Public Health Surveillance of Construction Site Injuries in Delhi, India Using the First Information Reports (FIRs) Registered by Delhi Police

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Research affiliation: None

Declaration of own work

I, Dr Sajjan Singh Yadav, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

[redacted]

Signed: ___________________________

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Abstract

Background

An injury surveillance system can inform strategies to reduce the incidence of injuries.

Aim

To explore whether the First Information Reports (FIRs) of Indian police can form the basis of an unintentional injuries surveillance system.

Methods

Initially, a systematic review of literature on "The use of police records for injury surveillance" was undertaken. Three different but related studies were then conducted. The Minimum Data Set (MDS) recommended for injury surveillance was identified in the first study; a tool for the extraction of data from FIRs was also developed, and its inter-rater reliability was assessed using Cohen's Kappa; the percentage availability of each MDS data item in the FIRs was calculated. The total numbers of fatal and non-fatal construction site injuries in the Delhi population in 2017 were estimated by applying the two-sample capture-recapture method in the second study. The third study describes the epidemiology of construction site injuries in Delhi between 2016 and 2018.

Results:

The systematic review of literature showed that police records are a potentially useful source of information on unintentional injuries. The first study identified 12 MDS data items for injury surveillance; FIRs were found to contain complete information on 5 MDS data items but for 7 MDS data items, information was less complete. The second

study estimated that FIRs ascertained 37%, 42.6% and 30.2% of the estimated total, fatal and non-fatal construction site injuries respectively. The third study found that 1,227 construction workers sustained injuries in 939 construction site incidents. Male workers (87%) and workers in the age group of 22 to 44 years (58.77%) accounted for most of those injured. The risk of a fatal injury was higher in migrant workers. The non-fatal injury rate per 100,000 workers per year was almost 3 times higher in female workers (98.55; 95% CI 82.52 to 116.8) than in male workers (34.36; 95%CI 31.92 to 36.94). Workers were at higher risk of injury in the rainy season and during 12:00 to 16:00 hours. Electricians and plumbers were the trade groups at higher risk of injury. Construction sites of government companies, and construction through a construction company, and works related to water supply, road construction, and power generation/distribution works were associated with higher odds of fatal injuries. The head (including face and eyes) was most prone to injury.

Conclusion:

Information on injuries can be reliably extracted from FIRs, however FIRs occasionally have incomplete information on some of the MDS data items. Furthermore, any epidemiological estimates made using these data must be adjusted to allow for the approximately two-thirds of injuries not reported to the police. Enforcement of existing legal provisions and the training of police personnel could help to reduce the 'missingness' of MDS data items and help to improve the ascertainment of injuries by FIRs. Imputation of missing data may help to improve the system further.

Dedicated to my wife Sunita Yadav

Acknowledgements

I am immensely grateful to my supervisor Prof John Porter for providing me with rock solid support over the last four years. His wisdom, kindness, inspiration and guidance slowly but successfully transformed a hardcore bureaucrat into a budding researcher. Undoubtedly, I could not have asked for a better supervisor.

My infinite gratitude also goes to Dr. Phil Edwards, my co-supervisor for his untiring work and immense patience in helping me at every stage with the design and conduct of this research. I am eternally grateful to him for equipping me with skill sets used in the quantitative research. I am also grateful to Dr Samantha Watson, my earlier co-supervisor who constantly guided and supported me in writing my Organizational and Policy Analysis (OPA) Report.

I profusely thank the Department of Personnel and Training, Ministry of Personnel, Public Grievances and Pensions, Government of India for granting permission to pursue a DrPH from LSHTM and for partially funding my tuition fee.

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I am grateful to Prof Ronan Lyons from Swansea University and Prof Denise Kendrick from the University of Nottingham for their valuable comments on my research protocol. I also profusely thank Dr Jonathan Bartlett, Reader, Department of Mathematical Sciences, University of Bath, for providing me guidance on dealing with the missing data.

My special thanks go to Dr. Ankush Sanghai, State Veterinary Consultant, Integrated Disease Surveillance Program, Dadra and Nagar Haveli, India, for helping me in data extraction work for inter-rater reliability study. I would also like to thank Dr. V.K. Das, Dr. Ranjit Ambad, Dr. Vishnu Udan, Dr. Chintan Parmar and Dr. Vaibhav from the Department of Health, Dadra and Nagar Haveli for testing the data extraction tool and providing valuable feedback.

I profoundly thank my wife Sunita, daughter Siya and son Karan to whom this thesis is dedicated for bearing with all the odd hours and efforts that went into the thesis without complaining. They have been my pillars of strength.

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Abbreviations

CCTNS	Crime and Criminal Tracking Network & Systems
CI	Confidence Interval
DBOCWWB	Delhi Building and Other Construction Workers' Welfare Board
Delhi RECS Rules	Delhi Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2002
DALY	Disability Adjusted Life Years
DARE	Database of Abstracts of Reviews of Effectiveness
DrPH	Doctor of Public Health
ESIC	Employee State Insurance Corporation
EMBASE	Excerpta Medica dataBASE
FIR	First Information Report
GDP	Gross Domestic Products
GIS	Geographical Information System
HICs	High Income Countries
HMICs	Higher Middle Income Countries
ILO	International Labour Organization
LSHTM	London School of Hygiene and Tropical Medicine
LICs	Low Income Countries
LMICs	Low-Middle-Income-Countries
MBA	Master of Business Administration
MDS	Minimum Data Sets
MEDLINE	Medical Literature Analysis and Retrieval System Online,
MI	Multiple Imputation
NICMAR	National Institute of Construction Management and Research

NISTRCBC	National Injury Surveillance Trauma Registry and Capacity Building Centre
NPM	New Public Management
OPA	Organizational and Policy Analysis
OR	Odds Ratio
PhD	Doctor of Philosophy
PPE	Personal Protective Equipment
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RECS Act	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act-1996
SMS	Short Message Service
UMIC	Upper-Middle-Income-Countries
USA	United States of America
WHO	World Health Organization

Integrating Statement

Context

I decided to pursue a Doctorate after a successful career of 22 years in the Government of India. During this period, I handled diverse assignments, such as Director, National Rural Health Mission of India, Commissioner of a Municipal Corporation, Chief Executive of Delhi Water Board and Commissioner of Food and Supplies Department. After considering multiple options for my future, I chose to gain expertise in public health and become a leader and an influencer/expert in this domain. After minutely studying all available options, I decided on a DrPH program from the London School of Hygiene and Tropical Medicine (LSHTM) to acquire the necessary skill sets and expertise in conducting research and formulating and evaluating health policies. The DrPH scored over a traditional PhD, due to its practical orientation. It is a more suitable degree for a career bureaucrat like me who will occupy top leadership positions in public health for at least a decade. I believe that the degree would act as a bridge for my smooth transition from the civil service to teaching and research when I decide to 'hang up the boots of a bureaucrat'.

So, with tremendous excitement about going back to school, I landed up in London in the last week of September 2016.

Compulsory Modules

The beauty of the DrPH is its compulsory modules, which provide students with an opportunity to learn from expert faculty drawn from diverse fields. Moreover, there is substantial learning from fellow students. I was thrilled to have eight other future leaders in Public Health from seven different countries in my cohort. Their diverse background and rich experience offered me insights into various topics discussed both in class and beyond. The modules also provide the springboard to launch into the subsequent phases of the DrPH, the Organizational and Policy Analysis (OPA) and the Thesis.

The “Understanding Leadership, Management & Organizations” module refreshed my knowledge of management and organizational theories, which I had learnt as part of my Master of Business Administration (MBA) degree. It was a delight to understand how I could have applied them in managing organizations in the past and gave me a plethora of ideas to leverage them in my future leadership assignments. The module’s assignment on strategic analysis of an organization helped deepen my understanding of the workings of organizations and how to apply organizational theories. As I had decided to devote my DrPH work to the issues faced by construction workers, I chose to do a strategic analysis of the Delhi Building and Other Construction Workers’ Welfare Board (DBOCWWB).

The other compulsory module “Evidence Based Public Health Policy & Practice” aroused further interest. It made me understand the evidence hierarchy, how to assess the methodological quality of studies and to how to critically evaluate evidence. It helped the practitioner and policy maker in me realize how important it was to incorporate evidence in policy making. It also made me realize the importance of building an effective relationship between research, policy, and practice for an effective policy making cycle. I also learnt about barriers in getting research into policy. It was interesting to learn about the struggle of actors involved in agenda setting. The concepts learnt were reinforced in the first assignment of this module which involved preparing an influencing strategy to put a research-driven issue onto the policy agenda. Here again, I continued my focus on the issues concerning construction workers and wrote a paper on *"Need for a new health policy for construction workers and a strategy to put it onto the policy agenda of the Delhi government".*

The high point of the module was its systematic review. I was happy to get the skillset for designing, analysis and interpretation of systematic reviews. A systematic review of "*the effectiveness of the use of early warning systems by health care professionals for infectious disease prevention and control in primary and secondary care*", was done as the assignment for the module, and provided me with a good opportunity to conduct a systematic review. The feedback I received from the examiners was valuable and helped me to acknowledge my weaknesses and mistakes and to further sharpen my review skills to conduct future systematic reviews.

Organization and Policy Analysis (OPA)

The next milestone was the OPA. I had full freedom from my supervisors to choose the organization to work with and to choose the topic for my OPA report. Carrying my commitment to the construction workers forward, I opted to work with the Delhi Building and Other Construction Workers Welfare Board (DBOCWWB). I decided to focus my research on its organisational problems. I was very closely supervised by my co-supervisor Dr Samantha Watson in my OPA with periodic and valuable guidance from my main supervisor Prof. John Porter. I produced my OPA report entitled *"Can the Foundation of New Public Management Build an Effective and Efficient Public Organization? A Brick by Brick Analysis of the Delhi Building and Other Construction Workers' Welfare Board".* The objective of my OPA study was to review the performance of the board, identify key barriers to its performance using an NPM (New Public Management) framework developed by me, and to make recommendations for improvement. The OPA findings were shared with the Delhi Government and other stakeholders for future policy corrections.

Thesis

The next and the most important phase was my DrPH thesis. A huge effort went into finalizing the topic of research. I was fortunate to get the constant support and motivation from my supervisor Prof John Porter in this endeavour. I explored several possible areas of research concerning construction workers before finalizing the one and prepared my DrPH Review document. However, I selected a very broad topic - "*Reported Causes of Construction Site Accidents and Workers' Perception of Risk at Construction Sites in Delhi*." The research questions were:

i. What are the reported reasons for construction site accidents in Delhi?

ii. What demographic patterns of the victims emerge from the reported cases?

iii. What are the perceptions of risk of construction workers in their daily work?

iv. What gaps do these perceptions indicate in the safety policy for construction sites?

The DrPH review committee members went carefully through my review document and presentation and advised me to either select the first two or the second two objectives as the stated focus on the four objectives would be an arduous task to achieve. After a lot of reflection, I decided to focus on the first two objectives. I am so grateful that I got a new supervisor Dr Phil Edwards, who has a rich experience in injury epidemiology and statistical methods, to guide me in this research. With him and Prof John Porter, I decided the title for my thesis- "*Public Health Surveillance of Construction Site Injuries in Delhi, India Using the First Information Reports (FIRs)*

Registered by Delhi Police". The aim of my research was to explore whether a public health surveillance system can be developed for construction site injuries based on the FIRs registered by Delhi Police. The following research questions were framed and answered to help achieve this aim:

a. Do the First Information Reports (FIRs) registered by Delhi Police contain sufficient information to describe the epidemiology of construction site injuries in Delhi?
b. Are FIRs a complete record of all construction site injuries?
c. Can we use FIRs for construction site injury surveillance?
d. If so, what do FIRs tell us about the epidemiology of construction site injuries in Delhi?

Conducting research for the next two years was an enriching learning experience. I learnt about quantitative research methods, framing research questions, conducting literature review, and research writing. A journals' club that was started by my supervisor Dr Phil Edwards to search and discuss published papers in my sphere of work was a valuable experience. I had a strong desire to publish in peer reviewed journals. My supervisors, with great patience, built my knowledge, writing abilities and skill sets to achieve this feat. My thesis comprises three papers, two of which have been accepted for publication in peer reviewed journals, one in the Indian Journal of Medical Research, and another in the Indian Journal of Occupational and Environmental Medicine. I also published a paper on injuries sustained by industrial workers in the Indian Journal of Occupational and Environmental Medicine during this period, under the guidance of Dr Phil Edwards.

I also benefited from comments on my research protocol from Prof Ronan Lyons from Swansea University and Prof Denise Kendrick from the University of Nottingham.

During the research, I found that FIRs do not always contain complete data on all the variables required for an injury surveillance system. Therefore, I approached Dr Jonathan Bartlett, Reader, Department of Mathematical Sciences, University of Bath, for guidance on dealing with the missing data. He was kind enough to agree to provide the necessary guidance. I am confident that my piece of research for DrPH thesis will be able to provide missing links in the construction site injury literature. I also hope that it will inform policy makers of the need for more focussed attention on construction site injuries.

Concluding thoughts

To conclude, my entire DrPH experience has been very fruitful and enriching. I believe that there has been a perceptible value addition to my skill sets and knowledge and it is influencing my approach to public health practice in my daily work. I feel more confident and enthusiastic about playing a leadership role in public health in India and abroad in the times to come. I also feel equipped to take a plunge into teaching and research.

Preface

While reading the morning dailies, stories of workers' deaths and injuries at construction sites often shook me. While all sorts of gruesome crime and accidents– including those in factories and on the roads are a regular feature in many local newspapers, what affected me the most were the news reports of fatal incidents


Four died after under-construction building collapsed in Delhi

BY NEHA PUBLISHED: JANUARY 25, 2020, 10:36 PM IST

New Delhi: As many as four people died after an under-construction building collapsed in Bhajanpura area here on Saturday, police said.

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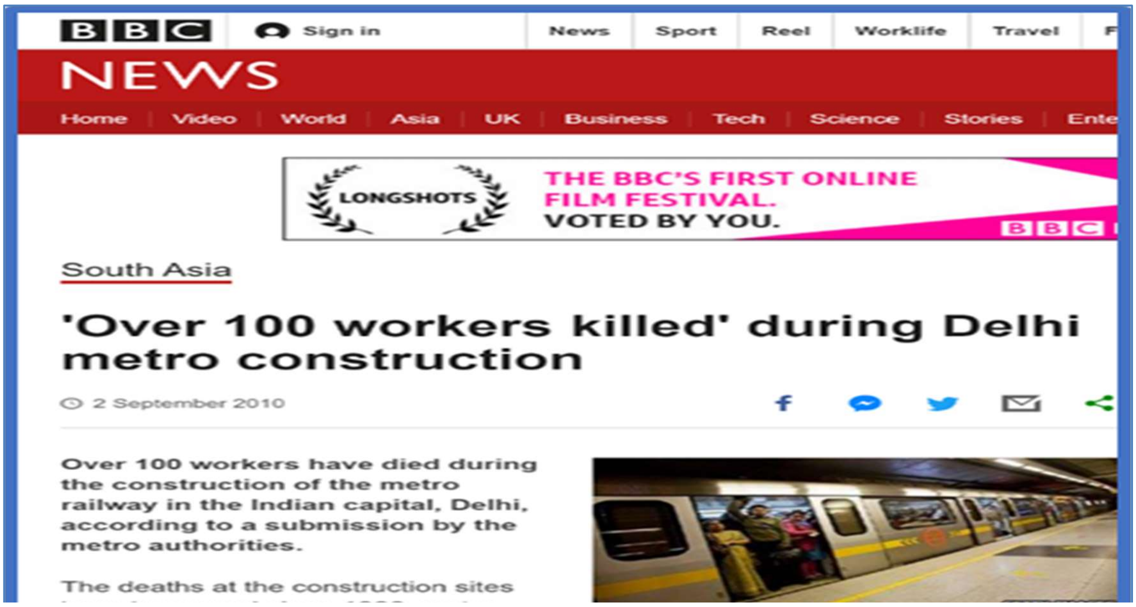
Box-1: Collapse of under construction building in Delhi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South Asia

'Over 100 workers killed' during Delhi metro construction

2 September 2010

Over 100 workers have died during the construction of the metro railway in the Indian capital, Delhi, according to a submission by the metro authorities.

The deaths at the construction sites

Box-2: Construction site incidents in Delhi Metro Rail Corporation involving construction workers which seemed to be becoming more and more common (Box-1 &2).

This reaction may have been because of my past conditioning and my years growing up in a remote village, Nadngaon, located in the Bhiwani district of the Haryana State of India; this may be the reason that I feel an emotional connection with the construction workers, who are predominantly migrants from the most interior parts of the country.

This connection increased through multiple opportunities to interact closely with construction workers and their family members when my official bungalow in Delhi was being repaired. Further, I had an opportunity to delve deeper into the issues of construction workers in Delhi during my Organisational and Policy Analysis (OPA) project for this DrPH research. I also studied the details of a welfare and regulatory framework created for construction workers by a special federal legislation "The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act-1996 (RECS Act)[1]. The Rules were framed under the RECS Act by the Delhi Government entitled "The Delhi Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2002 (Delhi RECS Rules).[2]

The focus of my OPA was on the welfare aspects of this legal framework, which created an organisation named "The Delhi Building and Other Construction Workers' Welfare Board (DBOCWWB)" that is trying to create a social safety net for construction workers, which is entwined with numerous welfare schemes.[3]

The regulatory provisions of the RECS Act and the Delhi RECS Rules provide a strong legal framework for the health and safety of construction workers in order to improve their living and working conditions at construction sites.[1,2] The Labour Department of the Delhi Government has been entrusted with the responsibility for ensuring compliance with the provisions of the RECS Act and Delhi RECS Rules. However, during my interactions with the officers of the Labour Department in the course of my OPA project, I found them apparently ignorant of these legal provisions. I also noticed that the provisions regarding compulsory notification of accidents to the Labour Department was not being enforced. Moreover, even in cases of compensation claims received for deaths and disabilities, the officers were not investigating the causes of such incidents and injuries.

The literature informed me that beyond the magnificent buildings and modern infrastructure, the construction industry has a darker side, plagued with accidents leading to injuries, deaths and disabilities. Globally, India ranks high in construction site accidents. An International Labour Organization (ILO) study claims that the construction site accident rate in India is the highest in the world and 165 out of every 1,000 construction workers are injured on the job.[4] Discussions with the officers of the Labour Department during my OPA further revealed that around 50 to 60 compensation cases, arising from deaths at construction sites, are filed before them annually, under the Workmen Compensation Act, 1923.[5] Sadly, this information is neither compiled, nor analysed. Moreover, there may be more “silent deaths” and sufferings due to construction related health hazards and injuries that do not make it to the authorities, perhaps due to a lack of attribution or possibly active suppression.

I dug deeper into the literature on construction site accidents and risks in India, especially in its national capital, Delhi, which is estimated to have more than 620,000 construction workers.[6] But, except for a few single site or small sample studies, the literature was found to be lacking in both quantitative and qualitative studies in this area. Comprehensive data on construction site injuries are also lacking nationally, as India does not report and publish statistics on occupational injuries and illnesses.[7]

Studies on the causes of construction site injuries in Delhi, patterns in the incidents, and demographic profiles of the victims are lacking too. In my occasional observations at construction sites in the past, I have observed an apparent disregard to risk of injuries by workers, managers and contractors. These gaps in the literature brought my attention to the need for research into the area of accidents, injuries and deaths in the construction industry in Delhi. Therefore, I proposed to fill this gap in the literature through my DrPH research.

Presently, injury prevention in India is no one's baby and responsibility for it is scattered among Labour, Industries, and Police Departments. Even though it is an important public health issue, the Ministry of Health and Family Welfare, surprisingly, has no section to deal with injuries and no program on injury prevention. Effective interventions are also lacking in the states. I hope that the efforts put into this research will go far beyond rewarding me with a Doctorate in Public Health. I hope my findings will be valuable to federal and state governments, international organisations, construction companies, other employers of construction workers, construction workers themselves, professionals in occupational safety, researchers and numerous other stakeholders.

I have made a sincere effort to reveal the true picture of construction injuries, the size and intensity of this public health problem to top policy actors for policy interventions. I sincerely hope that the media will come forward to disseminate the findings of this research to a wider audience. I hope this might catalyse country-wide recognition of injury problems in the construction sector and help to initiate strategies for further improving construction injury surveillance, and to implement and evaluate preventive measures and undertake appropriate policy corrections.

