68	0.74
Mean			1.97	1.63	1.31	2.05	1.25
S.D.			0.70	0.61	0.58	0.69	0.43

Table 5: Pearson correlations between MRBQ factors

	Speed	Safety equipment	Errors	Traffic violation	Unsociable riding
Speed	1				
Safety equipment	0.024*	1			
Errors	0.455*	0.049*	1		
Traffic violation	0.406*	-0.038*	0.296*	1	
Unsociable riding	0.493*	0.186*	0.308*	0.318*	1

** p < 0.05 level (2-tailed)*

Despite the number of factors being similar to the original MRBQ study by Elliot et al. (2007), the findings of this study clearly show that the five-factor structure found for experienced riders in the UK (Elliot et al.,2007), Turkish riders (Özkan et al., 2012), licensed riders in Australia (Stephens et al., 2017) and young riders in India (Sumit et al., 2021) was not replicated for the sample of young riders in the current study. The inclusion of several new MRBQ items in the present study likely altered the factor structure.

In contrast to earlier studies, significant differences have been found. All the items that loaded in the "*safety equipment*" factor in this modified Indonesian MRBQ were items that rarely exist in the Indonesia context (for example: wear body armour) and therefore shows a relatively low mean score whilst the use of *"safety equipment*" is the factor that usually shows a higher mean in earlier studies (for example in Sumit et al., 2021). Furthermore, the current study added items related with helmet wearing because they were not included in the original study of UK riders and being an essential safety equipment for motorcycle riders. However, instead of loading onto the *"safety equipment"* factor, the items related to helmet wearing were loaded onto "*traffic violation"* factors in this study. These results could indicate that young Indonesian riders seem to consider the use of

such safety-equipment (except helmet wearing) as voluntary. Taken together, the “safety equipment” factor in this study is different to previous studies.

3.4. Comparison of MRBQ scores across rider characteristics

In order to examine the differences between MRBQ scores across rider’s characteristics, factor scores were compared by rider gender, reason for riding, licensing status, average riding hours and distance per week, area of residence, and riding experience. Given the non-normal distributions of the five MRBQ factors, non-parametric tests (Mann Whitney U Test for two independent groups, Kruskal-Wallis for more than two independent groups) were used. Furthermore, to reduce the probability of Type I error because of multiple comparisons, a Bonferroni correction was applied and therefore the significance level adjusted to $p < 0.01$. Table 6 show the results of these non-parametric tests, by comparing the mean of summed factor scores between rider’s characteristics.

Table 6: MRBQ factors scores by rider's characteristics

		Speed	Safety equipment	Errors	Traffic violation	Unsociable riding
Gender	Male (n= 3,697)	2.11	1.42	1.68	2.06	1.38
	Female (n= 3,384)	1.81	1.19	1.56	2.04	1.12
	Sig	0.001*	0.001*	0.001*	0.177	0.001*
	z	-17.564	-17.563	-8.706	-1.351	-29.146
	r	-0.209	-0.209	-0.103	-0.016	-0.346
Reason	School (n= 5,461)	1.97	1.31	1.62	2.00	1.24
	Shopping (n= 303)	1.63	1.32	1.53	2.19	1.15
	Recreation (n= 724)	2.03	1.31	1.71	2.29	1.33
	Other (n= 593)	2.01	1.26	1.63	2.17	1.30
	Sig	0.001*	0.056	0.001*	0.001*	0.001*
	X2 (3)	100.148	7.559	28.361	138.338	55.093
Licensing status	Unlicensed (n= 5,029)	1.93	1.28	1.63	2.08	1.26
	Licensed (n= 2,052)	2.06	1.38	1.62	1.98	1.24
	Sig	0.001*	0.001*	0.828	0.001*	0.005*
	z	-6.776	-6.408	-0.218	-5.109	-2.823
	r	-0.081	-0.076	-0.003	-0.061	-0.034
Average hours	Less than 5 hours (n=3,735)	1.82	1.30	1.58	2.03	1.21
	5-10hours (n=2,337)	2.07	1.29	1.65	2.07	1.27
	10-20hours(n=710)	2.27	1.35	1.73	2.11	1.35
	More than 20hours (n=299)	2.31	1.40	1.73	2.09	1.46
	Sig	0.001*	0.032	0.001*	0.004	0.001*
	X2 (3)	413.233	8.838	82.947	13.462	209.326
Average distance	Less than 50 kilometres (n=3,497)	1.81	1.28	1.56	2.03	1.19
	51-100 kilometres (n=2,303)	2.07	1.32	1.66	2.07	1.28
	101-200 kilometres (806)	2.20	1.34	1.70	2.08	1.34
	201-300 kilometres (251)	2.28	1.42	1.76	2.06	1.40
	More than 300 kilometres (224)	2.22	1.29	1.83	2.04	1.37
	Sig	0.001*	0.001*	0.001*	0.142	0.001*
	X2 (4)	399.671	18.006	108.544	6.883	214.268
Area of residence	Rural (n=3,052)	2.04	1.26	1.64	1.95	1.31
	Urban (n=4,029)	1.91	1.35	1.61	2.12	1.21
	Sig	0.001*	0.001*	0.001*	0.001*	0.001*
	z	-9.631	-5.971	-5.71	-9.605	-16.211
	r	-0.114	-0.071	-0.068	-0.114	-0.193

