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Caution Signages and Their Relevance in Commuter Safety in High-Density Construction and Traffic Areas of Two Smart Cities in Odisha: A Cross-Sectional Study to Ensure Eco-Mobility

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Abstract

Introduction: India has regulations to control RTA and is thus skewed towards regulating traffic and imposing fines if appropriate protective gear is not worn while driving. However, considering the population and perhaps also the socioeconomic standards of a major section of society, it is imperative to be equally vigilant towards the protection of commuters.

Commuters can fall into all age ranges and, given the compounded problems of multiple constructions, bad roads, lack of proper walking space, stray animals, and mostly even rash driving, are at the highest risk of accidents. The most cost-effective and basic initial effort to offer them some protection would be to have signages and instructions posted at appropriate points of busy junctions or requisite points.

Objectives:

Primary:

1. To assess the awareness among commuters regarding danger signages and pedestrian norms in age groups and among genders.

Secondary:

1. To identify the enabling factors that contribute to injuries/accidents among this section of the population on busy roads in sampled areas.
2. To make recommendations to ensure commuter safety and compliance with safety rules.

Methods: Select four sites each as per police station jurisdiction in the twin cities of Bhubaneswar and Cuttack. Two team members are deputed to stand at a convenient hour and seek permission as well as consent from commuters and assess their knowledge from a standardized pictorial flow chart by the Disaster Management Board. Responses were noted in a Google form by the survey team comprising interns and postgraduate students and interviewed at least ten

each day. Five consecutive consenting commuters, each from age groups 11-21, 21-50, and >50 years from each gender, for five working days of two weeks, were completed.

In the last six months, data from the police station was taken regarding reports of accidents by commuters in those areas and correlations were developed between relevant factors.

Results were shared with the commuters and police in random groups to educate and generate a felt need for reinforcement of regulations that would prevent accidents to some extent.

The study was conceived in the two busiest cities of Odisha state- Cuttack and Bhubaneswar, where active development activities occur throughout the year.

Results: From both cities, 64 commuters were selected for the study. Awareness of signages improved with increasing age, from 56% to 65% to 88%. Signages for construction sites and malls were poor in Cuttack, as it did not have many malls. Accidents were common among those aged 11 to 21 years, especially among females, and no correlation was seen between the reported injuries, gender-wise or socioeconomic status. Although increasing age was protective for injuries (21%; SD ±4.5, OR 0.21, p<0.03), the ones reported were primarily due to the use of alcohol, oversight, and lack of knowledge of signages. The police administration also admitted to under-reporting such injuries. The presence of stray animals was also a highly significant enabling factor for such injuries (OR 5.6, P<0.0001).

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Text Box 1. Contribution to the literature
There are limited studies available in the developing world on the reasons for the increasing number of accidents in busy areas.
Developmental activities often disregard public safety, causing more hazards if precautions are not adopted in time. However, evidence of these is not documented.
Odisha, a state often hit by cyclones causing widespread disruption of life and property, has a city plan of putting up caution signages to aid the public. However, its dissemination is sketchy.
This study re-emphasises the need to understand these signages, to avert some unfortunate incidents, and also advocates for the need for commuter safety.

Introduction

Commuters span all age groups; they are at the greatest risk for accidents due to ongoing construction projects, poor

roads, lack of walking space, stray animals, and reckless driving, to name a few.

The mass movement of populations from rural to urban settings and the consequent physical changes to urban settings leading to rapid urbanisation is affected by three factors: distribution of economic activity and availability of jobs over space, the distance between residence and job location, and the wage differential between source and destination. These factors together determine the decision of workers to either migrate or commute. The huge demand for mobility, housing facilities, and infrastructure increases construction in and around cities, traffic congestion, and road traffic accidents [1].

Commuter safety is of paramount importance in assessing the safety of various work sites. Road Traffic Accidents/Injuries (RTA/RTI) are regulated in India by traffic laws and fines for driving without protective gear. It is crucial to be equally cautious for the security of commuters, considering the population and socioeconomic diversity in society [2]. The frequent occurrence of safety-related accidents poses great harm to human lives and social harmony. To curb accidents, safety signs are used to inform people about potential hazards or prompt people to take reasonable actions. Safety signs are widely applied in our daily surroundings, such as in industrial production sites, commercial and residential buildings, national highways, malls, and busy roads.

