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Trend towards Helmet Usage and the Behavior of Riders While Wearing Helmets

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Abstract: Nowadays, it is relatively common to follow traffic rules, such as wearing a helmet and fastening seat belts, but accidents are increasing daily. Concerned with these traffic safety issues, this study focuses on the psychology of bike riders. First, a brief questionnaire is prepared by filtering some significant traffic safety factors. For effective results and analysis, a questionnaire survey (i.e., interviews) is conducted across different road junctions in Sargodha, Pakistan, with the assistance of traffic police. The data is analyzed through a multiple regression analysis, forming a different model for effective outcomes. A risk compensation hypothesis theory is considered; based on the questionnaire designed and the input received from participants, three models are developed with significant variables. The first two models evaluate the physical impact of helmets on riders/cyclists, while the third observes changes (in terms of obeying traffic laws) in behavior when wearing a helmet. It has been observed that cyclists wearing helmets may follow zigzag patterns while wearing helmets, which may cause accidents. Moreover, it has been observed that cyclists wearing helmets may be more responsible regarding traffic rules. These problems should be considered in creating effective traffic safety campaigns and policy making.

Keywords: risk compensation theory; helmet safety; helmet use behavior; multiple regression; motorcyclist

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1. Introduction

Keeping in mind the broad significance of mass transportation as a basic part of our everyday life, road safety plays an important role in a community's wellbeing. Traffic accidents represent a significant concern regarding public health [1]. For example, every year, more than about 1.4 million people expire as a result of accidents worldwide, meaning road accidents are a prime cause of fatalities on a worldwide scale [2]. Moreover, modes of transportation are constantly changing. These days, various alternative modes of mass transportation allow us to rethink the importance of road safety as only a vehicular or infrastructural problem. They are forcing us to enhance our understanding of the very origin of accidents and related mediations based on the study of human experiences, making it a goal to prevent the negative consequences of the poor safety of road users. According to research, motorcyclists have the highest disability rate among all other road users [3].

In Pakistan, motorcycles comprise 75% of registered vehicles [4]. Pakistan takes the same position as that of the global trend towards helmet wearing. According to studies that were carried out in medium- and low-income countries, it was found that 50% of the accidents related to motorcycle accidents are fatal [5]. This study also shows that wearing a helmet can reduce fatal head injuries by at least 4% [6]. Despite the proven benefits and necessary legislation, improper helmet usage is common in under-developed countries [6,7]. Furthermore, a brief analysis of the literature shows that the usage of helmets in Karachi lags (about 7%) behind that of other bordering countries [8]. Helmet use was reported to be almost 70% in most cities in India [9] and approximately 90% in China [10].

Various studies [11–15] have sought to understand the different types of driver behavior in which a road user engages and the frequency of engagement. Different techniques, i.e., naturalistic studies, observations, and questionnaires, have been applied to collect the data. Many studies have adopted the Driver Behavior Questionnaire (DBQ) [16–18]. Typically, the DBQ measures two categories of behavior related to errors (unintentional mistakes) and violations (deliberate behavior) [19]. Unique psychological origins are associated with the reasons for a driver's behavior, which are the prime concern of research and need to be addressed by the motivations provided by policymakers. In the same vein, a cycling behavior questionnaire was developed by Useche et al. [20], identifying and validating the key dimensions of violations and errors that describe risky bicycle riding behavior. Further, Useche et al. [21] associated an increase in crashes with risky riding behavior [22]. A subsequent study [23] explored the positive behaviors of riders while riding bicycles. Moreover, it was shown that engagement in positive and risky behavior is influenced by a rider's awareness of traffic rules, knowledge of traffic norms, and attitude toward risk perception, which was gauged by the Cyclist Risk Perception and Regulation Scale (RPRS) [24].

Helmet use is considered to help minimize the intensity of accidents and avoid most of the fatalities of motorcyclists that occur during riding, which is the reason behind the formation of legislation that exists in countries across the globe. However, practically, scenarios related to helmet wearing are complex, mainly in developing countries. This study investigates the helmet-wearing behavior of motorcycle riders in an under-developed country: Pakistan. We herein attempt to determine the significant factors that essentially change the behavior of the helmet user.

Expected reasons for not wearing a helmet can be a lack of thoughtfulness regarding the rider's behavior surrounding helmet use and the inadequacy of awareness or enforcement campaigns. Other reasons can include physical discomfort and environmental conditions. In addition, risk-taking behavior always represents an opposing statement against mandatory helmet laws [25]. This study addresses these issues by exploiting different methods of analysis, i.e., via a multiple regression analysis, to investigate the trends of road users and suggest an efficacious approach by which to cope with the problems highlighted. Other objectives are accomplished by analyzing the behavior and perception of riders regarding non-helmet-wearing excuses. The following are the objectives of our work:

- To examine the theory i.e., a risk compensation hypothesis, against the behavior of motorcycle helmet use.
- To study behavioral changes during helmet usage.
- To examine whether the use of a helmet is beneficial and to what extent it can reduce the severity of injuries and avoid fatalities for motorcyclists while riding.

