Assessing the Influence of Socio-Demographic Factors on Road Traffic Injuries and Fatalities in Nepal

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Abstract

The impact of socio-demographic factors on road traffic injury and death rates in Nepal was studied using data from the 2022 National Demographic and Health Survey (NDHS). A two-stage stratified cluster sampling method was utilized to gather information from 14,280 households in urban and rural areas. Descriptive statistics were employed, and multiple regressions were conducted to explore road traffic injuries as the dependent variable and age, gender, education, income, and place of residence as the independent variables. The findings reveal that accident rates are highest among young adults aged 15-34 years, while mortality is most prevalent in individuals aged 60 years and above. The distribution of injuries and fatalities varied across regions, with Karnali and Sudurpashchim provinces reporting the highest combined numbers. Additionally, social status played a role in the likelihood of accidents, with the most economically disadvantaged individuals being more vulnerable to severe crashes due to limited and less secure transportation options. The majority of motorcycle traffic casualties involved men, while women were more frequently affected by bus and bicycle accidents. This research highlights the impact of socio-demographic factors on the frequency of road traffic injuries and fatalities in Nepal and suggests the need for further investigation into addressing infrastructure, alcohol and drug use, and distractions to prevent road traffic accidents in the country.

***Keywords*:** Fatalities Nepal, NDHS, Road safety, Socio-demographic factors

INTRODUCTION

Globally, road traffic injuries pose a significant public health concern and result in at least 1.35 million fatalities annually, with a particularly high impact on individuals aged 15-29. Despite low- and middle-income countries representing over 60% of the world's vehicles, they are responsible for 90% of road traffic fatalities (WHO, 2024).

Falls are the leading cause of traumatic spinal cord injuries, with a staggering 69.6 percent of cases through falls from trees. The second cause is road traffic injuries, which account for 29 percent of TSCIs caused mostly by two- or three-wheeled motorized vehicles. Before admitting those, males' young adults aged 21-30 years were 2.3 times more admitted to the hospitals than females (Willott et al., 2021). Most previous research conducted in Nepal has examined road safety from a more mechanical or infrastructural perspective without accounting for how people cause road traffic accidents (Poudel et al., 2021). Young males have always been shown to be at risk of engaging in more high-risk activities such as speeding, drinking, not wearing helmets or seatbelts, and the like (Kritsotakis, 2019).

Some of the factors exacerbating the situation include reckless driving, speeding, and excessive use of motorcycles. There is an urgent need for focused strategies such as public education campaigns and increased curbing of illegal behavior targeted at road users (Khadka et al., 2024).

Road traffic injuries in Nepal are impacted by income level, as they influence resources, transportation, and safety. People in the lower income bracket experience challenges such as living in slums and facing delays in medical care. Additionally, they may struggle to afford safety-appropriate gear like helmets and seat belts, which contributes to the severity of their injuries (Moroni, 2019). Conversely, individuals with higher incomes are at lower risk of such injuries due to the availability of safety measures.

There are also road traffic injury inequalities between various geographic regions in Nepal. For instance, the mountainous regions have a higher death toll because the roads are typically narrow and serpentine. As a result, road usage in these regions is especially risky because of the terrible driving conditions (Sedain & Pant, 2021).

Rural residents are at a higher risk of severe accidents compared to urban dwellers due to the limited access to medical services. In rural areas without well-equipped emergency facilities, the chances of surviving serious accidents are low, as many victims do not receive timely treatment (Atreya et al., 2022).

This research aims to examine how societal-demographic characteristics in Nepal contribute to the understanding of risk factors for road traffic injuries and fatalities. While global studies have drawn various conclusions about road traffic injuries overall, it is crucial to consider country-specific case studies to understand the unique challenges each country faces. Nepal's diverse geographic topography

and varying socio-economic conditions create an intriguing context for exploring how they impact road traffic-related outcomes (Ziakopoulos, A., & Yannis, G. (2020).

This study aims to investigate how social and demographic factors impact road traffic incidents, particularly accidents and fatalities, in Nepal. The research will analyze primary data from both rural and urban areas over the past five years, excluding data related to structural and mechanical causes. Specific demographic and economic measures, including age, gender, education, income, and location.

MATERIALS AND METHODS

Study Design

Data for the 2022 National Demographic and Health Survey (NDHS) was collected using a two-stage stratified cluster sampling design. The survey was conducted in provinces that were pregnant with urban and rural subdivisions; hence, 14 strata were realized. To address any bias and make sure that the results of the survey corresponded with the distribution of the population, sampling weights were applied.

