



A STUDY ON HIGH SCHOOL AND COLLEGE STUDENTS' JAYWALKING BEHAVIOR IN DHAKA CITY

By

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APPROVAL

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DECLARATION

We hereby declare that the undergraduate research work presented in this thesis has been conducted by us, under the guidance and supervision of Professor Dr. Shakil Mohammad Rifaat. We assure you that the findings and conclusion presented in this work are the result of our own investigation and have not been duplicated or submitted previously for any other purpose (except for publication)

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DEDICATION

We would like to highlight that the completion of this study is dedicated to everyone who has assisted us, including the students who participated in the survey, our respected faculty members who supported our study, and our parents and peers for their valuable time and unwavering support. We would also like to dedicate this work to our thesis supervisor Professor Dr. Shakil Mohammad Rifaat for his detailed guidance and patience with us.

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We would like to start by addressing in the name of Allah (SWT), without whose blessing our research would not have been possible.

We would like to highlight that the completion of this study was a collaborative effort and would like to use this occasion to extend our heartfelt appreciation to everyone who assisted us including the students who participated in the survey, our respected faculty members who supported our study and our parents and peers for their valuable time and unwavering support. We would also like to show our sincerest gratitude to our thesis supervisor Professor Dr. Shakil Mohammad Rifaat for his detailed guidance and patience with us.

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ABSTRACT

In Bangladesh, especially in the city of Dhaka, the number of students injured in traffic accidents is rising. It emphasizes the lack of attention given to this problem in the context of Bangladesh and the need for research on students' road-crossing behavior. A report by Road Safety Foundation indicated that in 2022, 26.96% of student fatalities occurred in Dhaka. While studies on students' road-crossing behavior have been conducted in countries like South Korea, India, and Qatar, the issue has received limited attention in Bangladesh's context and requires urgent consideration. Hence, our study aims to address this gap to investigate the factors that affect the road-crossing behavior of high school and college students in Dhaka City.

To gather data for the study, a questionnaire survey was prepared having 68 questions that is divided into 7 sections. Surveys were conducted physically with 273 students from classes 6 to 12, from 13 different schools and colleges. The surveys focused on various aspects, including the students' socio-economic and demographic features, parental supervision, travel behavior, and the medium of instruction in their institutions, among others.

The study's findings revealed that several factors had a significant impact on the road-crossing behavior of students. Travel characteristics, such as the mode of transportation used and the traffic conditions in urban settings, were found to be influential. Additionally, the study highlighted the importance of respondent particulars, including their age and the devices they use that enhance distractions. It was observed that sixth through ninth graders were more likely to engage in jaywalking, especially if they observed others engaging in unlawful road crossing. This age group often exhibits a combination of curiosity, impulsiveness, and limited awareness of potential dangers, which can lead them to take risks while crossing roads.

The study also emphasizes the crucial role of parental guidance and traffic knowledge in mitigating risky road-crossing behavior among students using the logistic regression model. It is important to note that these attributes and factors influencing jaywalking among school-going children were thoroughly investigated in the study.

The study's results are expected to provide valuable insights for policymakers in developing appropriate crossing policies, improving road safety, and enhancing infrastructures to ensure safer roads for students and the general public. By addressing these factors, policymakers, NGOs and government officials can work towards reducing student casualties and creating a safer environment for pedestrians in Dhaka city.

Keywords: *Jaywalking; Unsafe Road Crossing; Child Pedestrian; Logistic Regression; Parental Supervision; Student Road Safety; Road Safety Perception*

TABLE OF CONTENTS

APPROVAL	i
DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	v
TABLE OF CONTENTS	vi
LIST OF FIGURES	ix
LIST OF TABLES	x
Chapter 1 Introduction	1
1.1 Background	1
1.1.1 Global Scenario	1
1.1.2 Scenario in Bangladesh	1
1.1.3 Safety Concerns for Child Pedestrians and Students	2
1.2 Objective of the study	3
1.3 Scope of research	4
1.4 Significance of the research	4
1.5 Outline of Thesis	5
1.5.1 Chapter 2- Literature Review	5
1.5.2 Chapter 3- Data and Methodology	5
1.5.3 Chapter 4- Analysis and Model Development	5
1.5.4 Chapter 5- Results and Interpretation	5
1.5.5 Chapter 6- Conclusions and Recommendations	5
Chapter 2 Literature Review	7
2.1 Aspects affecting crossing behavior	7
2.1.1 Crossing medium	7
2.1.2 Negligence	8
2.1.3 Companionship on the Road	8
2.1.4 Negative peer influence	8
2.1.5 Physical & psychological issues	9

2.1.6	Demographics classification	9
2.1.7	Socio economic status	9
2.1.8	Traffic knowledge	10
2.1.9	Route selection	10
2.1.10	Exposure time	10
2.1.11	Distraction	11
2.1.12	Theory of planned behavior	11
2.1.13	Environmental Factors	12
2.1.14	Traffic density	12
2.1.15	Visual Clutter	12
2.1.16	Walking speed	13
2.1.17	Pedestrian facilities	13
2.1.18	Land Use	13
2.2	Psychological issue	13
2.3	Parental supervision	14
2.3.1	Parent education	14
2.3.2	Traffic safety education	15
Chapter 3	Data and Methodology	16
3.1	Study area	16
3.2	Study workflow	16
	Questionnaire preparation	16
3.2.2	Data Collection	25
Chapter 4	Model Development and Analysis	27
4.1	Model assumptions	27
4.2	Model Equation	28
4.3	Model outcomes	28
4.3.1	About STATA	29
4.3.2	Correlation of variables	29
Chapter 5	Result and Interpretation	32
5.1	Class of students	33
5.1.1	6-8 and 9-10	33

5.2	Estimated time of reaching school	33
5.3	Occupation of mother	33
5.4	Mode of travel (school to home and vice versa)	33
5.4.1	Walking	34
5.4.2	Rickshaw	34
5.5	Traffic exposure time	34
5.6	School/college/educational institution zone	34
5.7	Residency in Dhaka	34
5.8	Traffic conditions on the road	35
5.9	Safety of overpass	35
5.10	Jaywalking tendency	35
5.11	Distractions while crossing	35
5.12	Taking classes/training/sessions on traffic knowledge	36
5.13	Condition of footpath	36
5.14	Encroachment of footpath	36
Chapter 6	Conclusion and Recommendation	37
6.1	Key findings	37
6.2	Study implications	38
6.3	Limitations of the study	39
6.4	Recommendations	39
Reference		41

LIST OF FIGURES

Figure 1: Workflow diagram	16
Figure 2: Jaywalking of pedestrians	24
Figure 3: Jaywalking of parent-child pair in Uttara	26
Figure 4: Flow chart of model development	27

LIST OF TABLES

Table 1: Physical observation of jaywalking of high school and college students in Dhaka city.	23
Table 2: Study time of observations	24
Table 3: Statistical description of selected variables	30
Table 4: Results of logistic regression model	32

Chapter 1 Introduction

1.1 Background

1.1.1 Global Scenario

With great technological advancements, motorization and urbanization are occurring at an alarming rate globally. In 2021, around 80 million motor vehicles were produced, which accounted for a 3% increase in vehicles around the globe. However, this growing number of motor vehicles with lagging transportation infrastructures creates traffic mismanagement in developing countries in comparison to developed countries. This also makes active modes of transportation (e.g., cycling, walking, etc.) difficult to use.

Every year around 1.2 million people die from road traffic accidents (pedestrian and vehicle crashes). This is nearly 3700 people dying every day (Geneva: World Health Organization, 2018). It also states that in 2016, the world witnessed an increasing 1.48 million traffic deaths that, caused around 50 million injuries. It is estimated that global death from traffic incidents has become 18.2 per 100,000 population. However, this varies across developed and developing regions, such as African and South-East Asian countries, which saw 26.6/100,000 and 20.7/100,000 deaths, respectively, in 2016 (Geneva: World Health Organization, 2018).

It was also reported that 70% of the deaths were more persistent in developing countries, making the risk of road traffic death three times higher. Unfortunately, death caused by traffic injuries is the eighth leading cause and the sole leading cause of death for children, students, and young adults who were aged 5-29 (Geneva: World Health Organization, 2018). Over half of all fatality victims worldwide were vulnerable road users, including motorcyclists, cyclists, and pedestrians. Interestingly, two-thirds of all the fatalities include pedestrians and bicycles. A significant portion of these pedestrians consists of students and children. This inevitably is caused due to poor road safety conditions for students and children worldwide, especially the developing countries. If explored in depth, these statistics reveal significant economic and life losses associated with vulnerable road users like pedestrians, especially children and students.

1.1.2 Scenario in Bangladesh

Bangladesh is a densely populated country with approximately 18 million population and a population density of 1,119 people per square kilometer. In 2022, Bangladesh was declared the 34th largest economy by World Bank. Bangladesh's GDP is predicted to increase by 6.6% in 2023. The transportation section plays a significant role in this regard. However, the infrastructure and system facility is one of the significant blockades causing losses of billions of dollars in Bangladesh. Dhaka, the capital of Bangladesh, has a population density of 30,474 people per square kilometer in Dhaka North and 39,353 people per square kilometer in Dhaka South (Bangladesh Bureau of Statistics, 2022). This is 35 times more than the country's entire population density. This has resulted in more vehicles against the limited number of roads.