Significant strategies for cyclist safety include improvements to the built environment (i.e., bike paths and cycle tracks) and cyclists' use of other safety devices, such as lights and bells [26,27]. Moreover, incorporating a helmet use can reduce the severity of head injuries and death [28,29]. Meta-analyses by Olivier [3], Creighton [30], Attewell et al. [29], and Hoye et al. [31] demonstrated that for cyclists involved in a crash or fall, helmet use was associated with reduced odds of a head injury. Despite their proven efficacy, the use of helmets by cyclists is inconsistent where legislation makes them mandatory while enforcement is not in effect. In recent studies [32], it has been observed that non-helmet-wearing injured cyclists were frequent commuters with the general perception that cycling is not safe, though they chose not to wear a helmet because of inconvenience and discomfort. These perceived barriers must be overcome by initiatives to use helmets and by further exploring cyclists' perceptions regarding the risk of injury and death.

Based on the questionnaire designed and the input received from participants, three models are developed with significant variables. The first two models evaluate the physical impact of helmets on the rider/cyclist, while the third observes changes (in terms of obeying traffic laws) in behavior when wearing a helmet.

This study presents factors influencing the use of helmets. The results of the study are compared with the results of other studies conducted in other developed and under-developed countries to propose the most efficacious campaign measures. The results of the study are shown in different sections below in the literature review, which addresses each problem and its effective mitigation measures.

2. Literature Review

Approximately millions of people die all over the world each year due to road accidents, and many of them are badly injured, which is a burden on government GDP [33]. The highest level of motorcyclist fatalities being in Southeast Asian countries is due to their high use of motorcycles; approximately 59%, 78%, 83%, and 95% of people in Southeast Asian countries use motorcycles in Thailand, Laos, Indonesia, and Vietnam, respectively [9]. A study that was conducted to check the riding behavior of school children in Yamuna Nagar, India found that young riders that are under 18 show more aggressive behavior while riding [34]. A survey conducted in Hanoi, Vietnam on the risky riding behavior of motorcycle riders showed that risky behavior, such as speeding, running red lights, turning carelessly, and using mobile phones, depended upon individual habits and intentions [35]. A questionnaire study was conducted in Indonesia to assess traffic rule violations among motorcyclists; they found that most young adults use mobile phones while riding and violate traffic regulations [36].

For motorcycle riders, wearing a helmet leads to riskier behavior, which is against the safety afforded by the helmet [37]. There is much research about the risk-taking behaviors of motorcyclists, which aims to find out why motorcyclists take risks while riding [38,39]. There was research conducted in a city in Vietnam to find out about how many motorcyclists use mobile phones and take part in other risky riding behaviors, such as running red lights, overtaking on the left, riding on sidewalks, and searching information on their mobile phone while riding. An online survey was conducted in a Vietnam university to find out the percentage of students who use mobile phones while riding and take part in other risky riding behaviors. For their data analysis, they used a discrete regression analysis of the percentage of students who used mobile phones while riding and showed other risky behaviors, such as speeding, not using a helmet, violating traffic regulations, and overtaking recklessly. They found that approximately 74% of students used mobile phones while riding for calling and 49% and 51.2% used mobile phones for messaging and searching information, respectively [40].

Research was conducted in three cities in Vietnam to find out why motorcyclists showed risky behavior while riding. They found that unhealthy habits were a cause of risky riding behavior among motorcyclists. Unhealthy habits included smoking, drinking, and other risky behaviors among motorcyclists. For data collection, they used online surveys and field survey methods. They selected three cities in Vietnam for data collection, including Hanoi, Ho Chi Minh City, and Da Nang during the summer of 2018. First, they designed a Google form for online data collection and conducted paper-based surveys at different locations in these cities. They used SPSS statistics2 for their data analysis. They used a logistic regression analysis for their data analysis to find out that an unhealthy lifestyle was a cause of risky riding behavior among motorcyclists. The results showed that unhealthy habits, such as smoking, led to several risky riding behaviors. They found that the riders who were smokers and alcohol users showed more risky riding behaviors while riding a motorcycle than did the riders who were non-smokers and non-alcohol users [41]. In summary, helmet usage behavior has been studied in several studies, but it needs to be explored further in terms of the behavior changes observed while wearing a helmet [42].

Helmet use is considered to be beneficial for minimizing the intensity of accidents [43] and avoiding most of the fatalities of motorcyclists while riding, which is the reason behind the formation of legislation that exists in all countries across the globe. But practically, the scenario related to helmet wearing is complex, mainly in developing countries across the globe [44,45]. Therefore, we target one of the developing cities in Pakistan to study and investigate the helmet-wearing behavior of motorcycle riders in the city of Sargodha, Pakistan. We attempt to determine the significant factors that essentially change helmet behavior and propose some important effective campaign measures to implement to promote trends in helmet use.