Study Population and Sampling

The demographic focus of the survey was women between the ages of 15 and 49 years, and approximately 14,924 women were intended to be interviewed. Sample allocation included a total of 8,010 interviews conducted in urban settings and 6,914 in the countryside, with at least 910 women proposed per area as a minimum. The sample size was finally computed based on power considerations and requirements at the domain level.

Sampling Design

A two-stage stratified cluster sampling design was adopted for the survey, First Stage of Sampling: 476 Primary Sampling Units (PSUs) were selected using probability proportional to size (PPS) sampling with 30 in each PSU. The total of 14,924 women target was split between urban and rural areas adequately representing each domain and having a minimum of 910 women per domain. Power allocation adjustments were done.

Data Collection Methods

What here would be successful is a recounting of an integrated household consumption survey in selected all studied residential households. In the case of PSUs with household numbers greater than 300, sub-ward divisions were done, and one division was picked at random using probability proportional to size. Every sampled food shop was then visited in turn, and interviews were conducted without deviation from the randomization strategy to obtain an unbiased sample.

Materials/Tools

Household listing and mapping created detailed lists and maps to develop a sampling frame. Structured questionnaires and collected data on the respondents'

demographics, health indicators, and socio-economic variables. Weights were computed in order to correct for differences in sample design and response rate reliability to guarantee that the sample was representative of the whole national population.

Data Analysis

SPSS was utilized for conducting descriptive statistics, specifically for analyzing frequencies and percentages in the data. Additionally, the study employed multiple regression analysis to determine the relationship and extent to which the dependent variable (road traffic injuries/fatalities) was associated with the independent variables of age, gender, education, income, and place of residence.

RESULTS

Table 1

Deaths and Injuries from Road Traffic Accidents or Crashes

Background Characteristic	Road Traffic Deaths per 100,000"	Nonfatal Traffic Injuries per 100,000"	Traffic Accidents: Deaths and Injuries per 100,000"	Household Population	Total % (Deaths & Injuries)"
Age Group					
<15 years	0	824	824	9,213	8.94
15-34 years	34	3,154	3,188	17,075	18.92
35-59 years	17	2,197	2,214	19,506	11.33
60+ years	45	541	586	7,614	7.70
Province					
Koshi	0	909	909	9,388	9.69
Madhesh	12	1,418	1,430	11,640	12.28
Bagmati	12	1,144	1,156	11,095	10.42
Gandaki	34	766	800	4,897	16.34
Lumbini	25	993	1,017	9,505	10.70
Karnali	14	982	996	3,289	30.28
Sudurpashchim	10	1,101	1,112	4,570	24.33
Wealth Quartile					
Total Low Wealth	31	1,334	1,365	21,646	6.30
Total High Wealth	40	4,099	4,139	32,739	12.09
Total	71	5,433	5,504	54,384	2.03

The data from Table 1 indicates that road traffic injuries and fatalities are most prevalent among individuals aged 15 to 34, with a rate of 3,188 per 100,000, representing 18.92 percent of the population. The older age group (60 years and above) experiences the highest fatality rate at 45 per 100,000, while children under 15 suffer injuries at a rate of 824 per 100,000, with no resulting fatalities. The provinces of Karnali and Sudurpashchim have the highest combined rates of deaths and injuries at 30.28 and 24.33 per 100,000, respectively. There is an observed inequality pattern where outdoor endurance sports-related incident rates are higher at 12.09 percent for the richest (high fourth quartile) and lower at 6.30 percent for indoor sports. Factors such as age, geographic location, and economic status play a role in road traffic accidents in Nepal.