Studies in Tehran have suggested that safety signs in the workplace are effective in controlling workplace hazards. Correct interpretation of signs is vital in preventing injury and saving lives [3]. In Israel, studies have suggested that making construction sites and other commuter areas as safe as possible requires a concerted effort on the part of all involved: owners, designers, construction companies at all levels of management, construction workers, regulators, and educators [4]. In Malaysia, there are a number of incidents highlighted by the media involving school children, which caused injuries and death. The majority of incidents happen due to poor safety signage in the particular area where the hazards are present [5]. Studies in China suggest that although previous studies have paid attention to the design and effectiveness of safety signs, little attention has been devoted to investigating how people process the information conveyed by different types of safety signs. In this processing of information, the age group of the commuters plays an important role. Similar studies at national and regional levels are scarce.

The present study seeks to assess the awareness of commuters of different age groups regarding danger signage and contributing factors causing injuries/accidents, assessing safety amongst various categories of commuters in the large cities of Bhubaneswar and Cuttack in the state of Odisha.

Materials & Methods

Study design and setting: This study was conducted using a cross-sectional study design in the cities of Cuttack and Bhubaneswar in the state of Odisha, where active development activities occur throughout the year.

Study Period: It was conducted from November 2022 to March 2023.

Sample size: A total of 240 general commuters from the selected sites were included in the study.

Methodology: The sites for the investigation were selected randomly by the lottery method from the jurisdiction area of two police stations (one each from Bhubaneswar and Cuttack) at the convenience of the investigating teams. The commuters were interviewed from three broad groups according to their commuting type and time: 11-20 years (mostly school and college-going students), 21-59 years (mostly working or mobile population), and more than 60 years (senior citizens). A two-member team was formed and deputed to stand at a convenient hour at the selected site. The commuters were approached by the team, and those who agreed to participate were explained about the study. A written informed consent/assent (age-appropriate) was taken from them, and the assessment was done. The commuter's knowledge was assessed from a standardised pictorial flow chart by the Disaster Management Board. Ten responses were noted per day in a Google form by the survey team comprising interns and postgraduate medical students. Five consecutive consenting commuters each from the age groups of 11-20, 21-59, and >60 years from each gender for five working days of two weeks. Thus, at least 80 subjects of either gender in the stated age groups participated in the study. Scores on 26 signages were compared against a few prominent sociodemographic variables if identified correctly 1 mark and if not then 0. Thus, the total score was 28. The last 6 months' data from the police station was taken regarding reports of accidents by commuters in those areas correlations were developed between relevant factors and a costing comparison was done between the management of injuries and the cost of putting an alert. Institute Research Committee and Ethics approval was sought for the same.

Study tool: A pre-tested and pre-validated standardised pictorial flow chart by the Disaster Management Board and parivahan.gov.in was used for assessing the commuter's knowledge.

Results were shared with the commuters, police, and municipalities alike, to advocate regulations that would help minimise accidents.

Statistical analysis: Data were analysed using SPSS software version 25. Frequencies and proportions regarding knowledge of signages were analysed. The police data were discussed as case incidences and all stakeholders' opinions were compiled to suggest recommendations.

Results

Out of 240 participants who participated in the study, the maximum knowledge about signages was in the age group of 21-50 years.