Dr Sajjan Singh Yadav,
Delhi, September 19th, 2020

1. Introduction

1.1 Setting the context

1.1.1 Injuries- a formidable public health challenge

Injuries account for 12% of the global disease burden and exert a significant pressure on health systems worldwide.[8] They claim more than 5 million lives annually, contribute 9% to global mortality and leave many millions more with disabilities.[9,10] 71% of the worldwide injury burden was attributed to unintentional injuries.[9] Region wise injury rates and years of life lost due to injuries are presented in table-1.1 below[9]:

Table 1.1: Injury rates and years of life lost by region

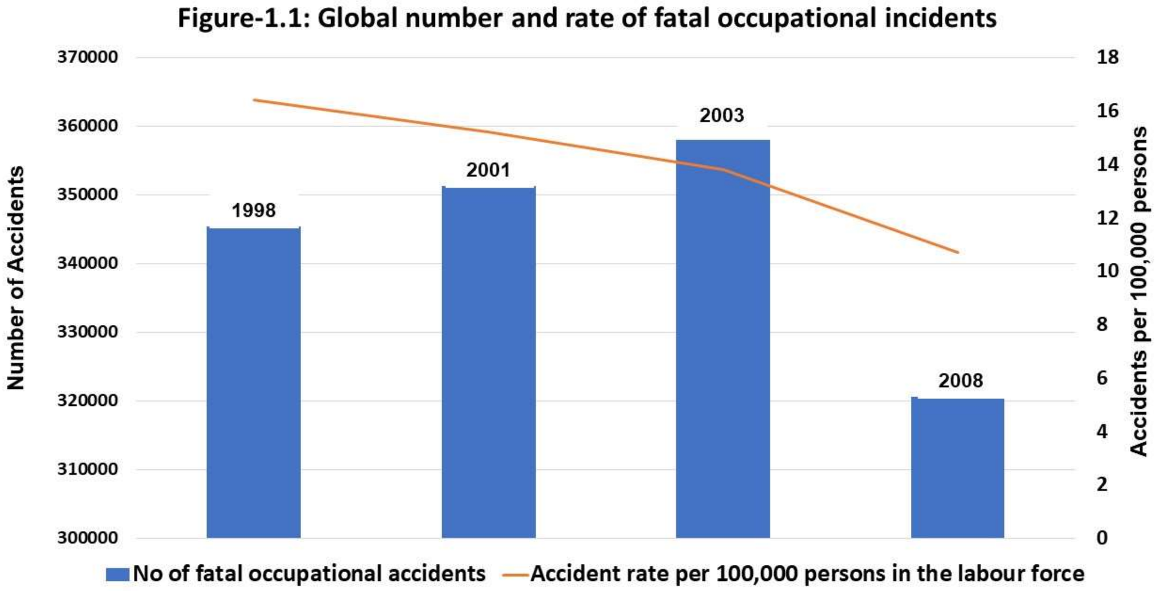
Region	Injury rate (per 100,000 population)	Years of life lost (per 100,000 population)
African Region	116	6 480
Region of the Americas	62	3198
South-East Asia Region (includes India)	99	4 165
European Region	49	2421
Eastern Mediterranean Region	91	4 796
Western Pacific Region	50	2268
Global	73	3654

90% of global injury related deaths were reported from Lower-Middle-Income-Countries (LMIC).[10,11,12] These countries have also reported the highest injury fatality rates.[13,14] Moreover, 82% of mortality and 92% of disability adjusted life years (DALY) lost due to falls occurred in LMICs.[15,16]

Injury is an important contributor to the disease burden in India and is a leading cause of death for all ages.[17,18,19] An estimated one million people died due to injuries in India in 2012 which accounted for 11% of the total mortality.[9] India reported an age-standardized mortality rate of 116 per 100,000 population due to injuries which was much higher than the global average.[9] Similarly, the 4,785 years of life lost per 100,000 population in India was 23.6% higher than the global average.[9] Unintentional injuries account for 75% of injury deaths in the country.[9] Thus, unintentional injuries present a formidable public health challenge.[10]

1.1.2 Occupational injuries

Work-related injuries make a significant contribution to global morbidity and mortality from unintentional injuries.[20,21] They killed 380,500 people in 2014 globally, an increase of 8% compared to 2010.[16,] Occupational injuries accounted for 12% of the total deaths in LMICs and 6% of the total deaths in the high income countries.[16,22] Worldwide, the contribution of unintentional occupational injuries was 13.7% to the total work related mortality.[16] Moreover, 374 million non-fatal occupational injuries resulting in a minimum of four days' absence from work were also reported across the world.[16] Many of the victims incurred temporary or permanent disabilities.[23] The good news is that health and safety in the workplace and injury prevention measures are receiving greater attention across the globe now.[23,24] This has been reflected globally in a decline in both the number and the rate of fatal accidents in 2008 when compared to 2003, (Figure-1.1).[16]



Occupational injuries may have disastrous consequences for both victims and their families, including loss of the sole breadwinner of a family, disability, loss of job, early retirement, and poverty.[25,26] Occupational injuries are also responsible for a high proportion of work related disability.[27,28] Occupational injuries and illnesses led to an annual loss equivalent to 3.94% of the world's Gross Domestic Product (GDP) in the year 2014.[23] This included cost of compensation, medical treatment, cost of replacement training and damage to property.[16,29] While occupational injuries impact on the livelihood of individuals and their families, they also cause loss of productivity, damage to the reputation and competitiveness of a construction enterprise.[30]

1.1.3 Data on occupational injuries

Estimation of the injury burden requires accurate and comprehensive data, comparable across nations and over time;[31] consequently, the true magnitude of occupational injuries is not well known due to the lack of comprehensive statistics.[23] It has been reported that statistics on work related injuries are unavailable in a third of countries.[32] Statistics on occupational injuries are less available in developing countries and those data that are available are often less reliable.[6,24,33] The reasons for this include: a higher percentage of the workforce in the informal sector; small and micro enterprises;[34] deficient reporting systems; non-existent or dysfunctional injury registries; a higher proportion of hazardous industries; poorer working conditions; employment of child labour; incomplete coverage of civil registration and vital statistics reporting systems; and facility based health information systems.[16,23,25] Moreover, the reports are limited by the unavailability of data by type of injury, type of workers and type of activities.[23] Even in developed countries with well-established reporting systems, data availability on occupational injuries has been estimated to be 50%.[32] Hence, official figures do not necessarily provide an accurate estimate of the scale of the public health challenge presented by occupational injuries.[32]

The lack of injury data is also one of the reasons for a lack of focus on injury prevention in LMICs.[7] It also leads to the under-allocation of resources for injury prevention measures starting a vicious cycle of less attention to workers' safety and welfare, and a decline in the productivity and availability of the workforce.[16] The non-availability of information makes the size of the problem less visible and is also one of the reasons why sufficient research on construction safety is not conducted.[35]

1.1.4 Occupational injury burden in the construction industry

Construction is among the top three most hazardous sectors of the economy and is also one of the leading contributors to work-related injuries.[13,23] Construction work presents workers with a disproportionate risk of injury.[35-43] Construction workers face a five times higher risk of a fatal injury compared to other industries.[28] This is likely due to the hazardous nature of work and to a focus on productivity.[35-43] The construction industry employs about 7% of the global work force but is responsible for 30–40% of all work-related fatalities.[44] The injury burden in the construction industry is unequally distributed among developed and developing countries. In developing countries, construction sites are reported to be ten times riskier than the sites in developed countries.[45] However, in developed countries, the construction industry is also one of the leading contributors to occupational injuries and construction sites are riskier than other work places.[35,37,40,46,47]

Younger construction workers tend to be at a greater risk of injury:[40,46-48] the incidence of injuries in workers aged between 15 years and 24 years has been reported to be 40% higher when compared to older workers.[23] Injury severity, however, has been reported to be greater among older construction workers.[40,48,49] More male than female workers are injured.[47,50] Male construction workers tend to suffer injuries due to the construction work itself, whereas female workers tend to suffer injuries due to work that is not directly related to construction.[40,49] Other reported risk factors for construction injuries are time of day, day of the week, type of employment contract, length of service in the company, and company size.[49] Injury risk has been found to be higher in: unskilled than in skilled workers, migrant than native workers.[40,51-55] Reasons reported for the higher vulnerability of migrant workers include: abusive and exploitative working conditions, language barriers, cultural differences, lower average level of education, a higher proportion of exposure of unskilled workers to new technology, and stress.[55-58] Migrant construction workers also tend to work in high-risk jobs, and lack access to information and training.[58]

1.1.5 Causes of construction injuries

The leading causes of construction injuries and fatalities are: falls from height, electric shocks, injuries from falling objects, being hit by a moveable object vehicle or piece of equipment, injuries by lifting heavy objects, squashing, hitting a stationary object or piece of equipment, contact with cutting or piercing object, falling into collapsing material, burial by earth collapse, hazards in using different types of machines and equipment, slips and trips, collapse of scaffoldings and working platform, and fire hazards.[28,40,49,50,52,56,59-67]

The conditions at construction sites that have been reported to be important risk factors for construction injuries include: site location, site layout, complexity of design, poor housekeeping, space availability, shortcomings with Personal Protective Equipment (PPE), quality and suitability of construction material and equipment.[61-66] A lack of visibility due to obstructions, blind spots, and lighting conditions are other reported contributing factors.[56,68-74]

1.1.6 Indian construction industry

In India, the construction industry is important in powering the growth of both employment and Gross Domestic Product (GDP). Construction GDP posted an average annual growth of 15.2% between 2000-01 and 2011-12.[75] The industry also made a substantial contribution of 81.2% to growth of employment between 2004-05 to 2009-10.[32,76]

Photograph-1A: A construction site in Delhi, India

Photograph-1B: Construction workers' camp

Construction in India, however, is the second biggest cause of workplace injuries after mining, contributing 24.2% of all occupational incidents.[6] Construction workers can be exposed to a wide variety of occupational safety and health hazards.[77] The Indian construction industry is often demanding: labourers work under the scorching sun, often bare-foot, without protective gear or basic safety equipment.[78] Workers are often made to work long hours which can make them prone to injury.[78,79] It has been estimated that around 11,600 people died annually in the construction sector in India between 2008 and 2012.[6]

Although the economic burden of construction site injuries in India is yet to be quantified and published, if we were to assume that the economic burden of occupational illnesses and injuries in India is similar to the global average, and that the burden is equally distributed between occupational illnesses and injuries, the economic burden of occupational injuries in India would amount to 2% of India's GDP.[23] As the construction sector contributes 24.2% to all occupational accidents in India, the economic burden of construction site injuries would be about 0.5% of India's GDP.[6] This burden, however, has not been fully appreciated by policy makers in India due to under reporting of accidents and injuries at construction sites: According to information submitted in the Parliament by the federal Ministry of Labour and Employment, there were 58 fatal and 11 non-fatal injuries sustained at construction sites in India in 2016.[80] This is a fraction of the estimated figure of 11,614 deaths annually at construction sites in India.[6]

Photograph 1C: A female construction worker in Delhi working at a height without PPE and without railing

Photograph 1D: Children remain with their mothers at construction sites

1.1.7 Causes of construction site injuries in India

Reported causes of construction site injuries in India are electric shock, falls from a height, struck by a falling object, struck by construction material, exposure to radiation, caught between objects, and over-exertion.[78,79,81-83] A lack of knowledge about earth connection for power tools and a lack of knowledge about protecting cables from mechanical damage were found to be the main causes of electric shock.[82] Unsafe working conditions resulting from poor safety measures, high workload, long working hours, lack of training, and stress due to low wages, and uncertainty of job were reported as risk factors for construction site injuries.[79,83-86] Moreover, the construction industry employs migrant workers from different states of India speaking different

Photograph 1E: Female Construction Workers Carry Heavy Head Load

languages.[85] The linguistic diversity of India presents a communication challenge to the migrant workers and is a risk factor for construction injuries.[77]

Delhi, the capital of India entices construction workers due to its geographical centrality and high wages.[85] It was estimated that 619,767 persons were employed in the construction sector in Delhi in the year 2012.[6] Between 2008 to 2012, 256 incidents leading to fatal injuries were reported every year at construction sites in Delhi.[6] However, the literature was found to be lacking in studies on the prevalence of construction injuries in Delhi. A literature search retrieved only three studies on construction workers in Delhi; one of them focused only on demographic and social aspects, while the other two reported on construction site injuries.[6,85,87]

Photograph 1F: Exposure to sun and heat impacts health of construction workers

1.1.8 Injury prevention

Injuries have a definitive causative pattern and mechanism and thus are both predictable and preventable.[18,88] However this requires the availability of timely and comparable data, segregated by different variables like sex, age, trade, residence, etc to identify risk factors and trends.[88,89] This in turn aids in formulating procedures, drafting policies and regulations, designing safety campaigns and safety equipment, and evaluating their impact.[90] The availability of data on injuries is also important for decisions on the allocation of health resources.[21] However, injury data collection systems are often plagued by limitations.[7,23] Resource poor settings particularly lack data on injuries and their impact on society.[90] This has led to slow or non-recognition of injuries as a public health challenge by policy and decision makers in LMICs.[90] Therefore, despite experiencing a heavy injury burden, LMICs are lagging behind in public health programs targeted at injury prevention.[89]

The injury burden is hidden and under recognised in India too. This is partly due to a lack of injury surveillance and the unavailability of comprehensive data on the subject. India does not report or publish statistics on occupational injuries and illnesses.[7] Research in the health and safety of construction workers is still at a nascent stage in India and the volume of research conducted so far is very limited. Moreover, conducting research in the construction industry is also a challenging task owing to the dynamic, hazardous and temporary nature of the industry.[26] The presence of a large proportion of migrant workers, who not only lack language skills but also come for a limited period every year, adds to this challenge.[91]

1.1.9 Occupational legislations in India

There are multiple legislations in India that mandate reporting of accidents and injuries by the people as well as their employers to the police and other authorities. These legislations include general laws, namely: The Code of Criminal Procedure 1873;[92] and the Indian Penal Code 1860[93], as well as specific laws, namely: The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996,[1] the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 1998,[2] the Workmen Compensation Act 1923,[5] and the Employee State Insurance Act 1948.[94] Relevant provisions of these legislations regarding reporting of accidents are given in Table-1.2.

Table-1.2: Occupational legislations in India		
1	The Code of Criminal Procedure 1873	Section-39: A person aware of the commissioning of an offence punishable under Section 304 of the Indian Penal Code (which includes accidental deaths) is bound to give information to the nearest Magistrate or the police officer.
2	The Indian Penal Code 1860	Section-176: Failure to provide information mandated by Section-39 of the Code of Criminal Procedure is punishable by imprisonment
3	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996	Section-39: An employer must give notice of an accident resulting in injury to the authorities prescribed in the rules.
4	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules 1998	Rule 210: the notice of an accident shall be given by the employer to the Regional Labour Commissioner, the Building and Other Construction Workers' Welfare Board, Director General Labour Welfare, next of kin of the injured, officer in-charge of the nearest police station, and the District Magistrate. Accidents at construction sites should also be reported by the employer to the Labour Inspector
5	Workmen Compensation Act 1923	Section 10B: the employer must send a report on an accident leading to death or serious bodily injury to the Commissioner of Workmen Compensation within 7 days of the accident.
6	Employees' State Insurance (General) Regulations, 1950	Section-68: All registered employers must submit a report on accidents leading to deaths or disablement of the employee within 24 hours of their occurrence on the ESIC portal

1.1.10 Construction site injury surveillance in India

A surveillance system to provide quality data on the burden and epidemiology of construction site injuries in India is necessary to inform strategies to reduce the burden of these injuries. Such a system would, aside from estimating the burden of such injuries, also facilitate preventive measures and advocacy for appropriate policy corrections. The research presented in this thesis, for the fulfilment of the requirements of the Doctor of Public Health (DrPH) is aimed at exploring the feasibility of putting in place an injury surveillance system for construction injuries in Delhi, the capital of India, based on information extracted from First Information Reports (FIRs) registered by Delhi police. A format of FIR is placed at **Appendix-1**. Such a surveillance system is intended to collect, compile and analyse data and make it available to all stakeholders.

1.2 Aims Objectives and Research Questions

1.2.1 Aim

The overall aim of this DrPH thesis is to study whether a public health surveillance system can be developed for unintentional injuries in Delhi, India, based on the information extracted from the First Information Reports (FIRs) registered by Delhi Police.

1.2.2 Research questions

The aim was achieved by framing and answering the following research questions:

i. Do the First Information Reports (FIRs) registered by Delhi Police contain sufficient information to describe the epidemiology of construction site injuries in Delhi?

ii. Are FIRs a complete record of all construction site injuries?
iii. Can we use FIRs for construction site injury surveillance?
iv. If so, what do FIRs tell us about the epidemiology of construction site injuries in Delhi?

Three different but related studies were designed to answer these research questions.

1.2.3 Objectives:

The objectives of the three studies were as follows:

Study-1: Study-1 was entitled *"Evaluation of First Information Reports (FIRs) of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation."* This study was designed to answer the first research question – *"Whether the First Information Reports (FIRs) registered by Delhi Police contain sufficient information to describe the epidemiology of construction site injuries in Delhi?"* The study was not confined to construction injuries only but covered all unintentional injuries reported to the Delhi Police in one year. Objectives of this study were:

i. To identify the minimum data set (MDS) recommended for injury surveillance
ii. To develop a tool for the extraction of MDS data from FIRs
iii. To evaluate whether FIRs contain this MDS
iv. To assess the inter-rater reliability of a tool designed for data extraction from FIRs.

Study-2: Study-2 was entitled *"Completeness of ascertainment of construction site injuries using First Information Reports (FIRs) of Indian police: capture-recapture Study".* This study was designed to answer the second research question- "Are FIRs a complete record of all construction site injuries?" The study focussed on unintentional construction site injuries reported to the Delhi Police over a period of one year, from 1st January to 31st December 2017. The objectives of this study were:

i. To estimate the number of all, fatal and non-fatal construction site injuries in Delhi in a year;
ii. To estimate the percentage of fatal, non-fatal and all construction injuries ascertained by the First Information Reports (FIRs) of the Delhi Police.

Study-3: Study-3 was entitled *"Epidemiology of construction site injuries in Delhi, India: protocol for a retrospective cohort study".* This study was designed to answer the final research question- *"What do FIRs tell us about the epidemiology of construction site injuries in Delhi?"* The study was again confined to the unintentional construction site injuries reported to the Delhi Police. However, the period of study was three years, from 1st January 2016 to 31st December 2018. The objectives of this study were:

i. To estimate the incidence rates of fatal, non-fatal and all construction injuries in Delhi, India.
ii. To assess risk factors for construction site injuries in Delhi, India.

At the end of this thesis the findings of all three studies are considered and whether the FIRs can form the basis of an Indian unintentional injury surveillance system is discussed.

1.3 Structure of Thesis

The thesis thus comprises three separate, but interlinked studies that aim to assess, step-by-step, whether public health surveillance of construction site injuries is feasible using the First Information Reports (FIRs) registered by Delhi Police. The thesis starts with an overall abstract followed by a DrPH Integrating statement which provides an overview of learnings and explains the inter-relationship between the different components of the DrPH program. As the DrPH thesis is shorter than a traditional PhD, due care has been taken to adhere to the prescribed limit of 60,000 words. The thesis has a preface and six chapters. After the “Introduction” chapter, the second chapter is “Use of police records for injury surveillance: a systematic review” which summarises the worldwide literature on surveillance systems for unintentional injuries and on the use of police records for injury surveillance. This is followed by Chapter-3 which reports on the first research study: “Evaluation of First Information Reports (FIRs) of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation.” This is followed by Chapter-4 which reports on the second research study: “Completeness of ascertainment of construction site injuries using First Information Reports (FIRs) of Indian police: capture-recapture Study”. The third and final study forms Chapter-5 and is entitled “Epidemiology of construction site injuries in Delhi, India”. This is a descriptive retrospective cohort epidemiological study covering a three-year period from 1st January, 2016 to 31st December, 2018. A detailed protocol for the study was developed first and was published by “LSHTM Research Online”.[95]

The three research studies are followed by a “Discussion and Conclusion” chapter containing a detailed discussion of the findings of the three individual studies and some recommendations for the policy makers and other stakeholders.

1.4 Research Ethics Review

1.4.1 Research and ethics approval

This research was approved by the LSHTM Observational/Interventions Research Ethics Committee on 26th November, 2018 (LSHTM ethics ref: 15992). A copy of the approval letter is in **Appendix-2.** Local ethics approval was obtained from the Ethics Committee of Dr Baba Saheb Ambedkar Medical College and Hospital, Delhi, India on 13th December, 2018 **(Appendix-3).** The research protocol was shared with the Commissioner of Police, Delhi. The Delhi police granted approval for conducting the research on 29th September, 2018 **(Appendix-4).** Approval and data were also obtained from ESIC **(Appendix-5)** and the Labour Department of Delhi Government **(Appendix-6)**

1.4.2 Confidentiality

All the data was obtained from the Delhi Police, ESIC and Labour Department of Delhi Government in an electronic format except a few FIR documents which were not found available on the website of the Delhi police and were obtained in hard copy from the police station concerned. Hard copies of these documents were destroyed after converting them into PDF format. The data was stored in a password protected folder in a password-protected laptop of the researcher. The data from the FIRs was extracted in a Microsoft Excel Sheet.

For calculating the inter-rater reliability as part of study-1, 50 FIRs, selected by a simple random sampling method were shared with another person for extraction of data from these 50 FIRs to test the inter-rater reliability of the Data Extraction Tool. Before sharing these FIRs, the names of victims were replaced by codes and other details like address of the victim, address of incident site, and the name of the police station were masked. A confidentiality agreement was also signed with the data extractor to keep the data strictly confidential and to delete the information from his email and computer once the extracted data was shared with the researcher **(Appendix-7)**. Backup of the data was kept on a hard drive which was also password-protected.

1.4.3 Anonymization

After removing the duplicates and completing the matching exercise for study-2, the names of all the victims were replaced by codes to anonymise them. The analysis presented in this thesis is quantitative in nature and does not contain details of individual victims or the place of occurrence of the accident or any other information which may lead to the identification of a victim or employer or place of occurrence of incident.

1.5 Conflict of interest

My tuition fee for the DrPH program was partly covered by the Department of Personnel and Training, Government of India. The remainder of the tuition fee and living and travelling expenses were borne out of my personal savings. However, the funding body had no role in the design of the studies included in this thesis as well as in the collection and analysis of data, interpretation of results or in the writing this thesis. Thus, there is no conflict of interest.

2. Use of police records for injury surveillance: A Systematic Review

2.1 Introduction

2.1.1 Global injuries burden

Injuries are an emerging global health epidemic that affect millions of people annually.[9] They claim more than 16,000 lives across the world daily and are among the leading causes of global morbidity and mortality.[9,96] Injuries account for almost 50% of deaths in young people between the age of 10 to 24 years[97] and it is estimated that the burden of injuries will grow in the coming years.[98] In terms of years of life lost worldwide, injuries have climbed from the 9th leading cause in 1990 to the 2nd leading cause in 2020.[97]

Injuries have serious economic and social consequences and levy a heavy burden on communities, especially in the Low Income Countries (LICs) and Lower Middle Income countries (LMICs) who shoulder 90% of the total global burden[9,96-99] South-East Asia, which includes India, contributes more than a quarter of the annual total of 5.1 million deaths from injuries reported worldwide.[97] They are the 4th leading cause of death in this region.[97] In India, injuries make a significant contribution to the mortality and are the top contributor to the years of life lost for persons older than 4 years of age.[97]

Injuries, like other diseases, result from an interaction of agent, host and environment and are also predictable and preventable.[100] However, injury prevention remains a low priority for policy makers, particularly those in LMICs.[101] Consequently, there is minimal government funding of injury prevention programmes when compared with those funds allocated to other comparable health problems.[101]

The foundation necessary for the design and evaluation of health programmes is information on the incidence and prevalence of diseases and injuries.[102] Moreover, to communicate the injury burden to policy makers and other stakeholders, it is important to have access to good quality data obtained from an injury surveillance system.[102] The precise calculation and reporting of injury indices assist policy makers in designing effective policies to mitigate the burden of injuries.[103] Unfortunately, reliable data that would help in the analysis of injury problems are lacking in many countries; and injury registries are not in place, particularly in LMICs.[104] The scarcity of data in LICs and LMICs contributes to a lack of awareness among policy makers about the extent of injury problems and is one of the main reasons for the neglect of this health problem.[105]

2.1.2 Data sources for injury surveillance

Developed countries often have more comprehensive data on injuries that are extracted from a range of sources such as: hospital discharge records, hospital emergency room records, death certificates, medical examiners', and coroners' reports.[105] Ambulance and police reports have also been used to study injuries.[105] But in developing countries, vital registration systems are often lacking and available data tends to suffer from low validity.[105,106]

Police records are a potentially important source of data. However, due to a low percentage of injuries being reported to the police in LMICs, police records may underestimate both injury morbidity and mortality.[107-110] Substantial international variations in police recording levels of hospital admissions have also been reported.[111-114]

In India, the data sources on injuries are limited as India does not publish data on occupational injuries and illnesses.[7] Health records are a potential source of data on injuries. However, in India health records are either manual or are in disparate computer systems without inter-operability or cross-sharing.[115] Reports of accidents and injuries filed with various authorities are other possible data source on injuries. But they suffer from serious underreporting issues. FIRs are a potential nationwide source of data on injuries in India because all the FIRs are required to be uploaded on a centralized, web-based system, named the Crime and Criminal Tracking Network & Systems (CCTNS), put in place by the Ministry of Home Affairs, Government of India.[116]

A critical review of the existing world literature is therefore needed to help understand what proportion of injuries are reported to the police in different countries and to learn whether surveillance systems to monitor the burden and trends of unintentional injuries have been established using police records.

