Epidemiology of construction site injuries in Delhi, India: protocol for a retrospective cohort study

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ABSTRACT

Background: Unintentional occupational injuries are a formidable public health challenge. Construction injuries make a significant contribution to occupational injuries. A public health approach to deal with this challenge warrants determination of the magnitude, scope, and characteristics of construction injuries.

Objectives: To describe the epidemiology of construction injuries; to investigate trends and risk factors for injuries to construction workers and to thereby generate

information vital to mitigating the burden of injuries to construction workers in Delhi, India,

Methods: It is a retrospective cohort studybased on the First Information Reports of Delhi Police registered between 1st January 2016 to 31stDecember 2018.

Results: injuryrates per 100,000 construction workers per year will be estimated and injury risk factors and trends will be presented. The results of the study will be published in an international, peer-reviewed journal. Findings of the study will also be presented at national and international injury and trauma conferences.

Keywords: *construction injuries, occupational injuries, epidemiology, police reports, Delhi, India*

Introduction

Injuries kill five million people annually and are a formidable public health challenge.[1,2] Deaths and disabilities due to injuries lead to substantial societal costs, productivity losses, and a financial burden of the treatment and rehabilitation.[3] The construction sector is known for high rates of fatal and non-fatal occupational injuries and disabilities.[4,5,6]Construction is likely to contribute 20% to Disability-Adjusted Life Years (DALYs) by 2020.[2,6]Globally, poor attention to safety is associated with fatal and non-fatal construction injuries.[7-10]

Demographic and socioeconomic transitions have added to the burden of injuries, especially in low and middle-income countries (LMICs).[11] Paradoxically, despite their burden and impact, injuries have received limited attention as a public health problem in LMICs.[11,12] Inaction is largely rooted in poor records and accident reporting systems which make the extent of the problem less visible to policy makers.[11]

In India, the construction industry is powering both growth of employment and Gross Domestic Product (GDP);[13] it accounts for 8.2% of GDP and employs 12% of the workforce.[14] Construction is the second biggest source of employment after agriculture.[15] Construction is also the second biggest cause of workplace accidents in India, after mining, representing 24.2% of total occupational accidents.[16] Delhi, the capital of India attracts construction workers due to its geographical centrality and

high wages.[17]It was estimated that 256 fatal construction accidents happened every year in Delhi between 2008 and 2012.[16]

A first step in the public health approach to any health problem is to determine the magnitude, scope, and characteristics of the problem.[11] Current injury literature lacks extensive studies on the epidemiology of injuries in the construction sector in India. India does not report and publish accident statistics on occupational injuries and illnesses.[18]While population-based injury surveillance systems are desirable, such infrastructure is unlikely to be established in India for several decades.[18] In many countries, data on injuries are collected by the police.[19]In the absence of any other comprehensive dataset for construction site injuries in India, police records are a potential data source.

Aim of this study is to describe the epidemiology of construction site injuries in Delhi, to investigate trends and risk factors for injuries to construction workers and to thereby generate information vital to mitigating the burden of injuries to construction workers in Delhi, India, using data extracted from the First Information Reports (FIRs) of Delhi Police.

Material and Methods

Study design

This is a descriptive epidemiological study based on a retrospective cohort using data extracted from FIRs of police in Delhi.

Setting

This study will be conducted in Delhi, the capital of India and will include all cases of accidents at construction sites reported to the Delhi Police during the three-year period from 1st January 2016 to 31st December 2018. The definition of Building and Other Construction Worker, given in the Building and Other Construction workers (Regulation of Employment and Conditions of Service Act 1998), will guide inclusion of injured persons in the study.[20]

Data Sources

In India, information pertaining to an accident, whether received orally or in writing, is to be entered in a book by the officer in-charge of a police station, in a prescribed format, commonly known as the ‘First Information Report’ (FIR).[21]In a previous study

we have shown that information on injuries can be reliably extracted from FIRs using a data extraction tool.[22]

Data Extraction

Data will be extracted from FIRs of all cases of accidents at building and other construction sites reported to Delhi Police during the study period, using the data extraction tool designed to extract data from FIRs. The data extraction tool has been tested for inter-rater reliability by us in a previous study where strength of inter-rater reliability was found to be “Almost Perfect”.[22]

Sample size

All injuries sustained in construction site accidents reportedto the Delhi Police during the study period will be included in the study. In 2017, FIRs included 374 construction site injuries.[23]Assuming that we wish to detect a difference in rates between groups by trade, say ‘Electricians’ versus ‘Unskilled workers’, and we hypothesise that these rates are 100 per 100,000 versus 300 per 100,000 (0.001 versus 0.003) respectively, there would need to be 7,832 workers in each group in the city. According to table 4 in appendices, in 2017 there were 411,517 unskilled and 3553 electricians, which gives us 65% power to detect this difference at the 5% level of significance.