Table 1. Age-wise correct identification of common signages in large establishments/construction sites (pooled for 2 cities)

	Large Establishment/Construction Safety			
Sl. No.	**Symbols (correct responses)**	**Age Group in Years (n = 240)**		
		11-20 (n = 80)	**21-50 (n =80)**	**>50 (n =80)**

1	 Construction Area	13 (16.25)	18 (22.5)	8 (10)
2	 Electrical Hazard	12 (15)	7 (8.75)	8 (10)
3	 Risk of Falling	12 (15)	19 (23.75)	1 (1.25)
4	 Deep Excavation	5 (6.25)	11 (13.75)	0
5	 Confined Space	0 (85)	8 (10)	4 (5)

6	 Risk of Asbestos Exposure	0	5 (6.25)	0
7	 Construction Area	18 (22.5)	29 (36.25)	8 (10)
8	 Material may fall	1 (1.25)	21 (26.25)	8 (10)
9	 Uneven floor or Surface, Watch your Steps	7 (8.75)	3 (3.75)	4 (5)

10	 Flammable Substance	14 (17.5)	34 (42.5)	23 (28.75)
11	 Battery Charging Area	7 (8.75)	4 (5)	0
12	 Fire Exit	4 (5)	13 (16.25)	5 (6.25)
13	 Fire Extinguisher	43 (53.75)	47 (58.75)	35 (43.75)
14		19 (23.75)	13 (16.25)	9 (11.25)

	Slippery Sign			

Table 1 depicts the knowledge of signage among commuters in large establishments or construction sites. The respondents were equally taken from three age groups: 11-20, 21-59, and over 60. Most of the commuters could identify some common symbols but had average or poor knowledge about the rest.

Approximately fifty percent of commuters, irrespective of their age group, had a good understanding of fire extinguisher signs. Around thirty percent of commuters from the 11-20 and 21-50 years age groups recognised the construction area symbols. Commuters in the age group of 21-50 years had better knowledge than the other two age groups for construction safety signs: ‘material may fall’ (26.25%), ‘flammable substance’ (42.5%), ‘slippery’ and ‘fire exit’ (16.2%).

Commuters in the age group of 11-20 years, though at less risk of injury due to slipping, had better knowledge (23.75%) than the other age groups who are at higher risk of injuries due to falls.

Most of the commuters, irrespective of age, had poor knowledge about symbols like ‘electric hazard’, ‘deep excavation’, ‘battery charging area’ and ‘uneven floor’. This lack of knowledge was most pronounced in the senior age group, which is a matter of concern. The overall knowledge about signage related to safety in large establishments and construction sites was satisfactory in the age group of 21-50 years. The knowledge in the other two age groups is poor, and there is scope for improvement of overall knowledge in the aforementioned age groups.

Table 2. Age-wise responses for signage used for road safety

	Road Safety			
	Symbols (correct responses)	**Age Group in Years (n = 240)**		
		11-20 (n = 80)	**21-50 (n =80)**	**>50 (n =80)**
1	 Cross road ahead	7 (8.75)	4 (5)	4 (5)
2		13 (16.25)	31 (38.75)	23 (28.75)

	 No Bullock carts			
3	 No Parking	11 (13.75)	33 (41.25)	16 (20)
4	 Road Widens ahead	0	6 (7.5)	1 (1.25)
5	 Pass either side	7 (8.75)	8 (10)	0
6	 Merging traffic ahead	12 (15.25)	13 (16.25)	14 (17.5)
				

7	 Parking both sides	17 (21.25)	27 (32.5)	10 (12.5)
8	 No through side road	0	4 (5)	1 (1.25)
9	 No through road	6 (7.5)	7 (8.75)	4 (5)
10	 Line passing allowed when safe	0	14 (17.5)	16 (20)
				

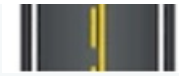
11	 Passing allowed only when safe and broken line on your side	6 (7.5)	5 (6.25)	8 (10)
12	 No Passing allowed	9 (11.25)	15 (18.75)	14 (17.5)

Table 2 depicts the knowledge of commuters about road safety signage in various age groups. Commuters in the age group of 21-50 years overall had better knowledge about signage than the other age groups.

Most of the respondents in that age group had good knowledge about no parking signage (41%), parking on both sides (32.5%), and no bullock carts (38.75%). This can be attributed to the frequent use of this signage in almost all places and commuters in the age group of 21-50 years being the most mobile group. However, knowledge about road signage like road widens ahead (7.5%), pass either side (10%), and no through side road (5%) was poor for all age groups due to its limited use on Indian roads. These signs are, however, important for overtaking and speed control at intersections of the roads, which are accident-prone areas.