Table 2

Types of Road Traffic Accidents or Crashes by Background Characteristics

Background Characteristic	**Car**	**Truck**	**Bus**	**Motorcycle**	**Bicycle**	**Pedestrian**	**Three-wheeler/ Tempo**	**Other Vehicle**	**Number Killed or Injured**
	%	%	%	%	%	%	%	%	
Age Group									
<15	2	3.6	3.8	44.4	34.6	10.3	1.3	0	76
15–34	4.5	4.4	4.5	73.3	5.5	3.6	2.6	0	271
35–59	2.4	2.6	4.4	69.3	10.9	5.3	3.1	0.9	227
60+	1.8	1.1	5.2	65.2	19.8	5.8	5.2	0	45
Sex									
Male	3.3	4	3.2	70.4	10.6	3.9	3.8	0.9	434
Female	2.8	0.4	7.7	62.4	15.4	6.5	4.8	0	165
Province									
Koshi	3.8	0	4.2	68	10.9	6.5	6.6	0	85
Madhesh	2.2	2.0	0.9	65.3	21.3	4.4	2.7	1.2	166
Bagmati	5.3	6.0	4.3	75.2	6.5	2.7	0	0	128
Gandaki	3.2	1.8	18.5	69.6	4.9	1.9	0	0	39
Lumbini	1.5	3.4	5.8	69	6.2	2.4	10.4	1.3	97
Karnali	3.7	7.6	6.0	55.1	4.4	15.7	5.8	1.7	33
Sudurpashchim	2.8	0.9	2.1	66.2	17.3	6.0	4.7	0	51
Wealth Quintile									
Low	4.3	6.5	5.5	56.2	14.6	6.2	6.3	0.6	148

High	2.7	1.8	4.1	72.5	12.7	4.4	1.5	0.1	453
Total	3.2	3	4.4	68.2	11.9	4.6	4.1	0.6	599

The data presented in Table 2 delves into road traffic collisions in Nepal, examining various characteristics including age, gender, province, and socio-economic status. Motorcycles are the primary vehicle involved in 68.2 percent of cases. Among children aged 0–15 years, bicycles are responsible for 34.6 percent of accidents, followed by motorcycles at 44.4 percent. For the 15-34 age group, 73.3 percent of crashes involve motorcycles, with a slight fluctuation for older age brackets: 69.3 percent for 35-59 years and 65.2 percent for 60 and above. Men are involved in 70.4 percent of motorcycle crashes, while women account for 62.4 percent. Females have higher rates of road traffic accidents involving buses (7.7 percent) and bicycles (15.4 percent). Bagmati province has the highest proportion of motorcycle crash accidents at 75.2 percent, while Madhesh province leads in bicycle involvement at 21.3 percent. There are differences in accident types based on socio-economic status, with lower wealth quintiles more likely to be involved in truck accidents (6.5 percent) and higher wealth individuals frequently involved in motorcycle accidents (72.5 percent).

Table 3 "

Multiple Regression Analysis of Road Traffic Deaths and Injuries in Nepal (2022)

Variable	Coefficient (β)	Standard Error	t-value	p-value	95% Confidence Interval
Intercept	1.2	0.25	4.8	<0.001	(0.71, 1.69)
Age group					
15-24	0.4	0.08	5.00	<0.001	(0.25, 0.55)
25-44	0.25	0.05	5.00	<0.001	(0.15, 0.35)
45+	0.35	0.07	5.00	<0.001	(0.22, 0.48)
Sex (Male)	0.25	0.05	5.00	<0.001	(0.15, 0.35)
Province					
Koshi	0.1	0.07	1.43	0.154	(-0.04, 0.24)
Madhesh	0.15	0.07	2.14	0.033	(0.01, 0.29)
Bagmati	0.05	0.07	0.71	0.478	(-0.11, 0.21)
Gandaki	0.2	0.08	2.5	0.013	(0.04, 0.36)
Lumbini	0.1	0.07	1.43	0.154	(-0.04, 0.24)
Karnali	0.3	0.08	3.75	<0.001	(0.14, 0.46)
Wealth quintile					
Low	0.15	0.04	3.75	<0.001	(0.07, 0.23)
High	0.05	0.06	0.83	0.41	(-0.07, 0.17)

Note: P-value < 0.05 indicates statistical significance. 95 percent confidence Interval: Range where true parameter value lies with 95 percent confidence.

An assessment was conducted using regression analysis to study the factors contributing to road traffic injuries and fatalities in Nepal. The results of the data analysis revealed a highly significant intercept ($\beta = 1.20$, $p < 0.001$), indicating a fixed effect. When categorizing the respondents into different age groups, it was observed that Age Group 1 (15-24 years) showed a strong negative association with the risk factors ($\beta = 0.40$, $p < 0.001$), followed by Age Group 2 (25-44 years, $\beta = 0.25$, $p < 0.001$) and Age Group 3 (45+ years, $\beta = 0.35$, $p < 0.001$). Therefore, it can be inferred that older individuals are more vulnerable to road traffic injuries and fatalities.

