Modelling the Risk of Pedestrians in Walkways

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ABSTRACT

Pedestrians engaged crashes were increased day by day in the world. There is a high risk of accidents for pedestrians when crossing the road than walking on the road. To minimize the crash rate on pedestrians it is important to know about the risks faced by pedestrians on the road. This study aimed to report pedestrians' perceptions of risks while walking and crossing the road. A questionnaire survey was carried out to get the data about pedestrians' perceptions of risks while walking and crossing the road in Matara district. Data were collected with questions with a five-point scale during August and September 2021 from 225 females and 175 males. The collected data were validated by estimating the Cronbach Alpha values and analyzed using chi-square tests and multinomial logistic regression methods. The results of the study were shown the usage of that technical device while walking on the road is the most reported (66.2%) pedestrian risk in the walkways. Whereas crossing the road without using pedestrian crossings is the most reported risk (73%) during the time of crossing the road. The chi-square test results of the survey were indicated that some of the self-reported risks have a significant association with age and gender. Male pedestrians involved with risky behaviours than female pedestrians because male pedestrians have high observed values than the expected values in the reported risks. Age groups, less than 18 years and 18-30 pedestrians were mostly engaged with risky behaviours on the road. Their observed values in the pedestrian risks especially in using technical devices on the road are higher than the observed values compared to other age groups. When the average walking distance of pedestrians per day is increased, accidents happening on pedestrians is also increased. The results of this study would help infrastructure designers to make safer roads.

KEYWORDS: *crossing*, *pedestrians*, *self-reported risks, walking, age, gender*

1 INTRODUCTION

Pedestrian crashes were increased day by day in the world. The rapid increment of motor vehicles is one of the main reasons for motor crashes on pedestrians (Agarwal and Vikram, 2021). In the world, 23% of road injuries are caused by pedestrians. Pedestrian accident rates are at a higher value in low-income countries than in high-income countries (Yagil, 2020). In Australia, pedestrians represent 14% of road accidents (Williamson, 2015). Among the total deaths, 1.8% of deaths were resulting due to road accidents in the United States (US) (Costello, 2004). In European countries, the younger generation was involved with road accidents most of the time because of their high technical device usage on the road. The pedestrian fatality rate in Bangladesh is 32.7 per 10,000 vehicles (World Bank, 2020) and 25,858 pedestrian deaths happened in India in 2019 (Goswami, 2021).

Figure 1 shows the total deaths that happened for different road user categories due to road accidents in the world in 2015. Pedestrians have the third-highest value; 22% of the total road traffic deaths. According to Department of Motor Traffic, the total number of registered vehicles in Sri Lanka is 8,297,852 on the day of 2020.12.31 (DMT, 2021). In Sri Lanka, there were 23,415 road accidents happened during 2020 (Sri Lanka Police, 2020). Compared to 2018 and 2019 it was a lower value that may be due to Covid 19 pandemic travel restrictions in the year 2020. In 2020, 22% of deaths out of total road traffic deaths were reported for pedestrians (Sri Lanka Police, 2020). In 2020, 265 accidents were occurred due to the carelessness of pedestrians, out of that 32 were fatal accidents (Sri Lanka

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Police, 2020). About 3,165 pedestrian- motor crashes were happened because of failure to use marked pedestrian crossings to cross the road (Sri Lanka police, 2020).

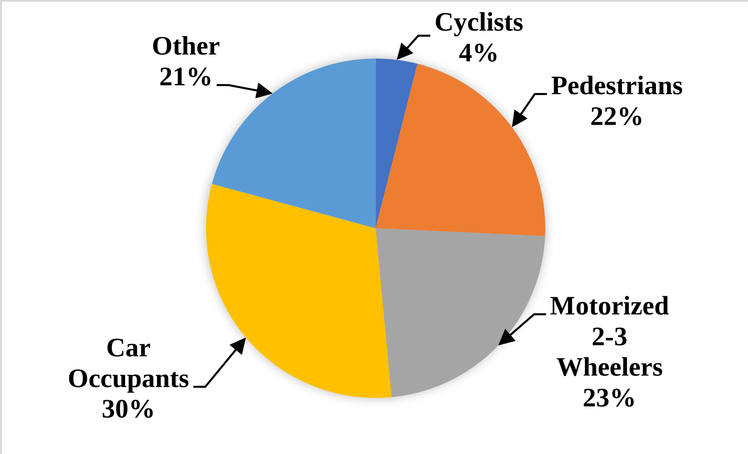

Figure 1. Road traffic deaths by type of the user in the world in 2015 *(Source – WHO, 2015)*

Figure 2 describes the total deaths that happened in different types of road user categories due to road accidents in 2018, 2019 and 2020 in Sri Lanka (Sri Lanka police, 2020). Accordingly, it pedestrians have the second-highest value. However, a proper studies on pedestrian safety in rural areas of Sri Lanka is not available. The objectives of this study are to identify the pedestrian risks from the self-reported data, find the reasons for those risks and propose suitable countermeasures to reduce the pedestrian risks.