2.2 Objectives

The purpose of this review was to systematically search, summarise and present the worldwide literature on:

i. The proportions of fatal and non-fatal injuries that are ascertained by police records;
ii. The extent to which police records are utilised in surveillance systems worldwide to monitor the burden and trends of unintentional injuries.

2.3 Methods

A systematic review of literature was undertaken to identify all studies published between January 2000 to 16th July 2020 in peer and non-peer reviewed (i.e. grey) literature. This chapter has been structured in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[117]

2.3.1 Protocol and registration

A review protocol was not drafted and published. The review was also not registered.

2.3.2 Study eligibility criteria

All types of studies were included. Studies were considered eligible for inclusion in the review if the study investigated:

- ascertainment of unintentional injuries by police records;
- the establishment of an unintentional injury surveillance system based on police records;
- results of an evaluation of an unintentional injury surveillance system built on police records as one of the data sources.

Only studies on injuries sustained by humans, published in the English language from the year 2000 to the date of final search, with available abstracts and full texts were included in the systematic review. Studies related to the epidemiology of injury, population surveys, and letters to the editor were excluded. Studies restricted to only a segment of population (e.g., pedestrians or cyclists) were also excluded.

2.3.3 Participants

All individuals who sustained an unintentional injury were included.

2.3.4 Types of outcome measures

Studies reporting any of the following measures were included in the review:

- proportions of fatal, non-fatal or total injuries reported to the police or were found missing in the police records;
- the establishment of an injury surveillance system based on police records or on a linkage of police records with other data sources;
- reporting of any results of an evaluation of such injury surveillance systems.

2.3.5 Information sources

Potentially eligible studies were identified by searching electronic bibliographic databases and scanning the reference lists of eligible studies. The search was applied to Medline (2000 – present) and adapted for EMBASE (2000 – present), PubMed (2000-present) and Google Scholar (2000 – present). The Cochrane database and the DARE (Database of Abstracts of Reviews of Effectiveness) database was also searched.

2.3.6 Searches

To retrieve potentially eligible studies, an extensive search was conducted in accordance with PRISMA requirements.[117] After several rounds of test searches in January to March, 2020, the main search occurred in May-June 2020 which was then updated on 16th July, 2020.

The search terms were formulated first for MEDLINE and were later adapted for EMBASE, PubMed and Google Scholar. The search terms were: *"Surveillance; monitor*; report*; injur*; wound; hurt; police; records;".* The terms were selected on the basis of MeSH terms and the keywords used in the eligible studies. The terms were combined using "AND/OR" Boolean operators (table-2.1).

Table-2.1: Search Strategy	
MEDLINE (OVID)	
01	Surve* or Monitor* or Report*
02	Limit 1 to (abstracts and English language and humans and yr="2000 - Current")
03	injur* or wound or hurt
04	Limit 3 to (abstracts and English language and humans and yr="2000 - Current")
05	2 and 4
06	*Police/cl, ec, lj, sn [Classification, Economics, Legislation & Jurisprudence, Statistics & Numerical Data]
07	Limit 6 to (abstracts and English language and humans and yr="2000 - Current")
08	5 and 7
EMBASE	
01	Surve* or Monitor* or Report*
02	limit 1 to (abstracts and human and English language and yr="2000 - Current")
03	injur* or wound or hurt
04	limit 3 to (abstracts and human and English language and yr="2000 - Current")
05	2 and 4
06	Police
07	limit 6 to (abstracts and human and English language and yr="2000 - Current")
08	5 and 7
Google Scholar	
	Surveillance injur* police
	Anywhere in the article
	2000 to 2020
PubMed	
	((surveillance[Title/Abstract]) AND (injur*[Title/Abstract])) AND (police[Title/Abstract])

Relevant literature was retrieved using a two-stage screening process – in the first stage, titles and abstracts were screened to identify potentially eligible studies meeting the inclusion criteria. In the second stage, screening of the full texts of potentially eligible studies was undertaken using the same inclusion criteria. Additionally, the reference lists of the eligible studies were screened to retrieve other eligible studies.

Studies finally selected were collated in a Microsoft Excel sheet. Each study was reviewed, relevant data were extracted and the results were analysed.

2.3.7 Data collection process:

Data were extracted from eligible studies using a proforma developed for the review (table-2.2).

Table-2.2: Proforma for data extraction from selected studies			
Title			
Author			
Year of publication		Country	
Study type		Type of injury studied	
For studies reporting completeness of injury information in police records			
Other data source compared		Method	
Percentage of fatal injuries captured by police	Fatal	Non-fatal	Total
For studies on injury surveillance system:			
Whether an injury surveillance system was set up using police records			
If Yes, were police records sole source of injury data or other sources were also used?			
Other sources of data used in the surveillance system			

2.3.8 Data items

Information was extracted from each study on: country, year of publication, method, study type, other data sources compared, percentage of fatal, non-fatal and total injuries ascertained by police records, and whether an injury surveillance system was established based on police records (table-2.2).

2.3.9 Risk of bias in individual studies and across studies:

Risk of bias was not assessed as this review did not aim to make any statistical estimates.

2.4 Results

2.4.1 Study selection

The searches of Medline, EMBASE, PubMed and Google Scholar retrieved a total of 855 records of potentially eligible studies: Medline (53 records), EMBASE (161), PubMed (149) and Google Scholar (492). After removing duplicates there were 754 records of potentially eligible studies. Of these, 712 records were discarded at the first stage screening of the abstract as it was clear that they did not meet the inclusion criteria. The full text reports of the 42 remaining records of potentially eligible studies were obtained and examined in detail and 10 of these were discarded as they did not meet the inclusion criteria. Four additional studies that also met the inclusion criteria were identified by screening the reference lists of eligible studies and were also included. Thus, 36 studies met the inclusion criteria and were included in the review.[105,109,118-150,152] (figure-2.1).

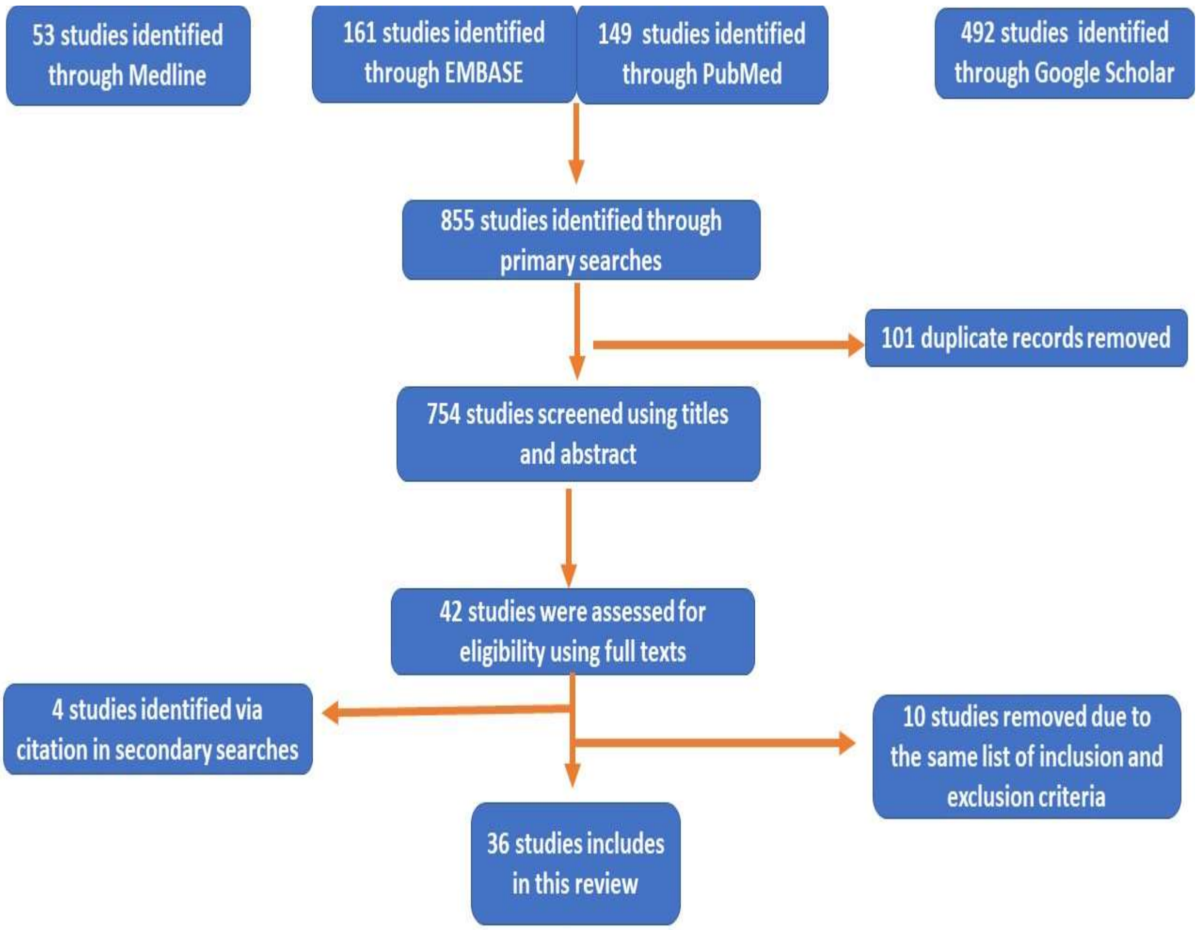


Figure-2.1: PRISMA flow diagram of study selection process

2.4.2 Study characteristics

36 studies were included in the review (tables 4 and 5). [105,109,118-150,152]

Geographical settings

The geographical settings of the included studies were distributed across 30 countries, with the highest number from Australia (4 studies),[119,122,128,149] two studies each from India,[135,140] and Pakistan.[142,143] There was one study each from United States,[109,146] Portugal,[118,126] Italy,[147] Ireland,[148] Peru,[150] Bangladesh,[105] Burkina Faso,[152] Greece,[120] France,[121] New Zealand,[123] Japan,[124] Saudi Arabia,[127] China,[129] Malaysia,[130] South Africa,[131] Dominican Republic,[131] Iran,[133] Phillipines,[134] Cameroon,[136], Vietnam,[137] Nicaragua,[138] Mangolia,[139] Lao PDR,[141] Uganda,[144] and Mali.[145] One study was a multi-country study spread across 8 European countries: Austria, Czech Republic, France, Greece, Hungary, Netherlands, Spain, and United Kingdom.[125] For analysis, these 33 countries were categorised using the World Bank's classification of countries by income group (Table-2.3)[151]. There were 15 studies from High Income Countries (HICs), 6 studies from Upper-Middle-Income Countries (UMICs), 11 studies from Lower-Middle Income Countries (LMICs) and 3 studies from Low-Income Countries (LICs). In addition, there was a multi-country study spanning across 8 HICs

Table-2.3: Income group wise distribution of studies

Income Group	**Country Names**	**Number of studies**
High-Income Countries (HICs)	Portugal, Australia, Greece, France, New Zealand, United Kingdom, Japan, United States, Italy, Saudi Arabia, Ireland	15
Upper-Middle-Income Countries (UMICs)	China, Malaysia, South Africa, Dominican Republic, Iran, Peru	6
Lower-Middle-Income Countries (LMICs)	Philippines, India, Vietnam, Nicaragua, Mongolia, Lao, Pakistan, Bangladesh, Cameroon	11
Low-Income Countries (LICs)	Uganda, Mali, Burkino Faso	3
Multi-country	Czech Republic, France, Greece, Hungary, Netherlands, Austria, Spain, UK	1

Year of publication : The most frequent year of publication was 2011 (5 studies), with 3 studies published in each the years: 2008, 2009, 2010, 2012, 2016, 2016 and 2019.

2.4.3 Studies on ascertainment of injuries by police records:

29 studies reported on the completeness of ascertainment of unintentional injuries by police records (table 4). Of these, 28 studies reported on road traffic injuries and one study reported on industrial injuries.[140]

The study designs were either cross-sectional[108,119,120,122,123,125-128,130-150,152] or retrospective cohorts.[109,118,121,129] The methods used for the investigation of completeness of police records were: (i) the capture-recapture method[119,129,132,134,137,138,140,141,143,145] (ii) calculation of the percentage of injuries ascertained in the police data base[109,118,120, 123,124,125, 126,127,129,130,133,135,136,138,141,144,146], (iii) percentage of disagreement between the police database and another data base (discordance rate)[119], (iv) linkage rate of police records with other data sources.[127,147] One study[135] used survey data whereas the majority of studies used hospital data to ascertain completeness of police records. Other sources of data used for the comparative analysis were: fire department and fire insurance records[124], civil registries[129,134], trauma registries[119,121,122], mortuary records[131,134], health insurance data[132], population survey[136], and newspaper reports[124]. The capture recapture method was more commonly used in studies in LMICs.

2.4.4 Studies on use of police records for an injury surveillance system:

The remaining 7 studies reported on the use of police records for an injury surveillance system or on the linking of police records with other databases to obtain a more complete picture of unintentional injuries (table 2.4).

Four studies were from HICs,[146-149] one from UMICs,[150] and one each from a LMIC[105] and a LIC[152]. Six studies[146-150,152] were on road traffic injuries, the remaining one study[105] covered all injuries.

Table-2.4: Characteristics of studies on completeness of ascertainment of unintentional injuries by police records								
Sl No	Title	Author **Setting**	Study type (Method)	Type of injuries studied	Other data source compared	Percentage of injuries ascertained by police records		
						Fatal	Non-fatal	Total
High-income Countries								
1	Reporting road victims: Assessing and correcting data issues through distinct injury scales.[118]	Couto, A. et al (2016) **Portugal**	Retrospective cohort (Econometric and statistics tools)	Road traffic injuries	Hospital records	-	-	71
2	Estimating under-reporting of road crash injuries to police using multiple linked data collections.[119]	Watson et al (2015) **Australia**	Cross sectional (Discordance rate between police and hospital data)	Road traffic injuries	Hospitals and injury surveillance unit	-	31.4	-
3	Linking emergency medical department and road traffic police casualty data: a tool in assessing the burden of injuries in less resourced countries.[120]	Petridou et al (2009) **Greece**	Cross sectional (Under reporting coefficient)	Road traffic injuries	Emergency Department	96.6	16	-
4	Actual incidences of road casualties, and their injury severity, modelled from police and hospital data, France.[121]	Amoros et al (2008) **France**	Retrospective cohort (Capture-recapture)	Road traffic injuries	Road trauma registry			29.3
5	Complementing police road-crash records with trauma registry data–an initial evaluation.[122]	Lopez et al (2000) **Australia**	Cross sectional (Wilcoxon signed test)	Road traffic injuries	Trauma registry of hospitals	-	82	-
6	Validity of using linked hospital and police traffic crash records to analyse motorcycle injury crash characteristics.[123]	Wilson et al. (2012) **New Zealand**	Cross sectional (Percentage of police records linked to hospital records)	road traffic injuries	Hospital discharge records	-	46	-
7	An evaluation of police reporting of road casualties.[109]	Jeffrey et al (2009)	Retrospective cohort study (Percentage of	Road Traffic Injuries	Hospital records	-	55	-

		United Kingdom	hospital admissions not reported to the police					
8	Underreporting of traffic injuries involving children in Japan.[124]	Nakahara, & Wakai (2011) **Japan**	Cross sectional (Ratio of police data to fire department and insurance data	Road traffic injuries	Fire department & Marine and Fire Insurance Association of Japan.	-	50	-
9	Estimation of the real number of road casualties in Europe.[125]	Broughton et al (2010) **Czech Republic, France, Greece, Hungary, Netherlands, Austria, Spain, UK**	Cross-sectional three-step methodology: (Calculation of the national coefficients to estimate the actual casualties from the police database)	Road traffic injuries	Hospital records	-	Czech Republic-1.07, France 1.43, Greece-5.92, Hungary-0.84, Netherlands-1.29, Spain-1.22, United Kingdom-1.24 for serious injuries	-
10	The quality of the injury severity classification by the police: An important step for a reliable assessment[126]	Ferreira et al. (2015) **Portugal**	Cross sectional (Percentage of under reporting)	Road traffic injuries	Hospital records	-	71	-
11	Epidemiology of Road Traffic Injuries in Qassim Region, Saudi Arabia: Consistency of Police and Health Data[127]	Barrimah et al (2012) **Saudi Arabia**	Cross sectional (Percentage of underreporting)	Road traffic injuries	Hospital records	35	47.8	45.3
12	Data Linkage of Hospital and Police Crash Datasets in NSW[128]	Boufous (2008) **Australia**	Cross sectional (Percentage of underreporting)	Road traffic injuries	Hospital records	-	-	44.9

Upper-middle-income countries								
13	Comparing road traffic mortality rates from police-reported data and death registration data in China.[129]	Hu et al (2011) **China**	Retrospective cohort (Percentage of underreporting)	Road traffic injuries	Official death registration data	50	-	-
14	Matching of police and hospital road crash casualty records – a data-linkage study in Malaysia.[130]	Kamaluddin et. al (2019) **Malaysia**	Cross sectional (Percentage of police records with hospital records)	Road traffic injuries	Hospital records	-	4.70	-
15	Assessing Quality of Existing Data Sources on Road Traffic Injuries (RTIs) and Their Utility in Informing Injury Prevention in the Western Cape Province, South Africa.[131]	Chokotho et al (2013) **South Africa**	Cross sectional (Capture-recapture) Percentage of under reporting	Road traffic injuries	Mortuary	46.4	-	-
16	Feasibility of road traffic injury surveillance integrating police and health insurance data sets in the Dominican Republic[132]	Puello et al (2014) **Dominican Republic**	Cross sectional (Capture-recapture) Percentage of under reporting	Road traffic injuries	Health insurance data set	-	19.8 to 39.8	-
17	Necessity of an Integrated Road Traffic Injuries Surveillance System: A Community-Based Study[133]	Hatamabadi (2011) **Iran**	Cross sectional (Percentage of police records with hospital records)	Road traffic injuries	Hospital records	56.2	51.5	55.8
Lower-middle-income countries								
18	Applying the capture-recapture method to estimate road traffic deaths and injuries in three non-contiguous cities in the Philippines.[134]	Rivera & Lam (2019) **Phillippines**	Cross sectional (Capture-recapture)	Road traffic injuries	Hospitals, civil registry	4.2 to 59.3	3.4 to 18.4	-
19	Under-reporting of road traffic injuries to the police: results from two data sources in urban India.[135]	Dandona et al (2008) **India**	Cross sectional (Percentage of injuries reported to the police)	Road traffic injuries	Population survey and hospital records	77.8	17.2	-

20	Exploring data sources for road traffic injury in Cameroon: Capture and completeness of police records, newspaper reports, and a hospital trauma registry.[136]	Juillard et al (2017) **Cameroon**	Cross sectional (Percentage of injuries reported to the police)	Road Traffic injuries	Trauma registry, and newspapers.	45	14.6	-
21	Estimation of non-fatal road traffic injuries in Thai Nguyen, Vietnam using capture-recapture method.[137]	Van et al. (2006) **Vietnam**	Cross sectional (Capture-recapture)	Road traffic injuries	Hospital records	-	12.3	-
22	Measuring transport injuries in a developing country: an application of the capture–recapture method[138]	Tercero & Andersson (2004) **Nicaragua**	Cross sectional (Capture-recapture)	Road traffic injuries	Hospital records	56.1	2.6	-
23	Comparing Police-and Health Authority-Based Road Traffic Injury Surveillance Systems in Ulaanbaatar, Mongolia[139]	Karamira & Bhatti (2013) **Mongolia**	Cross sectional (Number of injuries reported by health authorities for every RTI reported by police	Road traffic injuries	Hospital records	47.6	5.07	-
24	How safe are industries in India? Ascertaining industrial injuries in Dadra and Nagar Haveli, India by capture-recapture method[140]	Yadav S.S. (2019) **India**	Cross sectional (Capture-recapture)	Industrial injuries	Hospital records	30	3.6	6.7
25	Road traffic injuries in northern Laos: trends and risk factors of an underreported public health problem[141]	Slesak et al (2015) **Lao**	Cross sectional (Capture-recapture)	Road traffic injuries	Hospital records	58.8	24.2	24.7
26	A successful model of road traffic injury surveillance in a developing country: process and lessons learnt[142]	Razzak (2012) **Pakistan**	Cross sectional (Percentage of the total injuries in the surveillance system reported to the police	Road traffic injuries	Hospital records	50	2-3	-
27	Estimation of Fatalities Due to Road Traffic Crashes in Karachi, Pakistan, Using Capture–Recapture Method[143]	Lateef (2010) **Pakistan**	Cross sectional (Capture-recapture)	Road traffic injuries	Hospital records	44	-	-
Low-income Countries								

28	Estimating the burden of road traffic crashes in Uganda using police and health sector data sources.[144]	Muni et al (2020) **Uganda**	Cross sectional (Percentage of estimated injuries reported to the police)	Road traffic injuries	Health facilities and mortuaries	46.3	-	-
29	Mortality and Morbidity of Urban Road Traffic Crashes in Africa: Capture-Recapture Estimates in Bamako, Mali, 2012.[145]	Sango et al (2016) **Mali**	Cross sectional (Capture-recapture)	Road traffic injuries	Health records	58	17	-

	Table-2.5: Studies on use of police records for injury surveillance system					
	Title	Author **Setting**	**Study type (Method)**	**Injury type**	**Other data sources**	**Summary of surveillance system method**
1	Development of a US Child-Focused Motor Vehicle Crash Surveillance System: A Pilot Study.[146]	Durbin et al (2011) **USA**	Cross sectional (Survey)	Road traffic	Information collected through survey	Additional child-specific data were collected via three survey modes: phone, web-based and hard-copy self-administered.
2	Road traffic injuries in one local health unit in the Lazio region: results of a surveillance system integrating police and health data.[147]	Chini et al (2009) **Italy**	Cross sectional (record linking and analysis)	Road traffic injuries	Hospital emergency visit, hospitalization and mortality databases	Surveillance system for road traffic injuries by integrating municipal police reports and healthcare records is feasible.
3	Record linkage for road traffic injuries in Ireland using police hospital and injury claims data[148]	Short & Caulfield (2016) **Ireland**	Cross sectional (record linking and analysis)	Road traffic injuries	Hospitals and injury claims	Anonymized datasets from three separate sources of injury data: hospitals, police, and injury claims were linked using probabilistic and deterministic linkage techniques.
4	The Western Australian Road Injury Database (1987–1996): ten years of linked police, hospital and death records of road crashes and injuries[149]	Rosman (2001) **Australia**	Retrospective Cohort study (record linking and analysis)	Road traffic injuries	hospital and death records	Road Injury Database created through the linkage of crash details from reports to police with the details of injuries to casualties contained in hospital and death records which provided accurate outcome information for casualties in crashes reported to the police. It also enabled estimation of under reporting of crashes for different road user groups
5	A road traffic injury surveillance system using combined data sources in Peru[150]	Medina et al (2011) **Peru**	Cross sectional (data extraction, analysis and dissemination)	Road traffic injuries	Health facility records & vehicle insurance reports	A national, hospital-based non-fatal road traffic injury surveillance system was designed. A data collection form was used to record information. Data were analyzed periodically and findings were disseminated

6	Potential of using existing injury information for injury surveillance at the local level in developing countries: experiences from Bangladesh[105]	Rahman et al (2000) **Bangladesh**	Cross sectional (interviews and validity assessment by comparison of different data sources	All injuries	Hospital records, newspaper reports, post mortem reports	Identified and assessed existing data sources for their usefulness in forming a sustainable injury surveillance system. Also interviewed local health practitioners to elicit their opinion on participation in injury surveillance system. Found under reporting in police data but also observed that fatality data may be complete in communities with well-funded police departments and can be used for injury surveillance provided police personnel are motivated for comprehensive injury data recording
7	Technological solutions for an effective health surveillance system for road traffic crashes in Burkina Faso[152]	Bonnet et al (2017) **Burkina Faso**	Cross sectional (Descriptive reporting and analysis)	Road traffic injuries	Hospital records	A surveillance system was deployed which sent data in real-time to a central platform via SMS. The system extracted the relevant information from the SMS and integrated with the map. Additional information was extracted from reports prepared by police officers.