Firstly, a significant effect of gender was found on rider's engagement in all five MRBQ factors except the *"traffic violation"* factor. Prior studies that have examined the effect of gender usually have a male-skewed sample. Given this study used a large and gender-

360 balanced sample, the finding that males still significantly engaged more in all behaviours
361 compared to females, supports previous research in the motorcycle domain (Sexton et
362 al., 2004; Lin and Kraus, 2009; Stephens et al., 2017).

363 It is worth noting that where respondents live (and therefore ride) is associated with rider's
364 engagement in all MRBQ factors. Riders who live in rural areas engage in "*speed", "error"*
365 and *"unsociable riding"* behaviour more frequently compared to riders who live in urban
366 areas. On the other hand, riders who live in urban areas report "*safety equipment"* and
367 "*traffic violation"* behaviours more frequently. Prior MRBQ studies have not examined the
368 relationship between where riders use their motorcycle (urban or rural area) and their
369 behaviour. It is possible that these results are due to stricter traffic enforcement in urban
370 areas which could increase young rider's willingness to use safety equipment.

371 When the reason for riding is examined, the analysis revealed that riders who ride for
372 recreational purposes reported higher engagement with all risky riding behaviour. This
373 finding raises the possibility that students behave differently when they ride for school
374 and outside school hours.

375 Forty percent of the sample reported riding for more than two years and more than 70%
376 of the study population were unlicensed riders. Interestingly, it was the licensed riders,
377 not unlicensed riders, that were found to have significantly higher involvement in "*speed*"
378 behaviour. A possible explanation for this result is that the confidence of licensed riders
379 has resulted in a greater intention to "push my limits" (Watson et al., 2007) that could
380 lower their concern about getting caught by the police given they are legally allowed to
381 be on a motorcycle, compared to unlicensed riders. Furthermore, the findings shows that

riders with higher average hours of riding reported engagement with “speed”, “errors” and “unsociable riding” more frequently compared to those with fewer average hours. These findings broadly supports the work of other studies in this area linking exposure with risky riding behaviour (Truong et al., 2018; Kontaxi et al., 2021). This finding poses an important issue for future research related to the relationship between Indonesian rider’s attitudes toward road safety.

3.5. Prediction of traffic offences and crash involvement in the past 12 months

Having examined rider’s riding behaviour by their characteristics, it is now necessary to discuss the association between rider’s riding behaviour and their traffic offence and crash history. Negative binomial regression analyses were conducted to investigate the association between three outcome variables of interest: 1) traffic offences in the past 12 months; 2) near-crashes in the past 12-months; 3) crashes in the past 12-months; and MRBQ factor scores, see Table 7.

The final model for predicting traffic offences in the last 12 months was statistically significant ($\chi^2(4, N = 7{,}081) = 322.874$, $p < .0001$) and showed that riding experience, average distance travelled weekly, frequency of “*errors”*, and “*unsociable riding”* are the main contributory factors associated with traffic offences among young riders. According to the incidence rate ratios (IRR), each increase in additional year of riding experience was associated with a 9.6% increase in reported traffic offences. Each 50 kilometres increase in average distance travelled weekly was also positively related to the likelihood of reporting traffic offences with a 10.6% increase. Moreover, the likelihood of reporting a traffic offence increased by 34% and 51.8% with each increase in mean propensity towards “*errors”* and *“unsociable riding”,* respectively.

In terms of self-reported near-crash involvement, the final model was also statistically significant ($\chi^2(7, N = 7{,}081) = 563.442$, $p < .001$). According to IRR in Table 7, an increase of average weekly hours and distance spent riding, gender, area of riding, and increased frequency of *speed, errors* and *traffic violation* were all found to be positively associated with experiencing a near-crash in the past 12 months. Male riders reported higher numbers of near crashes (1.144 times) than female riders. Young riders in rural areas reported 1.204 times higher near-crash experiences than riders in urban areas. Moreover, an increase mean propensity towards "*speed"*, "*errors"* and "*traffic violation"* behaviour was associated with an increased reporting of near crashes with 43%, 9.3% and 15.5% increase, respectively.

The final model for predicting crash involvement was statistically significant ($\chi^2(5, N = 7{,}081) = 312.985$, $p < .0001$). Table 7 shows that riding experience, average distance travelled weekly, "*speed"*, "*errors",* and "*unsociable riding"* are the major predictors of crash involvement. The cumulative years of riding experience was associated with a likelihood of 2% increased reporting of crash involvement. Looking at riding behaviour, for each increase in mean propensity towards *"speed", "errors"*, and "*unsociable riding"* behaviour, the probability of being involved in a crash increased by 26%, 19% and 27%, respectively.