The intended effects of road safety measures might be detracted from by behavior adoptions by riders. This phenomenon has been demonstrated by several road safety measures at an individual and aggregated accident risk level. This review tries to cluster the literature concerned with offsetting behavior in road safety.

Risk compensation theory in traffic encompasses the road system changes that are perceived as capable of improving safety by adapting behavior [46]. Thus, in this way, measures designed to improve traffic safety may have some negative consequences in terms of risky riding, and measures designed to improve traffic safety may have some negative consequences in terms of risky riding when feeling safer [47]. The term closely related to risk compensation is behavior adoption, which may be positive or negative changes induced by road safety measures [48].

The road safety literature is full of claims for the efficacy of a wide range of traffic safety measures. Risk compensation is a widely raised issue when promoting helmet use for motorbikes. Briefly, risk compensation theory suggests that an individual provided with protective measures, such as a helmet, will act in a riskier way because they have a sense of increased protection, thereby nullifying the protection afforded by the helmet. Risk compensation theory is not only applicable to case studies; rather, its potential applicability includes the widespread use of helmets.

Helmet usage is a critical issue all around the world. Without a rule, habitual helmet use is scarce. In 2015, in Germany, only 15% of cyclists were reported to use a helmet [49]; previously, it was less than this [50–52] although it is a known fact pointed out unambiguously by available research that cycling helmets can reduce crash severity [53–55]. In particular, they can reduce the risk of head injury [56]. Data from the United States revealed that the number of severe head injuries and fatalities decreased after a mandatory helmet usage law was introduced in Seattle [57]. Nevertheless, legislation regarding the mandatory use of helmets is highly controversial because of the associated side effects. It has been argued that legislation might impact cycling frequency [58]. In a frequently cited (although heavily criticized [59]) study, Walker [60] found that drivers might modify their passing distance dependent on a cyclist's usage of a helmet, passing closer to those who wore helmets.

It has also been argued that cyclists wearing helmets might adopt behavior based on perceiving risk differently in a given situation; thus, as per risk compensation theory, a risk would be perceived as being reduced because of the cyclist wearing a helmet [61,62]. Consequently, cyclists wearing helmets, for instance, cycle faster, objectively increasing their risk of being involved in a crash [63]. However, evidence for this argument is harder to find. An experiment with 1500 cyclists conducted in Norway revealed that an intention/expectation of riding fast is the reason for helmet use, and not the other way around [64]. In addition, it was observed that participants were aware of the increased risk attached to fast cycling, and self-reporting provided no evidence about the relationship between crash involvement and helmet use. Similarly, experimental studies have so far failed to provide evidence for cyclist risk compensation [65]. The results showed that routine helmet users cycled slower when not wearing a helmet compared to the condition in which they wore a helmet (i.e., they slowed down when their usual protection was removed). However, there was no comparable effect for non-helmet users (i.e., they did not increase their speed once they wore a helmet).

One argument against mandatory helmet use is based on risk compensation, which means that cyclists might ride faster when wearing a helmet [63]. However, questionnaires and experimental studies could not find evidence to support this assumption [64,65]. Simultaneously, there are other factors that play a potential role in helmet use and cycling speed. Therefore, the analysis presented in this paper investigates the relationship between helmet use, behavior change in general, and disobeying rules/regulations while wearing helmets. Recently, Schleinitz [66] conducted detailed experiments to investigate the question of whether cyclists overspeed while wearing helmets. It is interesting to note that the assumption of risk compensation as a result of the use of a helmet could not be confirmed. Instead, the findings seemed to support the suggestion that cyclists who undertake trips at potentially higher speed levels are aware of their increased risk, and actively try to reduce it through the use of a helmet. However, it was stated that all other factors that were analyzed (i.e., trip length, ridership characteristics) except gender had a significant relationship to cycling speed. Keeping this in mind, this study explores further:

1. The impact of wearing a helmet on the physical discomfort of a rider.
2. The impact of helmet wearing on obeying traffic laws.
3. Behavior changes in the general cycling environment when wearing a helmet.

3. Methodology

For the collection and analysis of data, a questionnaire was designed (Table 1) after exploring the most relevant literature [67–70], the outcomes of which were analyzed on SPSS (Statistical Package for the Social Sciences) through a regression analysis.

Table 1. Questionnaire and responses for bike rider behavior survey.