1.1.2.1 Context of Dhaka City

According to Road Safety Foundation, in 2022, there were 6,829 road accidents, where 12,615 people were injured, and 7,713 people died (Pedestrian and vehicular crash). However, among them, there were 60.53% of pedestrians. Unfortunately, there were 16% of students among those

pedestrians. In 2022, 1,237 students died in Bangladesh. Regrettably, Bangladesh sees the deaths of at least three students in road accidents yearly (Rahman, 2022). According to research by Anjuman and Siddiqui (2007), 21% of all traffic accident fatalities in Bangladesh involved children under the age of 16. In Bangladesh, Dhaka accounted for 26.96% of the accidents in 2022. Abdel et al. (2007) found that most school-going accidents happen near school areas in Dhaka. There are 3981 educational institutions (Junior High Schools, Secondary High Schools, and Colleges) in Dhaka. Generally, junior high schools, secondary high schools, and colleges students are aged between 10 to 18 (Bangladesh Bureau of Statistics, 2022). Hence, this makes Dhaka unsafe for the student movement. Adding to that, the rate of accidents in Dhaka city has increased to 97.7% from previous years. Pedestrians are the main victims, and experts suggest that uncontrolled road crossing, ignorance during the crossing, and use of distractions are the main reasons. However, child pedestrian injury is not just a major concern in Bangladesh but a public health challenge globally, as the data mentioned above affirms. Therefore, prevention programming necessitates understanding the context in which children cross the street.

Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET) in Bangladesh identified the ten most accident-prone mid-blocks/road links in Dhaka city. As such, areas around Dhanmondi-27, Shishu Hospital, Bashundhara City Shopping Complex, Kakoli-Sainik Club, Sainik Club-Chairmanbari, Merul Badda-Madhya Badda, Rampura TV Center, East side of Khilkhet Police Station and Kalyanpur BRTC Bus Stand (Adhikary, 2022), among many others. It was found that 71% of the accidents occurred where there was no junction and 63% of the time where there was no traffic control in the area (Ahmed, 2012). Another study finds similar results saying that 37% of the children's fatalities occurred on national highways followed by the city or arterial roads (Afifah & Hossain, 2016). Unfortunately, most schools and educational institutions in Dhaka are situated along the arterial roads connecting the mentioned accident-prone areas. Making students vulnerable to road accidents and injuries. Not only are the roads susceptible to road accidents, but students themselves are vulnerable because of physical and psychological builds.

According to Dhaka North City Corporation (DNCC), there are 52-foot over-bridges, 70 signalized intersections, 390 kilometers long footpaths, four underpasses (DSCC, 2013), and numerous crossings in Dhaka. These legal crossings are opened to the citizen for safe use. However, from adults to children, they are mostly unused, underused, or have lost their purpose. These crossings are predefined pathways designed for people to cross to the other side of the road. They are situated at either intersections, mid-block sections, or as overpasses, crosswalks, and underpasses. Crossings are placed at places where there are large gatherings. Primarily there are two types of pedestrian crossings: At grade crossing and grade-separated crossing. The grade crossing is where pedestrians and vehicular movement occur at the same grade. They can be average zebra crossing to intersections. However, using legal options to cross refers to the controlled crossing and crossing illegally in the uncontrolled crossing. The uncontrolled crossing is one of the major causes of traffic fatalities. The grade-separated crossing is the type of crossing that can be underpasses or overpasses, separating the grade of pedestrians and incoming vehicles.

1.1.3 Safety Concerns for Child Pedestrians and Students

Similar studies of concern for children's pedestrian safety have been carried out in different countries in the last 25 years. In South Africa, China, and Belgium, studies on Child Pedestrian

behavior have been carried out (Koekemoer et al., 2017; Schwebel et al., 2018; Sullman et al., 2012). Similar studies on safety impact (Corbett & Morrongiello, 2017; Petch & Henson, 2000), traffic collisions (Blazquez et al., 2016), and a child pedestrian's ability to identify hazardous situations (Forde & Daniel, 2021) was also done on Canada, South Korea, Israel, and the UK. However, it was found that one of the major causes of child accidents on roads is due to a lack of solid education on traffic regulations. Students or child pedestrians occasionally choose not to use the facilities available to cross the road (e.g., junction crossings, zebra crossings, overpasses, underpasses, etc.) for various reasons, including location, built environment, parental guidance, and psychology. In fact, in developing countries, some facilities are so poorly constructed that it discourages users from using them. Perhaps because of these factors, many students are frequently seen jaywalking to cross the street when traveling. A survey by Mfinanga (2014) discovered that most of the surveyed users preferred to walk on medians and level ground, while females and younger pedestrians were more ready to use non-level crossings.

Children undergo the process of physical and mental growth. These growth factors are responsible for making them vulnerable to traffic fatalities. For instance, because of their bone development, they are more susceptible to crash impacts. Children of smaller heights are at higher risk for head and neck injuries. They also have less developed senses making them unable to fully gauge the traffic environment, from visual timing judgments and crossing to assessing the speed and trajectory of incoming vehicles. Along with biological development, psychological and emotional changes are major concerns in children going through puberty.

1.1.3.1 Child behavior

As a pedestrian, a child has to perform physiological tasks to cross or walk on the road. A child must coordinate perception and action (Afifah & Hossain, 2016) to find the perfect time to cross, which depends on the age and the child's behavioral pattern. Jean Piaget tried to explain children's behavior patterns in road traffic at four levels of development (Soori, 2009). These stages start as early as the age of 2 and fully mature at 12, and the process keeps on continuing throughout the lifetime. These four stages are the sensorimotor stage (up to the age of 2), the pre-operational stage (2-6 years), the concrete operational stage (6-12 years), and the formal operational stage (Approx. 12 years and above). To develop the psychology of children and students, road safety education perhaps can be a solution, among many others. Government organizations, NGOs, and many other public bodies play a significant role in educating the group. Many steps are also being taken in this regard to promote good education and formulate new policies.

Hence it is imperative that further steps are taken in this regard to lessen Jaywalking students in Dhaka city. Therefore, our study aims to analyze the road crossing or jaywalking behavior of Dhaka City high school and college students.

1.2 Objective of the study

We have briefly pointed out the objectives that are studied in our research-

1. Identifying the factors which will influence the jaywalking decision of school and college students in Dhaka city.
2. Explore the effects of travel behavior, situational characteristics, socio-economic demography, and road safety perceptions in road crossing behavior of students.

3. Reveal the factors that provoke jaywalking and safe crossing behavior.
4. Reveal how the factors obtained in the statistical model help in preventing safety issues for students caused by Jaywalking.

1.3 Scope of research

The study examines the effect and relationship of different factors derived from the data of high school and college students on the decision-making process of road crossing or mid-block crossing. Our study focuses on creating a model to determine road-crossing behavior. Our area of study is Dhaka, the capital city of Bangladesh. Our study group is randomly selected from high school and college students across Dhaka, from classes 6 to 12. Their travel behavior, situational characteristics, socio-economic demography, and road safety perception data, among many others, are collected through a physically conducted survey.

The dependent variable for this model is Jaywalking or mid-block crossing. The independent variables in our model will be data extracted from the survey of high school and college students. These independent variables will then be used to analyze the road crossing behavior of students.

These are some of the areas that our research can be further expanded into-

1. Age-specific analysis
2. Comparative analysis for students who use vehicles and who walk to school
3. Impact of daytime on jaywalking
4. Impact of the commercial zone on Jaywalk
5. Traffic condition impact jaywalking
6. Use of headphones/ cell phone during jaywalking
7. Impact of hawkers and mobile market on jaywalking
8. Teenage psychology while walking on the road

1.4 Significance of the research

This study will contribute to the research literature in several ways, some of which are listed below- This study will indicate whether there are any significant factors or discerning patterns that can affect road crossing behavior among high school and college students.

Our study can add to the current literature on road crossing behaviors by analyzing the different behavioral, psychological, and physical aspects. Most of the studies and research in this area have mainly focused on crash analysis, safety analysis, and pedestrian crossing facilities. Very few studies have been done on the effects on students or child pedestrians, which are further discussed in the literature review section of this study. However, there is a focus on travel safety perception for children. Those studies only cover policy making and safety perception and do not work to define the factors that induce jaywalking.

1. The study will develop a model that would be helpful in analyzing the road crossing decision based on different characteristics of a student or child pedestrian.
2. The study will help create road crossing policies, education, and training facilities for students.
3. Governments and NGOs will learn better about high school and college students' road crossing behavior to take preventive measures against crossing fatalities.
4. This study will unveil the unorthodox relationships between physiological and parental factors in road-crossing facilities.
5. The proposed research will provide recommendations on constructing different transportation infrastructures or safety solutions like putting road crossing signs, imposing speed limits on roads, installing surveillance cameras, and many more for areas around high schools and colleges.

1.5 Outline of Thesis

The thesis is divided into six chapters. After the first chapter's introduction, the remaining five chapters will address the following topics:

1.5.1 Chapter 2- Literature Review

Studies that have analyzed the factors associated with jaywalking among students, studies related to safe crossing, and traffic education programs, among many others, have been reviewed in this chapter. Significant findings and research gaps from these studies are documented here.

1.5.2 Chapter 3- Data and Methodology

The process for preparing the survey questionnaire and using the accumulated data from the survey to develop the statistical model has been described in Chapter 3. In our case, the statistical model was the logistic regression model, which was used because of the dichotomous nature of our dependent variable, which has been further discussed in this chapter.

1.5.3 Chapter 4- Analysis and Model Development

The logistic regression model developed in STATA for our study has been discussed in this chapter. The model details and procedure have been thoroughly documented.

1.5.4 Chapter 5- Results and Interpretation

This chapter presents a detailed interpretation derived from the model development that addresses the objective of this research. All the results obtained from the analysis are stated here.

1.5.5 Chapter 6- Conclusions and Recommendations

This chapter draws the final conclusion on the finding of our model development, whether the variables have produced proper relationships, and whether it can fulfill its purpose of determining

the crossing behaviors of high school and college students. Several directions for future research in this field are also discussed.