Table 7: Negative binomial analysis of traffic offences, near-crashes and crashes in the past 12 months (only significant result shown)

Predictor	B	Incidence rate ratio (IRR)	95% Wald CI (Lowest - Highest)	S.E.	Wald X^2	Sig.
Dependent Variable: Self-reported traffic offences in the past 12 months						
Riding Experience	0.091	1.096	1.069 - 1.123	0.0125	53.574	0.000
Average Distance	0.101	1.106	1.055 - 1.16	0.0244	17.149	0.000
Errors (MRBQ factor)	0.292	1.34	1.24 - 1.447	0.0394	55.037	0.000
Unsociable riding (MRBQ factor)	0.417	1.518	1.371 - 1.681	0.052	64.417	0.000
Dependent variable: Self-reported near-crash in the past 12 months						
Average Distance	0.051	1.052	1.014 - 1.092	0.0189	7.243	0.007
Average Hours	0.093	1.098	1.049 - 1.148	0.023	16.409	0.000
Gender = Male	0.134	1.144	1.066 - 1.227	0.036	13.94	0.000
Area = Rural	0.186	1.204	1.123 - 1.291	0.0358	26.954	0.000
Speed (MRBQ factor)	0.362	1.437	1.355 - 1.524	0.03	146.303	0.000
Errors (MRBQ factor)	0.088	1.093	1.026 - 1.163	0.032	7.646	0.006
Traffic violation (MRBQ factor)	0.144	1.155	1.092 - 1.221	0.0285	25.634	0.000
Dependent variable: Self-reported crash in the past 12 months						
Riding Experience	0.022	1.022	1.001 - 1.043	0.0107	4.07	0.044
Average distance	0.103	1.109	1.065 - 1.154	0.0205	25.404	0.000
Speed (MRBQ factor)	0.232	1.261	1.176 - 1.351	0.0352	43.168	0.000
Errors (MRBQ factor)	0.175	1.191	1.109 - 1.278	0.0363	23.166	0.000
Unsociable riding (MRBQ factor)	0.238	1.269	1.15 - 1.4	0.0502	22.596	0.000

Among all MRBQ factors, "*errors*" was the only one associated with the involvement in all three outcomes of interest: self-reported traffic offences, near-crash and crash experience in the past 12 months. Errors are broadly defined as the "failure of planned actions to achieve their intended consequences" (Reason et al., 1990, p. 1315). It was evident that *"errors"* among young Indonesian riders involved non-intentional behaviour relating to not paying attention (for example: "pull out on to a main road in front of a vehicle that you had not noticed, or whose speed you have misjudged"). The original MRBQ study and earlier studies also found "*errors"* to be the leading cause of crash involvement (Elliott et al.,

2007; Hung and Huyen, 2011; Gruyter et al., 2017). Whilst the use of *"safety equipment"* does not reduce crash involvement, *"traffic errors"* or *"stunts"* could increase the odds of crash risks (Stephens et al., (2017). As mentioned earlier in the introduction, the inconsistencies of which MRBQ factors can better predict crash involvement are evident and findings from this study further corroborates the argument that there are some MRBQ factors that remain consistently associated with crash involvement (Stephens et al., 2017).

In addition, when only the odds of crash involvement are considered, *"speed", "errors",* and "*unsociable riding"* were found to be the most likely associated. *"Speed"* and *"errors",* not including "unsociable riding", were also associated with the increased odds of a near-crash. A possible explanation for this might be that because "unsociable riding" in this study has a more direct role in the occurrence of actual crashes compared to near crashes. That being said, it could also mean that engaging in unsociable riding leads to higher possibility to not being able to avoid the crash. While *"unsociable riding"* factor in this study did not appear in the previous studies, the items that loaded onto this factor are similar to the previously named *"stunts"* factor in earlier studies. Comparing the findings from previous MRBQ studies in developing countries, *"speed"* and *"unsociable riding*" factors were also predictors for crash and/or traffic offences involvement. For example, "*err*ors" were found to be associated with crash involvement in India (Chouhan et al., 2021), Vietnam (Trung Bui et al., 2020) and Turkey (Özkan et al., 2012). These similarities could suggest that there are similar characteristics between countries from developing countries with high levels of motorcycle dependency.

The most recent MRBQ study by Chouhan et al., (2023) questioned whether MRBQ could predict crash involvement. In their meta-analysis, even though their model observed a significant effect of "*speed violation*" on crashes, they concluded that MRBQ has limited ability to predict crashes. Furthermore, they suggest that further study with a larger sample and including items related with distraction is needed to enhance the predictive ability of MRBQ. Chouhan et al. (2023) used 11 MRBQ studies with sample sizes ranging from 146 to 2,399 with the samples biased towards male or female participants. The current study recruited 7,081 participants with a balanced proportion in gender (52.2% male and 47.8% female). This study also included items related to distraction (for example: mobile phone use, smoking while riding and carrying large baggage). Therefore, this study somewhat addresses Chouhan et al.'s (2023) criticisms and indicates that the MRBQ can be used as a robust instrument for researching rider behaviour. However, it should be noted that the MRBQ model in this study only explained 45.61% of the variance in crash risk which means other factors outside MRBQ factors must be considered (e.g., road and vehicle characteristics).