2.4.5 Participants

Studies on road traffic injuries included all victims of road crashes irrespective of their demographic profile. However, the studies that were restricted to only a segment of population were excluded from the review. The study on industrial injuries included the entire population of industrial workers. The two studies on all injuries did not exclude participants based on their demographic profile or other criteria.

2.4.6 Outcomes

2.4.6.1 Studies on completeness of ascertainment of injuries by police records

In HICs, police records were compared with hospital records or injury surveillance systems or trauma registries, except in one case in Japan, which compared police records with Fire Department records and Marine and Fire Insurance records.[124] In other countries, besides the hospital records, comparisons were made between police records and death registrations, mortuaries, health insurance records, civil registration records, newspaper reports and population surveys.

In HICs, the ascertainment of fatal injuries by police records was reported in two studies and ascertainment was found to be 96.6%[120] and 35%[127] complete. Ascertainment of non-fatal injuries by police records was reported in 9 studies from HICs; reported levels of completeness of ascertainment ranged from 16% to 82%. Three studies reported ascertainment of total injuries (fatal and non-fatal combined); levels of ascertainment by police records were 71%, 44.9% and 29.3%.[118,121,128]

In 3 studies from UMICs, the reported levels of completeness of ascertainment by police records of fatal injuries were 46.4%, 50% and 56.2%.[129,131,133] Three further studies reported levels of completeness of ascertainment of non-fatal injuries and found that police records ascertained 4.7% to 51.5% of the injuries.[130,132,133] One study reported ascertainment of total injuries and the level of completeness of ascertainment was found to be 55.8%.[133]

Nine out of 11 studies from LMICs reported the level of completeness of ascertainment of fatal injuries by police records and found that police records ascertained between 4.2% to 77.8% of fatal injuries. Nine studies from LMICs reported the percentage of non-fatal injuries ascertained by the police records which varied from 6.7% to 24.7%. Two studies from LMICs reported that 6.7 % and 24.7% of the total injuries were ascertained by police records.[140,141] Two studies from LICs reported that 46.3% and 58% of the fatal and 17% of the non-fatal injuries could be ascertained from the police record. [144,145]

Table 2.6: Incompleteness of ascertainment of injuries by police records

Setting	levels of completeness of ascertainment of injuries by police records		
	Non-fatal	Fatal	Total
LICs	17%	46.3% and 58%.	
LMICs	6.7% to 24.7%.	4.2% to 77.8%	6.7 % and 24.7%
UMICs	4.7% to 51.5%.	46.4%, 50%, 56.2%.	55.8%.
HICs	from 16% to 82%.	96.6%and 35%	71%,44.9%, and 29.3%.

2.4.6.2 Studies on use of police records for injury surveillance system:

The studies in this group can be divided into three categories- studies on injury surveillance systems based on police records, studies on injury surveillance systems based on integrated data, including police records, and studies reporting results of linking of data from various sources. There were two studies in the first category.[146,152] The first study was from Burkina Fasso, an LIC.[152] It reported development and results of an injury surveillance system for road traffic injuries based on information extracted from police records.[152] The system used mobile technologies for reporting of information from crash sites via SMS.[152] Additional information was extracted from reports prepared by police officers.[152] Integration of information with the map helped in identifying hot spots for traffic crashes.[152] The second study in this category was from the USA which reported the development of a surveillance system for road traffic injuries in children by using a motor vehicle crash surveillance system as a base and collected supplementary child-specific information by telephonic, web-based and hard copy self-administered surveys.[146]

Studies in the next category (injury surveillance systems based on integrated data of police and other sources) combined data of police and health facilities, [105] combined data of police, hospital records and insurance reports.[150] One study in this category from Bangladesh identified and assessed existing data sources, including police records for their usefulness in forming a sustainable injury surveillance system.[105] The study found underreporting in police data but also found that fatality data may be complete in communities with well-funded police departments and can be used for injury surveillance provided police personnel are motivated for comprehensive injury data recording.[105]

The third category in this group comprised studies which linked police records and other data sources to estimate under reporting and obtain a more comprehensive picture of the injury burden.[148,149] The first study in this category was from Ireland which linked injury data from three separate sources: hospitals, police, and injury claims to obtain better estimates on the nature and extent of non-fatal injuries.[148] The study found that non-fatal injuries were underestimated by the police and it also identified a number of additional injury cases when the three datasets were combined.[148] The second study in this category linked 10 years of road traffic injuries data from police, hospital records and death records. It found that the combined data provided more accurate outcome information on causalities and enabled estimation of under-reporting of crashes for different road user groups.[149]

2.5 Discussion

2.5.1 Key findings

The completeness of ascertainment of unintentional injuries reported to the police has received the attention of researchers in many countries. The capture-recapture method has been most commonly deployed in these studies in LMICs. The percentage reporting of fatal injuries to the police tends to be higher than for non-fatal injuries.

In HICs, studies used hospital records, trauma registries and injury surveillance systems more often to estimate the proportion of injuries captured in police records. Studies from HICs, LMICs and LICs used other sources of information to estimate ascertainment of injuries by police. This suggests a better availability of hospital records, trauma registries and injury surveillance systems in HICs when compared to other countries.

2.5.2 Limitations

This review has certain limitations. The main limitation is that due to time and resource constraints, the review excluded the studies published in languages other than English as well as the studies published before 1st January, 2000. Studies not having an abstract or full text available were also not included. In addition, the number of databases searched was limited and searches were confined to studies listed in only four data sources- Medline, EMBASE, PubMed and Google Scholar. Therefore, there might be studies and documents which did not find a place in the study due to not meeting the inclusion criteria. However, the four databases searched were the most relevant databases and I believed that I could obtain relevant papers for the review. Therefore, aforesaid limitations are not likely to have significant impact on our results and conclusion. However, a more rigorous systematic review may be undertaken in the future.

2.5.3 Meaning of the study: possible mechanisms and implications for policymakers

The higher ascertainment of injuries by police records in HICs suggests better maintenance of records by police and a higher awareness among the victims regarding reporting of injury incidences to the police in these countries. If police reports are to be used as a primary data source for injury surveillance in UMICs, LMICs and LICs, this suggests a need to raise awareness among people in these countries regarding the reporting of injuries to the police, and for the simplification of procedures for such reporting, training of police personnel and better capture and maintenance of injury records by the police.

The evidence presented in this review suggests that police records are not a popular data source for setting up injury surveillance systems: their use in injury surveillance systems was reported in a few countries only. Only in one study were police data used as a basis for setting up an injury surveillance system. Besides this study, one study used traffic crash data as a base and collected additional information for injuries to children in road accidents. In other studies, police records were either used for setting up an injury surveillance system in combination with other data sources or were linked with other data sources to get a better picture of the burden of road traffic injuries.

2.6 Conclusion

Police records are a potentially useful source of information on unintentional injuries and may ascertain a good proportion of fatal injuries. However, there is a need for improvement in the reporting of non-fatal injuries for which raising awareness among people and training and educating police personnel may be needed. The use of police records for basing an unintentional injury surveillance system is presently at a nascent stage.

3. Evaluation of First Information Reports (FIRs) of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation

This chapter has been accepted for publication in the "Indian Journal of Medical Research", a peer reviewed journal (**Appendix-8**)[153]

3.1 Introduction

Unintentional injuries kill more than 5 million people each year and cause many millions more to live with disability.[89,154] Low-and-Middle-Income-Countries (LMICs) report 90% of global injury related deaths.[11,12] Injury is an important contributor to disease burden in India and is one of the leading causes of death for all ages.[17,18,19,155] Injuries have a definitive causative pattern and mechanism and thus are both predictable and preventable.[18,89]

The policy makers and public health professionals need to know the distribution, patterns, trends, and risk factors of injury occurrence. This data can help in developing public health strategies that reduce the incidence of injuries.[91] An injury surveillance system can provide these data and can be used to: provide quantitative estimates of injury morbidity and mortality; identify trends and underlying causes; detect clustering of injury events; identify potential risk factors and circumstances related to injury occurrence; help in designing interventions, and in evaluating their impacts.[18,106,108,156]

Injury surveillance systems are often based on hospital records.[157] Such surveillance systems tend not to ascertain all injury events and may be biased towards the more severe of injuries.[108,158] This is because in LMICs hospital attendance for non-fatal injuries is low and documentation of such injuries is generally poor.[108,143,159] Moreover, information about the circumstances of an injury is often lacking in hospital records.[108,143,159] Police records are a potential data source for injury surveillance.[91,108,156,160] But again, reporting of minor injuries is lower to the police too.[161,162] Moreover, the First Information Reports of Indian police do not capture details of injured persons who die subsequent to the registration of FIRs and first round of investigation by the police officer.

In Chapter 2, my systematic review of the literature on the use of police records for injury surveillance showed that studies in this area have largely been confined to road traffic injuries. I found that the percentage of reporting of fatal injuries to the police was higher than the percentage of reporting of non-fatal injuries. Among non-fatal injuries, more severe injuries were more likely than minor injuries to be reported to the police. It also suggested that the availability of hospital records and trauma registries for injury surveillance is better in the High-Income Countries (HICs). In the Low-Income Countries (LICs) and Lower-Middle-Income Countries (LMICs) other sources of data are used more often, possibly due to a lack of proper maintenance of hospital records and trauma registries. The results of my systematic review also pointed towards better maintenance of police records in HICs and a higher awareness among victims regarding reporting of injury incidences to the police in these countries. My findings also underscored the need to alert people in Upper-Middle-Income Countries (UMICs), LMICs and LICs regarding the reporting of injuries to the police, and the needs for: simplification of procedures for such reporting; the training of police personnel; and for better ascertainment and maintenance of injury records by the police.

In India, the information received by the police pertaining to a crime, including an accident, is required to be recorded at local police stations in a prescribed format, known as the ‘First Information Report’ (FIR).[92] An FIR format is enclosed as **Appendix-1.** These FIRs are a potential data source for an injury surveillance system.[161] This chapter presents a study that was undertaken to: identify the minimum data set (MDS) recommended for injury surveillance; develop a tool for the extraction of MDS data from FIRs; evaluate whether FIRs contain this MDS; and to assess the inter-rater reliability of a tool designed for data extraction from FIRs.

3.2 Material & Methods

3.2.1 Study design, settings and participants

This was a cross-sectional study set in Delhi, India and was based on FIRs of accidents registered from 1st January to 31st December 2017. Injuries included in this study did not include psychological harms. A list of all accident FIRs was first obtained from Delhi police, then FIR documents were downloaded from the Delhi Police website.[163]

3.2.2 Data extraction tool development

I conducted a systematic search of the published and grey literature to identify minimum data sets (MDS) recommended for injury surveillance. Standard classifications and codes recommended by WHO and other international guidelines were identified.[17,164,165] I then designed a tool for the extraction of these data from FIRs. The tool was reviewed by two injury experts and then by three professionals, each qualified at least as Masters in Public Health.[166,167] In a third round of development, the tool was applied by four data extractors who were subsequently invited for a focus group discussion. A set of instructions for data extractors when using the tool was also prepared.

3.2.3 Sample size

A random sample of 50 FIRs was selected from all 8,638 FIRs pertaining to accidents reported in Delhi in 2017. The sample size for the inter-rater reliability study was based on published recommendations.[168-170] All 8638 FIRs were serially numbered. A list of 50 random numbers in the range of 1 to 8638 was then generated from the website RANDOM.ORG. FIRs having serial numbers corresponding to these random numbers were selected for inclusion in the study. A sample size of 50 participants was also sufficient to allow us to estimate percentage availability of data items with reasonable precision (i.e., to within 13% of the true percentage with 95% confidence). Data were extracted from these 50 FIRs using the data extraction tool. The percentage availability of each MDS data item in respect of each of the 58 persons reported injured in these FIRs was calculated.

3.2.4 Estimation of Inter-Rater Reliability

To assess inter-rater reliability of the data extraction tool, I first conducted data extraction and data extraction then was then conducted a second time by one of the professionals who had helped me to test the tool. I calculated Cohen's kappa coefficient (κ) as the measure of inter-rater reliability.[171-172] Cohen's kappa gives a quantitative measure of the magnitude of agreement between observers after taking into account any agreement due to chance alone. Cohen’s kappa was calculated using the following formula:[173]

$$\text{Cohen's Kappa (K)} = \frac{(P_o - P_e)}{(1 - P_e)}$$

$$\text{Where: } P_o = \text{Proportion of observed agreement}$$

$$P_e = \text{Proportion of agreement by chance alone}$$

Kappa values range from -1 to 1, where 1 is perfect agreement, and 0 is no agreement beyond what would be expected by chance. Kappa values <0 indicate no agreement or "poor agreement".[174] I interpreted the estimates of Cohen's kappa using the standard for strength of agreement provided by Landis and Koch (1977).[174] Accordingly, a kappa value of "0" indicates "Poor-agreement"; 0.01–0.20 indicates "Slight-agreement"; 0.21–0.40 indicates "Fair-agreement"; 0.41– 0.60 indicates "Moderate-agreement"; 0.61–0.80 indicates "Substantial-agreement"; and 0.81–1.0 indicates "almost-perfect-agreement".[174] After obtaining values of kappa, I calculated 95% confidence intervals for each kappa value.

3.3 Results

3.3.1 Dataset requirements for an injury surveillance system

My literature search yielded 24 studies including 13 national and international guidelines and data standards. These included three sets of WHO guidelines.[160,165,175] WHO guidelines recommend 8 data items which must be collected for injury surveillance: a person identifier, age and sex of the injured person, intent, place of injury, nature of activity when the injury happened, cause and nature of injury.[160,165,177] These 8 data items were included as the MDS in my data extraction tool. In addition, if a data item was recommended as an MDS data item by the majority of the remaining 10 guidelines, I also included it in the tool. This yielded 4 further data items: date and time of injury, occupation and residence of the injured person.

3.3.2 Development of the Data Extraction Tool

The draft data extraction tool was first reviewed by two international experts on injury prevention. Based on their recommendations, local terms used in the tool were replaced with internationally accepted ones. I then sent it to three professionals in public health for their comments, which led to me reorganising some of the questions and simplifying the language of others. Subsequent testing of the tool by four data extractors led to further improvements. Questions that were not clear were modified. More response codes were added to some questions; for example, code ‘100’ was added to indicate that a question was not relevant. I estimated the inter-rater reliability of the tool and I found Kappa values were between 0.40 and 1.0, indicating between ‘substantial’ to ‘almost perfect’ agreement for extraction of the MDS items between the two raters. Subsequent focus group discussion with the four data extractors highlighted the following reasons for poor agreement: a lack of clarity between some response options; too many response options for some questions; multiple response options for a few questions, and a lack of information about type of health facility and legal status of colony (means an area of land divided into plots or flats for residential purpose) These issues were addressed in the final revised tool.

3.3.3 Availability of information on MDS

The data extracted from the random sample of 50 FIRs indicated a total of 58 persons were injured in these 50 incidents reported to the Delhi Police. Results on the percentage availability of information on the 12 MDS items in respect of these 58 victims are presented in Table-3.1. FIRs contained complete information on 5 of the 12 MDS items: Sex/Gender, Date, Time, Place and Intent; for 4 items, information was over 80% complete: name (93.1%), residence (86.2%), cause (93.1%) and activity (86.2%) of the injured person; for 3 items, information was over 30% complete: age (67.2%), Occupation (32.8%), nature (41.4%) of the injury.

Table-3.1: Percentage availability for each MDS data item for 58 injured persons			
	Data item	**Numbers of injured persons for which information was available**	**Percentage availability**
1	Unique Identification/Name of the injured person	54	93.1
2	Age	39	67.2
3	Sex/Gender	58	100
4	Occupation	19	32.8
5	Residence	50	86.2
6	Date of Injury	58	100
7	Time of Injury	58	100
8	Place of injurious event	58	100
9	Intent	58	100
10	Mechanism/External cause of injury	54	93.1
11	Nature of injury	24	41.4
12	Nature of activity	40	86.2

The percentage availability of data varied between fatal and non-fatal injuries. Of the MDS variables for which information was not 100% complete, the percentage availability of data was higher in case of fatal injuries for: Age, Occupation, Mechanism/External cause of Injury, Nature of injury and Nature of activity. The percentage availability of data was higher for non-fatal injuries in case of Unique Identification, and Residence of victim. The differences in the percentage availability of data between fatal and non-fatal injuries are shown in Table 3.2.

Table-3.2: Difference in availability of information on MDS in fatal and non-fatal injuries			
	Data item	**Percentage Availability**	
		Fatal	**Non-Fatal**
1	Unique Identification	33.3	96.4
2	Age	100	65.5
3	Sex/Gender	100	100
4	Occupation	66.7	30.9
5	Residence	33.3	89.1
6	Date of Injury	100	100
7	Time of Injury	100	100
8	Place of injurious event	100	100
9	Intent	100	0
10	Mechanism/External cause of injury	100	92.7
11	Nature of injury	100	38.2
12	Nature of activity	0	90.9

3.3.4 Inter-Rater Reliability

Cohen's kappa values were found to range between 0.87 and 1 indicating 'almost perfect' agreement between the two data extractors when extracting data for the MDS. The Kappa coefficients calculated for the MDS data items along with number of response options in the tool, standard errors and 95% confidence intervals are presented in Table-3.3.

Table-3.3: Agreement between two data extractors in extracting MDS data items from 50 FIRs					
	Data item	**No of Response Options in data extraction Tool**	**Cohen's kappa Value**	**SE**	**95% Confidence Intervals for the kappa estimates**
1	Unique identification	2	1	0.00	1
2	Age	2	1	0.00	1
3	Sex/Gender	3	1	0.00	1
4	Occupation	19	1	0.00	1
5	Residence	2	1	0.00	1
6	Date of injury	2	1	0.00	1
7	Time of injury	2	1	0.00	1
8	Place of injurious event	2	1	0.00	1
9	Intent	2	1	0.00	1
10	Mechanism/External Cause of Injury	15	0.87	0.01	0.86 – 0.88
11 (a)	Nature of injury (non-fatal)	19	1	0.00	1
11 (b)	Nature of injury (fatal)	19	1	0.00	1
12 (a)	Nature of activity (non-fatal injury)	18	0.97	0.02	0.80 – 0. 98
12 (b)	Nature of activity (fatal injury)	18	0.97	0.02	0.95 – 0.99

3.4 Discussion

3.4.1 Principal findings

I identified 12 data items that form the Minimum Data Set (MDS) for injury surveillance. FIRs were found to contain complete information on 5 of the 12 MDS data items. For 7 MDS items, information was less complete. Missingness of data was "substantial" (i.e. >10%) for 5 data items and "slight" for 2 data items.[173] The reliability of data extraction from the FIRs was assessed using Cohen's Kappa and inter-rater agreement was found to be "almost-perfect".

3.4.2 Strengths and weaknesses of the study

This is the first study to evaluate the use of FIRs of Indian police for injury surveillance. Studies from other countries have reported on completeness of police records as a source of data on road traffic and other injuries, but none of them have evaluated the suitability of police records for an injury surveillance system.[136,178] No study has so far reported on the use of police records to ascertain construction injuries. Moreover, this is probably the first study from India which has identified the MDS recommended for injury surveillance. The systematic extraction of data from police records using a data extraction tool and an assessment of the tool's reliability has also been done for the first time. In India, where data on injuries are not routinely published, this study contributes a new area of research on injury epidemiology.