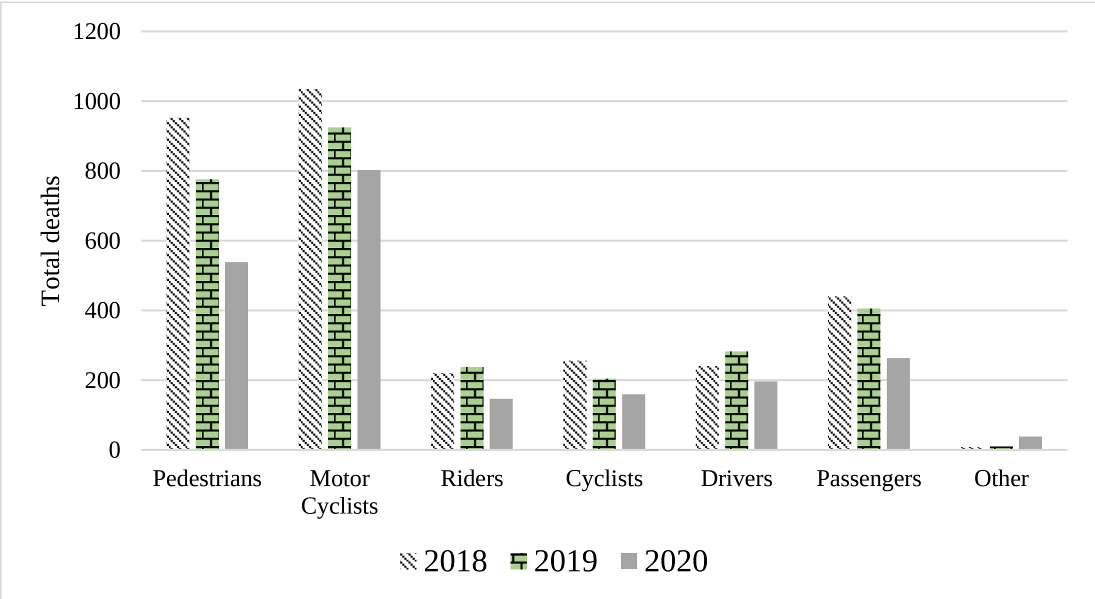

Figure 2. Total road fatalities in Sri Lanka in 2020 (Source- Sri Lanka Police, 2020)

Environmental factors, driver-related factors, pedestrian-related problems have a contribution to accidents on pedestrians (Hou et al., 2021). Crossing the road is riskier than walking on the road because when crossing the road pedestrians have a connection with vehicles. Mobile phones are now common among the young generation due to the increment of smart type. The usage of mobile phones while walking and crossing the road make people distracted. Purposes behind the interruptions of pedestrians who are utilizing cell phones are, cell phone clients walk more gradually, shift course more regularly, are more averse to recognizing others and are less inclined to take a gander at traffic before beginning goes across the street (Williamson and Lenon, 2015). Most crashes happened to pedestrians when crossing the road. Mobile phone usage can reduce situation awareness and increase the unsafe behaviour of pedestrians. Cognitive distraction, physical distraction, visual distraction and auditory distraction can be happened due to technology used on the road. The walking speed of mobile phones using pedestrians was lesser than normal pedestrians (Egodawatta and Amarasinghe, 2019). Pedestrians' careless road behaviours are another leading factor for pedestrian crashes. Pedestrian behaviour is affected by the age and gender of pedestrians. Unintentional mistakes by pedestrians, engagement with technology while walking, rude behaviours towards other pedestrians and road using groups and violating road rules are some of the behaviours that affect pedestrian crashes (O'Hern et al., 2020).