Finally, the relationship between risky riding behaviour and the risk of crash involvement has been the subject of considerable discussion in the literature (Lawton et al., 1997b; Ambo et al., 2020; Chouhan et al., 2021; Setoodehzadeh et al., 2021; Das, 2021). The results from the current study regarding the association between MRBQ factors and traffic offences and crash involvement further supports the relationship.

4. Conclusion

The findings from this study have three implications. Firstly, this study strengthens the idea that MRBQ can be used as a robust instrument for investigating riders' behaviour and their association with traffic offences and crash, but it is sensitive to geographical and demographic characteristics of the riders. In addition, these findings highlight the usefulness and the applicability of the MRBQ in identifying risky riding behaviours that have an underlying association with traffic offences and crash involvement. Also, this study appears to be the first study to investigate the association between risky riding behaviour with traffic offences and crash involvement in the context of Indonesia.

Secondly, that "*speed" and "errors"* were associated with increased risk of self-reported near-crash and crashes is interesting because these two behaviours have been defined differently in previous studies. "*Speed*" behaviour is an intentional behaviour, while "*errors"* are referred to unintentional behaviours (Sumit et al. (2021) and are broadly defined as the "failure of planned actions to achieve their intended consequences" (Reason et al., 1990, p. 1315). Despite the nature of "errors", the fact that a common theme in *"errors"* among young Indonesian riders involved not paying attention to their surroundings, indicates that even though they may be unintentional, there is a possibility to develop safety interventions linked with "*speed"* and *"errors"*. Possible examples of this include combining road safety training that targets improving rider awareness and riding skills (for example: hazard perception training, control skills training such as cornering and speed) and road safety campaigns that focus on increasing young riders' willingness to ride safely instead of scaring them with "fear appeal" campaigns (Shanahan et al., 2000; Witte and Allen, 2000). Supporting this suggestion, the EU Advanced Project (Bartl

et al., 2002) concluded that road safety training should not only focus on improving skills but also on improving riders' understanding and knowledge related to risk and the perception of their own level of ability (for example: how rider and motorcycle characteristics can influence their overall road safety).

Finally, it is worth mentioning that the results revealed that many of those surveyed were riding on public roads before they reached the legal age for riding. The opportunity of accessing the public road without a license before the legal age could explain why many Indonesian riders do not have a strong willingness to get a license when they reach 17 years old. As mentioned in the introduction section, urban forms of transport and the need for travel for education makes young unlicensed riders a complex issue in Indonesia. The fact that unlicensed riders were found to have higher engagement with *"traffic violatio*n" and *"unsociable riding"* and these two types of risky behaviour were associated with traffic offences and crash involvement in the past 12 months, has significant implications for understanding how to develop effective interventions. It seems obvious that everyone needs to be licensed to improve safety. However, taking the culture and environment into consideration, increasing perceived enforcement and focused educational programs aimed at reducing the social acceptability of these "traffic violations" and "unsociable riding" behaviours could be more appropriate in improving road safety for young Indonesians.

5. Limitations and future research

The reader should bear in mind this study was designed to specifically investigate young rider's behaviour in a limited age range (17 to 19 years old) and place (Java, Indonesia). Therefore, the findings from this paper cannot be simply generalised to other riders.

However, given that similar to the findings of other LMIC countries with high dependency on motorcycles (Chouhan et al., 2021; Trung Bui et al., 2020; Özkan et al., 2012), “errors” were associated with reported crashes, it is possible that the findings from this study could be applied to other developing countries with high motorcycle use or dependency.

To gain a more comprehensive understanding of the influence of age on the MRBQ factor structure in Indonesia, further research with a wider age range is recommended. Nevertheless, the large sample size of 7,081 participants enhances the robustness and reliability of the findings. Further research with a broader age range could complement these findings and extend their generalisability.

Furthermore, we acknowledge that heterogeneity exists in behavioural data. NBR accounts for overdispersion but does not directly control for all forms of heterogeneity, particularly unobserved heterogeneity. Therefore, future research should consider this issue to improve the reliability of predictive models.

Finally, the self-report approach used in this study could encourage socially desirable responses (Cerri et al., 2019; Bergen and Labonté, 2020). To minimise this potential social-desirability bias, the survey completion instructions were provided by the researcher before the questionnaire was distributed. The respondents were told that there were no sanctions for filling out the questionnaire honestly because the feedback is anonymous, whilst filling it out honestly could help provide the best solutions for the current road safety problem in Indonesia. However, future studies on the current topic using police-reported data are recommended. The lack of detailed data is a shortcoming

of the crash database in Indonesia, and having this data available would enable more targeted interventions.

Declaration of Competing Interest

The authors declare no competing financial interests or personal relationships that may have had any influence on the work presented in this paper.