Denominators

Authoritative data on the size of the construction workforce and its distribution by trade, are not available in India.[24]Therefore, we will estimate the number of construction workers in Delhi based on the total population of Delhi, the labour force participation rate, and the proportion of construction workers in the labour force.

Missing data

FIRs may not always contain complete information on all data items required for injury surveillance.[22] Missing data may reduce statistical power, introduce bias and undermine the validity of research results.[25] The number of missing values in each variable will be summarised and the most common patterns (which variables are missing/observed) of missing data described. Logistic regression analyses will be used to model how missingness in those variables most affected by missing data is

related to other variables, in order to try and assess whether the 'missing at random' assumption is plausible.

Imputation method

We propose to use Multiple Imputation (MI), one of the most popular approaches to handling missing data.[26,27]MI may help in reducing bias, increasing precision and allows individuals with incomplete data to be included in analyses.[28,29]Multiple plausible imputations will be created for each missing value leading to several completed or imputed datasets. Thereafter, each imputed dataset will be analysed separately and identically to obtain estimates of various parameters and corresponding standard errors. Finally, the results will be combined using rules derived by Rubin (1987).[29]

Data Analysis

i. Descriptive analysis

A descriptive analysis will initially be conducted to summarise the frequencies and percentage distribution of fatal and non-fatal injuries by characteristics of construction site workers injured (gender, age group, trade and place of residence) (Appendices, table-1). Injury rates will be estimatedper 100,000 population with 95% confidence intervals. Data will be analysed using STATA/IC 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC).

Injury rates for fatal and non-fatal construction injuries per 100,000 construction workers per year will be calculated using the formula:

$$Injury\ Rate = \frac{Numberof ConstructionInjuries\ reported\ in\ a\ year}{EstimatedtotalnumberofConstructionWorkers} \text{ x } 100{,}000$$

ii. Characteristics of construction site worker

Age group

For analysis of injury rates by age group, we will use the categories suggested by WHO Injury Surveillance Guidelines- <5 years; 5-14 years; 15-19 years; 20-21 years; 22-44 years; 45-64 years; and >64 years.[30]

Residence

Injuries will be analysed as per place of permanent residence- native of Delhi;migrant from other State of India;migrant from other country studied (Appendix, table-1)..

Gender

Gender wise trend of injuries for the three-year period will be studied (Appendix, table-1). Gender differences in number of injuries sustained for type of construction work, cause of accident, mechanism of injury, and body part injuredwill be investigated.

Trade

Trade wise total estimated number of construction workers in Delhi will be estimated usingthe proportionate distribution of manpower among various trades in the construction industry in India.[31]The frequencies and percentage distribution of fatal and non-fatal injuries, trade wise, will be presented (Appendices, table-1). Associations between trade and body part injured, mechanism of injury, and nature of injury will be presented.

iii. Injury rate ratios

Injury rate ratios will be reported comparing each category of the construction site worker characteristics with a referent category: 'native of Delhi' for residence, 'male' for gender, 'unskilled workers' for trade, and the median age group for age group.

iv. Years of potential life lost (YPLLs)

Years of potential life lost (YPLLs) will also be calculated to measure the impact of premature mortality. For calculation of YPLLs, Life Expectancy at Birth in India will be taken as 70.2 years for females, 67.4 years for males and 68.7 years for total population.[48]

v. Injury Trends

Analyses will be conducted to investigate trends in construction injuries in Delhi:

a. **Yearly**: trends in numbers of incidents, numbers of fatal and non-fatal injuries, and in the injury rates over the study period will be investigated(Appendices, Table-2).

b. **Seasonal**: seasonal variations in construction injuries will be analysed for Summer (March to June), Rains (July to October), and Winter (November to February)(Appendices, Table-2).
c. **Monthly trends**: monthly variations in injuries will be investigated by studying trends by month over the three-year period(Appendices, Table-2).
d. **Day of the Week:** results will be presented according today of the week of injuries to investigate any association of injuries with day of week(Appendices, Table 2).
e. **Time of the day:** The day will be categorized into different time periods as prescribed by WHO Injury Surveillance Guidelines: 00.00 to 3.59, 04.00 to 07.59, 08.00 to 11.59, 12.00 to 15.59, 16.00 to 19.59, 20.00 to 23.59.[46] Number of injuries sustained in each time period will be presented to discern any trends (Appendices, Table-2).

vi. **Geographical Distribution of injuries**

The distribution of injuries among the districts of Delhi will be analysed to identify any geographical areas of concentration for injuries.