When considering sex as a demographic factor, it is found that males are at a higher risk ($\beta = 0.25$, $p < 0.001$) of road traffic injuries. People living in the Gandaki region ($\beta = 0.20$, $p = 0.013$) and Karnali provinces ($\beta = 0.30$, $p < 0.001$) are more susceptible to road traffic accidents compared to others. Individuals in the low-wealth quintile are more likely to encounter road traffic accidents compared to those in the high-wealth quintile, who do not exhibit any risk ($\beta = 0.15$, $p < 0.001$; $p = 0.410$). These findings indicate that factors such as age, gender, location, and socioeconomic status are crucial in the analysis of road traffic accidents in Nepal.

DISCUSSION

The paper is focused on understanding the road traffic injuries and fatalities in Nepal among socio-demographic determinants of age, sex, location, and economic status. The study shows that the specific age group of 15–34 years contributes the greatest number of road traffic injuries in the study area, which is 18.92 percent (Table 1).

Studies have shown that new drivers often engage in unnecessary risky behavior, such as not wearing helmets or seatbelts, particularly in open vehicles, increasing their chances of suffering fatal injuries in an accident. Implementing targeted educational programs for high-risk groups is practical, as evidenced by successful interventions and positive results (Malekpour et al., 2023).

Exceeding speed limits and driving under the influence of drugs and/or alcohol are examples of risky driving, which are more common among young adults and in cultures that embrace fatalistic attitudes. (Champahom et al., 2023).

This increased vulnerability of young adults to road traffic injuries is further linked to their participation in risky practices such as speeding and flouting traffic laws, as the findings of the research conducted in Kuwait showed (Akhtar et al., 2022).

In Nepal, the elderly population has age-specific risk factors for injury and death from trauma and has the highest injury death rates (45 per 100,000 people) compared to younger age groups, despite the more favorable rates of old-age injuries. Older adults face an increased risk of severe injury and death due to their frail condition and longer recovery times (Breen et al., 2021). The increasing trend emphasizes the importance of implementing suitable road safety measures that take

into account people's ages. For example, building pedestrian-friendly infrastructure in neighborhoods with a high concentration of older individuals and improving accessibility to public transportation could help reduce risks within this demographic (Hossain et al., 2023).

The alleviation rates of road traffic deaths and injuries are highest in Karnali and Sudurpashchim provinces, at 30.28 percent and 24.33 percent, respectively, based on the geographical distribution of deaths. As a result, these regions face increased dangers due to poor roads and limited access to healthcare facilities. In areas with peripheral and hilly terrains, there is a higher incidence of vehicle-related deaths due to delays in emergency services and an unfriendly road network (Rusli et al., 2018).

Emergency response mechanisms are often lacking in regional and mountainous areas, resulting in delays in obtaining medical assistance after accidents and exacerbating the severity of injuries among victims. The reduction in accidents can be credited to enhancements in road design and maintenance. Studying the effective road safety approaches of developed countries can improve safety standards in rural areas (Reddy, 2024).

The variations in accident patterns across different provinces underscore the need for tailored solutions in each area. For instance, Bagmati province, including Kathmandu, experiences a notably high 75.2 percent of motorcycle-related accidents, primarily due to the widespread use of motorcycles in the urban area. Conversely, provinces like Madhesh report a higher than average 21.3 percent of bicycle accidents, indicating a reliance on non-motorized transportation. Implementing advanced solutions such as intelligent traffic management and physical infrastructure improvements like speed bumps can contribute to enhancing safety and reducing the incidence of road accidents (Giri, 2024).

Deaths from road traffic injuries show an unequal distribution based on socioeconomic status, with a higher concentration among individuals in the lowest wealth bracket compared to those in the highest wealth bracket (6.30% vs. 12.09%). People in the lower socioeconomic groups are more at risk of using risky modes of transportation like motorcycles, bicycles, or walking due to limited transportation choices and the lack of infrastructure support.

In this theory's framework, it's not surprising that individuals with low incomes are more inclined to walk or bike instead of using cars due to their inability to afford vehicles, with a 5.4 odds ratio for seeking access to a one-car household compared to a two-car one (Younkin et al., 2024). Vulnerable populations are at an even higher risk of deadly accidents, especially in areas with high traffic density and insufficient protective measures like raised medians (Patwary et al., 2024). Additionally, individuals in lower wealth quintiles may struggle to purchase essential protective equipment such as helmets and seat belts (WHO, 2023).

The connection between socioeconomic status and road traffic safety is

complex. Despite driving safer vehicles, individuals with higher incomes often engage in reckless behaviors such as speeding or using a cell phone, leading to accidents. Additionally, behavioral economics indicates the necessity of educating individuals on managing cognitive biases related to unsafe driving habits, which are prevalent across all socioeconomic groups (Segun et al., 2024; Ramírez & Scartascini, 2024).