The use of Cohen's kappa for estimating inter-rater agreement, requires certain conditions to be met: cases rated must be independent of each other, the raters must work independently of each other, rating categories must be mutually exclusive and exhaustive, the sample of cases used in the reliability data should be a random sample, and the data extractors used for inter-rater reliability are persons who are not difficult to find.[173] All these conditions were met in this study.

Another limitation of the study lies in the inherent limitation of police records as a source of information on injuries, including under-reporting, bias towards fatal and severe injuries, and recording of information without going into veracity of claims.[105] One more limitation of the study is that the data extraction tool was reviewed by public health experts and not by someone from police department and experts in medicine dealing with trauma and injuries.

3.4.3 Meaning of the study: possible mechanisms and implications for clinicians or policymakers

Missing data increase the risk of bias and may undermine the validity of research results.[179] However, the problem of missing data is ubiquitous and unavoidable in epidemiological research.[179,180] Even in the developed countries, electronic health records are reported to have considerable missing data.[181] The problem of missing data is well-recognised in health surveillance systems and has been dealt with by various methods.[182] Moreover, in injury surveillance, imperfect data may still be a valuable source of information; work should therefore continue on improving the quality of these data.[103] The challenge of missing data can be addressed using "Multiple-Imputation" or Full-Information-Maximum-Likelihood-Method".[178] Thus, although I have shown that FIRs do not contain complete information on all 12 MDS data items, FIRs could still usefully form the basis of an injury surveillance system provided that any missing data are imputed. Information on the MDS data item "nature of injury" which was recorded in only 41.4% cases, might be supplemented by information from other documents such as hospital records or from the police record named charge sheet which has a medico-legal report attached. Efforts could also be made to improve recording of data in FIRs by training police personnel. FIRs could become an important component of an integrated injury surveillance system based on multiple data sources being studied in India.[161]

FIRs may not ascertain all injuries and the percentage of injuries ascertained by police records could be less than those ascertained by hospital records, as has similarly been found in the UK.[183] However, health records in India are either manual or are in disparate computer systems without inter-operability or cross-sharing.[115] FIRs are presently a better source for obtaining country-wide information on injuries because of the availability of FIRs from all over India in a centralized, web based system, the Crime and Criminal Tracking Network & Systems (CCTNS).[116] The system is now operational in 94.8% of police stations in India and 5,176,457 FIRs were registered in 2019, using CCTNS.[184] Moreover, although all injuries may not be reported to the police, the total number of injuries occurring can be estimated from FIRs using capture-recapture methods.[185] Estimates of the total number of injuries that occur can help to make the problem of injuries more visible to policy makers and may trigger an appropriate policy response.

The Sections of the Indian Penal Code dealing with unintentional injuries, only consider acts of negligence causing injuries to other persons to be criminal offences and so FIRs may only be registered for such acts. Thus, self-sustained unintentional injuries are not required to be reported to the police and would therefore be outside the scope of any such injury surveillance system. Moreover, access of people to police to register a FIR is affected by their socio-economic class and place of residence in an urban or a rural area. This could make FIRs less representative of all injuries and limit their use in an injury surveillance system.

My study can help policy makers in India in designing an injury surveillance system based on police FIRs. It can also guide on the revision of the FIR format to enable the better collection of information on the MDS. It also makes a case for the need for training of police personnel in recording information on injuries in FIRs.

3.5 Conclusion

Information on injuries can be reliably extracted from FIRs using a data extraction tool designed in this study. Although FIRs do not always contain complete information on all 12 data items in the MDS for injury surveillance, they may still usefully form the basis of an Indian injury surveillance system provided that any missing data are imputed. Alternatively, complete case analysis may also be used where in each analysis performed, the records having missing values in the variables involved in that analysis are ignored.

In the absence of any other comprehensive data source, efforts can be made to improve the quality of data extraction and deal with missing data to make FIRs better suited for injury surveillance.

India is a diverse country with different languages being used in police records by different states and with possible differences in the skill sets of police personnel. It may therefore be helpful to repeat this study in other parts of India. The suitability of the charge-sheet, another police record, for injury surveillance could also usefully be the subject of future research. Further research is presented in the next chapter that seeks to estimate the percentage of all injuries in the population that are ascertained by FIRs.

4. Completeness of Ascertainment of Construction Site Injuries Using First Information Reports (FIRs) of Indian police: Capture-Recapture Study

This chapter has been accepted for publication in the "Indian Journal of Occupational and Environmental Medicine", a peer reviewed journal (**Appendix-9**)[186]

4.1 Introduction

4.1.1 Background

Occupational injuries, which kill approximately 335,000 persons annually, are a serious public health concern.[14] With a 30-40% share, the construction industry is the lead contributor to occupational injuries.[13,45] Workers in the construction industry are at five times greater risk of an accident compared to other industries.[6] The burden of construction injuries is also unequally distributed, with construction sites in developing countries ten times more dangerous than those in developed countries.[7] In India, construction is the second biggest cause of workplace accidents after mining, contributing 24.2% to total occupational accidents.[6] However, comprehensive data on construction site injuries are lacking, as India does not publish statistics on occupational injuries and illnesses.[7] This has also been cited as one of the reasons for inadequate research on construction safety in India.[6]

4.1.2 Injury Surveillance

To develop public health strategies that reduce the incidence of injuries, public health professionals need to know about the distributions, types and causes of these injuries.[88] An injury surveillance system can provide quantitative estimates of injury morbidity and mortality, and can be used to: identify trends and underlying causes, detect clustering of injury events, identify potential risk factors and circumstances related to injury occurrence, help in designing interventions, and in evaluating their impacts.[86,103,105,156]

4.1.3 First Information Report (FIR)

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).[92] In the previous chapter I found that information on injuries can be reliably extracted from FIRs using a data extraction tool.[186] I concluded that although FIRs do not always contain complete information on all 12 data items in the Minimum Data Set (MDS) required for injury surveillance, they may usefully form the basis of an Indian injury surveillance system provided that any missing data are imputed.

There is good evidence that police records tend to under-report injury cases.[139,151,187-189] However, these studies were confined to road traffic injuries. No study could be found in the literature on completeness of police records in the reporting of construction site injuries. Therefore, this study was undertaken to estimate the completeness of ascertainment of construction site injuries using FIRs of police in Delhi, India.

4.2 Materials and Methods

4.2.1 Study design

This was a two-sample capture-recapture study. The capture-recapture method was initially used in zoology to estimate wild animal populations.[185] It is an indirect method based on the degree of overlap between different samples. In this method, independent samples of animals are captured sequentially, tagged, and released. Thereafter, they are recaptured and counted. Based on the number of animals captured and then recaptured in such multiple, overlapping samples, the size of the animal population may be estimated.[190]

The method has been used in epidemiology, to estimate morbidity and mortality using multiple, overlapping, but incomplete data sources.[191] The method has also been used to estimate injury morbidity and mortality.[143,187,189] The two capture-recapture data sources in the epidemiological context may be two lists relating to the same disease like hospital records and death certificates. The data sources may be original (for example a list of cases from a hospital), or analytic (a list constructed by the investigator from one or more original sources).[185] The method has the potential to reduce the costs of disease registers, reduce bias in the estimation of incidence and comparison of population groups.[185] But to achieve valid and reliable results, the application of capture-recapture method requires certain critical assumptions to be met. However, even when the assumptions are not met, capture-recapture method may provide useful estimates of considerable epidemiological value.[191]

I obtained the data for accidents reported to the police, Employee State Insurance Corporation (ESIC), and Commissioners of Workmen Compensation of Delhi Government from 1st January 2017 to 31st December 2017. FIRs of construction site accidents were downloaded from the Delhi Police website and data were extracted.[163]

4.2.1.1 First Sample - First Information Reports (FIRs)

The first sample was data on construction site injuries extracted from FIRs downloaded from Delhi Police website.

4.2.1.2 Second Sample - Employee State Insurance Corporation (ESIC) records combined with records of claims for compensation for injuries sustained in the course of employment

According to the Employees' State Insurance Act (1948), employers having more than 10 workers must file a report of all accidents at worksites.[94]Another Indian law, *The* Workmen's Compensation Act (1923) provides for payment of compensation by employers to their employees for injuries sustained by accidents during the course of their work.[5] Such claims for compensation are to be filed with the Commissioner of Workmen Compensation of Delhi Government. The second 'recapture' sample therefore comprised data on construction injuries reported to the Employee State Insurance Corporation (ESIC), combined with data on claims for compensation filed with the Commissioners of Workmen Compensation. This combination of datasets was made because ESIC largely covers workers employed in the 'organised' sector (enterprises employing 10 or more workers), while people going to the Commissioners of Workmen Compensation with claims are largely from the 'unorganised' sector (enterprises employing less than 10 workers).[192] Thus, once any duplicates had been removed, the combination of these two datasets provided a more complete, and independent source of data for this study.

4.2.2 Case definitions

A case was defined as any injury sustained at a construction site in Delhi. A site was classified as a construction site based on the definition of building and other construction work provided in the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act-1996.[1] A construction worker was defined as any person engaged in building and other construction work.

4.2.3 Record linkage

I created separate databases, using Microsoft Excel, for the data extracted from each of the two samples, described above. Each database contained the name, gender, and age of each injured person, the date and place of the injury event, the name of the employer and the source of the data. In the next step, the two databases were merged into one Microsoft-Excel worksheet. The combined data were then sorted into alphabetical order by name. Record linkage of these two databases was designed carefully because defining linkage conditions too tightly may cause some correct matches to be to be missed, while weak linkage criteria may produce a large number of incorrect matches.

4.2.3.1 Linkage criteria

The process for the linkage of injury records in the two samples was as follows:

Linkage stage 1

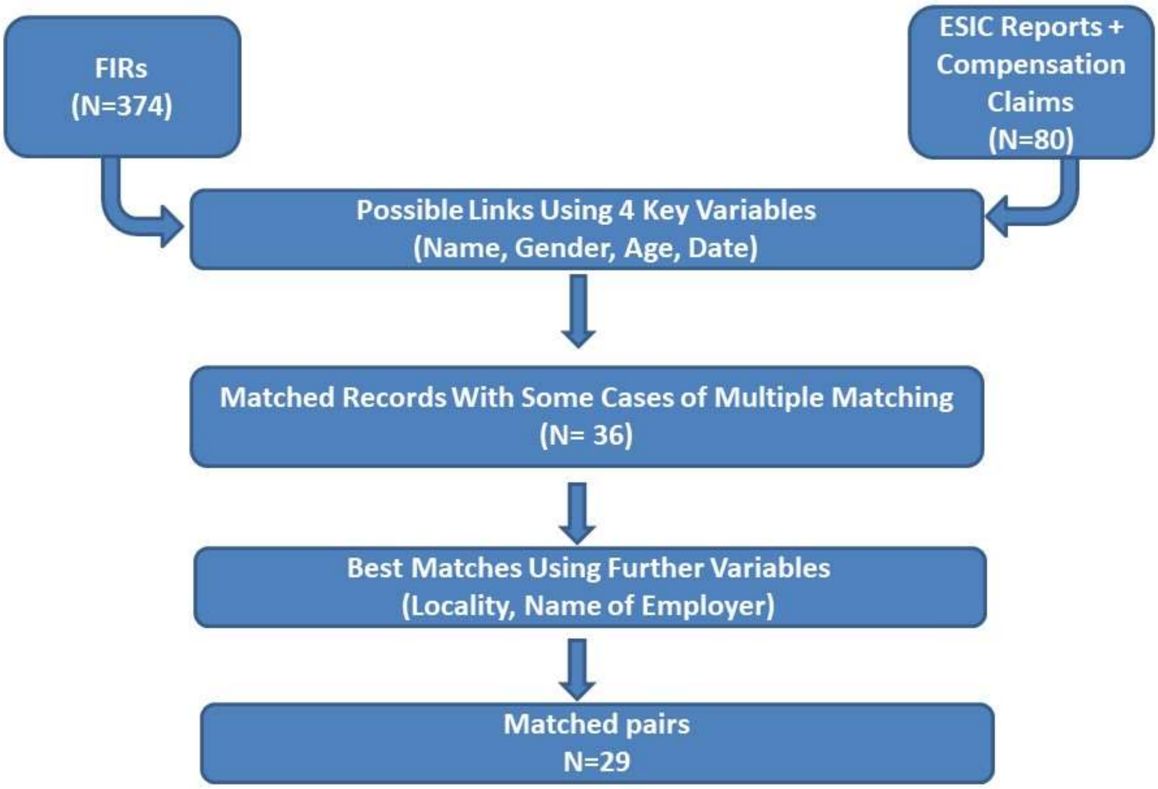
In the first stage of linkage, I generated matched pairs of records by matching on four identifying variables: (i) name, (ii) gender, (iii) age of the injured person, and (iv) date of the injury event. Our aim was to produce a manageable number of possible matched pairs, without excluding any correct matches. While matching, I allowed for some disagreement in all variables, except gender, to allow for inaccuracies in recording or for genuine differences between the two datasets. For (iv) date of the injury event, I allowed for differences of up to three days, as injuries are sometimes reported late and the victims may not be able to recall the precise date of the injury event. For (ii) age of the injured person, I allowed for differences of plus or minus 5 years, as age was not recorded in either of the two datasets on the basis of date of birth, but instead by an estimate of age given by the injured person, or by friends or relatives of the injured person. Spelling errors in (i) name of the injured person were ignored and the name was considered as matched if it sounded phonetically the same in the two databases.

This linkage process resulted in some police records in the first sample linked to more than one {ESIC + Labour department} record in the second sample, and some {ESIC + Labour department} records linked to more than one police record.

Linkage stage 2

In the second stage of linkage, I resolved the cases involving more than one match using information contained in two additional variables: (v) locality of the injury event and (vi) name of the employer. Spelling errors in both of these variables were ignored. Where the name of the injured person was not available in either or both databases, an injured person was considered as matched if the other five variables matched. An overview of the matching process is depicted in Figure-4.1. After completing the matching process, names and localities were replaced by codes to anonymise the records.

Figure-4.1: An Overview of Matching Process



4.2.4 Setting and Participants

This study was conducted in Delhi the capital of India. The city is home to 19 million people and has over 600,000 construction workers.[6] The participants were the people injured at a building or other construction work site in Delhi from 1st January to 31st December, 2017. Victims of intentional injuries, including intentional self-harm, sexual assaults etc. were excluded.

4.2.5 Statistical methods

4.2.5.1 Estimation of total number of construction injuries in Delhi

The total number of construction injuries in Delhi was estimated using the Chapman estimator.[188,189] Estimation was done using the following formula:[185]

$$Total\ Injuries\ (N_t) = \frac{(P_t + 1)(E_t + 1)}{(m + 1)} - 1$$

Where P_t is total number of construction injuries as per police FIRs (first sample); E_t is total number of construction injuries as per the combined database of ESIC and Labour Department (second sample); m is the number of construction injuries identified in both databases (i.e. where data linkage resulted in a match).

4.2.5.2 Precision of the estimate of total number of construction injuries in Delhi

The precision of the estimate was quantified by a confidence interval calculated through a variance-based approach using the following formula:[185]

$$Variance = \frac{(P_t + 1)(E_t + 1)(P_t - m)(E_t - m)}{(m + 1)^2\,(m + 2)}$$

An approximate 95% confidence interval (CI) for the estimate of N_t was calculated using the following formula:

$$95\%\ CI = N_t \pm 1.96\ \sqrt{\text{Variance}}$$

Where N_t is the estimated total number of construction injuries.

After estimating the total number of injuries, the percentage of injuries captured by FIRs was calculated to estimate the completeness of ascertainment of injuries by FIRs.

4.2.6 Missing FIRs

Documents of 90 FIRs were found missing on Delhi Police website which were obtained from the police station concerned. Similarly, in case of ESIC, the missing incident reports were obtained from the regional offices of ESIC. Offices of Commissioners of Workmen Compensation were also visited to get complete records.

4.2.7 Assessment of reporting bias

Subsequently, I also assessed reporting bias in the injuries to construction worker ascertained by the First Information Reports as a separate study which is attached as **Appendix-10**.

4.3 Results

Analysis of FIR data revealed that 8,638 accidents were reported in Delhi from 1st January 2017 to 31st December, 2017. Of these, 7,374 were road traffic accidents and 1,264 other accidents including 321 construction site accidents. Further analysis indicated that in the 321 incidents at construction sites reported to the police, 374 people were reported injured, 110 fatal and 264 non-fatal. ESIC received 798 incident reports during this period of which 13 cases, all of non-fatal injuries, pertained to construction site injuries. Commissioners of Workmen Compensation received 321 compensation claims during this period, of which 67 cases were of construction site injuries (48 fatal and 19 non-fatal). The combined data of ESIC and the Labour Department indicated that 80 people were reported injured, 48 fatal and 32 non-fatal. The process adopted for selection of participants for the study is depicted in Figure-4.2

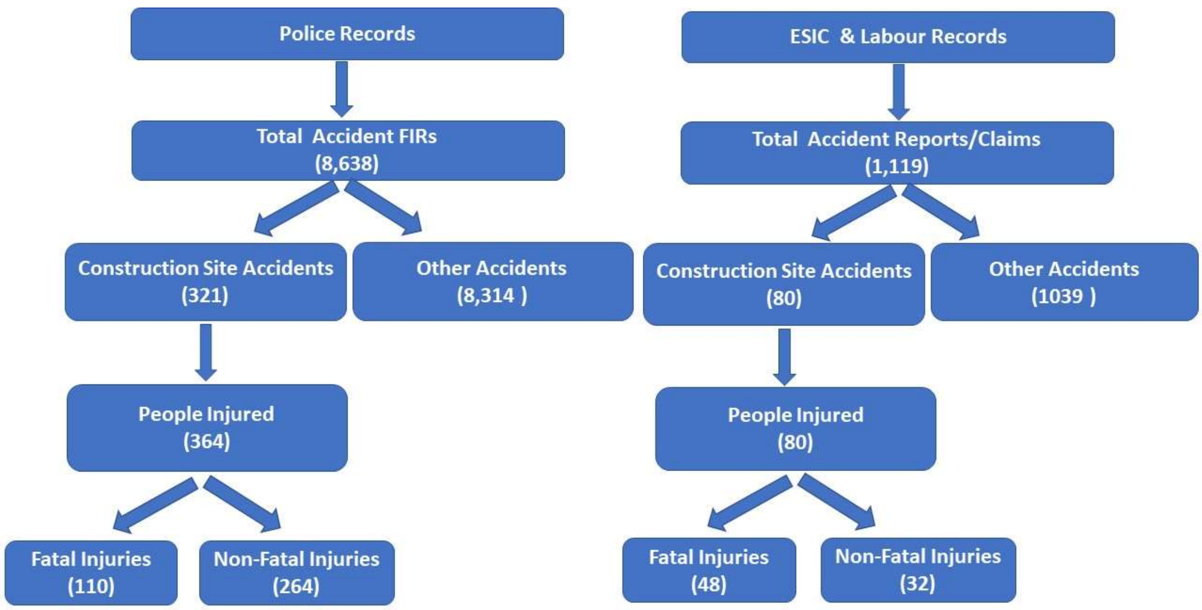


Figure-4.2 : Process of Selection of Study Participants

Record linkage of injured people in the two databases yielded 29 matched cases (20 fatal and 9 non-fatal). Using the Chapman estimator, I estimated that the total number of construction injuries in Delhi was 1,011 (95% CI: 873 to 1,149). The total number of non-fatal construction injuries was estimated to be 873 (95% CI: 765 to 1,053). The total number of fatal injuries was estimated to be 258 (95% CI: 221 to 295). The estimated percentages of total, fatal, and non-fatal construction injuries captured by FIRs were 37%, 42.6%, and 30.2% respectively (table-4.1).

Table-4.1: Construction injuries in Delhi in the year 2017

Source	Number of injuries sustained		
	Fatal	Non-fatal	Total
FIRs (% ascertainment)	110 (42.6%)	264 (30.2%)	374 (37.0%)
ESIC and Labour Department combined	48	32	80
Matched records	20	9	29
Capture-recapture analysis estimate of total numbers (95% CI)	258 (221 to 295)	873 (765 to 1053)	1011 (873 to 1149)

Subsequent study on reporting bias **(Appendix-10)** showed that there is evidence for differences in the percentage ascertainment by FIRs of both fatal and non-fatal injuries according to gender: FIRs ascertained a greater proportion of all injuries to female workers than to male workers. There was 100% ascertainment of non-fatal injuries by FIRs for female workers. There is evidence of a gender bias in the reporting of non-fatal injuries to the ESIC and the Commissioners of Workmen Compensation against female construction workers.

4.4 Discussion

4.4.1 Principal findings

This study found that a little over one third of all construction site injuries was ascertained by FIRs in 2017. Percentage ascertainment was higher for fatal than for non-fatal injuries.

4.4.2 Strengths and weaknesses in relation to other studies

Our results showed that the percentage of injuries captured by police reports are comparable to those reported by studies in other countries.[109,111,138,189] Our estimate of 258 fatal injuries in a year in Delhi is also close to an earlier estimate of 256 fatal accidents every year at construction sites in Delhi between 2008 and 2012.[6]

4.4.3 Strengths and weaknesses

To the best of our knowledge, this is the first study of the completeness of police reports in the ascertainment of construction site injuries. Moreover, no study has previously used the capture-recapture method for estimating the number of construction site injuries in a population. As construction injuries tend to be under reported, the capture-recapture method may help to estimate their true magnitude in a population. As construction safety is a less researched area in India, this study bridges an important gap in the literature.

This study also has certain weaknesses: Accidents at construction sites will include motor vehicle crashes. If such incidents were classified in FIRs as Road Traffic Accidents instead of construction site accidents, they will not have been included in our FIR data. This is likely to induce reporting bias leading to an underestimation of construction injuries.