Chapter 2 Literature Review

The literature review of this research aims to systematically examine the existing body of knowledge on the road-crossing behavior and traffic education of school and college students, among many more, in Dhaka City, the capital of Bangladesh. The review is divided into several subtopics, focusing on the various factors that influence students' jaywalking or unconventional crossing behaviors.

2.1 Aspects affecting crossing behavior

Several factors can influence pedestrian crossing behavior. In today's quick-paced world, where time is of the essence, pedestrians want to cross the street in comfort, safety, and ease without taking any chances for the slightest delay. Pedestrian jaywalking causes more disputes in mid-block areas and puts them at risk for serious injuries (Avinash et al., 2020). Studies have also demonstrated how risky it is for pedestrians to cross at unprotected mid-block crosswalks in developing nations (Aziz et al., 2013; Kadali and Vedagiri, 2016).

According to Alonso et al. (2021), pedestrians' actions while crossing roads may be the leading cause of many road accidents. Despite being involved in approximately 50% of all fatal collisions in Bangladesh, pedestrians remain the most understudied and under-protected group of road users. This figure increases to almost 65% in Dhaka's urban area (Debnath et al., 2021). Child pedestrians are among the group at most risk for injuries in motor vehicle accidents (Zare et al., 2019).

Road accidents are the greatest cause of injury-related deaths among children aged 1–17 in Israel and a top source of unintentional injuries in children worldwide (Peden, 2008; Nir et al., 2017). It was found that children were hurt more frequently while walking than in other forms of transportation. According to research, 38% of children who died in road accidents were pedestrians (WHO, 2015). Pedestrians' illegal mid-block crossing increases the chances of a crash compared to crossing at marked or signalized crosswalks (Shaaban et al., 2018). It is also one of the leading causes of child deaths and injuries in industrialized nations. It was noticed that in urban areas, there was a concentration of pedestrian deaths (Sukhai et al., 2009).

2.1.1 Crossing medium

Children usually opt for the most convenient or direct route possible when crossing the road, even if this means crossing diagonally or between parked cars to reach their destination (Thomson et al., 1992).

Young children are less efficient at crossing roads compared to older children or adults. Specifically, although children choose the same size gaps between cars as adults to cross into, they hesitate longer before starting, which decreases their available time to cross. This increases the risk of being hit as they cross (Demetre et al., 1992; Pitcairn and Edlmann, 2000; Plumert et al., 2004).

Pedestrians are an integral element of the transport system and are at a greater risk of being involved in a crash compared to other road users. Furthermore, crossing at unmarked mid-block sections increases the chances of a crash (Shaaban et al., 2018).

Based on the statistical data, it was found that most pedestrian fatalities occurred at midblock locations, although there were various patterns of the crosswalks (Mohammed, 2021). Pedestrian crossing behavior affects pedestrian safety. Hence, among these behavioral characteristics, pedestrian crossing medium is a highly influential factor.

2.1.2 Negligence

Children aged 7–10 made riskier road-crossing decisions when asked to make real decisions in a simulated setting (Tapiro et al., 2020). Youngsters walking alone to school reported riskier negligent behavior than children walking with an adult (Koekemoer et al., 2017).

2.1.3 Companionship on the Road

According to a study, it was found that, in general, for 81% of the children, walking was the only mode of transportation, and a sizable portion of these children walked alone. Although kids who walked with a companion had fewer pedestrian collisions, kids who traveled alone to or from school were reported with riskier road-crossing characteristics. Of the children who did not stroll alone frequently, a great majority were accompanied by friends or siblings rather than an adult (Koekemoer et al., 2017).

When parent-child pairings crossed the road, the adult controlled their offspring's behavior (Li et al., 2013). However, because of multiple obligations and time restraints, it is impractical for parents to accompany their children to and from school always, especially in low-income areas with scarce resources (Bartlett, 2002; Porter et al., 2010). However, just 70% of the time did youngsters heed adult instructions given at the crossing, indicating that 30% of the time, they made their own decisions about when to cross (Schwebel et al., 2018).

Pedestrians are less likely to make riskier traveling decisions when walking with a child. When a child is present, safer crossings are more likely to be used. In fact, the mid-block crossing option became less appealing (Cantillo et al., 2015). Hence, parents can improve children's pedestrian safety by setting a good example and giving them the right guidance (Barton and Schwebel, 2007; Morrongiello and Barton, 2009; Morrongiello and Corbett, 2015).

2.1.4 Negative peer influence

Since most accompanied children walk with friends or siblings, it is possible that these youngsters are being negatively influenced by their peers (Koekemoer et al., 2017). Previous studies have shown that youngsters are more prone to road traffic injuries than adults due to impulsive behavior

(Schwebel et al., 2012). Peer pressure may explain why older kids are more likely to engage in risky behavior purposefully (Peden et al., 2008).

2.1.5 Physical & psychological issues

Children were found to be more susceptible to pedestrian injuries due to their physical, cognitive, and emotional capacities, which also include their temperament and disposition (McMahon et al., 2008; Peden et al., 2008; World Health Organization, 2011)

2.1.6 Demographics classification

It is important to note that individuals from various demographic groups can exhibit jaywalking behavior. Analyzing demographic trends can provide insights into factors that may influence jaywalking tendencies.

2.1.6.1 Age

Younger kids generally are unable to understand the threat of random road crossings (Thomson et al., 1992). By the age of 11, kids start to have a higher awareness of the risks associated with driving (Koekemoer et al., 2017). A previous study saw that with age, risky crossing behaviors increased. This behavior declined as maturity came with age at a certain point after puberty (Sullman et al., 2012). According to the study, while certain adolescent pedestrian behavior was similar to that of adults, other behaviors were distinct, with sometimes higher and sometimes lower values of risky conduct compared to adults. This shows that teenage pedestrians should be considered as a distinct risk group because their behavior is not as predictable as adults. Due to their less experience, teens are considered less skilled than adults (Plumert and Kearney, 2014; O'Neal et al., 2018).

2.1.6.2 Gender

The child's gender has an impact on how they perceive the risk of traffic and what actions are necessary. Boys are more prone than girls to take more risks, report lower ratings of the chances of injury, and exhibit a greater degree of optimism bias (thinking that they are less likely to get wounded than other kids) (Morrongiello, 1997; Schwebel and Barton, 2005). On the other hand, girls were more likely than boys to have been taught how to cross a road safely by an adult (Koekemoer et al., 2017). Interestingly, boys in the age group of 10 to 15 were most likely to sustain a serious pedestrian injury (Koekemoer et al., 2017).

2.1.7 Socio economic status

Due to several reasons, including poor road infrastructure, exposure to higher traffic, and a lack of supervision, young children living in low-income regions are more endangered in road crossings. Results also support the same findings (Koekemoer et al., 2017). Children who live in informal settlements (slums) and other low-income areas rely mainly on walking (Behrens, 2003; Peden, 1998; Statistics South Africa, 2014). Due to financial crises or professional commitments, there is a lack of adult supervision in this type of neighborhood (Chakravarthy et al., 2007; Waylen and

McKenna, 2002), which may increase the risk of youngsters participating in unsafe road-crossing behavior (Desapriya et al., 2011).

2.1.8 Traffic knowledge

Given that some factors contribute to riskier negligence, it is critical to prioritize pedestrian safety. Providing education that highlights the safest areas for young pedestrians to cross the roadway can be one effective strategy. From a very young age, children could also be taught about reflective schoolwork, knowledge of road-crossing techniques, and a broad understanding of traffic safety rules (Koekemoer et al., 2017). One of the best ways to reduce child or student pedestrian injuries is to educate kids about crossing the street safely (McDonald et al., 2011; Schwebel et al., 2016). Nevertheless, according to a previous study, kids' safety awareness when crossing highways needs to be improved (Li et al., 2013).

2.1.9 Route selection

Locations of schools and adolescent-targeted attractions may raise the possibility of pedestrian injuries (Schwebel et al., 2012). The likelihood of being delayed in reaching the destination influences decision-making significantly. The shorter alternate path is frequently chosen by pedestrians (crossing directly or diagonally to save time). A study also found that a greater distance reduces a person's likelihood of selecting safer options (Cantillo et al., 2015). Younger children (aged 5-7 years) prefer direct routes across a street, which are more convenient, that are usually more dangerous (Thomson et al., 1992)

Young children also have difficulty identifying risk factors that could influence route selection—for example, failing to recognize the dangers of mid-street crossings or considering parked cars or shrubbery that may obstruct oncoming traffic's view (Thomson et al., 1992).

As they progress through middle childhood, children adapt their behavior to discover and choose safer routes across streets to their destinations. Children aged 8 and older have more sophisticated cognitive skills that allow them to process multiple stimuli when choosing safe street crossing routes (Ridderinkhof et al., 1997; Fenner et al., 2000).

By the age of nine, most children can identify safe routes with the same skill as adults, understand the need to move to alternative but more distant crossing locations to maintain safety, and recognize obstacles that may obstruct the view of oncoming traffic (Thomson et al., 1992).

2.1.10 Exposure time

Negligent road-crossing behavior was strongly linked to more severe pedestrian collisions, and predictors of negligent behavior included a lack of awareness of pedestrian safety and longer exposure to vehicles when walking. Children between the ages of 10 and 15 were more exposed to traffic than younger children (6–9 years) (Koekemoer et al., 2017). Compared to afternoon travels, children accept adult crossing instructions less frequently in the morning and walk less safely by

paying less attention to traffic. About 56% of pedestrian injuries to children and adolescents occurred in the afternoon and evening, with the biggest number of events occurring between 1:00 and 7:00 pm (Levi et al., 2015).