The overall knowledge about road safety signage was very little or poor in the 11-20 and more than 60 years of age groups. This can be attributed to their limited mobility, lack of awareness, and lack of knowledge about road safety. In India, this is a prerequisite only for driving license holders, which is recommended for those aged 18 years and above.

Based on the responses of Tables 1 and 2, mean scores of knowledge of commuters about signage were calculated. The respondents have been categorised on the basis of age groups, gender, and educational qualification. The mean score was calculated for all the three categories.

Table 3. Mean scores for correctly identifying signage; reporting of history of injury and risk effect.

Sample characteristics	Cuttack (n=120)		Bhubaneswar(n=120)		Risk estimate
	Mean	Hx of injury*	Mean	Hx of injury	
Age groups					
11-20yrs	12±2.6	11	16±2.7	18	
21-50yrs	21±3.1	18	26±0.5	20	21-50 yrs 67%; p= 0.001
>50yrs	10±0.2	14	15±3.4	12	
Gender					
Male (n=120)	18±2.4	60	21±3.1	72	Males 65%; p<0.03
Female (n=120)	08±4.6	31	12±5.2	54	
Education					
Primary (n=70)	11± 1.9	20	15±2.5	16	
Secondary (n=30)	18±4.5	08	18±4.6	23	
Higher secondary (n=20)	15±3.1	10	20±2.9	07	No effect; p=0.413

The mean knowledge was highest in the age group of 21-59 years (21 ±3.1) in Cuttack, with a history of the number of injuries also being highest in the same age group, around 18. In Bhubaneswar, the mean knowledge was highest in the 21-59 years group (26±0.5), with a history of reported injuries around 20 in the last 6 months. This association was statistically significant, with the risk estimate being around 67% in this age group of commuters in both these cities. The association in the other age groups was not significant.

The mean knowledge among male commuters in both Cuttack (18±2.4) and Bhubaneswar (21±3.1) was highest. The history of reported injuries was also highest among male commuters in both cities. The association of knowledge about safety signages with a history of reported injuries in both cities was statistically significant among male commuters, with a risk estimate of around 65%. Although female commuters had poor knowledge and a high injury rate, the association was insignificant.

Most of the commuters (n=70) from both cities were just literate, having poor mean scores of knowledge but high reporting of injuries. However, the educational qualification of commuters was insignificantly associated with the history of reported injuries amongst commuters from both cities.