vii. Magnitude of incidents

Magnitude of injuries in terms of number of persons injured and number of persons killed per accident will be summarized by the range, median, mode and mean with standard deviation.

viii. Construction site characteristics as injury risk factors

a. **Ownership of construction site**-In our data extraction tool,[22] three options have been provided to collect information on the ownership of the construction site: (i) Government (ii) Private company, and (iii) private individual. An analysis of the numbers of incidents, number of injuries and deaths for each type of site will be conducted. Any associations between ownership of site with magnitude of incident, and risk of injuries will be investigated.
b. **Mode of execution of work**: construction work may be executed by the owner herself/himself or it may be outsourced. Trends associated with mode of execution of work in terms of number of incidents, number of persons injured for each mode of execution, number of people injured per incident,

proportion of injuries sustained in each mode of execution and any association of mode of execution with magnitude of incident and risk of injuries will be investigated.

ix. **Construction work characteristics as injury risk factors:**

a. **Nature of construction work**: Nature of construction work varies. It could be new construction, maintenance, or dismantling of existing construction. The numbers of people injured or killed will be summarised by the range, median, mode and mean for each of these categories with standard deviation for each category. Relationship between nature of construction work and cause of accident or mechanism of injury will be investigated.

b. **Type of construction work**: Construction work can be divided into several types based on the elaborate list of works given in the Building and Other Construction Workers' (Regulation of Employment & Conditions of Service) Act, 1996.[32] The numbers of people injured or killed in each type of work will be presented.

c. **Type of building:** Type of building being constructed when the accident happened is another important parameter. It would be interesting to know the distribution of injuries as per type of building being constructed. The numbers of people injured or killed in accidents reported in each type of building will be summarised by the range, median, mode and mean with standard deviation.

x. **Cause of incident -** reasons behind the incidents which led to injuries will be analysed. How did the incident happen? What went wrong? What were the circumstances? A comprehensive list of possible causes has been prepared. Magnitude of accident in terms of average number of people injured and average number of people killed in an accident will be estimated for various reported causes.

xi. **Object/Substance/Product involved** - an analysis of the objects that inflicted the injuries will be made.[32] Number of injuries and deaths caused by each type of object will be analysed.

xii. **Mechanism of Injury** -Mechanism of injury means the way in which the injury was sustained i.e. how the person was hurt.[33] Total fatal and non-fatal injuries and percentage of injuries attributed to each mechanism will be calculated. Gender differences in mechanism of injury and Association between

mechanism of injury and trade and nature of construction work will be presented.

xiii. **2.19 Falls:**As fall is one of the leading causes of injury in construction, more information on falls will be collected. This will include the object from which fall occurred and the height from which the victim fell.

xiv. **2.20 Activity when injured**– We will capture the type of activity the injured person was engaged in when the injury occurred.[33] Total fatal and non-fatal injuries and percentage of injuries attributed to each activity will be calculated. Activity wise average number of people injured and average number of people killed will be estimated.

xv. **2.21 Body part injured**– analysis of body part injured would provide valuable information to policy makers and other stakeholders for injury prevention measures. Frequency and percentage of injury sustained by each body part and association of body part injured with trade of construction worker will be investigated.

xvi. Statement on ethics approval and consent

This study has been approved by LSHTM Observational Research Ethics Committee by reference number 15992 dated 26th November 2018. As the study is based on retrospective data collection over a three-year period, obtaining consent from the included individuals retrospectively is not possible.

xvii. Anonymisation

details will not be shared with anyone. There will be no mention of names of construction workers injured or addresses of the construction sites or details of the owners of construction sites while reporting results of the study to ensure complete anonymisation of any victims and of the site of incidents.

Discussion

Expectedoutcomes of the study

Epidemiological evidence serves as a foundation for planning of safety interventions. However, enough evidence on construction injuries in India is missing. This study may help to reveal details of construction injuries, their sociodemographic characteristics, and risk factors. The study will inform policy makers on the

magnitude and distribution of construction injuries. This study will advance our knowledge of injury profiles in construction workers in Delhi, India and will quantify the burden of work-related injury in construction workers in Delhi. The study will assist in identifying risk factors and inform policy makers on injury prevention strategies.

Strengths and Weaknesses:

This study has strengths and limitations that will be considered when interpreting the results.

Strengths

A strong point of the design of this study is its magnitude. The study spans all of Delhi and includes all construction workers over a period of 3 years. The number of variables included in the study is also exhaustive.