2.1.11 Distraction

Using cell phones while walking on the road was found to be a dangerous practice prevalent among teenagers (O'Dell et al., 2022). As per a study, preliminary evidence suggests that this behavior among children and teenagers may lead to riskier road crossings (Stavrinos et al., 2009; Tapiro et al., 2016). Virtual environment observations have also shown the risks of distracted crossing. In a recent study, participants preoccupied with texting or listening to music showed reduced eye gaze toward the virtual road environment and were more likely to collide with a vehicle than those not distracted in these ways (O'Dell et al., 2022).

As per estimates, 20–30% of pedestrians are distracted by activities including texting, eating, drinking, and group conversations (Bungum et al., 2005; Thompson et al., 2012). On the other hand, according to a review of hospital emergency room records from 2004 to 2010, there have been more recorded pedestrian injuries due to smartphone use every year since 2010 in the USA. (Nasar and Troyer, 2013). Distractions can delay road crossings (Byington and Schwebel, 2013; Tapiro et al., 2016) and prevent people from using legal crossings (Byington and Schwebel, 2013; Stavrinos et al., 2011).

Findings from a study indicated that children aged 7 to 13 made worse crossing decisions when talking on the phone, which was also true for pedestrians (Stavrinos et al., 2009; Tapiro et al., 2016). Distracted pedestrians at road crossings raised the risk of pedestrian-vehicle collisions. Sadly, people walking around using their phones, conversing with other pedestrians, or using headphones to listen to music have become more common (O'Dell et al., 2022).

2.1.12 Theory of planned behavior

A child's capacity to assess risk is constrained by a lack of development in their cognitive, behavioral, and physical abilities (Connely et al., 1998; Foot et al., 1999; MacGregor et al., 1999; Morrongiello et al., 2015). A previous study revealed that younger children had trouble orienting themselves in metropolitan settings and recognizing potential dangers when crossing roads in real-life situations (Leden et al., 2006; Meir et al., 2015).

The Theory of Planned Behavior, or TPB for short, is a framework that examines motivation or intention as it relates to human behavior (Ajzen, 1991). According to Armitage et al. (2008), there is a direct correlation between intention and behavioral actions. Subjective norm, attitude, and perceived behavioral control are the three elements of purpose that are most predictive. First of all, attitudes are assessments of good or bad behavior. A person's perception of social pressure to engage in the behavior is known as their subjective norm. PBC is the ease or confidence with which

a person assesses their ability to carry out the behavior successfully. TPB has been a well-liked motivating model when considering pedestrian crossing behavior, particularly in difficult circumstances. For instance, it has been claimed that TPB accounts for 37–52% of the variations in road crossing intention associated with risky crossings (Evans and Norman, 1998; Holland and Hill, 2007; Zhou et al., 2016).

Research has concentrated on mobile phone distractions regarding pedestrian distraction behaviors (such as texting, browsing, talking, listening to music, using applications, etc.). Interestingly, TPB was revealed to be responsible for 48–61% of the variation in intentions to cross the street while using a phone (O'Dell et al., 2022).

2.1.12.1 Perceived Behavioral Control

An important predictor of pedestrians' intentions to cross the street in perilous circumstances is their perception of risk, which forces pedestrians to constantly adapt their behavior to the surrounding conditions (Avinash et al., 2020). A study demonstrated that road users who reported higher levels of traffic risk perception exhibited safer pedestrian behaviors (Dinh et al., 2020). In addition, it was also found that the style of crossing was a key variable affecting emotions of comfort when crossing the road (O'Dell et al., 2022).

2.1.13 Environmental Factors

It is critical to evaluate the surroundings and conditions in which children cross the street, as well as the behaviors they exhibit during this activity. This is necessary to create successful child and pedestrian safety programs (Schwebel et al., 2018). This knowledge allows us to develop suitable measures to safeguard youngsters and ensure their safety when crossing roadways. Evidence also points to the influence of environmental conditions on pedestrian crossing behavior (O'Dell et al., 2022).

2.1.14 Traffic density

Traffic density plays a significant role in influencing jaywalking behavior. Research indicates that fewer pedestrians prefer to cross the street unconventionally with higher traffic density (Wang et al., 2021). This implies that infrastructural elements and dynamic factors influence pedestrian crossing decisions. Adult and child pedestrians may be particularly vulnerable in busy road conditions (Tapiro et al., 2020). Analysis suggests that pedestrians exercise greater caution when seeing an incoming vehicle (Avinash et al., 2019). However, a study also suggested that serious vehicle-pedestrian collisions are more likely to happen when traffic density is higher (Toran Pour et al., 2017).

2.1.15 Visual Clutter

It was evident that visual clutters had a greater impact on young kids of 9–10 year-olds than on older kids (11–13-year olds) and adults. Surprisingly, children would be more affected than adults

(Tapiro et al., 2020). Both children's and adults' visual attention are impacted by the increased visual load in the crossing environment. This implies that kids had a harder time maintaining their attention when the surroundings were more visually stimulating. Due to this, children may eventually overlook important information needed to decide whether to cross a road. They also miss more opportunities for safe crossing in such conditions. Hence, this makes visually complex urban settings danger zones for young pedestrians (Tapiro et al., 2020).

2.1.16 Walking speed

It is important to note that while walking speed can impact jaywalking behavior, it is crucial to prioritize pedestrian safety and encourage adherence to traffic rules. A significant speed variance exists in kids and adults when walking or crossing roads. Children might move up to 1.3 meters per second faster than adults. However, the kid's physiology and psychology can cause this speed to be abnormal or unpredictable (Li et al., 2013). Also, the layout of the pedestrian infrastructure and related traffic control measures directly affect this speed (Mohammed, 2021).

2.1.17 Pedestrian facilities

In addition to the child pedestrians' inherent vulnerability owing to their cognitive, physical, and behavioral development, the urban environment is often unsuited for children's safe transit. (Schwebel et al., 2012; Schieber and Vegega, 2002; Schieber and Thompson, 1996). It is common for urban pedestrian facilities to be designed without considering child pedestrians' needs and restrictions (Leden et al., 2006; Johansson and Leden, 2010; Johansson et al., 2011). High traffic volumes and subpar pedestrian crossing facilities negatively impact their accessibility (Mindell et al., 2017). Hence, before building any pedestrian crossing facility, it is important to comprehend how pedestrians behave (Patra et al., 2020).

2.1.18 Land Use

Land use that prioritizes pedestrian-friendly design and amenities can encourage pedestrians to follow designated crossing points rather than jaywalk. For example, mixed land use may boost walking while reducing motorization (e.g., Zegras, 2010). However, a high density of pedestrians may be linked to a greater incidence of traffic collisions due to increased exposure (Moudon et al., 2011).

2.2 Psychological issue

Child pedestrians are more likely to misidentify dangerous circumstances (Schwebel et al., 2018). PBC (Perceived Behavioral Control) emerged as the most significant predictor of intention in unsafe road crossing scenarios. One explanation can be that even if someone has a negative opinion of distracted crossing, they might still engage in the behavior if they believe they can do it successfully and confidently. This implies that even in high-risk crossing situations, pedestrians think they are secure (O'Dell et al., 2022).

The fact that adults are accompanying their kids at the crossing may have impacted how children behaved. In particular, kids might have assumed that an adult was there to watch out for them and believed they could keep them safe from danger. Findings suggest that adults may have directed their children to more dangerous crossings since they tend to stroll with them more frequently in the morning. In addition, the riskiest crossings occur in the afternoon when kids cross with their friends (Schwebel et al., 2018).

Lower thrill-seeking behavior is associated with lower levels of risky crossing behavior as well as lower levels of planned protective behavior. Additionally, those with little behavioral inhibition exhibited less deliberate protective behaviors (Sullman et al., 2012). Pedestrian mobility barriers, particularly for individuals with disabilities, can be categorized as psychological or physical factors. These factors include delays, detours, the effort to use bridges and underpasses, perceived risk, and unpleasant crossing environments (Anciaes et al., 2016).

2.3 Parental supervision

Parental supervision is one of the most effective behavioral techniques for lowering pediatric injury risk (Morrongiello, 2005). Supervision, defined as a parent's physical proximity to the child and willingness to intervene (Morrongiello, 2005), is likely to influence children's pedestrian safety in at least two ways. First, if a child begins to behave dangerously in a pedestrian environment, a supervising adult can physically or verbally intervene. The effectiveness of such interventions appears obvious—a parent holding a young child's hand can easily restrain the child if he or she begins to cross a street in front of an oncoming car (Morrongiello et al., 2004; Wills et al., 1997).

Second, as a moderator of the link between inhibitory control and injury risk, supervision may influence pedestrian behavior (Schwebel and Barton, 2005). Empiricists have long recognized the link between children's inhibitory control and injury risk (e.g., Manheimer and Mellinger, 1967). However, theorists have only recently considered how inhibitory control may influence that risk (Schwebel and Barton, 2005, 2006). One theory is that supervision causes under-control children to overestimate their abilities (Schwebel and Bounds, 2003). In other words, impulsive children overestimate their physical abilities more than non-impulsive children (Plumert, 1995; Schwebel and Plumert, 1999). According to recent research, one way to reduce children's tendency to overestimate their ability is to increase parental supervision while children make ability judgments (Schwebel and Bounds, 2003).

2.3.1 Parent education

Parents' behaviors have a significant impact on how their children behave. Educated parents can reinforce positive pedestrian behaviors and actively discourage jaywalking. Child pedestrians' negligent behavior depends on the lack of safety knowledge (Koekemoer et al., 2016).