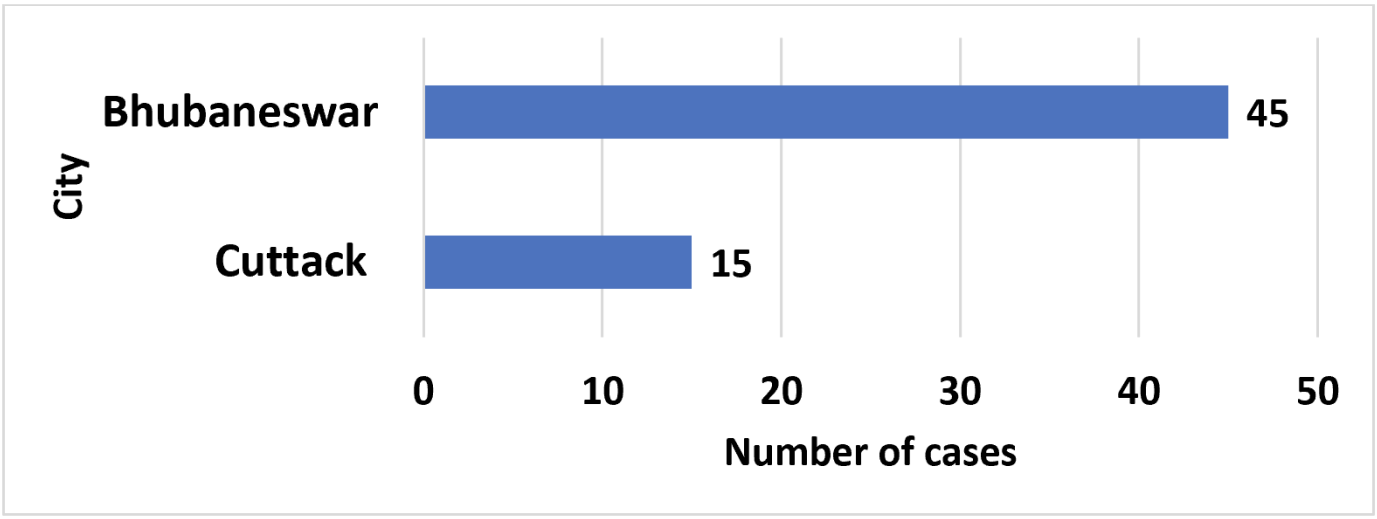


Figure 1. Four Police stations in two cities reporting injuries involving pedestrians in the last month, February 2023.

Figure 1 depicts injuries involving pedestrians in the month of February 2023 from four police stations in selected cities. Around 45 cases of grievous injuries were reported in Bhubaneswar and 15 cases in Cuttack. The presence of stray animals was also a highly significant enabling factor for such injuries (OR 5.6, P<0.0001).

The data of grievous injury is presumed to be unreported in Cuttack, as opined by the police personnel, the reason for which is beyond the scope of this study.

Discussion

Safety signages are important to warn people about untoward events that can occur due to a lack of knowledge of safety on roads and in construction areas. A study conducted in China (5) suggests that different types of safety signs lead to significant differences in individual hazard perception. Another study (GAOJ. et al. 2021) shows that safety signage is an emerging research field in countries like the United States, followed by China and Canada.

Construction area signage is used at construction sites to protect both employers and pedestrians from risks. As individuals over 50 years old usually commute in the early morning, they are more prone to injuries in these areas due to less knowledge regarding this signage. A study conducted in Tehran (Davoudian. et al) suggests that safety signs in the workplace are effective in controlling workplace hazards, and correct interpretation of signs is vital in preventing injuries and saving lives [6]. A study conducted in Israel (Sacks. et al.) suggests that a construction worker's ability to identify and assess risk is acquired through training and experience, and this is a key factor in determining their safety [7].

In the present study, the overall knowledge about signages related to safety in large establishments and construction sites was satisfactory in the age groups of 21-59 years and poor in 11-20 and above 60 years. Knowledge of senior-age respondents was poor about warning signs like 'slippery floor'. The commuters, irrespective of age groups, had poor knowledge about emergency guiding signs like 'fire exit' in public buildings. Signs like slippery signs are important to warn people regarding wet floors in places that use oils and lubricants. This is even more important for older commuters and

small children as they are at the highest risk of falls due to slippage.

Bian et al. classify safety signs as prohibitory, mandatory, warning, and guide. A slippery sign is a kind of warning sign that notifies people about potential hazards and plays an important role in directing commuter behaviour. Davoudian et al. suggested that a meaningful positive correlation between the rate of perception of safety signs and personal factors like age, gender, and literacy was significant. [5] The perception of emergency exit signs (fire exit) was high (63.3%) amongst workers from a study in Tehran. A study in Malaysia among primary school people (Murugan et al. 2019) showed that the students had average knowledge about fire exit signs and slippery signs, which was significantly improved after training and awareness sessions held in school. [4]

Accident-related deaths are a major problem in road transportation, especially in developing countries. Despite the legislation, death statistics continue to increase annually. Improving physical activity and developing sustainable transport, investigating how people process the information conveyed by different road safety signs is necessary to prevent any untoward events. The study conducted by Bian et al. in China suggests that behavioural warning signs like ‘no passing allowed’ induced a higher level of perceived hazard than prohibitory signs like no parking and mandatory signs merging traffic ahead. [4]

A study conducted in Glasgow (Crawford F et al. 2011) suggests that safety is a continuing issue for both walkers and cyclists. [8]