The capture-recapture method used in this study is also based on a set of assumptions.[194,196] The first assumption is that the study population should be closed. In our case, the capture and recapture samples took place at the same time (i.e. 2017) reducing chances of any change in the population between the two captures and thus the first assumption holds. A second assumption is that both data sources should cover the same geographical area and time period. This assumption has been fully met as our study covers the whole of Delhi and the data were obtained from different sources for the same period. A third assumption is that the two sources of ascertainment should be independent and that members of the population have the same probability of being captured. In our case, the Delhi police, ESIC and Commissioners of Workmen Compensation are independent and do not share data with each other. People report injuries to these organizations independently of each other. Thus, this assumption is also met. A further assumption is the perfect identification of subjects of interest. This is fulfilled to a large extent as the police tend to record details of the injured accurately due to legal requirements. Similarly, people filing compensation claims with the Labour department and employers filing incident reports in the ESIC portal are also assumed to provide correct details. A further assumption is the perfect identification of common records without missed cases or false matches, i.e., perfect linkage of data from the two data sources: To fulfil this assumption, I took all possible care to ensure perfect linkage of records. A final assumption is homogeneity of capture. This means that all injuries should have the same probability of becoming known to the police as well as to the ESIC and the Labour Department. This assumption is also met as the employers were mandated by the Law to report injuries to the police, ESIC as well as the Labour Department. If employers were under-reporting injuries sustained by their workers, it is likely that the probability of under-reporting injuries would not differ between these organisations.

4.4.4 Bias

As described above, efforts were made to eliminate bias from this study. I included all accident cases reported to the Delhi police, ESIC and Commissioners of Workmen Compensation from 1st January to 31st December 2017. Information bias was possible on account of non-availability of some FIRs on the website of the Delhi police. However, this was reduced by obtaining such FIRs from the police station concerned.

Similarly, in the case of ESIC and Commissioners of Workmen Compensation, efforts were made to obtain details of all the cases by visiting the offices personally. The chances of response bias were reduced by collecting the data from centralized, computerised databases and then obtaining additional details from multiple offices and police stations.

4.4.5 Meaning of the study and future research

This study showed that FIRs of Delhi police are a good source of information on fatal construction injuries. However, they miss a proportion of non-fatal injuries, ascertaining a little over one third of construction injuries overall. Country-wide data on injuries can be obtained from FIRs through the Crime and Criminal Tracking Network & Systems (CCTNS).[116] Many countries have used hospital records for injury surveillance. However, the hospital records in India are either manual or in disparate computer systems without inter-operability or cross-sharing.[115] Moreover, the hospital records do not classify injuries by type like construction injuries, road traffic injuries and other injuries.[115] Thus, FIRs can provide useful data for undertaking construction safety research in India. Further research is needed to identify reasons for some injuries not being reported to the police, in order to help to develop a strategy to improve the completeness of ascertainment of construction site injuries for the future.

4.5 Conclusion

A little over one third of all construction site injuries are ascertained by FIRs. Ascertainment is higher for fatal than for non-fatal injuries. In the absence of any other data source for construction injuries in India, FIRs may be used as the basis of a construction injury surveillance system, recognising that any estimates made using these data must be adjusted to allow for the approximately two-thirds of injuries not reported to the police. There is evidence of a gender bias in the reporting of non-fatal injuries to the ESIC and the Commissioners of Workmen Compensation against female construction workers. FIRs ascertain a greater proportion of all injuries to female workers than to male workers.

5. Epidemiology of construction site injuries in Delhi, India

Protocol of this study was published by LSHTM Research Online.[95]

5.1 Introduction

Injuries cause five million deaths worldwide annually and pose a formidable public health challenge to every country.[97,98] Deaths and disabilities due to injuries cause substantial societal costs, productivity losses, and a financial burden for the treatment and rehabilitation of those injured.[106] The construction sector is known for high rates of fatal and non-fatal occupational injuries and disabilities. [105,160,197-205] Construction is likely to contribute 20% to Disability-Adjusted Life Years (DALYs) by 2020.[97,159] Globally, poor attention to safety is associated with fatal and non-fatal construction injuries.[8,27,198-206]

Demographic and socioeconomic transitions have added to the burden of injuries, especially in low and middle-income countries (LMICs).[112] Paradoxically, despite their burden and impact, injuries have received limited attention as a public health problem in many LMICs.[112,113] Inaction is largely rooted in poor records and accident reporting systems which make the extent of the problem less visible to policy makers.[27,70,204-214] Knowledge of accident-related costs and the impact of safety programs on cost reduction has also been found lacking among people in management positions in the construction industry.[27]

In India, the construction industry is powering both growth of employment and Gross Domestic Product (GDP);[215] it accounts for 8.2% of GDP and employs 12% of the workforce.[76] Construction is the second biggest source of employment after agriculture.[216] Construction is also the second biggest cause of workplace accidents in India, after mining, representing 24.2% of total occupational accidents.[6] Delhi, the capital of India attracts construction workers due to its geographical centrality and high wages.[85] It was estimated that 256 fatal construction accidents occurred in Delhi every year between 2008 and 2012.[6] As injuries are both predictable and preventable, it is important to put in place measures to prevent accidents leading to injuries.[30,217.] A first step in the public health approach to any health problem is to determine the magnitude, scope, and characteristics of the problem.[21] Current injury literature lacks studies on the epidemiology of injuries in the construction sector in India. India does not report and publish statistics on occupational injuries and illnesses.[7] Research studies are therefore needed to inform the field of construction injury epidemiology in India.

While population-based injury surveillance systems are desirable, such infrastructure is unlikely to be established in India for several decades.[218] In many countries, data on injuries are collected by the police.[121] In the absence of any other comprehensive dataset for construction site injuries in India, police records are a potential data source. In this thesis, I have shown that the First Information Reports (FIRs) of the Indian police have the potential to provide data for injury surveillance. In this chapter I will use these data as the basis of an epidemiological investigation into construction site injuries in Delhi.

5.2 Aims

The overall aim of this study was to describe the epidemiology of construction site injuries in Delhi, India and to thereby generate information that may help to mitigate the burden of injuries to construction workers in India. Specific aims were: to estimate incidence rates of construction site injuries; to assess risk factors for construction site injuries and to estimate relative risks by calculating injury rate ratios; to investigate trends.

5.3 Materials and method

5.3.1 Study design

This was a retrospective cohort study based on data extracted from the FIRs of Delhi Police.

5.3.2 Setting

This study was conducted in Delhi, the capital of India. The study included all construction workers injured due to incidents at construction sites in Delhi reported to the Delhi Police during the three-year period from 1st January 2016 to 31st December 2018.

5.3.3 Participants

All construction workers who reported an unintentional injury to the Delhi police in an incident at building and other construction sites during the study period were included. 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), guided inclusion of injured persons in the study.[1]

5.3.4 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 FIR.[92] In Chapter-3, I showed that information on injuries can be reliably extracted from FIRs using a data extraction tool.[153] I also proposed that although FIRs do not always contain complete information on all 12 data items in the MDS required for injury surveillance, they might usefully form the basis of an Indian injury surveillance system provided that any missing data are imputed.[153] In case data imputation is not feasible, complete case analysis may also be used where in each analysis performed, the records having missing values in the variables involved in that analysis are ignored.

For this study, I first obtained data from the Delhi police that identified accident cases reported to them, viz: FIR number, year, name of police station, and name of district. I then downloaded the FIR documents from the Delhi Police website relating to each incident.[163] I examined these FIR documents to identify all accidents reported at building and other construction sites. If a FIR document was unavailable on the Delhi Police website for any accident, I obtained the document from the police station concerned.

5.3.5 Data Extraction

I extracted data from FIRs using the extraction tool designed in Chapter-3.

5.3.6 Sample size and power

In table 1.1, the injury rate per 100,000 population in the South-East Asia Region (including India) is 99. So, I assumed that this rate would approximate the injury rate of unskilled construction site workers in India. I also hypothesised that electricians are at 3 times higher risk of injury than unskilled due to the hazards of working with electricity. Thus, I hypothesised that these rates are 99 per 100,000 workers versus 297 per 100,000 workers (i.e., 0.001 versus 0.003 respectively) As there were 411,517 unskilled workers and 3553 electricians in 2017, my study had 85% power to detect this difference at the 5% level of significance. [Stata code used: “power twoproportions

0.001 0.003, n1(411517) n2(3553)"]. Details of command in Stata used to estimate the power of my study is at **Appendix-11**.

5.3.7 Denominators

Authoritative data on the size of the construction workforce and its distribution by trade, are not available in India.[219] Therefore, I estimated the number of construction workers in Delhi using data on the total population of Delhi, the labour force participation rate, and the proportion of workers in the labour force that works in construction.

The population of Delhi as per the 2011 population census was 16.78 million, comprising 8,987,326 males and 7,800,615 females.[220] The estimated annual growth rate of the population is 2.12%.[220] The labour force participation in Delhi was 59.7% for males and 12.4% for females.[220] In urban areas in India, the proportion of workers in the construction sector is 11.7% among males and 4.1% among females.[221] 97.5% of the population of Delhi lives in urban areas, so I assumed that the entirety of Delhi is an urban area.[220] Using these figures, I estimated the numbers of construction workers in Delhi by year and by gender.

5.3.8 Missing data

FIRs may not always contain complete information on all data items required for injury surveillance. As I showed in Chapter-3, in a random sample of 50 FIRs selected from all 8,638 FIRs pertaining to accidents reported in Delhi in 2017, data were incomplete for seven of the data items required for injury surveillance: name (93.1% complete), age (67.2%), occupation (32.8%), residence (86.2%), activity of the injured person (86.2%), cause of the injury (93.1%), and nature of the injury (41.4%). Missing data may reduce statistical power, introduce bias and undermine the validity of research results.[222]

5.3.9 Imputation method

I used Multiple Imputation (MI), one of the most popular approaches to handling missing data.[222-224] MI may help in reducing bias, increasing precision and allows individuals with incomplete data to be included in analyses.[225,226] I planned to create multiple plausible imputations for each missing value leading to several completed or imputed datasets. Thereafter, I planned to analyse each imputed dataset separately and identically to obtain estimates of odds ratios and corresponding standard errors. Finally, I planned to combine my results using rules derived by Rubin (1987).[227]

Specifically, I planned to impute missing values in the FIR data using chained equations imputation in Stata. I planned to impute each variable with missing values using a regression model whose type was to be selected according to the type of variable (continuous, binary, or categorical) and whose covariates were the other variables involved in the analysis (both those partially observed themselves and fully observed). Where feasible, interaction terms were to be included in these models to allow for the possibility of interaction effects. For continuous variables, I also planned to construct plots to examine the distribution of imputed values as compared to the distribution of the observed values, to highlight possible misspecifications of the imputation model(s). I planned to check convergence plots to ensure that a sufficient number of iterations were used.

5.3.10 Data Analysis

5.3.10.1 Construction incidents and injuries

For each year of the study period (2016-18), I analysed the number of construction site incidents reported to the Delhi police and the number of workers who sustained fatal and non-fatal injuries in these incidents. I also present the number of workers injured and number of workers that died per incident, trends in the number of workers injured (fatal and non-fatal) per incident and the proportion of fatal and non-fatal injuries sustained. I estimated injury rates per 100,000 construction workers per year with 95% confidence intervals (using the Stata command: "***cii means*** *population events*, *Poisson*" in Stata, where *population* is the denominator as described in 3.7 above, and *events* are the number of injuries in the population, and *Poisson* assumes that numbers of injuries follow a Poisson distribution) and also by using the formula:

$$Injury\ Rate = \frac{Number\ of\ Construction\ Injuries\ reported\ in\ a\ year}{Estimated\ total\ number\ of\ ConstructionWorkers} \text{ x } 100{,}000$$

I analysed the data using STATA/IC 16.[228]

5.3.10.2 Characteristics of construction site workers

Age group

For analysis of injury risk by age group, I used the age group categories suggested by the WHO Injury Surveillance Guidelines: <5 years; 5-14 years; 15-19 years; 20-21 years; 22-44 years; 45-64 years; and >64 years.[21]

Residence

For analysis of injury risk by place of permanent residence of the injured person I used three categories of residence:

- native of Delhi;
- migrant from other state of India;
- migrant from other country.

Gender

I estimated injury rates for the study period by gender. I also investigated gender differences in the nature of injuries sustained by type of construction work, by cause of accident, by mechanism of injury, and by body part injured.

5.3.10.3 Injury rate ratios

When population estimates were available by population subgroup characteristics (e.g., gender, trade), I calculated the injury rate per 100,000 workers for the subgroup of each characteristic. I estimated any differences in injury risk between different characteristic subgroups, by calculating the injury rate ratio comparing the rate in each characteristic subgroup with the rate in a referent category: e.g., ‘male’ for gender, and ‘unskilled worker’ for trade. When population estimates were not available by population characteristics, I calculated odds ratios to estimate relative risks, again comparing each subgroup of the worker characteristic with a referent category: e.g., ‘native of Delhi’ for residence, and the median age group for age group. I used logistic regression to estimate odds ratios with 95% confidence intervals.

5.3.10.4 Injury Trends

I investigated three trends in construction injuries:

i. **Yearly**: trends in numbers of incidents, numbers workers injured, and in the injury rates of fatal and non-fatal injuries over the three-year period 2016 to 2018;
ii. **Seasonal**: to investigate seasonal variations in construction injuries, I analysed injuries sustained in different seasons; I divided the year into three seasons:

Summer (March to June), Rains (July to October), and Winter (November to February).

iii. **Time of the day:** for this I divided the day into the time periods prescribed by WHO Injury Surveillance Guidelines: 00:00 to 03:59; 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.[21] I used the time period from 12:00 noon to 15:59 as the referent category when estimating rate ratios for relative risks at different times of the day.

5.3.10.5 Confounding

I investigated the joint effects of multiple risk factors on injuries through regression analysis. For this, I developed a regression model to investigate effects of several risk factors for injuries to construction workers. I developed the model using a step by step approach: I started with a simple univariable model to estimate the Odds Ratio (OR) for fatal injury comparing female and male workers; for this, I used the Stata command "***logistic*** *Fatal Gender*", where *Fatal* is my binary outcome variable (1=fatal injury, 0=non-fatal injury) and *Gender* is my binary exposure variable (1=female, 0=male).

Similarly, I built a simple univariable model to estimate the OR for fatal injury by age group using the Stata command "***logistic*** *Fatal* ***i.****AgeGroup*", where *Fatal* is my binary outcome variable (1=fatal injury, 0=non-fatal injury) and *AgeGroup* is my exposure variable (0=22-44 years, 1= 45-64 years, 2= >64 years, 3= 20-21 years, 4= 15-19 years, 5= 5-14 years, 6<5 years).

Next, I used a simple univariable model to estimate the OR for fatal injury by residence using the Stata command "***logistic*** *Fatal* ***i.****Residence*", where *Residence* is my binary exposure variable (0= Delhi, 1= Migrant from other Indian state, or other country). Developing my analysis further, I used the model to estimate the OR for fatal injury by year using the Stata command “***logistic*** *Fatal* ***i.****Year*”, where *Year* is my exposure variable (0=2016, 1=2017, 2=2018) .Finally I used the model to investigate the effect of season on fatal injuries to construction workers using the Stata command “***logistic*** *Fatal* ***i.****season*”, where *Season* is my exposure variable (0=winter, 1=rains, 2=summer).

In the final step, I built a multi-variable logistic regression model. I started with the investigation whether gender confounds the association with residence. For this, I used the Stata command “***logistic*** *Fatal* ***i.****Residence* ***i.****Gender*.” After this, I added another variable “Age Group” to the model, to adjust for any effects of age on the odds of a fatal injury, and I estimated the OR for fatal injury using the Stata command “***logistic*** *Fatal* ***i.****Residence* ***i.****Gender* ***i.****AgeGroup*”. As I was also interested in investigating trends over time, I added another variable “Year” to my multivariable model in the next step using the Stata command “***logistic*** *Fatal* ***i.****Residence* ***i.****Gender* ***i.****AgeGroup* ***i.****Year*”. Finally, I adjusted for trends in fatal injuries over different seasons by adding the variable “Season” to my multivariable model.

5.3.10.6 Construction trade and injuries

To estimate injury rates by trade, I first estimated the total numbers of construction workers in Delhi by trade using the proportionate distribution of manpower among various trades in the construction industry in India estimated by the National Institute of Construction Management and Research (NICMAR).[229] In this study I present the frequencies and percentage distribution of fatal and non-fatal injuries by the type of work in which the victim was engaged at the incident site.

5.3.10.7 Geographical distribution of injuries

Delhi comprises 14 territorial police districts, plus the Metro and Airport districts. I analysed the distribution of injuries among these 16 districts to identify any geographical concentrations of injuries.

5.3.10.8 Construction site characteristics as injury risk factors

i. **Ownership of construction site**- In my data extraction tool, I included four options to collect information on who owned the site where the incident was reported: (i) the construction site was owned by the federal or the state government directly (for example Public Works Department, Health Department, Social Welfare Department etc.); (ii) the site was owned by a company or board set up by the government (for example the Delhi Water Board, Delhi Metro Rail Corporation etc.) (iii) the site was owned by a non-government company; and (iv) the site was owned by a private person. In this study, I summarise the numbers of incidents, and the number of workers injured under each type of construction site ownership. I also estimate the odds of fatal injuries at different types of construction sites.

ii. **Mode of execution of work**: construction work may be taken up by the owner of a construction site, engaging the workers directly; or the owner hires a contractor who in turn hires the workers to carry out the construction; or a construction company is engaged by the owner to undertake the construction work. In this study I summarise the numbers of incidents, and the number of workers injured by each mode of execution of work.

5.3.10.9 Construction work characteristics as injury risk factors:

i. **Nature of construction work**: The nature of construction work varies. It can be: a completely new construction; an additional construction or an alteration;

maintenance work, such as repair or painting; demolition or dismantling of an existing construction; or the erecting of a temporary structure like a tent or a dome. In this study I summarise the numbers of incidents, and the number of construction workers injured for each category of the nature of construction work. I also investigate associations between the nature of construction work and the magnitude of the incidents.

ii. **Type of construction work**: Construction work can be divided into types based on the list of works given in the Building and Other Construction Workers' (Regulation of Employment & Conditions of Service) Act, 1996;[1] for example: building; road, flyover, bridge or underpass construction; railway works; airport/airfield; irrigation canals/channels; power distribution/transmission; water and sewerage works; mobile, radio, television, or telephone towers; tent/dome; landscaping/horticulture; and others. In this study I summarise the numbers of incidents, and the number of injuries for each type of construction work. I also investigate associations between the type of construction work and the magnitude of the incidents.

iii. **Type of building**: The types of building being constructed could be: residential; commercial (includes malls, hotels, shopping complex/restaurants etc.); institutional (includes offices, schools, colleges/hospitals); factory/industry; or cattle/agriculture related. In this study I summarise the numbers of incidents, and the number of injuries for each type of building being constructed. I also investigate associations between the type of building being constructed and the magnitude of the incidents.

5.3.10.10 Cause of incident

The causes of construction accidents vary. The probable causes listed in the data extraction tool for the extraction and analysis of data are as follows:

i. Collapse of old building or part thereof
ii. Collapse of scaffolding/platform
iii. Collapse of roof/wall/part of under construction building/building material
iv. Collapse of surrounding earth of a pit/basement/tunnel
v. Break of rope/harness
vi. Lack of barricade/railing/cover
vii. Slipping of ladder
viii. Gap in building/stairs
ix. Accidental fall of bricks/building material;
x. Accidental fall of other object/equipment
xi. stepping on sharp object
xii. Electrical shock
xiii. Accidental hit by vehicle or moving machine
xiv. Accidental injury by stationery machine/equipment
xv. Lifting of heavy object

xvi. Contact with chemical hazardous substance

xvii. Presence/release of harmful gases

xviii. Accidental fall in water

xix. Fire

xx. Slipping of person

xxi. Other

In this study I summarise the numbers of incidents, and the number of injuries for each cause. I also investigate associations between the cause and the magnitude of the incidents.

5.3.10.11 Object/Substance/Product involved

The object, substance or product causing the injury may be: a vehicle, machine, or powered tool; unpowered hand tool; building material; loose earth; nail or piece of metal; electric current; corrosive material/gas; fire; or other object/product/substance. In this study I summarise the numbers of incidents, and the number of injuries by each type of object/ substance causing injuries.

5.3.10.12 Mechanism of Injury

The mechanism of injury is the way in which the injury was sustained, i.e. how the person was hurt.[180] For analysis, I classified mechanism of injury into 11 categories:

i. Sharp force

ii. Blunt force

iii. Fall

iv. Drowning/submersion
v. Burning
vi. Poisoning
vii. Corrosion by chemical/other substance
viii. Suffocation/choking
ix. Electrocution
x. Explosive blast
xi. Other

In this study I summarise the numbers of incidents, and the number of injuries by each mechanism of injury.

5.3.10.13 Activity when injured – I recorded the type of activity the worker was engaged in when the injury occurred. For analysis, I classified activities into 18 categories:

i. Not doing any construction related work (just standing or walking at construction site);
ii. Excavation/tunnelling work;
iii. Transporting construction material/object;
iv. Masonry work including plastering, flooring, roof work and false ceiling;
v. Steel cutting/bending;
vi. Erecting/removing shuttering or scaffolding;
vii. Painting;
viii. Fixing door/window or other carpentry work;
ix. Glass work;
x. Aluminium work;

xi. Plumbing work;

xii. Electrical or other cabling or fixing work;

xiii. Working on a machine or equipment;

xiv. Driving a vehicle or moving machinery;

xv. Cleaning work;

xvi. Demolition old structure /building;

xvii. Erection of tent/dome;

xviii. Other.

In this study I summarise the numbers of incidents, and the number of injuries by each activity.

5.3.10.14 Body part injured – For analysis, I classified body parts injured into 15 parts of the body in the data extraction tool:

i. Head, Face, Eye;

ii. Thorax;

iii. Lumbar spine;

iv. Abdomen;

v. Lower back;

vi. Pelvis;

vii. Upper arm including shoulder;

viii. Lower arm including fore arm and wrist;

ix. Hand/fingers/Thumb;

x. Hip/Thigh;

xi. Lower leg including knee and ankle;

xii. Foot including toe;

xiii. Unspecified body location;

xiv. Multiple injuries;

xv. Other.

In this study I present total fatal and non-fatal injuries and the percentages of injuries involving each body part.

5.3.11 Data management

I coded the extracted data and entered them into a password-protected database. Access to this database was restricted to myself and other researchers only. I kept a backup of the data on a password-protected hard drive.