Driver's careless behaviour is another reason for pedestrian crashes as well as careless pedestrian's behaviour. These days' young drivers are more engaging in road accidents. Overestimate of their driving skills, multi-tasking with mobile phones, eating and talking with others while driving made young drivers distracted. The main reason for the crashes was high speed furthermore aggressive behaviour of young drivers was another reason for crashes because it reduced the attention of drivers (Amarasingha and Firdhaws, 2021). Most of the time risky road structures and vehicle density cause accidents on pedestrians. The number of vehicles on the road affected for crossing behaviours of pedestrians and the decision-making of pedestrians about walking and crossing while they are on the road (Agarwal and Vikram, 2021). When concerned about the time of high pedestrian crashes, in nighttime pedestrian crashes are high. Poor visibility in darkness is the main reason for pedestrian crashes during the nighttime. Pedestrian risks are between four- seven times greater in darkness than in light. Out of total pedestrian-involved crashes, 65.9% happened during darkness and according to the results of the study dark/light ratio for pedestrian crashes came as 4.14 (Sullivan and Flanngan, 2001). 20% of drivers were identified, pedestrians were presented after the crash occurred. Because of the headlight glare of the oncoming vehicles, drivers could not see the surroundings well. Headlight glare was a disturbance for drivers because of poor vision (Borzendowski et al., 2015). Because of the poor visibility drivers cannot see pedestrians. Size of the object, contrast with the background, ambient light levels and presence of glare were some of the properties that affected the detection ability of the object. Wearing reflective clothes had a contribution to accident rate reductions and adding reflective materials to the footwear, further decreased the accidents (Costello and Wogalter, 2004).

2 METHODOLOGY

2.1 Study Area

Matara district which is shown in Figure 3 was selected as the study area. Pedestrians who live in Matara District were taken as the respondents of the questionnaire survey. Matara district is one of the major districts in Sri Lanka among 25 districts. Matara district gives huge contribution to the Sri Lankan economy from multiple ways including agriculture, tourism, garments, fishery and production process.

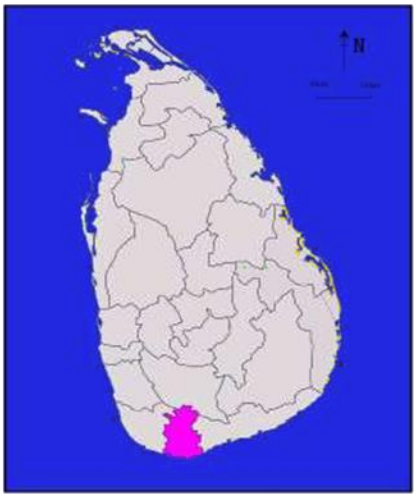

Figure 3 – Study Area (Matara District)

The total area of the Matara district is 1283Km^2 (Department of Census Statistics Sri Lanka, 2021). Akuressa, Deniyaya, Devinuara, Hakmana, Kamburupitiya, Matara, Weligama and Malimbada are polling divisions in Matara district. Sixteen Divisional Secretariats and 650 Grama Niladhari Divisions under Secretary Office Matara, 2020. Totally 196,397 vehicles were registered in Matara district (Department of Census Statistics Sri Lanka, 2021) and 784 accidents happened in Matara district in 2020 (Sri Lanka Police, 2020). According to all these reasons Matara district can be selected as a representative area for selecting the Sri Lankan pedestrian sample.

2.2 Sample Size Determination

Four Divisional Secretary divisions of Matara District were selected for data collection. Table 1 shows the population distribution of Matara, Malimbada, Weligama and Welipitiya polling divisions in Matara district.

Table 1 Population distribution at different polling divisions in Matara district

Divisional Secretary Division	Population (2020)
Matara	122 939
Malimbada	37 300
Weligama	77 330
Welipitiya	55 292
Total	292 570

Source: Department of Census Statistics Sri Lanka, 2021

The total population including all other polling divisions of Matara District is 866 000. Therefore the expected population proportion in the data collection polling division is ([292 570 / 866 000] * 100%) 33.78%. Equation 1 was used to calculate the same size (Bartlett et.al, 2001):

$$N = \frac{z^2 P(1-P)}{d^2} \qquad (1)$$

where N = Sample size,
z = Value corresponding to confidence level = 1.96 (critical value for 95% confidence level),
d = Margin of error = 0.05 (acceptance amount of absolute error is considered as 5%), and
P = Expected population proportion.

The sample size calculated using the equation is 350.

2.3 Data Collection

Paper-based questionnaire survey was used to collect data for the study. Forty-eight questions were included in the questionnaire focusing the walking distance per day as a pedestrian, walking areas, risky behaviours of pedestrians while walking and crossing the road, information on risky environmental factors that cause risks for pedestrians on the road, information on factors that affect the risky walking and crossing behaviours of the pedestrians and suitable countermeasures to mitigate the pedestrian risks. Both males and females under five age categories of 18, 13-30, 31-44, 45-65 and above 65 years were eligible for the questionnaire survey. The reliability of the questionnaire paper was checked by the Cronbach alpha method. Cronbach alpha value for the questionnaire paper was found as 0.787 and it is fallen under the acceptable region. (O'Hern et. al, 2020; Yagil, 2000; Williamson and Lenon 2015).

2.4 Data Analyzing

Data were analyzed using SPSS software.