6. References

Akasreku, B., Rwejumura, G., Maroko, A., Nyanza, R., Malekela, G., Kalolo, S., Yokeeswaran, U., Fiori, K.P., Abwe, F. and Teasdale, C.A. 2023. Road traffic injuries in Tanzanian children and adolescents: A cross-sectional household survey. *Injury*. **54**(1), pp.160–167.

Ambo, T.B., Ma, J. and Fu, C. 2020. Investigating influence factors of traffic violation using multinomial logit method. *International Journal of Injury Control and Safety Promotion*. **28**(1), pp.78–85.

Anggraeni, M. 2019. Fenomena Pengendara Sepeda Motor Anak Di Bawah Umur Dan Upaya Penanggulangannya Di SMPN 2 Sanden Kabupaten Bantul. *E-societas Jurnal Pendidikan Sosiologi*. **8**(5).

Bartl, G., Baughan, C., Fougere, J.-P., Gregersen, N.-P., Nyberg, A., Groot, H., Sanders, N., Keskinen, E., Hatakka, M., Pannacci, M., Willmes-Lenz, G., Bahr, M. and Stummvoll, G. 2002. *The EU ADVANCED Project : description and analysis of post-licence driver and rider training : final report* [Online]. Rijswijk. Available from: https://www.cieca.eu/sites/default/files/documents/projects_and_studies/1ADVANCEDFinalReportEn.pdf.

572 Berry, D.T., Wetter, M.W., Baer, R.A., Larsen, L., Clark, C. and Monroe, K. 1992. MMPI-
573 2 random responding indices: Validation using a self-report
574 methodology. *Psychological assessment*, ***4***(3), p.340.
575 Cassarino, M. and Murphy, G. 2018. Reducing young drivers' crash risk: Are we there
576 yet? an ecological systems-based review of the last decade of research.
577 *Transportation Research Part F: Traffic Psychology and Behaviour*. **56**, pp.54–73.
578 Chakraborty, A. and Maitra, B. 2024. Riding behaviours of motorcyclists in mixed traffic
579 condition and its association with crash risk. *Case Studies on Transport Policy*. **16**,
580 article no: 101177.
581 Chouhan, S.S., Kathuria, A. and Sekhar, C.R. 2021. Examining risky riding behavior in
582 India using Motorcycle rider behavior questionnaire. *Accident Analysis & Prevention*.
583 **160**, article no: 106312.
584 Chouhan, S.S., Kathuria, A. and Sekhar, C.R. 2023. The motorcycle rider behaviour
585 questionnaire as a predictor of crashes: A systematic review and meta-analysis.
586 *IATSS Research*. **47**(1), pp.61–72.
587 Cundill, B. and Alexander, N.D., 2015. Sample size calculations for skewed
588 distributions. *BMC Medical Research Methodology*, *15*, pp.1-9.
589 Das, S. 2021. Identifying key patterns in motorcycle crashes: findings from taxicab
590 correspondence analysis. *Transportmetrica A: Transport Science*. **17**(4), pp.593–
591 614.
592 Dobson, A., Brown, W., Ball, J., Powers, J. and McFadden, M. 1999. Women drivers'
593 behaviour, socio-demographic characteristics and accidents. *Accident Analysis &*
594 *Prevention*. **31**(5), pp.525–535.

595 Elliott, M.A., Baughan, C.J. and Sexton, B.F. 2007. Errors and violations in relation to
596 motorcyclists' crash risk. *Accident Analysis & Prevention*. **39**(3), pp.491–499.
597 Gruyter, C. De, Truong, L.T. and Nguyen, H.T.T. 2017. Who's calling? Social networks
598 and mobile phone use among motorcyclists. *Accident Analysis & Prevention*. **103**,
599 pp.143–147.
600 Guo, F., Klauer, S.G., Hankey, J.M. and Dingus, T.A., 2010. Near crashes as crash
601 surrogate for naturalistic driving studies. *Transportation Research Record*, ***2147***(1),
602 pp.66-74.
603 Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. 2010. *Multivariate data analysis :*
604 *a global perspective* Seventh edition. Upper Saddle River, N.J. ; Pearson.
605 Hsu, T.-P., Sadulla, A.F.M. and Dao, N.X. 2003. *A comparative study on motorcycle traffic*
606 *development of Taiwan, Malaysia and Vietnam* [Online]. Available from:
607 https://www.researchgate.net/publication/284685742_A_comparative_study_on_m
608 otorcycle_traffic_development_of_Taiwan_Malaysia_and_Vietnam.
609 Hung, K.V. and Huyen, L.T. 2011. Education influence in traffic safety: A case study in
610 Vietnam. *IATSS Research*. **34**(2), pp.87–93.
611 Indriastuti, A. and Sulistio, H. 2010. Influencing factors on motorcycle accident in urban
612 area of Malang, Indonesia. *International Journal of Academic Research*. **2**(5),
613 pp.252-255.
614 Indonesia Central Bureau of Statistics 2021. *Land Transportation Statistics*. BPS -
615 Statistics Indonesia.
616 Indonesia National Traffic Police. 2019. Road Traffic Accidents Annual Report.
617 Unpublished.