	0 = Never; 1 = Almost never; 2 = Sometimes; 3 = Frequently; 4 = Always					
	Gender: Male/Female Age: ______ years					
	What is your occupation? ○ Student ○ Employee (government) ○ Independent (self-employed) ○ Unemployed ○ Retired ○ Housekeeping ○ Other Do you have a driving license? ○ Yes ○ No					
Sr #	**Item**	**Frequency Degree**				
		Never	**Almost Never**	**Sometimes**	**Frequently**	**Always**
1	Do you wear a helmet while riding a bike?	66	36	85	54	85
2	Do you feel safe while wearing a helmet?	33	21	35	62	173
3	Are you afraid of unusual challan?	93	61	42	44	86
4	Do you feel physical discomfort while wearing a helmet?	117	56	66	28	59
5	Have you ever faced the stealing of your helmet by someone?	135	84	56	23	28
6	While wearing a helmet, do you feel that sometimes you are going at a higher speed than you should be?	95	76	59	38	58
7	When wearing a helmet, do you FOLLOW other laws of traffic? i.e., speed limit	30	50	56	40	150
8	When wearing a helmet, do you FOLLOW other laws of traffic? i.e., traffic signals	22	21	42	63	178
9	When wearing a helmet, do you FOLLOW other laws of traffic? i.e., right overtaking	26	46	41	74	139

Table 1. *Cont.*

10	Do you zigzag between vehicles when using a multiple lane road while wearing a helmet?	69	96	82	37	42
11	Does braking suddenly or being close to vehicles cause an accident?	55	92	77	58	42
12	Do you cross the road when the crossing appears clear, even if the traffic light is red?	56	93	92	49	36
13	Have you had a speed competition or "race" with another motorcyclist or driver?	68	103	93	36	26
14	Do you avoid circulating under adverse weather conditions?	32	90	74	64	66
15	Do you stop sometimes at crosswalks, or at other places that obstruct pedestrian traffic?	34	87	96	53	54
16	Do you cross the street unintentionally without having a proper look, thus forcing another vehicle to brake to avoid a crash?	52	75	94	61	44
17	Do you brake suddenly on a slippery surface?	48	95	77	67	39
18	Do you misjudge turns and crash due to something being on the road or being close to losing balance on the vehicle?	44	106	75	54	45
19	Have you ever misjudged the road conditions and lost control over a bump or hole in the road while riding?	28	94	70	65	69
20	Do you stop for a while and look at both sides before crossing a corner or intersection of roads?	14	72	56	67	117
21	Do you regularly check your motorbike to avoid any mechanical mishaps?	14	53	74	86	99
22	Do you avoid riding if you feel very tired or sick?	20	82	71	60	93
23	Do you indicate to other vehicles that you will turn before turning?	28	57	81	74	86
24	Do you feel aware of the other vehicles on the road that surround you?	30	67	74	80	75
25	Do you follow a zigzag pattern to avoid obstacles on the roads?	42	100	74	55	55
26	Do you sometimes realize that there are some signaling- and infrastructure-related issues that can affect your safety? If yes, then which of the following affect your safety?	86	87	61	36	56
27	1. Text messages or chats	118	70	51	56	31
28	2. Phone calls	116	56	72	53	29
29	3. Billboards	106	65	73	47	35
30	4. People that I find attractive	98	68	85	40	35
31	5. My own thoughts or concerns	96	63	67	60	40
32	6. Weather conditions	44	52	77	79	74
33	7. The behavior of other users	35	42	101	76	72
34	8. Obstacles on the roads	40	56	88	84	58
35	Do you observe that riding under the influence of certain conditions (e.g., alcohol, illegal and/or prescribed drugs) affects your ability to ride well?	74	77	64	33	76
36	Do you think riding in urban areas is usually risky, considering the large number of vehicles and the complexity of the roads?	28	39	96	68	95
37	Do you readily recognize traffic signals on the roads while riding?	6	27	60	55	178
38	Do you know the basic rules governing other types of vehicles?	2	25	65	73	161
	In a week, approximately how many hours do you use your bike? About _______ hours per week					

3.1. Questionnaire

The questionnaire was basically formulated in two parts. The first portion of the questionnaire was about the demographic details of riders, such as gender, age, occupation, driving license, and qualification level. The second part of the questionnaire consisted of 40 questions in which motorcycle riders were asked about their careless behaviors while riding a motorbike. The intensity of each careless behavior was calculated using a five-point scale, i.e., never, almost never, sometimes, frequently, and always. They were asked about their behavior while riding motorbikes, consisting of activities such as not wearing a helmet, speeding while wearing a helmet, running red lights, riding on the wrong side of the road, using a mobile phone (for calling, texting, and/or searching for information), etc.

3.2. Sample Set Determination

Confidence level corresponds to a Z-score. This is a constant value needed for the equation. The following are the Z-scores for the most common confidence levels:

- 90%—Z Score = 1.645
- 95%—Z Score = 1.96
- 99%—Z Score = 2.326

Plug in your Z-score, standard deviation, and confidence interval into this equation:

$$\text{Necessary Sample Size} = (\text{Z-score})^2 \times \text{StdDev} \times (1 - \text{StdDev})/(\text{margin of error})^2 \quad (1)$$

This is how the math works, assuming you chose a 90% confidence level, 0.5 standard deviation, and a margin of error (confidence interval) of +/−5%:

The following are the Z-scores for the most common confidence levels:

- 90%—Z Score = 1.645

Next, plug in your Z-score, standard deviation, and confidence interval into this equation:

$$((1.645)^2 \times 0.5(0.5))/(0.05)^2$$

$$0.676506/0.0025$$

$$\text{270 respondents are needed}$$

3.3. Data Collection

Data related to risky riding behavior were accumulated through interviews conducted in different junctions in the city of Sargodha, Pakistan. A paper-based questionnaire survey was conducted inside and outside the University of Sargodha. The questionnaire was distributed among different classes. For the road cross section survey, to make our work legal, first we got permission from the DPO Officer of Sargodha District. After that, we got permission at different intersections for the road cross section study, and during this survey, a group of traffic police officers were assigned for our assistance in the interviews with bike riders. Before they filled the questionnaire, we explained to the participants what the purpose of the questionnaire was, and asked them to give proper answers to the queries for effective information.

For the paper-based questionnaire survey, a total of 1000 questionnaires were distributed among motorcycle riders in the city of Sargodha. We considered 326 respondents and excluded some partially filled questionnaires (Table 2).

Table 2. The details of the participants.

Occupation	Number of Participants
Employee	91
Other	14
Retired	4
SELF Employed	64
Student	145
Unemployed	8
Grand Total	326

3.4. Assumptions Checked

The following data checks as suggested by [71] were observed before we moved to the multiple regression analysis:

- Linearity of dependent vs. independent;
- Collinearity (for this, tolerance must not be less than 0.2; otherwise, there will be multi-linearity issues);
- Assumption of independence (whether the residuals are correlated or uncorrelated, and we want residual to be uncorrelated;

- Durbin Watson (1–4) value near 2 shows assumption is met and that residuals are uncorrelated; if it is less than 2, then it shows +ve correlation; if greater than 2, then −ve correlated;
- Normality of residuals (*t* test, ANOVA, histogram, etc.).

3.5. Modeling The Data

Three models were created depending on different dependent and independent variables and selected based on the "*p*" value being a significant or insignificant model. Based on the questionnaire designed and the input received from participants, three models were developed with significant variables. The first two models evaluated the physical impact of helmets on riders/cyclists, while the third observed changes (in terms of obeying traffic laws) in behavior when wearing a helmet.

3.5.1. Model 1

Dependent variables are those which predict others' behaviors, contrary to those variables which predict the variables' behaviors, which are called independent variables.

Dependent variable:

- Do you wear a helmet while riding a bike?

Independent variables:

- Do you feel physical discomfort while wearing a helmet?
- Are you afraid of unusual challan?
- Do you misjudge turns and crash due to someone being on the road or being close to losing balance?
- Do you know the basic rules governing other types of vehicles while riding?

Analysis of the model **is** presented in Table 3. This table basically interprets whether the model is significant or not significant. The model is considered to be significant if its *p* value is less than 0.05. As shown in the table above, the significant value is 0.010, which is less than 0.05; thus, this model is significant.

Table 3. ANOVA for MODEL 1 [a].

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.741	4	6.935	3.404	0.010 [b]
	Residual	649.914	319	2.037		

[a] Dependent Variable: do you wear helmet while dirving a bike. [b] Predictors: (Constant), I know the basic rules governing other types of vehicles, Do you Misjudge a turn and hitting something on the road, or being close to losing balance (or falling)?, areyou afraid of unusal challan, do you feel physical discomfort while wearing helmet.

Model summary is presented in Table 4. This table shows the variance accounted in independent by dependent variable. If we multiply the r square value by 100 to get the percentage we get the value of variance. In this case, variance is 4.1%, which shows that 4.1% of variance is accounted for in helmet wearing by other independent variables as mentioned above.

Table 4. Model summary for MODEL 1 [b].

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin Watson
1	0.202 [a]	0.041	0.029	1.42736	1.827

[a] Predictors: (Constant); I know the basic rules governing other types of vehicles; Do you misjudge turns and hit things on the road or become close to losing balance (or falling)? Are you afraid of unusual challan? Do you feel physical discomfort while wearing a helmet? [b] Dependent variable: Do you wear a helmet while riding a bike?

Coefficients interpretations are in Table 5. Coefficient table explains variables significantly predict the dependent variable and how independent variables impact the dependent variable. In the above table, only the first variable, i.e., "Do you feel physical discomfort while wearing a helmet?" is significant, whereas all others have a value greater than 0.05. The same results were observed in previous literature [72]. The next step is to analyze the "B" column in the table. "B" tells us specifically how an independent variable impacts a dependent variable. In the above table, the first significant variable has a −0.197 B value. B value depicts that for every one unit increase in dependent variable there is a 19.7% decrease in independent variable. It depicts the level of discomfort observed by the sample set. The same sort of conclusion was drawn in [73,74] with a suggestion for policy makers to enforce the conformance of helmet makers to high quality standards to avoid rider dicomfort while wearing a helmet.

Table 5. Coefficients for MODEL 1 [a].