2.4.1 Chi-square test

Two main usages of Chi-square test are the Chi-square test for goodness of fit and Chi- square test for independence. Chi-square test for goodness of fit measures whether sample data match with population or not and the Chi-square test for independence measures the significant association between independent variables. In the study, Chi-square test for independence was used. Chi-square test can be used when independent and dependent variables belong to the categorical type. The significance level in the chi-square test was used as 0.05. If the given *P*-value by the Chi-square test is lower than the significance level, the null hypothesis will be rejected. Chi-square test is also comparing the deviation between observed and expected values of the variables (Statistical Discovery, 2021). In the study test null hypotheses were taken as age and pedestrian self-reported risk while walking and crossing the road are independent and gender and pedestrian self-reported risks while walking and crossing the road are independent. In this test age and gender are considered as independent variables and pedestrian self-reported risks were taken as dependent variables.

2.4.2 Binary logistic regression

The binary logistic regression model is a regression model that is used to measure the relationship between a categorical dependent variable with one or more independent variables. Equation 2 provides the model format of the binary logistic regression (Hua et.al, 2021);

$$P = \frac{\exp(a + b_1 x_1 + b_2 x_2 + b_3 x_3 + \cdots)}{1 + \exp(a + b_1 x_1 + b_2 x_2 + b_3 x_3 + \cdots)} \qquad (2)$$

where, P = Probability that a case is in a particular category,
a = the constant of the equation, and
b = the coefficient of the predictor variables.

The dependent variable in the model is binary, the observations are independent, no multicollinearity among the independent variables, there are no outliers, there is a linear relationship between independent variables and logit of the dependent variable and sample size sufficiently large are the assumptions of the binary logistic regression (Zach, 2021). In the study overall pedestrian risky behaviour associated with age, gender and mostly walking area were investigated by creating a binary logistic regression model.

3 RESULTS

The study was done with 400 pedestrian responses in Matara district. Out of the total sample, 56% were female pedestrians and 44% were male pedestrians. Data were collected under, five age categories. The large portion is from the 31-44 age category and that is 31% of the total sample size. About 28% of respondents were from the 18-30 age category and 26% of pedestrians were from the 45- 65 age category. Pedestrians who were below 18 years represented 8% of the sample. The least amount was in the age category of above 65 years which was 7% out of the total sample size. Out of the total sample, 54% of pedestrians were mostly walking in urban areas and 46% of pedestrians were mostly walking in rural areas. When considering the employment status of the respondents in the collected sample, out of the 400 responses, 39% of them were government employers. The other 17% of respondents were private-sector employers. Another 9% of the sample were running their own business. The collected sample was included the responses of 13% of undergraduates and 7% of students. Left 15% of responses were fallen under the other category.

Factors affecting the walking and crossing behaviours of the pedestrians were also reviewed through the questionnaire paper. Responses were taken under several factors. Their knowledge about road rules, obedience to the law, understanding the dangers of unsafe crossing and walking, traffic volume, bad weather conditions, pedestrian's mood, other pedestrian's behaviour and rush of the pedestrians. According to the responses of the sample, the most affecting factor for the behaviour of the pedestrians was their understanding of the dangers of unsafe crossing and walking. And knowledge about road rules, obedience to the law, pedestrian's mood, other pedestrian's behaviour and rush of the pedestrian were got 372, 371, 309, 299 and 301 responses out of 400 respectively. Traffic volume and bad weather conditions have the least contribution (287 responses) to the pedestrian's walking and crossing behaviours.

Table 2 presents the percentages of the different risky behaviours of pedestrians on the road.

Table 2 Percentages of pedestrian self-reported risks

Pedestrian risk	Never %	Occasionally %	Sometime %	Most of time %	Always %
Use of technical devices such as mobile phones, headphones, tablets while walking	33.8	36.8	22.3	5.3	2.0
Walk on the traffic lane, not on the walkways	38.5	37.0	18.3	5.3	1.0
Walking on the pedestrian paths as a group	46.3	32.0	16.0	4.3	1.5
Wear reflective clothing when walking on the road at night	53.3	22.5	15.3	7.5	1.5
Walking on the road after consumption of alcohol and drugs	81.3	8.3	8.3	2.0	0.3
Use of technical devices such as mobile phones, headphones, tablets while crossing the road	56.8	26.3	13.8	3.0	0.3
Cross the road without looking left and right	50	21.3	10.8	10.3	7.8
Cross the road without using pedestrian crossings	27.0	39.3	27.0	6.5	0.3
Crossing the road, when the red light is on for pedestrians	51.5	19.5	17.0	7.8	4.3
Cross the road between vehicles stopped on the roadway in traffic jams	33.0	36.5	24.5	5.8	0.3
Crossing the road after consumption of alcohol and drugs	82.0	10.8	5.5	1.8	0
Cross the road while talking with others	44.0	40.0	11.8	3.5	0.8