A study conducted in the state of North Carolina in the United States (M Zahabi et al. 2017) shows that the effect of sign familiarity within age groups was lowest among elderly groups (38%) compared to 65% in middle age and 64% in young age. Elderly and young drivers produced greater speed deviations when they were exposed to pictorial logos and safety signages. [9]

Another study in Rhode Island (Ott et al. 2012) showed a 31% variance in driving awareness items like spatial, environmental, traffic, and signage amongst drivers surveyed regarding safety measures of on-road driving tests. [10]

A study conducted in Mangalore city of South India found that the road safety features and safe environment around the schools were poor, with only 11.5% of schools having road safety signages, thus putting the stakeholders of the school at risk of accidents. [11]

A study conducted on roadways in New Delhi (Mundi et al. 2014) suggests that at any given moment, commuters like pedestrians were at the highest risk of injury due to poor driving behaviour and lack of proper signage amongst drivers on the road. It has been demonstrated that lack of strong enforcement of legislation, along with poor safety awareness, were major causes of road traffic accidents. [12]

In the present study, all the respondents, irrespective of age groups, had poor knowledge about safe driving and overtaking signages, which was significantly associated with reports of injury. In a study conducted in southern India (Kulkarni et al.), awareness among study participants regarding road traffic signs was average, with better awareness of signs in male commuters (52.5%) [13].

A study done in Telangana state amongst college students found that though the participants had positive attitudes towards road safety measures, translation into practice was poor. 65% of participants could identify 5 out of 10 signages correctly, and around 58% had adequate knowledge about road safety. 80.3% of students agreed strongly to the fact that road signs should be followed strictly; however, only 16% of students always followed the road signs while driving [14].

Conclusion

The study clearly shows negligence towards commuters' safety, especially among younger students, the elderly, and women.

Some precautions are present in big cities and larger establishments, but these are a rare feature in small cities and even worse for rural areas. In spite of some legislation, very low discipline and compliance amongst the commuters in the two cities is a matter of concern. There is no strict punitive action taken by concerned authorities for lack of signage, thus personal caution is the only resort for commuter's safety in this city.

Injuries caused on roads are preventable if appropriate signages are put in place and changed as per need and conditions. The police personnel who participated in the study were of the opinion that the cost of putting safety signage in danger points is nominal and has tremendous effectiveness in controlling commuters' injuries.

In the current context, where air pollution is increasing due to automobiles and walking is being encouraged, this aspect needs utmost attention. Stray animals are also a bigger threat in these cities of Odisha. Working adults'/adolescents' alcohol consumption is also seen as a potential threat to commuter's safety.

Limitations

Signages are not the only factor to help assess commuter safety; other factors associated with commuter safety are part of a larger project and beyond the scope of the present study. This study is not representative of the general commuter safety problems of the state; however, the study significantly brings out a few preventable aspects of commuter safety associated with safety signages, which are a cost-effective intervention and would help tremendously in bringing down unfortunate incidents in busy parts of human habitations.

Recommendations

Educational institutions and even workplaces should disseminate information on these signages, especially to the at-risk group. Training and awareness programmes should be conducted at regular intervals for the general public as well as students. Specific safety signages and tools should be developed for commuters of vulnerable age groups and offered to overcome the disadvantage of literacy in the area, as may be the case in developing countries like India. Common safety signages should be put up in common public gathering places like cafeterias, malls, and workplaces.

Strict implementation of existing laws and necessary amendments, if any, should be done to meet commuter safety.

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Contributions

- SK- conceptualised the study and tools development, article writing and statistical analysis.
- AS, AK, VS- Data collection, supervision, finalisation of the draft.
- All authors read and approved the final manuscript.

The results won the 1st prize as an Oral presentation at the Indian Public Health Association conference in Kolkata, India in February 2023.

Ethical considerations

Institute Research Committee approval letter KIMS/SLRC/79/2023/01 approved the study and all ethical considerations were upheld. It was a student activity and observation study with no intervention and being public health, the team offered requisite suggestions to the Road, construction managers, and police authorities.

Data Availability

Study data is with the team and will be shared on demand with appropriate justifications.

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