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.263	0.335		6.756	0.000		
	Do you feel physical discomfort while wearing a helmet?	−0.197	0.057	−0.203	−3.440	0.001	0.860	1.162
	Are you afraid of unusual challan?	0.060	0.052	0.066	1.145	0.253	0.915	1.093
	Do you misjudge turns and hit things on the road or become close to losing balance (or falling)?	0.084	0.063	0.073	1.330	0.185	0.995	1.005
	I know the basic rules governing other types of vehicles.	−0.020	0.081	−0.014	−0.248	0.804	0.927	1.079

[a] Dependent variable: Do you wear a helmet while riding a bike?

3.5.2. Model 2

Dependent variable:

- Do you wear a helmet while riding a bike?

Independent variables:

- Do you feel physical discomfort while wearing a helmet?
- Do you feel safe while wearing a helmet?
- Approximately how many hours do you use a bike every week?

Analysis of model is presented in Table 6. Table 6 basically interprets whether the model is significant or not significant. The model is considered to be significant if its p value is less than 0.05. As shown in the table above, the significant value is 0.00, which is less than 0.05; thus, this model is significant. We can proceed with our interpretation further ahead.

Table 6. ANOVA for MODEL 2 [a].

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	170.535	3	56.845	35.745	0.000 [b]
	Residual	510.492	321	1.590		
	Total	681.028	324			

[a] Dependent variable: Do you wear a helmet while riding a bike? [b] Predictors: (Constant); In a week, approximately how many hours do you use a bike? Do you feel safe while wearing a helmet? Do you feel physical discomfort while wearing a helmet?

Model summary is presented in Table 7. Table 7 shows the variance accounted in independent by dependent variable. If we multiply r square value by 100 to get the percentage, we get the value of variance. In this case, variance is 25%, which shows that 25% of variance is accounted for in helmet wearing by other independent variables as mentioned above.

Table 7. Model summary for MODEL 2 [b].

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin Watson
1	0.500 [a]	0.250	0.243	1.26108	1.739

[a] Predictors: (Constant); In a week, approximately how many hours do you use a bike? Do you feel safe while wearing a helmet? Do you feel physical discomfort while wearing a helmet? [b] Dependent variable: Do you wear a helmet while riding a bike?

Coefficients interpretations are presented in Table 8. Coefficient table tells us specifically which variables significantly predict the dependent variable and how independent variables impact the dependent variable. In the above table, only traveling frequency variable, i.e., "Do you feel physical discomfort while wearing a helmet?" is significant while all others have a value greater than 0.05. In the above table, only second variable, i.e., "Do you feel safe while wearing a helmet?" is significant. "B" tells us specifically how independent impacts dependent. In the above table, first significant variable has −0.197 B value. This value reveals that for one unit increase in dependent variable there is 19.7% decrease in independent variable. In the above table, second significant variable has 0.455 B value. This value reveals that for one unit increase in dependent variable there is 45.5% increase in independent variable. This is in line with risk compensation theory [75–77].

Table 8. Coefficients for MODEL 2.

Model		Unstandardized Coefficients [a]		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
2	(Constant)	1.054	0.197		5.359	0.000		
	Do you feel physical discomfort while wearing a helmet?	−0.182	0.047	−0.188	−3.854	0.000	0.983	1.017
	Do you feel safe while wearing a helmet?	0.455	0.047	0.467	9.649	0.000	0.999	1.001
	In a week, approximately how many hours do you use a bike?	0.006	0.040	0.007	0.145	0.885	0.982	1.018

[a] Dependent variable: Do you wear a helmet while riding a bike?

In above models, Model 1 has a significance value of 0.010 while Model 2 has 0.000 value. Thus, Model 2 is more significant than Model 1. Generally, both models are considered as significant. Moreover, Model 2 has more r square value, which interprets variance accounted in dependent by independent variable. Model 1 has only one significant independent variable while in Model 2 there are two significant variables. Thus, Model 2 is more suitable than Model 1.

3.5.3. Model 3

Dependent variable:

- While wearing a helmet, feeling that sometimes I am going at a higher speed than I should be.

Independent variables:

- Do you FOLLOW other laws of traffic, i.e., right overtaking?
- Do you zigzag around other vehicles using multiple lanes while wearing a helmet?
- Do you indicate to other vehicles that you will turn before turning?
- When wearing a helmet, do you FOLLOW other laws of traffic, i.e., right overtaking?
- Do you cross the street unintentionally without having a proper glance, making other vehicles brake to avoid a crash?
- I realize that there are signaling and infrastructure problems that can affect my safety. If yes, which of the following:
- Billboards, weather conditions.

Analysis of model is presented in Table 9. This table basically interprets whether the model is significant or not significant. The model is considered to be significant if its *p*-value is less than 0.05. As shown in the table above, the significant value is 0.00, which is less than 0.05; thus, this model is significant. We can proceed with our interpretation further ahead.

Table 9. ANOVA for MODEL 3 [a].