2.3.2 Traffic safety education

Some studies show that the annual traffic education program is not enough in many countries. However, some studies showed that a child's pedestrian behavior changes much if traffic education is provided. The efficiency of an annual one-time traffic education is not enough for children to be safe as adult pedestrians (Livingston et al., 2011). In Miami-Dade county, a program called Walk Safe was conducted, and a study was done to evaluate the Walk Safe program. The observational data demonstrated improved crossing behaviors from pre-test to post-testing conditions (Hotz et al., 2010)

From all our discussions, as mentioned above, we could find researches that have been done on Child pedestrians and students based on different types of crossing, road conditions, built environment, psychology, parental supervision, and their crossing behavior. However, in the above studies, research, and surveys, we found only the behavior that pertains at the time of crossing was thoroughly investigated. In some cases, the educational programs were taken into account. Regardless, traffic knowledge and education-related research are going on separately to prevent fatalities. From crash and safety analysis to crash predictions, all have been conducted through the years in many countries, especially developed countries. But what are the conditions that lead to crossings? Factors like parental involvement, biological changes, and physiological changes play a keen role in the decision-making process of crossing. However, there are few papers regarding the topic, which was more evident in the case of developing countries. In Bangladesh, this type of research is scarce and needs to be focused upon. Very few researches were conducted in this regard. That is why in this study, we have focused more on the decision-making process that affects the crossing behavior of a child or student pedestrian rather than what happens at the time of crossing to prevent fatalities. Therefore our objective in this study is to provide a broader analysis of the road crossing behaviors of high school and college students in Dhaka city.

Chapter 3 Data and Methodology

This chapter will describe the detailed procedure for data collection, data preparation, data analysis, and model development. In our study, the logistic regression model was used owing to the dichotomous nature of our selected dependent variable, which has been discussed in detail. Before the mathematical formulation of the model is detailed, the assumptions, estimates, study area, and data sources employed in this study are also thoroughly discussed.

3.1 Study area

We have selected Dhaka city as our study area. In Bangladesh, Dhaka has the highest number of educational institutions, including junior high schools, secondary high schools, and colleges. The total number of these institutions is 3981, catering to a huge pool of student population of 2,385,905 aged between 10 to 18 (Bangladesh Bureau of Statistics, 2022). It is worth noting that Dhaka City Corporation's report highlights that major accidents tend to occur on the city's major arterial roads. Specifically, the roads with the highest accident rates were Dhaka-Mymensingh Road, Dhaka-Chittagong Road, Airport Road, Mirpur Road, and Beribadh Road (Ahmed, 2012). Unfortunately, many educational institutions are located in the accident-prone areas of Dhaka city in Bangladesh. Moreover, Dhaka also witnessed the highest number of student fatalities in 2022 (Rahman, 2022), which suggests unsafe traveling conditions in Dhaka city. Hence, these unfortunate and alarming circumstances have prompted us to investigate the road crossing behavior of Dhaka city high school and college students. Data were collected from 13 schools in Dhaka city situated in the areas of, Motijheel, Dhanmondi, Mirpur, Uttara, Mohammadpur, and Tejgaon area.

3.2 Study workflow

A suitable workflow diagram was developed to accomplish the study's goal. From composing the questionnaire and refining the collected data to developing the statistical model, this workflow diagram was created, which is depicted in Figure 1.



Figure 1: Workflow diagram

Questionnaire preparation

While preparing the questionnaire survey, we chose questions that clearly defined the specific objectives of our research. The questionnaire was prepared considering the local issues observed through field observations, the target group of students, reviewing existing literature and research studies that assessed walking behavior or related studies among children, and conducting a focus group discussion.

In the initial phase of questionnaire formation, we prepared 68 questions that were broken into seven sections, covering the following topics: respondent particulars demographics, traffic awareness, socioeconomic status of guardian, travel characteristics, crash history, and use of legal crossing options. After the formation of this questionnaire, a pilot test of the survey was carried out with a small group of randomly selected students. After this, nine questions were filtered out, leaving 59 finalized questions. The questionnaire is provided in the next page.

Final Year Research Project

Questionnaire Form Title: Studying the road crossing behavior of high school & college students in Dhaka city

Study Objective: To assess and understand the road crossing behavior of high school and college students

Characteristics of high school/college students by examining their travel behavior, situational characteristics, socio-economic demography, and road safety perceptions.

Note: The identity of the students shall remain anonymous. This questionnaire survey is solely for academic research and not for any other purpose. Your participation in this survey is highly appreciated to promote safe road crossing behavior of your fellow students.

Questionnaire Survey Form

Please put (√) in the appropriate option and write answers in the blanks provided.

Section A: Particulars of respondents and their walking behavior.

1	How do you cross the road? a. At intersection/ overpass/underpass/foot over bridge/zebra crossing b. Mid block crossing
2	Do you need to cross any road to school/ tuition? a. Yes b. No
3	What is your gender? a. Male b. Female
4	What is your age? Ans.
5	What class do you read in? Ans.
6	What is your height? Ans.
7	What is your weight? Ans.
8	What do you consider yourself to be? a. Introvert b. Extrovert c. Ambivert
9	If you find others jaywalking generally, would you do the same? a. Yes b. No

10	Does seasonal variation impact your decision-making process? (i.e., using intersection/overpass/ foot over bridge/zebra crossing or mid-block crossing) a. Monsoon b. Summer c. Winter d. Spring e. All the time
11	Do you use headphones/ mobile phones/any other distractions while crossing the road? a. Never b. Rarely c. Frequently d. Always
12	Do your parents use legal crossings to cross roads? a. Yes b. No
13	Do you run at the last moment to catch your ride in public transportation/(school bus/bus)? a. Yes b. No c. Sometimes d. Never used public transportation
14	When do you reach school? a. Just on time b. Well ahead of time c. A few minutes earlier
15	If you have enough time, how would you cross the road? Ans.
16	Do you think that you are an impulsive person? a. Yes b. No
17	When you are with your friends, how do you cross the road? Ans.
18	Are you pressurized/stressed from your classes and coaching? (e.g., labs, extra classes, PT, etc.) a. Yes b. No
19	Do you have any physical issues (e.g., leg pain, tiredness, etc.) using stairs? a. Yes b. No
20	Do you often see traffic law enforcers on the road near your school? a. Yes b. No

Section B: Demography

1	What's the educational qualification of your father? Ans
2	What's the educational qualification of your mother? Ans
3	What type of family are you part of? a. Joint family b. Single-family

Section C: Socio-Economic Status of Guardian(s)

1	Does your family/ legal guardians own private vehicle(s)? a. Yes b. No
2	What is your family's approximate monthly income? Ans.
3	Which area do you live in? Ans.
4	What is your father's occupation? a. Service holder b. Businessman c. Teacher d. House maker e. Others _____
5	What is your mother's occupation? a. Service holder b. Businessman c. Teacher d. House maker e. Others _____

Section D: Traffic Knowledge of Respondents

1	How did you know about pedestrian safety education? a. Newspaper b. Traffic awareness week c. Mass Media (e.g. Radio, Television) d. Social Media e. Text Books f. Others _____
2	Did you ever attend any seminars/ training/ classes on traffic safety? a. Yes b. No
3	Have you ever been taught about traffic safety by your school? a. Yes b. No
4	Have your legal guardians taught you about road safety and related knowledge? a. Yes b. No
5	Would you like to take classes/training/sessions on traffic knowledge if offered? a. Yes b. No
6	Are you aware of the penalties that come with jaywalking? a. Yes b. No

Section E: Travel Characteristics

1	Who are you accompanied by when you travel to and from school? a. Adult b. Older Sibling c. Parent d. Alone e. Driver
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2	Write down your estimated travel time between school and home. Ans.
3	What is the mode of your travel (School to home and Vice Versa)? a. Walk only b. Walk and use public transport c. Private Vehicle d. Rickshaw e. CNG/Auto Rickshaw d. Others _____
4	The road you mostly cross, what is the traffic condition there? a. Low traffic b Moderate traffic c. High traffic d. Congested
5	What time are you more exposed to traffic while crossing the road? Ans.
6	Do you find hawkers and different mobile shops(Vegetable sellers, accessory sellers, etc.) on the sidewalks/road crossings? a. Yes b. No
7	Do you have any extra classes/coaching after or before school hours? a. Yes b. No
8	Is there any zebra crossing/underpass/foot overbridge on your way to school? a. Yes b. No
9	Are there any traffic signs on the road near your school? a. Yes b. No
10	How would you describe your surroundings around school? (e.g., calm, friendly, busy, noisy, not secure, unfriendly) Ans.
11	Which zone of the city is your school/educational institution located in? a. Commercial zone b. Residential zone c. Mixed zone
12	Do you know how to drive/have the knowledge of driving? a. Yes b. No
13	How many years have you been living in Dhaka? Ans. _____

Section F: Crash History

1	Do you have a previous history of accidents while crossing the road? a. Yes b. No
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2	Did any of your relative(s)/family member(s) ever been a victim/killed in road accident(s) while crossing roads? a. Yes b. No
3	Have you ever seen pedestrian(s) involved in road crash(s) in front of you? a. Yes b. No
4	Have you ever seen a road accident victim in a hospital? a. Yes b. No

Section G: Use of Legal Crossing

1	Is there any median barrier in the road that you generally use while commuting to and from school? a. Yes b. No
2	Do environmental problems like air pollution and dirty roads make you take the shortest route? a. Yes b. No
3	Is your vehicle located/parked on the other side of the road/ opposite lane? a. Yes b. No
4	If the vehicles are stopped/parked on the other side of the road/ opposite lane, how would you cross? Ans:
5	Describe the condition of the footpath that is connected to a legal crossing that you generally use. Ans.
6	Have you ever faced any unwanted situation/obstacle that made you lose interest in using legal crossings like a foot over bridge? a. Yes b. No
7	Does the environment of the foot over bridge scare you? or do you feel unsafe? a. Yes b. No
8	Do you think the safety of the overpass is maintained? a. All the time b. sometimes c. Never
9	Do you have any personal suggestions for the authority/government that would decrease the traffic rule-breaking by child pedestrians? Ans.