618 Indonesia National Traffic Police. 2020. Road Traffic Accidents Annual Report.
619 Unpublished.
620 Kontaxi, A., Ziakopoulos, A. and Yannis, G. 2021. Investigation of the speeding behavior
621 of motorcyclists through an innovative smartphone application. *Traffic Injury*
622 *Prevention*. **22**(6), pp.460–466.
623 Lawton, R., Parker, D., Stradling, S.G. and Manstead, A.S.R. 1997a. Predicting road
624 traffic accidents: The role of social deviance and violations. *British Journal of*
625 *Psychology*. **88**(2), pp.249–262.
626 Lawton, R., Parker, D., Manstead, A.S.R. and Stradling, S.G. 1997b. The Role of Affect
627 in Predicting Social Behaviors: The Case of Road Traffic Violations. *Journal of*
628 *Applied Social Psychology*. **27**(14), pp.1258–1276.
629 Lin, M.-R., Chang, S.-H., Pai, L. and Keyl, P.M. 2003. A longitudinal study of risk factors
630 for motorcycle crashes among junior college students in Taiwan. *Accident Analysis*
631 *& Prevention*. **35**(2), pp.243–252.
632 Lin, M.-R. and Kraus, J.F. 2009. A review of risk factors and patterns of motorcycle
633 injuries. *Accident Analysis & Prevention*. **41**(4), pp.710–722.
634 Meade, A.W. and Craig, S.B., 2012. Identifying careless responses in survey
635 data. *Psychological methods*, **17**(3), pp.437–455.
636 Motevalian, S.A., Asadi-Lari, M., Rahimi, H. and Eftekhar, M. 2011. Validation of a persian
637 version of motorcycle rider behavior questionnaire. *Annals of advances in automotive*
638 *medicine. Association for the Advancement of Automotive Medicine. Annual*
639 *Scientific Conference*. **55**, pp.91–98.
640 Nurlia, D.A., Komariah, S. and Waluya, B. 2017. Faktor-faktor penyebab maraknya

pengendara motor di bawah umur di Desa Rancamanyar Kecamatan Baleendah Kabupaten Bandung. *E-societas Jurnal Pendidikan Sosiologi*. **7**(2).

Özkan, T., Lajunen, T., Doğruyol, B., Yıldırım, Z. and Çoymak, A. 2012. Motorcycle accidents, rider behaviour, and psychological models. *Accident Analysis & Prevention*. **49**, pp.124–132.

Parker, D., Reason, J.T., Manstead, A.S. and Stradling, S.G., 1995. Driving errors, driving violations and accident involvement. *Ergonomics*, **38**(5), pp.1036-1048.

Putranto, L.S. and Anjaya, I.S. 2014. Initial development of Indonesian motorcycle rider behaviour *In*: *Proceedings of the 9th Asia Pacific Conference on Transportation & the Environment* [Online]. Department of Civil Engineering, University of Moratuwa, pp.229–233. Available from: http://dl.lib.mrt.ac.lk/handle/123/13545/20.pdf.

Putranto, L.S., Setyarini, N., Rostiana, R. and Bunawan, R. 2014. Motorcycle Rider Behaviour of Tarumanagara University Lecturer and Employee *In*: *17th International Symposium of Inter-University Transportation Study Forum* [Online]. Available from: http://repository.untar.ac.id/id/eprint/1833.

Reason, J., Manstead, A., Stradling, S., Baxter, J. and Campbell, K. 1990. Errors and violations on the roads: a real distinction? *Ergonomics*. **33**(10–11), pp.1315–1332.

Republic of Indonesia. 2009. *Legislation No. 22 of 2009 about Traffic and Road Transport.* [Online]. [Accessed 7 August 2023]. Available from: https://korlantas.polri.go.id/wp-content/uploads/2021/03/uu_no_22_tahun_2009.pdf.

Republic of Indonesia Police Regulation (PERPOL) Number 5. 2021. *The issuance and marking of driving licenses.* [Online]. [Accessed 7 August 2023]. Available from: https://korlantas.polri.go.id/wp-content/uploads/2021/03/PERPOL-NO-5-TH-2021-

TTG-PENERBITAN-DAN-PENANDAAN-SIM.pdf

Minister of Education and Culture of the Republic of Indonesia Regulation (PERMENDIKBUD) Number 14. 2018. *Acceptance of New Students in Kindergarten, Elementary School, Junior High School, Senior High School, Vocational High School, or Other Equivalent Forms.* [Online]. [Accessed 10 September 2023]. Available from: https://peraturan.bpk.go.id/Details/138190/permendikbud-no-14-tahun-2018.

Sakashita, C., Senserrick, T., Lo, S., Boufous, S., Rome, L. de and Ivers, R. 2014. The Motorcycle Rider Behavior Questionnaire: Psychometric properties and application amongst novice riders in Australia. *Transportation Research Part F: Traffic Psychology and Behaviour*. **22**, pp.126–139.