Solutions for mitigating pedestrian risks were raised in the study according to the agreement of respondents. Proposed solutions in this study were conducting traffic awareness programs for school children about traffic rules and new technologies in the transportation industry, establishing footpaths for pedestrians, countdown time installations in signalized intersections, installing pedestrian push buttons at pedestrian crossings, maintaining tidy road system, establishing a quick process for road and pedestrian path maintenances, encourage people to wear reflective clothing when walking at night, establish special footpaths for disabled people, limiting the registration of new vehicles and conducting enforcement of fines for pedestrians violating traffic rules. Responses for the proposed solutions were taken under a five-point scale of strongly agreed, agreed, neutral, disagreed and strongly disagreed. Most of the respondents strongly agreed to conduct traffic awareness programs for school children to reduce pedestrian risks. A high disagree percentage was reported for limiting the registration of new vehicles as a mitigation solution for pedestrian risks.

3.1 Chi-square test results

A chi-square test was done to identify the significant association between age, gender and pedestrian self-reported risks. Table 3 presents the cross tabulation with expected values and observed values of the pedestrian risks which have a significant association with gender. Observed and expected data show that males have high observed value than the expected value. When considering the data collection of males, a higher deviation between the observed value and the expected value was shown by walking on the road after consumption of alcohol. And females have lesser observed values than the expected values. In the female category also the highest deviation between the observed value and expected value was shown by walking on the road after consumption of alcohol. The results show that male pedestrians are highly engaged with risky walking and crossing behaviours on the road than female pedestrians' engagement with risky behaviours on the road. Therefore, males have a higher probability of engaging in motor crashes than females.

Table 3 Expected values and Observed values of pedestrian risks versus gender

Risk			Never	Occasionally	Some time	Most of time	Always	Asymptotic Sig. (2 sided)
Cross the road between vehicles stopped on the roadway in traffic	Male	Observed	37	80	45	12	1	0.000
		Expected	57.8	63.9	42.9	10.1	0.4	
	Female	Observed	95	66	53	11	0	
		Expected	74.3	82.1	55.1	12.9	0.6	
Cross the road after consumption of alcohol	Male	Observed	119	33	17	6	0	0.000
		Expected	143.5	18.8	9.6	3.1	0	
	Female	Observed	209	10	5	1	0	
		Expected	184.5	24.2	12.4	3.9	0	
Crossing the road while talking with others	Male	Observed	63	78	22	10	2	0.023
		Expected	77	70	20.6	6.1	1.3	
	Female	Observed	113	82	25	4	1	
		Expected	99	90	26.4	7.9	1.7	
Walk on traffic lanes not, on walkways	Male	Observed	56	72	29	15	3	0.009
		Expected	67.4	64.8	31.9	9.2	1.8	
	Female	Observed	98	76	44	6	1	
		Expected	86.6	83.3	41.1	11.8	2.3	
Walking on the road after consumption of alcohol	Male	Observed	117	26	26	6	0	0.000
		Expected	142.2	14.4	14.4	3.5	0.4	
	Female	Observed	208	7	7	2	1	
		Expected	182.8	18.6	18.6	4.5	0.6	
Cross the road without looking right and left	Male	Observed	70	42	21	28	14	0.001
		Expected	87.5	37.2	18.8	17.9	13.6	
	Female	Observed	130	43	22	13	17	
		Expected	112.5	47.8	24.2	23.1	17.4	

Table 4 presents the Observed Values and Expected Values of the Pedestrian Risks which have a significant association with age. When comparing all age groups 18-30 and 31-44 age categories have larger variances between expected counts and observed counts. Most of the time their observed values for the pedestrian risks are higher than the expected values. In particular, 18-30 age group have a high frequency of using technical devices such as mobile phones, headphones, tablets etc. while walking and crossing the road.