5.3.12 Data extraction tool and instructions for data extractors

Two filled up samples of data extraction tool are in **Appendix-12**. Instructions for data extractors are in **Appendix-13**

5.3.13 Research ethics review

Details of research ethics review are in Section 1.5, Chapter-1 of this thesis.

5.4 Results

5.4.1 Denominators – estimated numbers of construction workers in Delhi

On the basis of the total population of Delhi, the labour force participation rate, and the proportion of construction workers in the labour force I estimated that there were 741,224 construction workers in Delhi in 2016, 756,938 workers in 2017 and 772,985 workers in 2018 (table-5.1).

Table-5.1: Estimated number of construction workers in Delhi			
Year	Estimated number of construction workers		
	Male	Female	Total
2016	697,180	44,044	741,224
2017	711,960	44,978	756,938
2018	727,053	45,931	772,985

5.4.2 Construction incidents and number of workers injured

During the study period, Delhi Police registered 939 FIRs of incidents at construction sites. The FIR documents for 916 incidents were available from the website of Delhi Police; hard copies of the FIR documents were obtained directly from the police station concerned for 23 incidents. A total of 1,227 workers were reported to have sustained injuries in these incidents, 360 (29.3%) of these were fatal and 867 (70.7%) were non-fatal (table-5.2). The number of incidents and the number of workers injured (sustaining a fatal or a non-fatal injury) declined over the study period. The number of workers injured per incident also declined over the study period (from 1.5 workers injured per incident in 2016 to 1.2 workers injured per incident in 2017 and 2018). The proportion of injuries that was fatal increased over the study period (from 26.3% in 2016 to 29.4% in 2017 to 34.4% in 2018).

Table 5.2: Construction incidents and numbers of workers injured									
Year	No of incidents	Number of workers injured			Percentage of injuries		Number of workers injured per incident		
		Fatal	Non-fatal	Total	Fatal	Non-fatal	Fatal	Non-fatal	Total
2016	364	141	395	536	26.3	73.7	0.4	1.1	1.5
2017	321	110	264	374	29.4	70.6	0.3	0.8	1.2
2018	254	109	208	317	34.4	65.6	0.4	0.8	1.2
Total	939	360	867	1,227	29.3	70.7	0.4	0.9	1.3

The number of workers injured in an incident ranged from 0 to 10 (the median number injured was 4.5). A single worker was injured in 464 incidents, two workers each were injured in 71 incidents; 3 workers each in 22 incidents; 4 workers each in 20 incidents; 5 workers each in 8 incidents; 6 workers each in 7 incidents; 7 workers in 1 incident; 8 workers each in 2 in incidents; and 10 workers were injured in one incident. In fatal incidents, the number of workers injured per incident ranged from 0 to 2 and in the majority of these incidents (346), only one person died while in 7 incidents each, two workers were killed.

5.4.3 Data imputation

I intended to impute missing data using Stata to successfully deal with the missing data for various variables in the FIRs. However, whilst attempting MI, I encountered several difficulties: imputation was successful when I imputed data for one variable at a time, and it was also successful in some of the cases when I imputed two variables simultaneously, but the imputation failed in the case of other variables when I tried imputing missing values for two or more variables simultaneously. Imputation of missing data for more than two variables always failed. The difficulties encountered in multiple imputation were possibly due to the large number of categorical variables with many categories. It was important to impute the variables simultaneously so that inter-relationships between the variables are present/preserved. However, this is quite difficult with categorical variables which have many categories, because of the sparsity and zeroes in their cross-tabulations which possibly caused the mlogit models Stata was trying to use to not converge. Therefore, I switched to conducting a complete case analysis (i.e. an analysis in which I simply dropped records with one or more missing values).

5.4.4 Characteristics of construction workers injured

The socio-demographic characteristics (i.e. gender, age and residence) of the construction workers who sustained injuries over the study period, are presented in tables 5.3A and 5.3B.

5.4.4.1 Age group

The ages of the persons injured in construction site incidents ranged from 1 to 84. The mean (SD) age was 30.31 (13.76) years. Most (58.77%) injuries were sustained by workers aged 22 to 44-years, followed by workers aged 45 to 64 years (14.75%). 9% of people injured were aged under 15 years; 2% of people injured were elderly people aged over 64 years. 74% of those injured were workers in the most productive age group of 15 to 44 years. My analysis by age group for fatal and non-fatal injuries produced similar results.

The odds of a construction site injury being fatal were highest in the 20-21 years age group (odds=0.53; 95% CI: 0.33 to 0.86), followed by the <5 years age group (Odds=0.50; 95% CI: 0.21 to 1.17) and then the 22-44 years age group. Compared to the median age group (22-44 years), the relative risk of a fatal injury appeared higher in the 20-21 years age group OR=1.24 (0.74 to 2.08), <5 years age group OR=1.16 (0.49 to 2.77), and 45-64 years age group OR=1.03 (0.69 to 1.55). Compared to the median age group the relative risk of a fatal injury appeared lower in workers aged above 64 years (OR=0.54; 95% CI: 0.15 to 1.91). None of these differences, however, was statistically significant. (Table-5.3A).

Table 5.3A: Characteristics of construction workers injured (age and residence)					
	Number (%) of persons injured			Fatal Injury	
	Non-Fatal	Fatal	Total	Odds (95% CI)	Odds ratio (95% CI)
Age Group					
<5 years	16 (2.43%)	8 (2.95%)	24 (2.58%)	0.50 (0.21 to 1.17)	1.16 (0.49 to 2.77)
5-14 years	47 (7.14%)	14 (5.17%)	61 (6.57%)	0.30 (0.16 to 0.54)	0.69 (0.37 to 1.3)
15-19 years	58 (8.81%)	15 (5.54%)	73 (7.86%)	0.26 (0.15 to 0.46)	0.60 (0.33 to 1.09)
20-21 years	47 (7.14%)	25 (9.23%)	72 (7.75%)	0.53 (0.33 to 0.86)	1.24 (0.74 to 2.08)
22-44 years	382 (58.05%)	164 (60.52%)	546 (58.77%)	0.43 (0.36 to 0.52)	1
45-64 years	95 (14.44%)	42 (15.50%)	137 (14.75%)	0.44 (0.31 to 0.64)	1.03 (0.69 to 1.55)
>64 years	13 (1.98%)	3 (1.11%)	16 (1.72%)	0.23 (0.07 to 0.81)	0.54 (0.15 to 1.91)
Total	658 (100%)	271 (100%)	929 (100%)	0.41	
Residence					
Native of Delhi	547 (68.63%)	176 (56.59%)	723 (65.25%)	0.32 (0.27 to 0.38)	1
Migrant from other State of India	248 (31.12%)	135 (43.41%)	383 (34.57%)	0.54 (0.44 to 0.67)	1.69 (1.29 to 2.22)
Migrant from other country	2 (0.25%)	0 (0.00%)	2 (0.18%)	0.00	0

5.4.4.2 Residence

Approximately two-thirds (65.3%) of the injured construction workers were residents of Delhi while approximately one third (34.6%) was migrants from other states of India (table-5.3A). Two of the injured workers were from other countries. The odds of a construction site injury being fatal were higher among migrants from other states of India than among the workers who were native to Delhi (OR 1.69; 95% CI: 1.29 to 2.22).

5.4.4.3 Gender

84.7% of the non-fatal, and 93.3% of the fatal injuries (87.2% of all injuries) were sustained by male workers. Female workers sustained 15.3% of the non-fatal, and 6.7% of the fatal injuries (12.8% of all injuries). Injury rates per 100,000 workers per year were higher in females than in males. The non-fatal injury rate per 100,000 female workers per year was 98.55 (95%CI 82.5 to 116.8) as compared to 34.4 (95%CI 31.9 to 36.9) per 100,000 male workers per year. The non-fatal injury rate per 100,000 workers per year was thus 2.9 (95% CI 2.4 to 3.45) times higher in female than in male workers. The fatal injury rate per 100,000 female workers per year was 17.78 (95%CI 11.4 to 26.4) as compared to 15.7 (95%CI 14.1 to 17.5) per 100,000 male workers per year. The fatal injury rate per 100,000 workers per year was thus 1.13 (0.75 to 1.71) times higher in female than in male workers (this difference in fatal injury rates by gender was not statistically significant) The total overall injury rate per year was 54.0 (95%CI 51.0 to 57.1) per 100,000 workers (table-5.3B).

Table-5.3B: Characteristics of construction workers injured (gender)

	Number (%) of persons injured (2016-2018)				Injury rate per 100,000 workers per year (95% CI)		rate ratio (95% CI)
Gender	non-Fatal	Fatal	total	Estimated population (2016-2018)	non-Fatal	Fatal	
Male	734 (84.7%)	336 (93.33%)	1070 (87.2%)	2,136,193	34.4 (31.9 to 36.9)	15.7 (14.1 to 17.5)	1.0
Female	133 (15.3%)	24 (6.67%)	157 (12.8%)	134,953	98.55 (82.5 to 116.8)	17.78 (11.39 to 26.46)	**Fatal**: 1.13 (0.75 to 1.71); **Non-fatal**: 2.9 (2.4 to 3.45)
Total	867 (100%)	360 (100%)	1,227¥ (100%)	2,271,147	38.2 (35.7 to 40.8)	15.85 (14.26 to 17.58)	

¥Total overall injury rate per year was 54.04 (95%CI 51.0 to 57.14) per 100,000 workers.

5.4.5 Regression analysis to investigate the association between the variables

Multivariable regression analysis showed that the crude OR indicates that females are less likely than male construction workers to suffer a fatal injury (OR:0.39; 95%CI: 0.25 to 0.62). Relative to 2016, the odds of a fatal injury increased with time (OR 1.19 in 2017 to OR 1.46 in 2018). There was weak evidence that the 15-19 years group was less likely than the 22-44 years group to suffer a fatal injury (OR 0.60; 95%CI: 0.33 to 1.09). When gender was taken into account, the OR for fatal injury for migrants reduced slightly (from 1.66 to 1.55) and the OR for fatal injury for females increased slightly (from 0.39 to 0.44). When both gender and age were taken into account, the OR for fatal injury for migrants reduced further (from 1.55 to 1.31), whereas the OR for fatal injury for females increased further towards the null (from 0.44 to 0.65). Thus, the association for fatal injury for females is weaker and it was being 'confounded' by residence and age group. The addition of the variable "Year" led to a slight increase in the OR for fatal injury for migrants (from 1.31 to 1.32) while the OR for fatal injury for females decreased slightly (from 0.44 to 0.6). Addition of "Season" resulted in a further increase in the OR for fatal injury for migrants (from 1.32 to 1.33) and a decrease in the OR for fatal injury for females (from 0.60 to 0.59) (table-5.3C).

5.4.6 Types of construction work, mechanism and cause of injury

Building work was the most common type of construction work during which injuries were sustained, similarly for both male (89.9% of all male injuries) and female workers (93.9% of all female injuries). Metro rail works were the second most common type of

Table-5.3C: Crude and adjusted Odds Ratio for fatal injuries for various variables

Variable	Label	Crude OR	95% CI	P	Adjusted OR*	95% CI	P
Residence	Delhi	1.00			1.00		
	Migrant	1.66	1.26 to 2.17	0.000	1.33	0.97 to 1.82	0.076
Gender	Male	1.00			1.00		
	Female	0.39	0.25 to 0.62	0.000	0.59	0.35 to 1.00	0.053
Age Group	22-44 years	1.00			1.00		
	45-64 years	1.02	0.68 to 1.54	0.911	0.97	0.62 to 1.52	0.893
	>64 years	0.53	0.15 to 1.90	0.333	0.60	0.17 to 2.20	0.446
	20-21 years	1.23	0.74 to 2.06	0.431	1.28	0.74 to 2.20	0.375
	15-19 years	0.60	0.33 to 1.09	0.092	0.50	0.26 to 0.96	0.036
	5-14 years	0.64	0.34 to 1.22	0.173	0.80	0.41 to 1.54	0.494
	<5 years	1.16	0.49 to 2.76	0.741	1.30	0.51 to 3.32	0.578
Year	2016	1.00			1.00		
	2017	1.19	0.88 to 1.59	0.256	1.26	0.87 to 1.82	0.227
	2018	1.46	1.08 to 1.97	0.014	2.00	1.38 to 2.91	0.000
Season	Winter	1.00			1.00		
	Rains	0.87	0.63 to 1.19	0.382	0.80	0.54 to 1.17	0.238
	Summer	0.85	0.62 to 1.17	0.319	0.81	0.55 to 1.19	0.273
*Adjusted for all other variables for whom the odds ratio is shown in this column							

work. The most common mechanisms of injuries were falls (46%), blunt force of a moving object (38%), and electrocution (13%). The leading causes of accidents were the collapse of a building or part thereof (18%), collapse of a wall (14%), electric shocks (16%), lack of a barricade or railing (10%), and slipping (12%). (table-5.4A)

5.4.7 Cause of incident

The highest numbers of accidents were caused by collapse of building or part thereof, followed by electric shock (Table-5.4A). Other main causes of incidents included slipping of person, lack of barricade, accidental fall of building material and collapse of scaffolding/platform.

Table-5.4A Type of construction work, mechanism, and cause of injury by gender

	Number of injuries			Percentage of injuries		
	Male	Female	Total	Male	Female	Total
Type of Construction						
Building	683	62	745	89.9	93.9	90.2
Flyover/bridge/underpass	11	0	11	1.45	0.0	1.3
Road/street	2	0	2	0.3	0.0	0.2
Railway works	0	0	0	0	0	0
Metro Rail works	25	2	27	3.3	3.0	3.3
Airport/airfield	0	0	0	0	0	0
Irrigation and flood control work	0	0	0	0	0	0
Power generation and distribution works	7	1	8	0.9	1.5	0.97
Water supply related works	6	0	6	0.8	0.0	0.7
Sewerage works	8	1	9	1.1	1.5	1.1
Oil and gas installations	0	0	0	0	0	0
Telecom and television works	5	0	5	0.7	0.0	0.7
Erection of a temporary structures (tent/dome)	13	0	13	1.7	0.0	1.6
Landscaping/horticulture	0	0	0	0	0	0
Others	21	3	24	2.7	4.4	2.2
Total	781	69	850*	100.0	100.0	100.0
*Total number of injuries are less than 1227 because the data on the type of construction was missing in case of 377 victims						
Pearson chi2(9) = 4.261			Pr = 0.893			
Mechanism of Injury						
Sharp force	4	0	4	0.50	0.00	0.46

Blunt force of static object	2	0	2	0.25	0.00	0.23
Blunt force of a moving object	277	57	334	34.28	80.3	38.0
Fall	395	13	408	48.89	18.3	46.4
Drowning/submersion	4	0	4	0.50	0.00	0.46
Burn (smoke/fire/flames)	2	0	2	0.25	0.00	0.23
Burn (contact with heat/scald)	1	0	1	0.12	0.00	0.11
Poisoning;	0	0	0	0	0	0
corrosion by chemical/other substance	0	0	0	0	0	0
Suffocation/choking	13	1	14	1.61	1.41	1.59
Electrocution;	110	0	110	13.61	0.00	12.51
Explosive blast	0	0	0	0	0	0
Exposure to sound, vibration	0	0	0	0	0	0
Other	0	0	0	0	0	0
Total	808	71	879*	100.00	100.00	100.00
*Total number of injuries are less than 1227 because the data on the mechanism of injury was missing in case of 348 victims						
Pearson chi2(8) = 60.3139				Pr = 0.000		
Cause of accident						
Collapse of old building or part thereof	114	19	133	17.25	27.5	18.22
Collapse of scaffolding/platform	45	1	46	6.81	1.4	6.30
Collapse of building/wall/building material	86	19	105	13.01	27.5	14.4
Collapse of surrounding earth	8	1	9	1.21	1.4	1.23
Break of rope/harness	11	0	11	1.66	0.0	1.51
Lack of barricade/railing/cover	68	8	76	10.29	11.6	10.41
Slipping of ladder	16	0	16	2.42	0.0	2.19
Gap in building/stairs	2	0	2	0.30	0.0	0.27
Fall of bricks/building material	38	10	48	5.75	14.5	6.58
Fall of other construction object/equipment	41	10	51	6.20	14.5	6.99
Stepping on sharp object	0	0	0	0	0	0
Electric shock	115	0	115	17.40	0.0	15.75
Hit by vehicle or moving machine	12	0	12	1.82	0.0	1.64
Hitting stationery machine/equipment	6	0	6	0.91	0.0	0.82
Lifting of heavy object	2	0	2	0.30	0.0	0.27
Contact with chemical hazardous substance	0	0	0	0	0	0
Harmful gases	0	0	0	0	0	0
Fall in water	4	0	4	0.61	0.0	0.55
Fire	2	0	2	0.30	0.0	0.27
Slipping	85	1	86	12.86	1.4	11.78
Other	6	0	6	0.91	0.0	0.82
Total	661	69	730*	100	100.0	100
*Total number of injuries are less than 1227 because the data on the cause of incident was missing in case of 497 victims						

5.4.8 Body parts injured

After 'unspecified bodily location' (57%), and multiple injuries involving more than one bodily location (20%), head injuries (14%) were the most commonly reported body part injured. 13% of injuries to men and 18% of injuries to women were head injuries (Table-5.4B).

Table-5.4B: Body Part Injured by gender

	Number of injuries			Percentage of injuries		
Body Part Injured	Male	Female	Total	Male	Female	Total
Head (excludes face)	101	24	125	13	18	14
Face (including eye)	4	0	4	0.5	0	0.4
Neck	1	0	1	0.1	0	0.1
Thorax	3	0	3	0.4	0	0.3
Back	9	3	12	1.2	2.2	1.3
Abdomen	4	0	4	0.5	0	0.4
Internal organs	1	0	1	0.1	0	0.11
Pelvis (includes perineum, anogenital area and buttocks)	0	0	0	0	0	0
Arm including shoulder and elbow	9	3	12	1.1	2.2	1.3
Hand, fingers, thumb	5	0	5	0.7	0	0.6
Leg including hip, thigh, knee, lower leg, ankle	30	2	32	3.9	1.5	3.6
Foot, toe	3	0	3	0.4	0	0.3
Unspecified bodily location	428	89	517	56	65	57
Multiple injuries (involving more than one bodily location);	161	16	177	21	12	20
Others	4	0	4	0.5	0	0
Total	763	137	900*	100	100	100

*Total number of injuries are less than 1227 because the data on the body part injured was missing in case of 327 victims

5.4.9 Injury trends:

5.4.9.1 Annual trends:

The injury rates for both fatal and non-fatal injuries declined during the study period (from 53.29 non-fatal injuries per 100,000 workers in 2016 to 26.91 non-fatal injuries per 100,000 workers in 2018). The non-fatal injury rate per 100,000 workers per year was 35% (95% CI 24% lower to 44% lower) lower in 2017 than in 2016. Further, the fatal injury rate was 26% (95% CI 5% lower to 42% lower) lower in 2018 than in 2016. These rate reductions are statistically significant (Table-5.5).

5.4.9.2 Seasonal variations:

The number of incidents reported ranged from 243 in the summers to 358 in the winters. The highest number of injuries was sustained in rains (472) followed by the summer season (461). The Winter season saw the fewest workers injured (294). As seasonal data on the number of construction workers in Delhi was not available, I estimated the seasonal injury rates per 100,000 workers assuming that the number of workers remained the same in all seasons. The fatal injury rate per 100,000 workers per year was 51% (95% CI 16% higher to 97% higher) higher in the Summer than in the Winter. The fatal injury rate per 100,000 workers per year was 40% (95% CI 7% higher to 83% higher) higher in the Rains than in the Winter. Similarly, the non-fatal injury rate per 100,000 workers per year was 59% (95% CI 34% higher to 90% higher) higher in the Summer than in the Winter. The non-fatal injury rate per 100,000 workers per year was 70% (95% CI 43% higher to 202% higher) higher in the Rains than in the Winter (Table-5.5A).