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	136.010	8	17.001	9.772	0.000 [b]
	Residual	551.511	317	1.740		
	Total	687.521	325			

[a] Dependent variable: While wearing a helmet, do you feel that sometimes you are going at a higher speed than you should be? [b] Predictors: (Constant); Obstacle in the roads; Do you zigzag between vehicles when using a mixed lane while wearing a helmet? Do you indicate to other vehicles that you will turn, well in advance? When wearing a helmet, do you FOLLOW other laws of traffic, i.e., right overtaking?; Do you cross the street unintentionally without looking properly, making another vehicles brake to avoid a crash?; I realize that there are signaling and infrastructure problems that can affect my safety: If yes, which of the following: billboards, weather conditions.

Model summary is presented in Table 10. This table shows the variance accounted in dependent by dependent variable. If we multiply r square value by 100 to get the percentage, we get the value of variance. In this case, variance is 19.8%, which shows that 20% of variance is accounted for in dependent by other independent variables as mentioned above.

Table 10. Model Summary for MODEL 3 [b].

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin Watson
1	0.445 [a]	0.198	0.178	1.31901	2.123

[a] Predictors: (Constant), obstacle in the roads, Do you move Zigzag between vehicles when using a mixed lane while wearing Helmet?, Do you indicate to the other vehicles that I will turn, well in advance?, After wearing helmet Do you FOLLOW other laws of traffic? i.e., right Overtaking, Do you cross the street Unintentionally without looking properly, thus making another vehicle brake to avoid a crash?, I realize that there are signaling and infrastructure problems that can affect my safety if yes answer following, billboards, weather conditions. [b] Dependent Variable: While wearing helmet, Do you Feel that sometimes you are going at a higher speed than You should be going at?

Coefficient Table 11 shows the variables significantly predict the dependent variable and how independent variables impact the dependent variable. In Table 11, first variable is significant with negative impact, i.e., "When wearing a helmet, do you FOLLOW other laws of traffic, i.e., right overtaking?". In Table 11, second variable is significant, i.e., "Do you zigzag between vehicles when using a mixed lane while wearing a helmet?". It demonstrates that one unit increase in dependent contributes 26.3 independent increase.

In Table 11, third variable is also significant, i.e., "Do you indicate to the other vehicles that you will turn, well in advance?", and one unit of dependent increase contributes an 11.7% independent increase. In Table 11, fourth variable is also significant, i.e., "Billboards", and one unit of dependent increase contributes a 21.6% independent increase.

"B" tells us specifically how independent impacts dependent. In Table 11, first significant variable has −0.215 B value. This value reveals that for one unit increase in dependent variable there is 21.5% decrease in the independent variable. It depicts that when wearing a helmet, riders' trend toward following the traffic rules is decreasing. Second significant variable has 0.265 B value. This value interprets that for one unit increase in wearing helmet there is 26.5% increase in a zigzag pattern.

Third significant variable has 0.117 B value, i.e., "Do you indicate to other vehicles that you will turn, well in advance?". This value reveals that for one unit increase in wearing helmet there is 11.7% increase in well-advanced indication of turning. Furthermore, fourth significant variable has 0.216 B value. This value reveals that increased helmet wearing increases attention toward billboards associated safety issues by 21.6%.

Table 11. Coefficient table for Model 3.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.336	0.281		4.761	0.000		
	When wearing a helmet, do you FOLLOW other laws of traffic, i.e., right overtaking?	−0.215	0.057	−0.198	−3.790	0.000	0.928	1.078
	Do you zigzag between vehicles when using a mixed lane while wearing a helmet?	0.263	0.062	0.233	4.223	0.000	0.833	1.200
	Do you cross the street unintentionally without looking properly, making other vehicles brake to avoid a crash?	0.015	0.062	0.013	0.244	0.807	0.885	1.130
	Do you indicate to other vehicles that you will turn, well in advance?	0.117	0.058	0.103	2.016	0.045	0.976	1.025
	I realize that there are signaling and infrastructure problems that can affect my safety: If yes, which of the following:	−0.020	0.056	−0.020	−0.358	0.720	0.848	1.180
	Billboards	0.216	0.061	0.202	3.571	0.000	0.794	1.259
	Weather conditions	−0.040	0.062	−0.037	−0.644	0.520	0.774	1.292
	Obstacle in the roads	−0.013	0.065	−0.011	−0.201	0.841	0.801	1.249

Taking speed as a dependent variable, we formulate a model which is significant to all other models. This model reveals that, while considering speed as a dependent, some independent variables are significant, i.e., "Do you zigzag between vehicles when using a mixed lane while wearing a helmet?" and "Do you indicate to other vehicles that you will turn, well in advance?"

4. Discussion

The main goal of this study was to investigate the relationship between helmet use and the characteristics of cyclists and bicyclists, as well as taking trip frequency into account.

This data analysis found a significant relationship between helmet use and physical discomfort and feeling safe. From the data, almost fifty percent of responses positively related to a high cycling speed when wearing a helmet. Based on this result, the assumption that helmet use may result in some form of risk compensation could be supported, which is not in line with the findings of [65,66].