Schreurs, K.V, Ross, V. and Brijs, K. 2023. Investigating the relationship between self-reported (near) crashes, fined traffic offences, and risky riding behaviours among Flemish motorcyclists using the motorcycle rider behaviour questionnaire. *Transportation Research Part F: Traffic Psychology and Behaviour*. **98**, pp.337–353.

Setoodehzadeh, F., Ansari-Moghaddam, A., Okati-Aliabad, H., Khammarnia, M. and Mohammadi, M. 2021. Self-reported Motorcycle Riding Behavior in Southeast of Iran. *Health Scope*. **10**(3).

Setyowati, D.L., Setyaningsih, Y., Suryawati, C. and Lestantyo, D., 2024. Indonesian version of the motorcycle rider behaviour questionnaire: cross-cultural adaptation and validation. *International Journal of Public Health*, ***13***(3), pp.1276-1285.

Sexton, B., Baughan, C., Elliott, M.A. and Maycock, G. 2004. *The accident risk of motorcyclists - Prepared for Road Safety Division, Department for Transport* [Online]. Available from: https://strathprints.strath.ac.uk/20274/1/strathprints020274.pdf.

687 Shaheed, M.S.B., Gkritza, K., Zhang, W. and Hans, Z. 2013. A mixed logit analysis of
688 two-vehicle crash severities involving a motorcycle. *Accident Analysis & Prevention*.
689 **61**, pp.119–128.
690 Shanahan, P., Elliott, B. and Dahlgren, N. 2000. *Review of public information campaigns*
691 *addressing youth risk-taking: A report to the National Youth Affairs Research*
692 *scheme*. Australia: Published for the National Youth Affairs Research Scheme by the
693 Australian Clearinghouse for Youth Studies.
694 Siswantoro, H. 2018. *Upaya peningkatan kesadaran hukum masyarakat dalam proses*
695 *ujian teori surat izin mengemudi di Polres Bantul* [Online]. STIE Widya Wiwaha.
696 Available from: http://eprint.stieww.ac.id/id/eprint/674.
697 Steinberg, L. 2008. A social neuroscience perspective on adolescent risk-taking.
698 *Developmental Review*. **28**(1), pp.78–106.
699 Stephens, A.N., Brown, J., de Rome, L., Baldock, M.R.J., Fernandes, R. and Fitzharris,
700 M. 2017. The relationship between Motorcycle Rider Behaviour Questionnaire
701 scores and crashes for riders in Australia. *Accident Analysis & Prevention*. **102**,
702 pp.202–212.
703 Sumit, K., Ross, V., Brijs, K., Wets, G. and Ruiter, R.A.C. 2021. Risky motorcycle riding
704 behaviour among young riders in Manipal, India. *BMC Public Health*. **21**(1), article
705 no: 1954.
706 Sunday, O., and Akintola, L. 2011. The motorcycle rider behaviour questionnaire (MRBQ)
707 and commercial motorcycle riders in Nigeria. *Driver behaviour and training*. **4**,
708 pp.193–209.
709 Trung Bui, H., Saadi, I. and Cools, M. 2020. Investigating on-road crash risk and traffic

offences in Vietnam using the motorcycle rider behaviour questionnaire (MRBQ). *Safety Science*. **130**, article no: 104868.

Truong, L.T., Nguyen, H.T.T. and De Gruyter, C. 2018. Correlations between mobile phone use and other risky behaviours while riding a motorcycle. *Accident Analysis & Prevention*. **118**, pp.125–130.

Uttra, S., Jomnonkwao, S., Watthanaklang, D. and Ratanavaraha, V., 2020. Development of self-assessment indicators for motorcycle riders in Thailand: Application of the motorcycle rider behavior questionnaire (MRBQ). *Sustainability*, **12**(7), article no: 2785.

Watson, B., Tunnicliff, D., White, K., Schonfeld, C. and Wishart, D. 2007. *Psychological and social factors influencing motorcycle rider intentions and behaviour*.

Witte, K. and Allen, M. 2000. A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns. *Health Education & Behavior*. **27**(5), pp.591–615.

World Bank Group. 2023. *The World Bank In Indonesia*. [Online]. [Accessed 12 December 2023]. Available from: https://www.worldbank.org/en/country/indonesia/overview.

World Health Organization. 2023. *Global status report on road safety 2018.* [Online]. [Accessed 23 February 2024]. Available from: https://www.who.int/publications/i/item/9789240086517.

Wu, K.-F., Aguero-Valverde, J. and Jovanis, P.P. 2014. Using naturalistic driving data to explore the association between traffic safety-related events and crash risk at driver level. *Accident Analysis & Prevention*. **72**, pp.210–218.