Weaknesses:

A limitation of the study is that it is based only on injuries reported in the FIRs registered by Delhi police. Our study on ascertainment of injuries captured by FIRs has informed that FIRs capture just over one third of the total construction injuries in Delhi.[23] Moreover, FIRs may not always contain complete information on all data items.[22] In another study we have calculated missingness of data on various data items in the FIRs.[22] The study will also be limited by its cross-sectional nature and by the fact that it is confined only to Delhi. Additional problem areas, which may impair the reliability of findings are misclassification of cases and mistakes in data analysis.

Data management and monitoring

Data will be encoded and stored in a password protected database in the personal laptop of the lead author. Its access will be restricted to the researchers only. A backup of the data will be kept in a password protected hard drive which will also remain in personal custody of lead author.

Dissemination of results and publication policy

The results of the study are planned to be published in an international, peer-reviewed journal. All four authors of this protocol will contribute to writing a report based on the findings of the study. Results of the study will also be shared with

policy makers. The findings of this study will be presented at national and international injury and trauma conferences, seminars and workshops.

Duration of the project

Permission to conduct the study has been obtained from Delhi Police. A tool has also been designed for extraction of data from the FIRs. Data extraction, analysis of data and synthesis of results will be completed in 3 months.

Problems anticipated

No major problems are anticipated in successfully completing the study within the stipulated time frame.

Authors' contributions

The initial draft of the manuscript was written by SSY under the supervision of PE. JB wrote the section on “Missing data” and also provided his comments and suggestions on the draft. The final draft was reviewed by JP. All authors read and approved the final manuscript.

Declarations

Availability of data and materials:

The anonymised dataset will be available from the lead author on request.

Conflict of interests: none declared

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APPENDIX

Table-1: Characteristics of construction site workers injured							
	Number (and %) of persons injured			Estimated population	Injury Rate per 100,000 population with 95% CI		
	Non-Fatal	Fatal	Total		Non-Fatal	Fatal	Rate Ratio
Gender							
Male	---- (--%)	---- (--%)	---- (--%)				1.0
Female	---- (--%)	---- (--%)	---- (--%)				
Total	---- (100%)	---- (100%)	---- (100%)				
Age group							
<5 years	---- (--%)	---- (--%)	---- (--%)				
5-14 years	---- (--%)	---- (--%)	---- (--%)				
15-19 years	---- (--%)	---- (--%)	---- (--%)				
20-21 years	---- (--%)	---- (--%)	---- (--%)				
22-44 years	---- (--%)	---- (--%)	---- (--%)				1.0
45-64 years	---- (--%)	---- (--%)	---- (--%)				
>64 years	---- (--%)	---- (--%)	---- (--%)				
Total	---- (100%)	---- (100%)	---- (100%)				
Trade							
Unskilled workers	---- (--%)	---- (--%)	---- (--%)	54.43%			1.0
Mason	---- (--%)	---- (--%)	---- (--%)	30.42%			
Carpenters	---- (--%)	---- (--%)	---- (--%)	7.94%			
Plumbers	---- (--%)	---- (--%)	---- (--%)	0.32%			
Electricians	---- (--%)	---- (--%)	---- (--%)	0.47%			
Others	---- (--%)	---- (--%)	---- (--%)	6.42%			
Total	---- (100%)	---- (100%)	---- (100%)				
Residence							
native of Delhi	---- (--%)	---- (--%)	---- (--%)				1.0
migrant from other State of India	---- (--%)	---- (--%)	---- (--%)				

migrant from other country	---- (--%)	---- (--%)	---- (--%)				
Total	---- (100%)	---- (100%)	---- (100%)				

Table-2: Injury Trends							
	Number of persons Injured			Estimated population	Injury Rate per 100,000 population with 95% CI		
	Non-Fatal	Fatal	Total		Non-Fatal	Fatal	Rate Ratio
Year							
2016							1.0
2017							
2018							
Total							
Season							
Summer							1.0
Rains							
Winter							
Month							
January							1.0
February							
March							
April							
May							
June							
July							
August							
September							
October							
November							
December							
Day of Week							
Monday							1.0
Tuesday							
Wednesday							
Thursday							
Friday							
Saturday							
Sunday							
Time of Day							
00.00 to 3.59							
04.00 to 07.59							1.0
08.00 to 11.59							
12.00 to 15.59							

16.00 to 19.59							
20.00 to 23.59							

Table-3: Construction site characteristics and injuries									
Parameter	**Number of incidents**	**Number of persons Injured**			**Percentage of Injuries**			**Number of injuries per incident**	**Number of deaths per incident**
		Non-Fatal	Fatal	Total	NonFatal	Fatal	Total		
Ownership of construction site									
Government									
Private Company									
Private individual									
Others									
Mode of Execution of Work									
Self construction									
Construction through a construction company									
Construction through an individual contractor									
Other									