Table 4 Expected values and Observed values of pedestrian risks versus age

Risk			Never	Occasionally	Some time	Most of time	Always	Asymptotic Sig. (2 sided)
Use technical devices such as mobile phones, headphones and tablets while walking	<18	Observed	15	12	4	1	1	0.013
		Expected	11.1	12.1	7.3	1.7	0.7	
	18-30	Observed	26	40	31	10	4	
		Expected	37.5	40.8	24.7	5.8	2.2	
	31-44	Observed	43	52	23	4	0	
		Expected	41.2	44.8	27.1	6.4	2.4	
	45-65	Observed	33	38	27	4	3	
		Expected	35.4	38.6	23.4	5.5	2.1	
	>65	Observed	18	5	4	2	0	
		Expected	9.8	10.7	6.5	1.5	0.6	

Table 4 Expected values and Observed values of pedestrian risks versus age continue…

Risk			**Never**	**Occasionally**	**Some time**	**Most of time**	**Always**	**Asymptotic Sig. (2 sided)**
Walking on the traffic lane, not on the walkways	<18	Observed	11	12	7	3	0	0.003
		Expected	12.7	12.2	6	1.7	0.3	
	18-30	Observed	30	42	25	11	3	
		Expected	42.7	41.1	20.3	5.8	1.1	
	31-44	Observed	51	48	17	5	1	
		Expected	47	45.1	22.3	6.4	1.2	
	45-65	Observed	54	37	13	1	0	
		Expected	40.4	38.9	19.2	5.5	1.1	
	>65	Observed	8	9	11	1	0	
		Expected	11.2	10.7	5.3	1.5	0.3	
Walking on the pedestrian path as a group	<18	Observed	9	13	7	2	2	0.000
		Expected	15.3	10.6	5.3	1.4	0.5	
	18-30	Observed	36	40	24	9	2	
		Expected	51.3	35.5	17.8	4.7	1.7	
	31-44	Observed	56	41	21	4	0	
		Expected	56.4	39	19.5	5.2	1.8	
	45-65	Observed	65	28	11	0	1	
		Expected	48.6	33.6	16.8	4.5	1.6	
	>65	Observed	19	6	1	2	1	
		Expected	13.4	9.3	4.6	1.2	0.4	
Use of technical devices such as mobile phones, headphones and tablets while crossing the road	<18	Observed	19	7	5	2	0	0.009
		Expected	18.7	8.7	4.5	1	0.1	
	18-30	Observed	43	42	20	5	1	
		Expected	63	29.1	15.3	3.3	0.3	
	31-44	Observed	75	33	10	4	0	
		Expected	69.2	32	16.8	3.7	0.3	
	45-65	Observed	70	18	17	0	0	
		Expected	59.6	27.6	14.4	3.2	0.3	
	>65	Observed	20	5	3	1	0	
		Expected	16.5	7.6	4	0.9	0.1	
Cross the road without looking right and left	<18	Observed	21	1	5	2	3	0.003
		Expected	16.5	7	3.5	3.4	2.6	
	18-30	Observed	48	36	9	13	2.6	
		Expected	55.5	23.6	11.9	11.4	8.6	
	31-44	Observed	63	26	12	12	9	
		Expected	61	25.9	13.1	12.5	9.5	
	45-65	Observed	61	13	9	12	10	
		Expected	52.5	22.3	11.3	10.8	8.1	
	>65	Observed	7	8	8	2	4	
		Expected	14.5	6.2	3.1	3.0	2.2	
Crossing the road, when the red light is on for pedestrians	<18	Observed	12	4	9	5	3	0.003
		Expected	17	6.4	5.6	2.6	1.4	
	18-30	Observed	40	27	26	13	6	
		Expected	57.2	21.6	18.9	8.6	4.7	
	31-44	Observed	72	20	21	4	5	
		Expected	62.8	23.8	20.7	9.5	5.2	
	45-65	Observed	68	21	7	6	3	
		Expected	54.1	20.5	17.9	8.1	4.5	
	>65	Observed	14	6	5	3	1	
		Expected	14.9	5.7	4.9	2.2	1.2	

The above 65 age group also have higher observed values than the expected values up to some extent. The age group 45-65 has the least variations between observed and expected values. These results showed that 18-30 and 31-44 have high risky behaviours on the road than other age categories**.**

3.2 Binary logistic regression results

The relationship of overall risks for the pedestrians on the road with the age, gender, mostly walking area and the average daily walking distance of pedestrians was evaluated through the binary logistic regression model. In the model accidents that happened or not on pedestrians was taken as the dependent variable and age, gender, mostly walking area and average daily walking distance of pedestrians were taken as independent variables. Reference categories for gender, age, mostly walking area and average daily walking distance were taken as male, above 65 years, urban areas and more than 2Km respectively. The reference category for the dependent variable is taken as a number of accidents that happened to pedestrians.

The Model Summary of the test contains the Cox & Snell R Square and Nagelkerke R Square values illustrate the variations of the dependent variable. According to the test results, Cox & Snell R Square value is 0.067 and Nagelkerke R-value is 0.092, which illustrates that variations of the dependent variable range from 6.7% to 9.2%. Hosmer and Lemeshow test is a goodness of fit test for the logistic regression model. This test calculates how much, observed data is matching with the predicted data. The test P value was got as 0.058 and that is greater than 5%. That means the model is fitting good with the data sample.