Each question represents an independent variable, which directly or indirectly affects our dependent variable. This has been described below-

3.2.1.1 Dependent variable

In our study, the following was the dependent variable question.

How do you cross the road?

- a. At intersection/ overpass/underpass/foot over bridge/zebra crossing*
- b. Mid-block crossing*

The above question can be translated into the dependent variable of Jaywalking or not Jaywalking. This variable depends on many independent variables developed in the statistical model from the independent variable questions.

3.2.1.2 Independent variable

Below is a question that represents an independent variable.

Does seasonal variation impact your decision-making process? (i.e., using intersection/overpass/foot over bridge/zebra crossing or mid-block crossing)

- a. Monsoon*
- b. Summer*
- c. Winter*
- d. Spring*
- e. All the time*

This question translates into the independent variable "seasonal variation in Jaywalking." Based on the significance of these independent variables, they are retained in the final model after countless iterations.

3.2.1.3 Collecting physical evidence

To justify the real-life scenario of jaywalking among high school and college students in Dhaka city and to collect physical evidence, we conducted a physical observation for about 30 minutes at the nearest legal crossing of five randomly chosen schools and colleges. This was also done to understand the current state of jaywalking in Dhaka city and support the conclusions of our study. We have presented the data of this observation in Table 1 and the time at which the observation was made in Table 2.

Table 1: Physical observation of jaywalking of high school and college students in Dhaka city.

Location	Crossing near School	Boys		Girls	
		Jaywalking	Not Jaywalking	Jaywalking	Not Jaywalking

Dhanmondi	Birshreshtha Noor Mohammad Public School (Morning Shift)	63	55	45	59
Dhanmondi	Dhanmondi Tutorial (Morning)	49	27	28	37
Motijheel	Notre Dame College (Morning)	89	43	-	-
Uttara	Rajuk Uttara Model College (Day Shift)	75	30	20	33
Farmgate	Holy Cross College (Day Shift)	-	-	36	71

Table 2: Study time of observations

Study Time	
Morning Shift	Day Shift
Starts: (7:30 pm-8:00 pm)	Starts: (12:30 pm-1:00 pm)
Ends: (12:30 pm-1:00 pm)	Ends: (4:30 pm-5:00 pm)

Ethical considerations, such as maintaining participant confidentiality and obtaining informed consent were taken into account. We considered the time it will take for participants to complete the survey and make it feasible within their schedules.

Figure 2: Jaywalking of pedestrians



3.2.2 Data Collection

Ethical considerations were taken into account, such as maintaining participant confidentiality and obtaining informed consent. Kindly note that the study was conducted only after getting ethical approval from the Department of Research, Extension, Advisory Services and Publication (REASP) of the Islamic University of Technology, Gazipur, in Bangladesh.

In Dhaka, 2,385,905 students are reading in classes 6-12 (Bangladesh Bureau of Statistics, 2022); considering this, we have obtained our sample population of 273. Here, we considered a 90% confidence interval, a 5% marginal error, and a 50% population proportion. We have used the following formula to obtain our sample population for a finite population-

$$n' = \frac{n}{1 + \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$$

Where-

z is the z score

ε is the margin of error

N is the population size

\hat{p} is the population proportion

Therefore, we finally collected 273 survey data from randomly selected students from 13 schools in Dhaka city's Mohammadpur, Dhanmondi, Tejgaon, Mirpur, Uttara, and Motijheel areas. We also ensured that the respondent's gender and educational background (English Medium, Bangla Medium, English Version, etc.) were given equal importance.



Figure 3: Jaywalking of parent-child pair in Uttara

Chapter 4 Model Development and Analysis

In our study, the dependent variable is the decision to Jaywalk or not jaywalk, meaning it can only take one of two possible values: 1 or 0. The logistic regression model is the appropriate statistical model for analyzing data in dichotomous or binary form. In investigating pedestrian behavior and traffic safety, the logistic regression model is a statistical approach that is frequently used (Simoncic, 2001; Valent et al., 2002). Hence, in our study, we have used the logistic regression model. To develop the model, we have divided the process into a workflow diagram illustrated in the following figure.

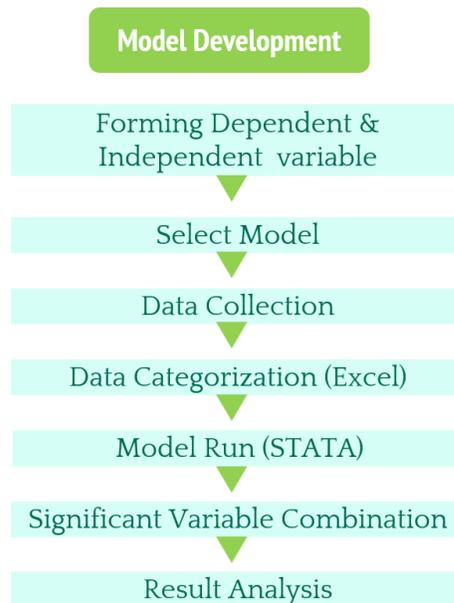


Figure 4: Flow chart of model development

4.1 Model assumptions

In developing the model, the following assumptions were made, which are important to consider when using this model for analyzing data (Simon, 2011; Washington et al., 2011). These are the key assumptions of logistic regression:

1. The dependent variable should be dichotomous in nature.
2. There should be no outliers in the data.
3. There should be no high correlations (multicollinearity) among the predictors.
4. Observations are independent of each other.
5. Typically, sufficient sample size is required to ensure stable model estimation and reliable inference.

4.2 Model Equation

Logistic regression provides probabilities as the outcome, representing the likelihood of an event happening. It is commonly used when the outcome variable is binary or categorical. The logistic regression model estimates the relationship between the predictor variables and the log odds (logarithm of the odds) of the event occurring. Here our dependent variable is whether the student will jaywalk or not (Y_i), and the independent variable will be various factors (X_i) obtained from the questionnaire like demographic, socio-economic, crash history, traffic conditions, etc., that will affect the jaywalking of a student or not.

Logistic regression model is expressed by,

$$Y_i = \log it(P_i) = LN\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_K X_{K,i}$$

Where-

β_0 = Model constant

β_1, \dots, β_K = Unknown parameters corresponding with the explanatory variable

$X_{k,i} = 1, \dots, K$ = Set of independent variables

P_i = Probability

Y_i = Dependent Variable

4.3 Model outcomes

The odds ratio is a measure of the association between a predictor variable and the outcome in logistic regression. It represents the ratio of the odds of the event occurring for one group or category compared to another. Odds is represented by the following equation-

$$O = P/(1 - P)$$

Where,

O is the Odds, P is the probability, and the Odds ratio compares the likelihood of two events. The comparison is scaled using a natural logarithm to get the log of Odds ratio or EXP [β_i]. The probability of a particular variable X_i increases by one unit (When others are considered constant), and the odds of that variable increase by the log of odds. The odds ratio can be further described by

$$\begin{aligned}
\left(\frac{P_i}{1-P_i}\right)^* &= EXP[\hat{\beta}_0] EXP[\hat{\beta}_i(X_i + 1)] \\
&= EXP[\hat{\beta}_0] EXP[\hat{\beta}_i X_i] EXP[\hat{\beta}_i] \\
&= \left(\frac{P_i}{1-P_i}\right) EXP[\hat{\beta}_i] \\
P_i &= \frac{EXP[\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_K X_{K,i}]}{1 + EXP[\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \dots + \beta_K X_{K,i}]}
\end{aligned}$$

If,

Odds Ratio >1 Dependent variable probability increases,

Odds Ratio < 1 Dependent variable Probability decreases,

Odds Ratio=1 there is no association between the predictor variable and the outcome.

The magnitude of the odds ratio indicates the strength of the association. A larger odds ratio implies a stronger association between the predictor variable and the outcome. After primary selection, the collected data were categorized in Excel and run in the STATA to determine the significant variable depending on the P value. Variables with $P \leq 0.05$ are considered significant; however, when $P \leq 0.1$, a variable is considered marginally significant. Hence, variables with a P value of less than 0.1 were also kept in the final model.

4.3.1 About STATA

STATA is a comprehensive statistical software program developed by StataCorp, a USA-based software company, for statistical modeling, data analysis, and data visualization. In this software, users get to use a variety of tools for managing data, describing statistics, and multilevel modeling, among many more. Due to its user-friendly interface and copious documentation, analysts and researchers use STATA extensively to execute complicated statistical studies, estimate models, investigate data trends, and produce better visualizations.

4.3.2 Correlation of variables

Correlation has also been checked in our model. Correlation values of within 0.5 were kept in the final model. In logistic regression, it is generally preferred to use variables with lower correlation to address the issue of multicollinearity. This phenomenon happens when there is a high correlation between two or more variables, which lowers the precisions of estimates, destroys the stability of the model, and creates issues in interpreting the coefficients. In our case, the primarily chosen variables based on P values all had a lower correlation and were retained in the final model. In table 3, the descriptive statistics of our variables in the model are provided.