Furthermore, it can be observed that the significant parameters related to cycle riders with helmet use are the following of traffic rules, a zigzag pattern in lane changing, and the non-observance of billboards while riding and wearing a helmet. Thus, a cyclist wearing a helmet obeys traffic rules, which is good practice; however, most severe crashes are due to lane changing and the behavior of the cyclist, and it has been observed that cyclists adopt zigzag lane-changing behavior and feel safe when wearing a helmet. Another significant finding is the realization that while cycling with a helmet on, cyclists do not observe billboards, and doing so can cause major crashes.

Most instructive, however, was the role of trip frequency in our analyses. In previous findings, there was a clear relationship between trip length and helmet use [66,78], as, on average, cycling trips for which riders wore a helmet were longer compared to those without. In our analysis, "In a week, approximately how many hours do you use a bike?"

did not find a significant positive relationship with helmet use, which is not in line with previous research.

Based on our experimental modeling, three models were developed:

Model 1

Helmet use = **2.263 − 0.203(physical discomfort)** + 0.066(challan fear) + 0.073(mis-judge) − 0.014(basic vehicle governing rules)

Model 2

Helmet use =1.054 − 0.188(physical discomfort) + 0.467(feeling safe) + 0.007(travel frequency)

Model 3

Wearing helmet and over-speeding = **1.336 − 0.198 9(right overtaking) + 0.233(zigzag) + 0.013(careful crossing)** + 0.103(turning indicator) − 0.020 (realization of signaling and infrastructure problem) + **0.202 (billboard)** − 0.037 (weather condition) − 0.011 (obstacles)

One major criticism is the issue of validity for these types of experiments. Even for real-time experiments on behavioral assessment, a reprobate argument might be that any long-term behavioral adaptation to a cycling helmet cannot be induced in or inferred from an experiment. Likewise, other characteristics cannot be tested in an experimental environment/arrangement.

For example, helmet usage is somehow related to trip length. In interviews and questionnaire surveys, cyclists stated that they do not use helmets for short trips [78–80]. At the same time, trip length is associated with trip purpose, road type, intersections available, etc. In addition, age and gender are factors related to speed and trip length [64,81]. Finally, conventional bikes and new e-bikes can be considered as having different inputs for trip length and speed [82,83]. In summary, long-term observations of bicyclists under naturalistic conditions are required to address the described issues. Such naturalistic cycling studies [84,85] help to paint a realistic picture of cyclists' behavior. Therefore, this study's goal was to make use of such data and assess the relationship between helmet use and physical and psychological behavior. An important consideration for establishing a successful validation study is establishing acceptance criteria, which were provided by comparing the current results with previous literature in Table 12.

Table 12. Comparison of results with previous research.

Sr No	Factor	This Study's Findings	Previous Findings
1	Do you feel physical discomfort while wearing a helmet?	Negatively significant parameter	In line with previous studies [86–88]
4	Do you feel safe while wearing a helmet?	Positively significant parameter	In line with previous studies [86,87,89]
5	In a week, approximately how many hours do you use a bike?	Insignificant parameter	Not in line with previous studies [66,78] as the previous studies considered trip length but we have considered trip frequency
6	Do you FOLLOW other laws of traffic, i.e., right overtaking?	Negatively significant parameter	In line with previous studies [60,90]
7	Do you zigzag around vehicles when using a multiple lane road while wearing a helmet? Careful crossing	Positively significant parameter	In line with previous studies [60,90]
8	I realize that there are billboard problems that can affect my safety.	Positively significant parameter	In line with previous studies [60,90]

5. Conclusions

As far as the factors affecting helmet wearing are concerned, one thing was widely observed: Physical discomfort was one of the determining factors of the excuse of not wearing a helmet. People usually complained about their line of sight and that they could not look behind for any incoming vehicles while wearing a helmet (since they did not use side mirrors). Another factor that could not go unnoticed was riders' reasons behind wearing a helmet. For most of the helmet users, it was surprising to hear that many people did not use helmets for safety purposes, but to tackle environmental conditions, i.e., physical discomfort, dust, and the cold. Among all of these, it was also concluded:

- Cyclists can feel discomfort when wearing helmets.
- Another significant factor was that people perceived that helmet wearing is important for life safety.
- By wearing a helmet, behavioral changes are noticed in terms of right turn signaling, zigzag lane changing, careful attitudes at intersections, and the non-observance of billboards.

To tackle the situation surrounding community behavior, guidance campaigns publicly and in schools and colleges are necessary. As far as risk hypothesis theory is considered, we formed models which showed that cyclists may follow zigzag patterns when wearing a helmet, which may cause accidents. This problem should be kept in mind in eliciting effective campaign results. Being responsible citizens, we must know the importance of helmet usage and law following, because disobeying the law or not wearing a helmet not only makes us prey to severe harm, but also endangers the lives of others.

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