Yeh, T.-H., Chang, H.-L. and Chang, H.-W. 2008. Initial age of unlicensed motorcycling

733 experience for a cohort of high school students. *Accident Analysis & Prevention*.
734 **40**(2), pp.511–517.
735 Zain, S.M.S.M., Latif, M.T., Baharudin, N.H., Anual, Z.F., Mohd Hanif, N. and Khan, M.F.
736 2021. Atmospheric PCDDs/PCDFs levels and occurrences in Southeast Asia: A
737 review. *Science of The Total Environment*. **783**, pp.1–14.
738

Appendix

Table 8: Final MRBQ items used in present study

No	Items	Source
1	Fail to notice that pedestrians are crossing when turning into a side street from a main road	Elliot et al., 2007
2	Not notice someone stepping out from behind a parked vehicle until it is nearly too late	Elliot et al., 2007
3	Not notice a pedestrian waiting to cross at a zebra crossing, or a pelican crossing that has just turned red	Elliot et al., 2007
4	Pull out on to a main road in front of a vehicle that you had not noticed, or whose speed you have misjudged	Elliot et al., 2007
5	Narrowly avoid colliding as a result of intentionally keep riding when you know that it is not your right of way	Elliot et al., 2007
6	Fail to notice or anticipate that another vehicle might pull out in front of you and have difficulty stopping	Elliot et al., 2007
7	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	Elliot et al., 2007
8	Distracted or pre-occupied, you belatedly realise that the vehicle in front has slowed and you have to brake hard to avoid a collision	Elliot et al., 2007
9	Attempt to overtake someone that you had not noticed to be signaling a right turn	Elliot et al., 2007
10	Not slow down when approaching a yellow light	Elliot et al., 2007
11	Ride so close to the vehicle in front that it would be difficult to stop in an emergency	Elliot et al., 2007
12	Run wide when going round a corner	Elliot et al., 2007
13	Ride so fast into a corner that you feel like you might lose control	Elliot et al., 2007
14	Exceed the speed limit on a country/rural road	Elliot et al., 2007
15	Disregard the speed limit late at night or in the early hours of the morning	Elliot et al., 2007
16	Exceed the speed limit on a residential road	Elliot et al., 2007
17	Race away from traffic lights with the intention of beating the driver/rider next to you	Elliot et al., 2007
18	Open up the throttle and just ‘go for it’ on country roads	Elliot et al., 2007
19	Ride between two lanes of moving traffic	Elliot et al., 2007

20	Get involved in unofficial ‘races’ with other riders or drivers	Elliot et al., 2007
21	Ride so fast into a corner that you scare yourself	Elliot et al., 2007
22	Attempt to do, or actually do, a wheelie	Elliot et al., 2007
23	Pull away too quickly and your front wheel comes off the road	Elliot et al., 2007
24	Intentionally do a wheel spin	Elliot et al., 2007
25	Unintentionally do a wheel spin	Elliot et al., 2007
26	Wear riding boots	Elliot et al., 2007
27	Wear shoes	From informal convorsation with police colleague
28	Wear protective trousers (leather or non-leather)?	Elliot et al., 2007
29	Wear a protective jacket (leather or non-leather)?	Elliot et al., 2007
30	Wear body armour (elbow pads, shoulder pads, knee pads, etc)	Elliot et al., 2007
31	Wear no protective clothing?	Elliot et al., 2007
32	Wear protective gloves?	Elliot et al., 2007
33	Wear bright/fluorescent strips/patches on your clothing	Elliot et al., 2007
34	Wear bright/fluorescent clothing when riding at night	Elliot et al., 2007 (Re-phrased)
35	Using helmet without chin straps or not fastening it	Putranto et al., 2014
36	Riding without a helmet	Putranto et al., 2014
37	Use dipped headlights on your bike?	Elliot et al., 2007
38	Brake or throttle-back when going round a corner or bend	Elliot et al., 2007
39	Change gear when going round a corner or bend	Elliot et al., 2007
40	Find that you have difficulty controlling the bike when riding at speed (e.g. steering wobble)	Elliot et al., 2007

41	Skid on a wet road or manhole cover	Elliot et al., 2007
42	Have trouble with your visor or goggles fogging up	Elliot et al., 2007
43	You get annoyed when other riders put you at risk	Elliot et al., 2007
44	Ride your motorcycle after having alcohol drink	Elliot et al., 2007
45	Call with a mobile phone while riding	Putranto et al., 2014
46	Carry more than one passenger with your motorcycle	Putranto et al., 2014
47	Carry a passenger who has not worn a helmet	Putranto et al., 2014
48	Cross junction when the traffic light is red	Putranto et al., 2014
49	Riding in the opposite direction of the roadway	Putranto et al., 2014
50	Riding with unroadworthy motorcycle	Putranto et al., 2014
51	Smoking while riding	Putranto et al., 2014
52	Carry a passenger who sit on one side (usually when woman wearing skirt)	From informal convorsation with police colleague
53	Carry a big carriage or big stuff with your motorcycle	From informal convorsation with police colleague
54	Riding zig-zag (move between lane quickly) to find road gaps	From informal convorsation with police colleague

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