Table 3: Statistical description of selected variables

	Explanatory Variables	Description for variables	Std. Dev.	Mean
(1)	<i>Class of student</i>			
	6-8	Class 6-8=1; otherwise=0	0.470	0.326
	9-10	Class 9-10=1; otherwise=0	0.470	0.326
	11-12	Class 11-12=1; otherwise=0	0.477	0.348
(2)	<i>Estimated time of reaching school</i>			
	Just on time	Just on time=1; otherwise=0	0.461	0.304
	Well ahead of time	Ahead of time=1; otherwise=0	0.468	0.322
	Few minutes earlier	Few minutes earlier=1; otherwise=0	0.465	0.315
(3)	<i>Mother's Occupation</i>			
	Service holder	Service holder=1; otherwise=0	0.393	0.190
	Businesswoman	Businesswoman=1; otherwise=0	0.242	0.062
	Teacher	Teacher=1; otherwise=0	0.294	0.095
	Housemaker	House maker=1; otherwise=0	0.498	0.553
	Others	Others=1; otherwise=0	0.294	0.095
(4)	<i>Travel Mode (school to home and vice versa)</i>			
	Walk only	Walk=1; otherwise=0	0.381	0.176
	Walk and use public transport	Walk and use PT=1; otherwise=0	0.399	0.198
	Private vehicle	Private vehicle=1; otherwise=0	0.485	0.374
	Rickshaw	Rickshaw=1; otherwise=0	0.388	0.183
	CNG/Auto Rickshaw	CNG=1; otherwise=0	0.228	0.055
	Others	Others=1; otherwise=0	0.120	0.015
(5)	<i>Traffic exposure time</i>			
	Morning	Morning=1; otherwise=0	0.491	0.399
	Noon	Noon=1; otherwise=0	0.402	0.201
	Evening	Evening=1; otherwise=0	0.489	0.392
(6)	<i>School location</i>			
	Commercial zone	Commercial=1, otherwise=0	0.447	0.275
	Residential zone	Residential=1, otherwise=0	0.417	0.223

	Mixed zone	Mixed=1, otherwise=0	0.501	0.502
(7)	<i>Residency in Dhaka (years)</i>			
	≤5	Years≤5=1; otherwise=0	0.249	0.066
	5-10	5<Years ≤10=1; otherwise=0	0.412	0.216
	≥10	Years≥10=1; otherwise=0	0.451	0.718
(8)	<i>Road traffic condition</i>			
	Low traffic	Low traffic=1; otherwise=0	0.278	0.084
	Moderate traffic	Moderate traffic=1; otherwise=0	0.488	0.388
	High traffic	High traffic=1; otherwise=0	0.459	0.300
	Congested	Congested=1; otherwise=0	0.417	0.223
(9)	<i>Overpass safety</i>			
	All the time	All the time=1; otherwise=0	0.375	0.168
	Sometimes	Sometimes=1; otherwise=0	0.481	0.359
	Never	Never=1; otherwise=0	0.500	0.465
(10)	<i>Jaywalking tendency (when others jaywalk)</i>	Yes=1; No=0	0.501	0.513
(11)	<i>Distractions while crossing (talking by cellphone, listening to music etc.)</i>			
	Never	Never=1; otherwise=0	0.501	0.516
	Rarely	Rarely=1; otherwise=0	0.439	0.260
	Frequently	Frequently=1; otherwise=0	0.343	0.136
	Always	Always=1; otherwise=0	0.085	0.007
(12)	<i>Taking training/sessions on traffic knowledge</i>	Yes=1; No=0	0.500	0.535
(13)	<i>Footpath Condition</i>			
	Good	Good=1; otherwise=0	0.451	0.282
	Moderate	Moderate=1; otherwise=0	0.437	0.256
	Poor	Poor=1; otherwise=0	0.499	0.462
(14)	<i>Footpath Enroachment (i.e., Presence of hawkers, mobile shops, construction material etc.)</i>	Yes=1; No=0	0.361	0.846

Chapter 5 Result and Interpretation

After over 200 iterations and primary screening, 16 significant variables were selected based on their p-values and correlation with each other. These significant variables were part of 14 questions that had 43 variables.

In our study, travel-related factors, respondent characteristics, and walking patterns significantly influenced the road crossing behavior of students. However, the respondents' demographic traits and crash history had little impact on how they crossed the road.

Table 4: Results of logistic regression model

	Variables	Odds Ratio	P-Value
(1)	Class of student		
	6-8	3.49	0.01
	9-10	3.01	0.018
(2)	Estimated time of reaching school		
	Just on time	0.45	0.035
(3)	Occupation of mother		
	Businesswoman	0.14	0.005
(4)	Mode of travel (school to home and vice versa)		
	Walk only	0.41	0.104
	Rickshaw	0.32	0.011
(5)	Time of more traffic exposure		
	Evening	0.40	0.016
(6)	Zone of school/college/educational institution		
	Commercial	0.41	0.03
(7)	Residency in Dhaka		
	5-10 years	2.56	0.029
(8)	Traffic condition of road		
	Moderate traffic	0.56	0.101
(9)	Safety of overpass		
	Never	2.86	0.003
(10)	Jaywalking tendency (when sees others jaywalking)	2.83	0.004
(11)	Distractions while crossing	2.17	0.001
(12)	Taking classes/training/sessions on traffic knowledge, if offered	0.28	0.001
(13)	Condition of footpath	1.53	0.051
(14)	Encroachment of footpath	0.42	0.067

Number of observations	273
Log likelihood	-121.3397
Likelihood Ratio (LR) Chi-Square test (17)	124.62
Prob > chi2	0.0000
Pseudo R-squared	0.3393

5.1 Class of students

5.1.1 6-8 and 9-10

It was found that, compared to students reading in classes 11–12, students who read in classes 6–8 had the highest likelihood of jaywalking (OR=3.49), followed by the students of classes 9–10 (OR=3.01). This finding suggests that younger teenagers are less concerned about their safety when crossing roads than older adolescents. A possible reason could be their growing enthusiasm, so taking risks becomes a matter of braveness. Hence, younger pedestrians can be found to be less predictable than their elderly counterparts when it comes to knowing what their subsequent actions will be (Holland and Hill, 2007).

5.2 Estimated time of reaching school

The estimated time of reaching school has a significant impact on the crossing behavior of students. If students arrived on time for class, they were 55% less likely to jaywalk or cross in unconventional ways. Students who came early usually had more time to cross the roads, which might have lessened their temptation to engage in risky road crossing. According to previous research, students frequently became nervous if they ran late for class, so they had to rush to cross the street (Hansen, 2011). It was also evident that most jaywalking students knew that they had to wait several minutes until the crosswalk signal changed, which meant being late for class. Anxious students were found to rush across the street at the first halt they found in traffic, putting themselves and the incoming motorists at major risk (Hansen, 2011). Another point to notice is that the students who are just on time cannot reach earlier because they spend more time on the road to avoid jaywalking.

5.3 Occupation of mother

Notably, children whose mothers engaged in business were 86% less likely to jaywalk (OR=0.14). Due to the nature of their employment, businesswomen may have a higher sense of responsibility and better attention to detail, making them more concerned about road safety. Hence, a stronger sense of safer road crossing is channeled through a child from an early age. Again, we must know that a child's parental figures are the role model, teacher, and first best friend.

5.4 Mode of travel (school to home and vice versa)

5.4.1 Walking

In our study, it was apparent that students who walked to their schools were less likely to jaywalk than those who used other modes of transportation (OR=0.41). Students who walk to school usually follow the same route daily, meaning they are more familiar with the pedestrian facilities, road crossings or crosswalks, and other structures, which offer a safer way to cross busy streets. Again, in some cases, younger students may be accompanied by guardians who offer additional supervision and guidance when they walk to school. This may be another reason that decreases jaywalking.

5.4.2 Rickshaw

Our study indicates that the students who rode rickshaws to school or home were less likely to engage in risky crossing behaviors (OR=0.32). They were 68% less likely to do jaywalking. Students who use rickshaws as a means of transport are generally dropped off at a designated location, such as a sidewalk or a specified drop-off point. Students in this situation do not need to cross roads. Also, students who use rickshaws are more likely to be accompanied by an adult, which can result in safer road movement.

5.5 Traffic exposure time

Time of traffic exposure is another significant characteristic in determining students' walking behavior. Students show 60% less jaywalking activity (OR=0.40) as traffic congestion begins to reduce in the evening. The possible reason could be that students go to school in the morning or day, and at noon or evening, they return to their homes. This gradually decreases the traffic congestion in the area. At this time, students usually do not worry about reaching somewhere early since they might not have extra coaching classes or any other engagement afterward. Hence they can use the extra time to use pedestrian facilities. However, a study showed that fatal accidents were more likely to occur during late morning and early afternoon (Williamson et al., 1995).

5.6 School/college/educational institution zone

As suggested by our study, students were more likely to use designated road crossings if their educational institutions were in a commercial area (OR=0.4). Commercial areas typically have higher levels of law enforcement and transportation infrastructures, which fosters an environment that encourages safer pedestrian behavior. Additionally, the presence of well-designed transportation infrastructure, such as traffic signals and pedestrian crossings, improves safety precautions and might motivate students to use designated crossings.

5.7 Residency in Dhaka

It is interesting to note that students with a 5-10 year residency in Dhaka had a higher likelihood of jaywalking (OR=2.56). Although staying in the city longer may have given them more confidence in navigating its streets quickly and efficiently, it has also reduced their feeling of accountability. Heavy traffic congestion, lack of adequate pedestrian infrastructure, demanding schedules, and academic pressures for a longer period can also be the reasons for increasing the probability.

5.8 Traffic conditions on the road

Compared to high or low-traffic situations, engaging in risky crossing was 44% less frequent under moderate traffic conditions. However, it was observed that in Cape Town, South Africa, most traffic accidents occurred when kids utilized routes with moderate traffic to travel to and from school (Koekemoer et al., 2017). Again, another study shows that on high and average traffic volume roads, the safety of children is more violated (Petch and Henson, 2000). That can be another reason for decreasing the probability of jaywalking in such traffic conditions.