Table 5 shows how the independent variables predict the dependent variable. Here, the variable, average walking distance per day as a pedestrian shows a significant association with the accidents happening on pedestrians and other independent variables are not significant with the dependent variable.

Table 5 –Binary Logistics Regression Model for Traffic Accident Occurrence in Matara District

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Gender(1)	-.406	.218	3.483	1	.062	.666
Age			14.825	4	.005	
Age(1)	-.361	.533	.458	1	.499	.697
Age(2)	.270	.430	.395	1	.530	1.310
Age(3)	-.759	.435	3.042	1	.081	.468
Age(4)	-.521	.437	1.424	1	.233	.594
Average walking distance per day as a pedestrian			10.202	2	.006	
Average walking distance per day as a pedestrian (1)	-.787	.253	9.701	1	.002	.455
Average walking distance per day as a pedestrian (2)	-.625	.289	4.686	1	.030	.535
Constant	.519	.426	1.484	1	.223	1.680
Dependent variable: Accident occurrence						

For independent variable *'average walking distance per day'*, the reference category is walking more than 2 km per day. The dependent variable '*accidents happening on pedestrians'* has the reference category is 'yes'. In step one, the average walking distance less than 1km and the walking distance between 1 km and 2 km have odds ratios of -0.797 and -0.628 respectively. It means that walking less than 1 km per day and walking between 1km and 2km have a lesser tendency for occurrence of pedestrian accidents compared to walking more than 2 km. In step two, average walking distance less than 1Km per day has a -0.787 odd ratio and walking and between 1km and 2km have per day has a -0.521 odd ratio. It shows that increasing walking distance increases the accidents happening probability on pedestrians.

4 CONCLUSIONS

Twenty-three percent of road accidents in the world are caused by pedestrians. The number of pedestrian accidents in low-income countries is higher than in developed countries due to the underdeveloped infrastructure and underdeveloped road networks in low-income countries. In 2020, 25% of pedestrian deaths were reported out of total deaths due to road accidents in Sri Lanka. The purpose of this study is to identify road accidents for pedestrians and to suggest appropriate measures to mitigate them. Self-reported risks of pedestrians, risky environmental factors, factors affecting the pedestrian's behaviour and proposed solutions to mitigate pedestrian risks were reviewed through the questionnaire paper. The pedestrian sample included 225 female pedestrians and 175 male pedestrians. The pedestrians were grouped into five age categories which were below 18 years, 18-30, 31-44, 45-65 and above 65 years. Walking area of pedestrians identified whether rural area or urban area. Average walking distance per day as a pedestrian were also accounted for the analyze. Pedestrian risks were reported under a five-point scale. The most reported risk at while walking on the road was using technical devices such as phones mobile (66.2%). The most reported risk while crossing the road was crossing the road without using pedestrian crossings (73%). The minimum reported risk both in crossing and walking the road was being a pedestrian after consumption of alcohol and drugs. The reported percentage for that is 18.7% and 18% respectively at walking on the road and crossing the road respectively.

Chi-square test and binary logistic regression test were used to statistically analyze the data. In the chi-square test significance association between the dependent variable and independent variables was evaluated. Age and gender were considered independent variables and pedestrian risks were taken as the dependent variables. Observed values and expected values of risks that have a significant association with age and gender were compared. Cross the road walking between stopped vehicles on the roadway in traffic jams, cross the road after consumption of alcohol, crossing the road while talking with others, walk on the traffic lanes not on the walkways, walking on the road after consumption of alcohol, and cross the road without looking right and left have a significant association with gender. When compared observed and expected data, it has been shown that males are involved with more risky behaviours than females. However, Yagil (2020) found that female pedestrians have high involvement with accidents. Use of technical devices while walking or crossing the road, walking on the traffic lane not on the walkways, walking on pedestrian path as a group, crossing the road without looking right and left and crossing the when the red light is on for pedestrians have a significant association with age. Here expected and observed data showed that below 18 years and 18-30 age categories have a high chance of engaging in risky behaviours than other age categories. Williamson and Lenon (2015) also discovered that the 18–30-year age category is the high-risk road user category compared to other age categories. Egodawatta and Amarasinge (2019) found similar results to these fundings that the younger generation has high involvement with the technical devices while on the road.Binary logistic regression model test results shows that, when walking distance is increasing, accidents happening probability on pedestrians is also increase.

The results of this study can be used to find mitigation methods for pedestrian risks and results of the study can be taken as a baseline for future studies. Recommendations of the study include to conduct traffic awareness programmes for school children, enforce the rules to minimize the technical devices used while on the road and encourage pedestrians to wear reflective clothing when walking at night. Objectives of the study were achieved through the data collection and data analysis parts of the study and identified research gaps were filled by the study.