Studies show that speeding contributes to more than half of the global road traffic crash fatalities, especially in low- and middle-income countries (Fondzenyuy et al., 2024). To address this issue, effective interventions such as emotionally impactful campaigns tailored to the income levels of the target audience are needed, given the significant road safety issues faced by low-income populations (Odijk et al., 2023).

The correlation between wealth and traffic risk is not significant in the upper wealth group ($p = 0.410$). While wealthier individuals may own cars that offer better protection in case of a crash, they may also engage in risky behaviors such as speeding or being distracted. Higher-income earners tend to drive at higher speeds for various reasons and because they feel more secure due to their vehicle's safety features (Kang, 2017). A study on distracted driving behavior found that drivers from the high-income group often overlook the dangers of distractions because of their ethnocentric attitudes (Geng et al., 2024). Therefore, addressing road traffic accidents requires implementing effective programs to change the behavior of all segments of the population, rather than just focusing on the availability of safe cars.

According to the research findings, being male is associated with a higher likelihood of being involved in road traffic accidents compared to being female, and this association is statistically significant with a coefficient of $\beta = 0.25$ ($p < 0.001$) (Table 3). Studies have shown that males, especially young males, tend to engage in more reckless driving behaviors compared to other drivers, which significantly contributes to the occurrence of road accidents. For example, the ratio of male drivers involved in serious crashes compared to female drivers is 3.25, and many of these cases are linked to alcohol consumption (Belov & Kazun, 2024). Risky behaviors such as aggressive driving and speeding can be linked to psychological characteristics like impulsivity and aggression (Shafiee-Kandjani et al., 2023; Tokko et al., 2022). Conversely, women are often involved in accidents as pedestrians or passengers because they are less likely to display risky driving behaviors (Karras et al., 2023).

The necessity of addressing the issue of road traffic fatalities and injuries in Nepal is underscored in this paper. Specifically, we emphasize the importance of implementing targeted actions, such as road safety education campaigns that prioritize young people and, in particular, motorcyclists who are responsible for the majority of accidents. It is crucial to establish and enforce stricter regulations concerning the use of helmets and speed limits for riders, as studies have shown

that wearing helmets significantly reduces head injuries and fatalities. The enforcement of these measures has been successful in reducing injuries, as shown by the notable decrease in casualties in Vietnam during the initial year of helmet law implementation (Mock et al., 2017).

Moreover, the enforcement of helmet laws has been found to increase compliance and reduce the severity of injuries (Busko et al., 2017). Vulnerable groups such as the young, elderly, poor, and disabled are the most impacted and should be the focal point of road safety initiatives (Gupta & Bandyopadhyay, 2020). Furthermore, enhancing pedestrian infrastructure and providing safer and more affordable transportation options in rural and underdeveloped areas can significantly reduce the incidence of road traffic injuries (Araujo et al., 2017).

The unequal distribution of road accidents and fatalities in regions such as Karnali and Sudurepashchim underscores the need to improve road infrastructure in these provinces. Implementation of road safety measures such as sidewalks and traffic calming measures is crucial in preventing injuries and fatalities among pedestrians, particularly in low and middle-income countries where the impact of these measures varies based on local conditions (Boun et al., 2024). Measures such as traffic calming, speed monitoring, and the installation of pedestrian crossings with speed-calming features can help reduce pedestrian fatalities (Stigson et al., 2023).

Urban interventions like painted green walkways have enhanced pedestrian safety and visibility in congested areas, leading to a reduction in pedestrian injuries (Huang & Huang, 2024). Addressing risk-taking behavior, particularly among urban males, is essential in curbing accidents (Cantisani et al., 2023).

The impact of various socio-demographic factors such as age, location, wealth, and gender on road traffic accidents and injuries in Nepal is the focus of this research. Addressing these issues will require enhancing road safety infrastructure, enforcing traffic regulations, and conducting awareness initiatives.

CONCLUSION

The research investigates how socio-demographic factors contribute to road traffic accident injuries and fatalities in Nepal. Young adults have the highest accident rate, while the elderly experience the highest fatality rate. Provinces like Karnali and Sudurpashchim, which are geographically isolated, suffer the most due to inadequate infrastructure. People with lower incomes are at higher risk due to their relatively unsafe means of transport. Males, especially motorcycle riders, are more likely to be involved in accidents. Future studies should examine the effectiveness of interventions and other factors such as alcohol consumption and driving distractions to gain a better understanding of the issue of road traffic accidents in Nepal.

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