5.9 Safety of overpass

The risk of jaywalking is greatly increased by the unfavorable perception of security issues of overpasses (OR=2.86). The finding could result from user inconvenience, a poor impression of safety, a lack of enforcement, or a weak surveillance system. A previous investigation also noted a similar outcome (Debnath et al., 2021). Most students thought that the overpass's safety was never maintained, which naturally made them wary of using overpasses.

5.10 Jaywalking tendency

Additionally, it has been found that when students notice other people jaywalking, they are more likely to engage in illegal road-crossing activity (OR=2.83). Due to peer pressure, the bystander effect (a social psychology phenomenon where people are more likely to act when others around are doing the same), time crunches, and underestimating risk when they are in groups, this result is expected. This outcome confirms the outcomes of another investigation (Zannat et al., 2019). As social creatures, humans frequently look to others for guidance on how to act in particular circumstances. When students see their friends jaywalking, they could think it is normal or socially acceptable.

5.11 Distractions while crossing

Students who were occupied with their phones, music, or other distractions while crossing the street are likelier to jaywalk (OR=2.17). Perhaps students who use cell phones while crossing the street exhibit poor judgment due to a lack of situational awareness. It is a common scenario that when someone is inattentive, their attention is misplaced, and they cannot finish a job properly. The same goes for walking on the road. In a study, this was similar for almost one-tenth of pedestrians

involved in road traffic accidents, where these people had their attention distracted by modern technical equipment. (Miroslava et al, 2021).

5.12 Taking classes/training/sessions on traffic knowledge

Jaywalking was less likely among students who were willing to participate in training or instruction sessions on traffic safety (OR=0.28). They are the group of students that are more worried about their safety because they want to learn more about concerns related to safety, which is seen in their attitude of lower probability of jaywalking. Because of having a better understanding of traffic rules, pedestrian safety, and the importance of following designated crossings, they have enhanced situational awareness, improved decision-making, a better understanding of consequences, and positive peer influence.

5.13 Condition of footpath

The condition of the footpath has a big impact on how people cross roads (OR=1.53). The findings indicate that when the state of the sidewalk is poor, there is a 53% greater likelihood of being involved in jaywalking. Poor footpath conditions represent several characteristics, including potholes, insufficient width, and an undulating and discontinuous path that frequently deter students from using roadside facilities. This promotes jaywalking. Similar findings were reported in the study by Zannat et al. (2019), which discovered that footpath conditions had a significant impact on how people crossed roads.

5.14 Encroachment of footpath

Another notable result is that if encroachment of a footpath is seen, students are 58% less likely to engage in this behavior (OR=0.42). The presence of shops, vendors, and building materials on the pedestrian walkway might discourage students from jaywalking. Most likely, barriers along the roadsides surround certain footpaths, preventing students from crossing the street unlawfully by stepping into the traffic lane from the pedestrian walkways. Because of increased pedestrian activities (often leads to slower traffic causing students to wait for their turn to cross), increased congestion (incoming vehicles slow down to let create safer opportunities to cross roads), improved visibility (acts as markers to identify legal crossings), and increased safety considerations, the students might be less prone to jaywalking.

Chapter 6 Conclusion and Recommendation

6.1 Key findings

Factors like parental involvement, biological changes, and physiological changes play a keen role in the decision-making process of crossing. Our study investigated the factors influencing road crossing behavior like weather conditions, distraction, footpath condition, parent education, their profession, traffic condition, time of exposure, etc. We observed that students, particularly those in sixth to ninth grade, were more prone to not using legal crossing facilities, which aligns with our field observations.

One significant finding was that students tend to mimic the behavior of other pedestrians. When they observe others jaywalking or using electronic devices while crossing the road, they are likelier to imitate this behavior and choose unauthorized locations to cross the road. This suggests that peer influence and observational learning play a role in shaping their road-crossing decisions.

Another noteworthy finding was that students who have been living in Dhaka for several years and hold negative perceptions about the security issues related to pedestrian overpasses are often involved in these unruly road-crossing activities. Their perceptions of safety, or lack thereof, appeared to influence their decision to bypass designated pedestrian infrastructure and take risks by crossing the road in unauthorized areas.

This behavior could be attributed to various factors. Firstly, the student's familiarity with the city and its road network may lead them to believe that they have a better understanding of the traffic conditions, leading to a disregard for designated crossing points. Secondly, their negative perceptions of pedestrian overpasses may stem from concerns about personal safety, such as the presence of crime or accidents in those areas. These factors contribute to their preference for taking shortcuts across the road rather than using authorized facilities.

Overall, our study highlights the influence of peer behavior, negative perceptions of pedestrian infrastructure, and familiarity with the city on the road crossing behaviors of Dhaka's high school and college students. These findings suggest that interventions aimed at promoting safe road crossing among students should address these factors by emphasizing the importance of following legal crossing facilities, raising awareness about the safety benefits of pedestrian overpasses, and fostering a sense of responsibility and accountability in road users.

We found from our study that students willing to acquire traffic safety knowledge through safety education programs and have parental guidance are less likely to engage in jaywalking behaviors. One notable finding from our study is that the presence of safety education programs plays a crucial role in shaping students' road-crossing behavior. Students who actively participate in these programs and receive formal instruction on traffic safety are more likely to stick to the rules and regulations of the road crossing. This indicates that providing students with proper education and

knowledge about safe road crossing practices can effectively reduce their inclination towards jaywalking.

Additionally, the influence of parental guidance on students' road crossing behavior cannot be understated. Students who receive guidance from their parents on road safety matters, including the importance of using designated crossing facilities, are more likely to follow these guidelines. Parental involvement and communication regarding road safety instill a sense of responsibility and awareness in students, leading to a decreased likelihood of engaging in jaywalking.

Moreover, situational factors such as traffic conditions, urban settings, and transportation modes were found to influence jaywalking behaviors among students significantly. For instance, in areas with heavy traffic congestion or limited access to pedestrian infrastructure, students may be more inclined to jaywalk for convenience or to save time. Similarly, students may resort to jaywalking as an alternative in densely populated urban settings where pedestrian infrastructure may be inadequate or poorly maintained.

6.2 Study implications

The findings of this study carry significant implications for educational institutions and traffic safety initiatives. Understanding the implications of this study can inform the development of targeted traffic safety interventions and policies aimed at promoting safer student pedestrian crossing practices. In this regard, further studies can be done on assessing the awareness level of road safety rules among school and college children, identifying common challenges or risks they face while crossing roads, or evaluating existing road infrastructure and safety measures as an extended part of the current study.

Our study can provide observations for improving road safety and mitigating risks associated with road crossing behavior among school and college children in Dhaka City. Additionally, considerations can be made on collaborating with relevant stakeholders such as schools, educational authorities, or road safety organizations to gain insights and enhance the study results. Our investigation can assist with the current road system by examining locations where students commonly cross and note shortcomings. We can also work with the relevant authorities to ensure adequate pedestrian crossings, signs, lights, and visible markings. The vigilance with which traffic laws are enforced can also be increased, especially around schools and institutions.

We can also implement targeted educational programs and awareness campaigns to raise knowledge of road safety among students in schools and colleges, focusing on the importance of observing traffic laws, utilizing designated pedestrian crossings, and exercising caution when crossing the street. Workshops, interactive sessions, and the distribution of instructional materials can all be a part of these efforts. We can also guide by introducing pedestrian safety education as a course in schools and universities, teaching each student about traffic laws, such as looking both ways before crossing, waiting for the green light at intersections, and crossing only at marked

intersections. Include hands-on activities and simulations to improve students' comprehension and application of road safety principles.

This study can also help to identify and promote safe pathways for students to walk to school or college by working with local authorities and urban planners. It can also determine how accessible the neighborhoods are by foot and remove any obstacles or dangers that deter people from crossing the street safely.

6.3 Limitations of the study

While our study provides valuable insights into road crossing behaviors among students in Dhaka city, it is important to acknowledge its limitations. Two significant limitations include the small sample size and the potential for self-reporting bias.

The small sample size is a limitation that can affect the generalizability of our findings. With a limited number of participants, the study may only partially capture the diversity and variability in road crossing behaviors among all students in Dhaka city. The findings might be specific to the particular sample we collected data from, and caution should be exercised when extrapolating the results to a larger population.

Another potential limitation is the presence of self-reporting bias. Our study relied on self-reported data obtained through surveys or interviews. Participants may have provided responses that they believed were socially desirable or aligned with expected norms, potentially leading to inaccurate or biased information. For example, participants might overstate their adherence to safe road-crossing practices or underreport their involvement in jaywalking. This bias can limit the accuracy and reliability of the data collected.

6.4 Recommendations

Future studies could be considered to mitigate these limitations by employing larger and more diverse sample sizes to ensure a broader representation of students in Dhaka city. Increasing the sample size would enhance the generalizability of the findings and provide a more comprehensive understanding of road-crossing behaviors among students. Additionally, researchers can employ a mix of research methods, such as direct observation and objective measurements, to complement self-reporting data and reduce the impact of bias.

Furthermore, it is crucial to acknowledge and address the potential for self-reporting bias. Researchers can employ techniques like anonymous surveys, providing clear instructions to participants to ensure honest and accurate responses, and cross-validating self-reported data with objective measures whenever possible. To inform parents of their responsibility in encouraging their children to cross the street safely, we can hold workshops and awareness campaigns with them

in mind. Encourage neighborhood involvement in observing and reporting dangerous driving practices or road conditions.

Our study serves as an initial exploration into the factors influencing road crossing behaviors among students in Dhaka city. It highlights the need for further research with larger samples and alternative data collection methods to understand this important topic comprehensively.

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