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REFERENCES

Agarwal, S., & Vikram, D. (2021). Impact of vehicular traffic stream on pedestrian crossing behaviour at an uncontrolled mid-block section. *Transportation Research Interdisciplinary Perspectives*, *9*, 100298. https://doi.org/10.1016/j.trip.2021.100298

Amarasingha, N., & Firdhaws, H. (2021). Self-Reported Habitual Practices and Perceptions of Young Drivers in Sri Lanka. *Journal Of South Asian Logistics and Transport*, *1*(1), 49. https://doi.org/10.4038/jsalt.v1i1.26

Bartlett J., Kotrlik, J. and Higgins, C., (2001). Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning, and Performance*, 19(1).

Costello, T., & Wogalter, M. (2004). Reflective Clothing is Attractive to Pedestrians. *Proceedings Of The Human Factors And Ergonomics Society Annual Meeting*, *48*(10), 1199-1202. https://doi.org/10.1177/154193120404801011

Department of Motor Traffic, (2021). Statistic, Available at https://dmt.gov.lk/index.php?option=com_content&view=article&id=16&Itemid=132&lang=en

Department of Census and Statistics, 2021. Statistics, available at www.statistics.gov.lk

Egodawatta, H.M.H. and Amarasingha, N.(2019). Mobile Phone Use at Un-signalized Mid-block Pedestrian Crossings in Sri Lanka. *The 13Th International Conference of The Eastern Asia Society For Transportation Studies (EASTS 2019) at: Colombo*, *12*. Retrieved 25 November 2021, from.

Goswami, S. (2021) Pedestrians not following norms for walking, crossing roads cause deaths: Govt to Rajya Sabha, Hindustan Times, 03 December, 2021.

Hou, M., Cheng, J., Xiao, F., & Wang, C. (2021). Distracted Behavior of Pedestrians While Crossing Street: A Case Study in China. *International Journal Of Environmental Research And Public Health*, *18*(1), 353. https://doi.org/10.3390/ijerph18010353.

Hua, C., Choi, Y. and Shi, Q., 2021. *Advanced Regression Methods*. 1st ed.

Marisamynathan, S., & Lakshmi, S. (2016). Method to determine the pedestrian level of service for sidewalks in Indian context. *Transportation Letters*, *10*(5), 294-301. https://doi.org/10.1080/19427867.2016.1264668.

O'Hern, S., Stephens, A., Estgfaeller, N., Moore, V., & Koppel, S. (2020). Self-reported pedestrian behaviour in Australia. *Transportation Research Part F: Traffic Psychology And Behaviour*, *75*, 134-144. https://doi.org/10.1016/j.trf.2020.10.002.

Department of Census and Statistics. Statistics.gov.lk. (2021). Retrieved 25 November 2021, from http://www.statistics.gov.lk.

Sullivan, J., & Flannagan, M. (2001). Characteristics of Pedestrian Risk in Darkness, (UMTRI-2001-33). Retrieved 25 November 2021, from.

Borzendowski, S. A. W., Sewall, A. A. S., Rosopa, P. J., & Tyrrell, R. A. (2015). Drivers' judgments of the effect of headlight glare on their ability to see pedestrians at night. *Journal of safety research*, *53*, 31-37. https://doi.org/10.1016/j.jsr.2015.03.001.

Williamson, A., & Lenon, A. (2015). Pedestrian self-reported exposure to distraction by smartphones while walking and crossing the road. *Proceedings of The 2015 Australasian Road Safety Conference (ARSC2015). Australasian College of Road Safety (ACRS), Australia*, 1-11. Retrieved 25 November 2021, from.

Yagil, D. (2000). Beliefs, motives and situational factors related to pedestrians' self-reported behavior at signal-controlled crossings. *Transportation Research Part F: Traffic Psychology and Behaviour*, *3*(1), 1-13. https://doi.org/10.1016/s1369-8478(00)00004-8.

Statistical Discovery, (2021). The Chi-Square Test, A free Online Introduction to Statistics, available at https://www.jmp.com/en_us/statistics-knowledge-portal/chi-square-test.html

Sri Lanka Police (2020), Statistics, Available at https://www.police.gov.lk/index.php/police-history/item/52.

World Bank, (2020). The World Bank In Bangladesh, available at https://www.worldbank.org/en/country/bangladesh/overview

World Health Organization, 2015. *Global status report on road safety 2015*. World Health Organization.

Zach, V. (2021). *The 6 Assumptions of Logistic Regression (With Examples)*. Scatology. Retrieved 25 November 2021, from https://www.statology.org/assumptions-of-logistic-regression.