Table-5.5A: Injury Trends (Year and Season)								
	Number of persons Injured (2016-18)			Estimated population	Injury rate per 100,000 workers per year (95% CI)			rate ratio (95% CI)
Year	Non-Fatal	Fatal	Total		Non-Fatal	Fatal	Total	
2016	395	141	536	741224	53.29 (48.16 to 58.81)	19.02 (16.01 to 22.43)	72.31 (66.32 to 78.7)	1.0 (referent)
2017	264	110	374	756938	34.88 (30.8 to 39.4)	14.53 (11.94 to 17.52)	49.41 (44.53 to 54.68)	**Fatal**: 0.76 (0.60 to 0.98); **Non-fatal**:0.65 (0.56 to 0.76)
2018	208	109	317	772985	26.91 (23.38 to 30.82)	14.10 (11.58 to 17.01)	41.01 (36.62 to 45.78	**Fatal**: 0.74 (0.58 to 0.95); **Non-fatal**:0.51 (0.43 to 0.60)
Total	867	360	1227	2271147	38.17 (95%CI 35.68 to 40.8)	15.85 (95%CI 14.26 to 17.58)	54.03 (95%CI 51.04 to 57.14)	
Season	Non-Fatal	Fatal	Total	Estimated population	Non-Fatal	Fatal	Total	
Winter	202	92	294	2271147	8.89 (95%CI 7.71 to 10.21)	4.05 (95%CI 3.27 to 4.97)	12.95 (95%CI 11.51 to 14.51)	1.0 (referent category)
Rains	343	129	472	2271147	15.1 (95%CI 13.55 to 16.79)	5.68 (95%CI 4.74 to 6.75)	20.78 (95%CI 18.95 to 22.74)	**Fatal**: 1.40 (1.07 to 1.83); **Non-fatal**: 1.70 (1.43 to 2.02)
Summer	322	139	461	2271147	14.18 (95%CI 12.67 to 15.81)	6.12(95%CI 5.15 to 7.23)	20.3 (95%CI 18.49 to 22.24)	**Fatal**: 1.51 (1.16 to 1.97); **Non-fatal**: 1.59 (1.34 to 1.90)

5.4.9.3 Time of Day:

The number of incidents ranged from between 23 incidents (during the 04:00 to 07:59 time period) and 293 incidents (during the 12:00 noon to 15:59 time period). The greatest number of injuries (376) was sustained during the 12:00 noon to 15:59 time period and the lowest number of injuries (46) was sustained in the early morning hours of 04:00 to 07:59 am. The number of fatal injuries ranged from 12 (during the 04:00 to 07:59 time period) to 115 (during the 12:00 noon to 15:59 time period); the range of non-fatal injuries was from 34 (during 04:00 am to 07:59) to 261 (during the 12:00 noon to 15:59 time period) (table-5.5B: Injury trends- time of day). As data on the number of workers working during each time period of the day was not available, I calculated the injury rate per 100,000 workers assuming that the number of workers deployed remained the same during all 6 time periods into which a day was divided. Injury rates were highest during the 12:00 noon to 15:59 time period and were lowest during the 04:00 am to 07:59 time period. Injury rates were statistically significantly lower during four other time periods than during the 12:00 noon to 15:59 period: (**i**) during 04:00 to 07:59 am the fatal injury rate per 100,000 workers was 90% (95% CI 81% lower to 94% lower) lower and the non-fatal injury rate was 87% (81% lower to 91% lower) lower; (**ii**) between 8 pm and midnight the fatal injury rate was 75% (95% CI 62% lower to 83% lower) lower and the non-fatal injury rate was 73% (95% CI 65% lower to 79% lower) lower; (**iii**) between 00.00 and 03:59 am the fatal injury rate was 88% (95% CI 79% lower to 93% lower) lower and the non-fatal injury rate was 79% (95% CI 72% lower to 85% lower) lower; and (**iv**) between 08:00am and 12:00 noon the fatal injury rate was 33% (95% CI 11% lower to 50% lower) lower and the non-fatal injury rate was 25% (95% CI 10% lower to 38% lower) lower; the non-fatal injury rate per 100,000 workers per year was 4% lower (95% CI 19% lower to 14% higher) between 16:00 to 19:59 pm (table-5.5B)

Table-5.5B: Injury trends (Time of day)								
	Number of persons Injured (2016-18)			Estimated population	Injury rate per 100,000 workers per year (95% CI)			rate ratio (95% CI)
Time of Day	Non-Fatal	Fatal	Total		Non-Fatal	Fatal	Total	
00:00 to 03:59	54	14	68	2271147	2.38 (95% CI: 1.79 to 3.1)	0.62 (95% CI: 0.34 to 1.03	2.99 (95% CI: 2.33 to 3.8)	**Fatal**: 0.12 (0.07 to 0.21); **Non-fatal**: 0.21 (0.15 to 0.28)
04:00 to 07:59	34	12	46		1.5 (95% CI: 1.04 to 2.09)	0.53 (95% CI: 0.27 to 0.92	2.03 (95% CI: 1.48 to 2.7)	**Fatal**: 0.10 (0.06 to 0.19); **Non-fatal**: 0.13 (0.09 to 0.19)
08:00 to 11:59	196	77	273		8.63 (95% CI: 7.46 to 9.93)	3.39 (95% CI: 2.68 to 4.24	12.02 (95% CI: 10.64 to 13.53)	**Fatal**: 0.67 (0.50 to 0.89); **Non-fatal**: 0.75 (0.62 to 0.90)
12:00 to 15:59	261	115	376		11.49 (95% CI: 10.14 to 12.97)	5.06 (95% CI: 4.18 to 6.08	16.56 (95% CI: 14.92 to 18.32)	1.0
16:00 to 19:59	251	113	364		11.05 (95% CI: 9.73 to 12.51)	4.98 (95% CI: 4.1 to 5.98	16.03 (95% CI: 14.42 to 17.76)	**Fatal**: 0.98 (0.76 to 1.27); **Non-fatal**: 0.96 (0.81 to 1.14)
20:00 to 23:59	71	29	100		3.13 (95% CI: 2.44 to 3.94)	1.28 (95% CI: 0.86 to 1.83	4.4 (95% CI: 3.58 to 5.36)	**Fatal**: 0.25 (0.17 to 0.38); **Non-fatal**:0.27 (0.21 to 0.35)

5.4.10 Construction trade and injuries

My estimates of the total numbers of construction workers in Delhi by trade for each of the three years in the study period are presented in Table-5.6.

Table-5.6: Trade wise estimated number of construction workers in Delhi					
Trade	Percentage of total construction workers as per NICMAR[49]	Estimated number of construction workers			
		2016	2017	2018	Total workers over 3 years
Unskilled workers	54.43	403448	412001	420736	1236185
Mason	30.42	225480	230261	235142	690883
Carpenters	7.94	58853	60101	61375	180329
Plumbers	0.32	2372	2422	2474	7268
Electricians	0.47	3484	3558	3633	10675
Others	6.42	47587	48595	49626	145808

Most (63.19%) of the workers who sustained injuries were unskilled workers (Table 4.7). Unskilled workers accounted for 66% of all workers who died. After excluding the "others" trade category which accounted for 22% of all workers injured, masons were the second largest trade group to be injured, accounting for 9.6% of workers injured. Electricians were the third largest trade group to be injured, accounting for 2.9% of workers injured.

The fatal injury rate per 100,000 workers was highest in electricians (131.16; 95% CI 71.71 to 220.06) followed by plumbers (55.04; 95% CI 15 to 140.93). Fatal injury rates were lowest in carpenters (1.11; 95% CI 0.13 to 4.01) and in masons (4.78; 95% CI 3.29 to 6.71). Non-fatal injury rates per 100,000 workers were highest in plumbers (151.37; 95% CI 75.56 to 270.84) followed by electricians (140.53; 95% CI 78.65 to 231.78) and 'other' trades (114.53; 95% CI 97.82 to 133.28) (Table-5.7).

Compared with unskilled workers, fatal injury rates were 7.58 (95% CI 4.41 to 13.01) times higher in electricians, 3.18 (1.18 to 8.55) times higher in plumbers, and 2.18 (1.62 to 2.93) times higher in 'other' trades; fatal injury rates were 93.6% (95% CI 74.2% to 98.4% lower) lower in carpenters and 72% (95%CI 60% to 81% lower) lower in masons. Similarly, compared with unskilled workers non-fatal injury rates were 4.4

(2.4 to 8.1) times higher in plumbers, 4.1 (95% CI 2.45 to 6.87) times higher in electricians and 3.35 (95% CI 2.80 to 4.00) times higher in 'other' trades. Non-fatal injury rates were 90.3% (95% CI 78.2% to 95.7% lower) lower in carpenters and 72.9% (95% CI 64.8% to 79.2% lower) lower in masons. (table-5.7)

Table-5.7: Trade wise analysis of injuries

Trade	Number of persons Injured (2016-18)			Estimated population	Injury rate per 100,000 workers per year with 95% CI			Rate ratio (95% CI)
	Non-Fatal	Fatal	Total		Non-Fatal	Fatal	Total	
Unskilled workers	423 (61.66%)	214 (66.50%)	637 (63.19%)	1236185	34.22 (95% CI: 31.03 to 37.64)	17.31 (95% CI: 15.07 to 19.8)	51.53 (95% CI: 47.61 to 55.69)	1.0 (Referent category)
Mason	64 (9.33%)	33 (10.30%)	97 (9.62%)	690883	9.26 (95% CI: 7.13 to 11.8)	4.78 (95% CI: 3.29 to 6.71)	14.04 (95% CI: 11.39 to 17.13	**Fatal**: 72% (95%CI 60% to 81%) lower; **Non-fatal**: 72.9% (95% CI 64.8% to 79.2%) lower
Carpenters	6 (0.87%)	2 (0.60%)	8 (0.79%)	180329	3.33 (95% CI: 1.22 to 7.24)	1.11 (95% CI: 0.13 to 4.01)	4.44 (95% CI: 1.92 to 8.74)	**Fatal**: 93.6% (95% CI 74.2% to 98.4% lower); **Non-fatal**: 90.3% (95% CI 78.2% to 95.7%) lower
Plumbers	11 (1.6%)	4 (1.20%)	15 (1.49%)	7267	151.37 (95% CI: 75.56 to 270.84)	55.04 (95% CI: 15 to 140.93)	206.41 (95% CI: 115.53 to 340.45)	**Fatal**: 3.18 (1.18 to 8.55) times higher; **Non-fatal**: 4.42 (95% CI 2.43 to 8.05) times higher.
Electricians	15 (2.19%)	14 (4.40%)	29 (2.88%)	10674	140.53 (95% CI: 78.65 to 231.78)	131.16 (95% CI: 71.71 to 220.06)	271.69 (95% CI: 181.95 to 390.19)	**Fatal**: 7.58 (4.41 to 13.01) times higher; **Non-fatal**: 4.1 (95% CI 2.45 to 6.87) times higher.
Others	167 (24.34%)	55 (17.10%)	222 (22.02%)	145808	114.53 (95% CI: 97.82 to 133.28)	37.72 (95% CI: 28.42 to 49.1)	152.26 (95% CI: 132.88 to 173.66)	**Fatal**: 2.18 (1.62 to 2.93) times higher; **Non-fatal**: 3.35 (95% CI 2.80 to 4.00) times higher.

There was no discernible association between workers' trade and injuries sustained; many of the counts in cells in the crosstabulation were 0 or less than 5 (Table-5.8).

Table-5.8 Trade and injuries sustained						
Body Part Injured	Unskilled Worker	Mason	Carpenter	Plumber	Electrician	Others
	Number of workers injured					
Head (excludes face)	40	5	2	2	3	42
Face (including eye)	3	0	0	0	0	0
Neck	1	0	0	0	0	0
Thorax	2	0	0	0	0	0
Back	5	2	1	0	0	4
Abdomen	4	0	0	0	0	0
Internal organs	1	0	0	0	0	0
Pelvis (includes perineum, anogenital area and buttocks)	6	0	0	1	1	3
Arm including shoulder and elbow	3	0	0	0	0	0
Hand, fingers, thumb	4	0	0	0	1	0
Leg including hip, thigh, knee, lower leg, ankle	19	2	0	0	2	5
Foot, toe	0	2	0	0	0	0
Unspecified bodily location	262	36	3	5	5	96
Multiple injuries (involving more than one bodily location);	93	21	2	4	6	26
98 (No Ext Injury)	2	1	0	0	0	1
Nature of Injury						
Contusion/bruise/abrasion/superficial injury	46	6	1	2	1	32
cut/open wound	38	4	1	1	1	23

Fracture	8	2	0	0	2	1
Dislocation and subluxation	0	0	0	0	0	0
Sprain and strain	5	2	0	0	0	0
Concussion/brain injury	15	1	1	0	1	1
Crushing injury	4	0	1	0	0	1
Poisoning	0	0	0	0	0	0
insertion of foreign body	2	0	0	0	0	0
Burns and scalds	8	1	1	2	1	0
Injury to muscle and tendon, blood vessels and nerves	8	2	0	0	0	8
Injury to internal organs	2	1	0	0	0	1
Poisoning	0	0	0	0	0	0
Corrosion (chemical)	0	0	0	0	0	0
Electrocution	69	17	0	4	9	7
suffocation	14	1	0	0	0	10
loss of hearing	0	1	0	0	0	0
Others	62	14	0	1	2	20

5.4.11 Geographical distribution of injuries

The Outer district of Delhi was the district that contributed the greatest proportion (12%) of the incidents, followed by the South East (11%), West (10%) and North West (10%) districts. The geographical distribution was similar for both fatal and non-fatal injuries (Table-5.9).

The odds of a fatal construction site injury were highest in the Metro district (odds=2.0; 95% CI: 0.18 to 22.1). Compared with the Central district of Delhi, the odds of a fatal injury were statistically significantly higher in the Dwarka, Rohini, South West and West districts (Table-5.9).

Table-5.9: Geographical distribution of accidents and injuries						
	Number of accidents	Number of persons Injured			Odds of fatal injury with 95% CI	Odds ratio with 95% CI
District		Non-Fatal	Fatal	Total		
Central	43	58	13	71	0.22 (95% CI: 0.12 to 0.41)	1
Dwarka	23	14	11	25	0.79 (95% CI: 0.36 to 1.73)	3.50(95% CI: 1.3 to 9.46)
East	58	62	22	84	0.35 (95% CI: 0.22 to 1.58)	1.58(95% CI: 0.73 to 3.73)
IGI Airport	2	2	0	2	0.00	0
Metro	3	1	2	3	2.00(95% CI: 0.18 to 22.05)	8.92(95% CI: 0.75 to 105.98)
New Delhi	18	14	6	20	0.43(95% CI: 0.16 to 1.12)	1.91 (95% CI: 0.62 to 5.91)
North	53	59	20	79	0.34(95% CI: 0.20 to 0.56)	1.51 (95% CI: 0.69 to 3.32)
North East	67	67	29	96	0.43(95% CI: 0.28 to 0.67)	1.93 (95% CI: 0.92 to 4.06)
North West	89	98	30	129	0.31(95% CI: 0.20 to 0.46)	1.37 (95% CI: 0.66 to 2.83)
Outer	106	123	44	166	0.36(95% CI: 0.25 to 0.50)	1.60 (95% CI: 0.8 to 3.19)
Rohini	63	48	32	80	0.67(95% CI: 0.43 to 1.04)	2.97 (95% CI: 1.41 to 6.3)
Shahdara	15	15	6	21	0.40 (95% CI: 0.16 to 1.03)	1.78 (95% CI: 0.58 to 5.48)
South	82	75	33	108	0.44 (95% CI: 0.29 to 0.67)	1.96 (95% CI: 0.95 to 4.06)
South East	96	103	36	139	0.35 (95% CI: 0.24 to 0.51)	1.56 (95% CI: 0.77 to 3.18)
South West	81	55	38	93	0.69 (95% CI: 0.46 to 1.04)	3.08 (95% CI: 1.49 to 6.4)
West	93	73	38	111	0.52 (95% CI: 0.35 to 0.77)	2.32 (95% CI: 1.13 to 4.76)

5.4.12 Construction site characteristics and injuries

5.4.12.1 Ownership of construction site

The highest number of workers injured were at the sites of private individuals (Table-5.10). The fewest incidents were reported from sites of private companies. The odds of a construction site injury being fatal were highest in sites owned by government companies (odds 0.72; 95% CI: 0.45 to 1.14). Compared with government-owned sites, the odds of a construction site injury being fatal in sites owned by government companies were over 50% higher (OR 1.60; 95% CI: 0.81 to 3.14) and were over one third higher in sites owned by private companies (OR 1.34; 95% CI: 0.64 to 2.82) (table-5.10).

Table-5.10: Construction site characteristics and injuries

	Number of incidents	Number of persons Injured			Odds of fatal injury	Odds ratio with 95% CI
		Non-Fatal	Fatal	Total		
Ownership of construction site						
Government	53	51	23	74	0.45 (95% CI: 0.27 to 0.74)	1 (Referent category)
Government company	68	43	31	74	0.72 (95% CI: 0.45 to 1.14)	1.60 (95% CI: 0.81 to 3.14)
Private Company	44	33	20	53	0.61 (95% CI: 0.35 to 1.06)	1.34 (95% CI: 0.64 to 2.82)
Private individual	653	669	256	925	0.38 (95% CI: 0.33 to 0.44)	0.84 (95% CI: 0.50 to 1.40)
Others	2	2	0	2	1.0 (95% CI: 0.06 to 15.99)	2.22 (95% CI: 0.13 to 37.02)
Mode of execution of work						
Self-construction	187	181	69	250	0.38 (95% CI: 0.29 to 0.50)	1 (Referent category)
Construction through a construction company	93	68	51	119	0.75 (95% CI: 0.52 to 1.08)	1.97 (95% CI: 1.25 to 3.11)
Construction through an individual contractor	238	258	100	358	0.39 (95% CI: 0.31 to 0.49)	1.02 (95% CI: 0.71 to 1.46)
Other	57	97	19	116	0.20 (95% CI: 0.12 to 0.32)	0.51 (95% CI: 0.29 to 0.90)

5.4.12.2 Mode of execution of work

The greatest number of incidents and the greatest number of workers injured were at sites where construction was being executed through individual contractors (Table-4.10). As the number of construction workers deployed by mode of execution of work was not available, I estimated the relative risks of a fatal injury for each mode of execution of work by calculating an odds ratio, using self-construction as the referent category. The odds of a fatal construction site injury were highest in sites where construction was being executed through a construction company (odds of fatal injury=0.75; 95% CI: 0.52 to 1.08). Compared with self-construction sites, the odds of a construction site injury being fatal were almost double in sites where construction was being executed through a construction company (OR 1.97; 95% CI: 1.25 to 3.11) (table-5.10).

5.4.13 Construction injuries and construction work characteristics

5.4.13.1 Nature of construction

The greatest number of incidents and workers injured were reported in new constructions (Table-5.11). The odds of a fatal construction site injury were higher in maintenance work than in new constructions (OR 1.36; 95% CI: 0.91 to 2.02) and in the erection/dismantling of tents or domes or other temporary structures (OR 1.25; 95% CI: 0.45 to 3.49)). However, these differences were not statistically significant (table-5.11).

Table-5.11: Construction work characteristics and injuries

	Number of incidents	Number of persons Injured			Odds of fatal injury	OR (95% CI)
		Non-Fatal	Fatal	Total		
Nature of Construction						
New construction	519	462	221	683	0.48 (95% CI: 0.41 to 0.56)	1 (Referent category)
Alteration/additional construction	64	84	24	108	0.29 (95% CI: 0.18 to 0.45)	0.60 (95% CI: 0.37 to 0.97
Maintenance (including repair, painting)	103	74	48	122	0.65 (95% CI: 0.45 to 0.93)	1.36 (95% CI: 0.91 to 2.02)
Demolition	70	91	24	115	0.26 (95% CI: 0.17 to 0.41)	0.55 (95% CI: 0.34 to 0.89)

Dismantling of old building/structure	0	0	0	0	0.00	-
Erection/dismantling of tent/domes/shamiayana or other temporary structures	12	10	6	16	0.60 (95% CI: 0.22 to 1.65)	1.25 (95% CI: 0.45 to 3.49)
Other	61	85	22	107	0.26 (95% CI: 0.16 to 0.41)	0.54 (95% CI: 0.33 to 0.89)
Type of construction work						
Building	747	746	302	1048	0.40 (95% CI: 0.35 to 0.46)	1 (Referent category)
Flyover/bridge/ underpass	12	7	6	13	0.86 (95% CI: 0.29 to 2.55)	2.12 (95% CI: 0.71 to 6.35)
Road/street	2	1	1	2	1.00 (95% CI: 0.06 to 15.99)	2.47 (95% CI: 0.15 to 39.62)
Railway works	0	0	0	0	0.00	-
Metro Rail works	27	18	11	29	0.61 (95% CI: 0.29 to 1.29)	1.51 (95% CI: 0.70 to 3.23)
Airport/airfield	0	0	0	0	0.00	0
Irrigation and flood control work	0	0	0	0	0.00	0
Power generation and distribution works	8	4	4	8	1.00 (95% CI: 0.25 to 4)	2.47 (95% CI: 0.61 to 9.94)
Water supply related works	6	1	5	6	5.00 (95% CI: 0.58 to 42.8)	12.35 (95% CI: 1.44 to 106.16)
Sewerage works	9	8	3	11	0.37 (95% CI: 0.1 to 1.41)	0.93 (95% CI: 0.24 to 3.52)
Oil and gas installations	0	0	0	0	0.00	-
Telecom and television works	5	3	2	5	0.67 (95% CI: 0.11 to 3.99)	1.65 (95% CI: 0.27 to 9.90)
Erection of a temporary structures (tent/dome)	13	16	7	23	0.44 (95% CI: 0.18 to 1.06)	1.08 (95% CI: 0.44 to 2.65)
Landscaping/horticulture	0	0	0	0	0.00	-
Others	25	32	8	40	0.21 (95% CI: 0.11 to 0.54)	0.62 (95% CI: 0.28 to 1.36)

5.4.13.2 Type of construction work

The majority of incidents (87%) and workers injured (88%) were reported from building construction sites. Compared with building construction sites, the odds of a fatal construction site injury were higher in water supply related works (OR 12.35; 95% CI: 1.44 to 106.16), construction of roads/street (OR 2.47; 95% CI: 0.15 to 39.62), power generation and distribution works (OR 2.47; 95% CI: 0.61 to 9.94)), and construction of flyover/bridge/underpass (OR 2.12 (95% CI: 0.71 to 6.35)). However, other than in water supply related works, none of these differences was statistically significant (Table-5.11).

5.4.14 Object or substance causing injury

Most workers were injured by unpowered hand tools (n=585) and by building material (n=234). Compared with injuries caused by vehicles/mobile machines, the odds of a fatal injury caused by unpowered hand tools were 77% lower (OR 0.23; 95% CI: 0.09 to 0.59) (Table-5.12).

Table-5.12 Object/Substance causing injury

Object/Substance	Number of persons injured				
	Non-Fatal	Fatal	Total	Odds of fatal injury (95% CI)	OR (95% CI)
Vehicle including mobile machines	10	9	19	0.9 (0.37 to 2.21)	1 (Referent category)
Machines powered hand tools	3	3	6	1 (0.20 to 4.95)	1.11 (0.18 to 6.97)
Unpowered hand tools	484	101	585	0.21 (0.17 to 0.26)	0.23 (0.09 to 0.59)
Building material	138	96	234	0.69 (0.54 to 0.90)	0.77 (0.30 to 1.97)
Loose earth	0	0	0	0	-
Nail or metal pieces	0	0	0	0	-
Electric wires	1	0	1	0	-
Corrosive material/gas	0	0	0	0	-
Fire	0	0	0	0	-
Other	10	9	19	0.9 (0.37 to 2.21)	1 (0.28 to 3.57)

5.4.15 Activity when injured

Most of the injuries (36%) reported in the FIRs occurred when the person was not doing any construction work. The next most frequent activities when injuries were sustained were during: masonry work including plastering, flooring, roof work and installing a false ceiling (24%), Demolition of an old structure /building (9%), transporting construction material/object (4.7%), working on a machine or equipment (4.6%) and excavation work (3.9%). Compared with people "not doing any construction related work", the odds of a fatal construction site injury were higher among people working on a machine or equipment (OR 9.44; 95% CI 4.87 to 18.29), painting (OR 5.36; 2.76 to 10.41), erecting or removing shuttering or scaffolding (OR 4.87; 95% CI 2.09 to 11.34), and cleaning work (OR 4.06; 95% CI 1.2 to 13.72). (table-5.13)

Table-5.13: Activity When Injured

Activity	Number of persons injured*				
	Non-Fatal	Fatal	Total	Odds of fatal injury (95% CI)	OR (95% CI)
Not doing any construction related work (just standing or walking at construction site)	307	63	370	0.21 (0.16 to 0.27)	1 (Referent category)
excavation/tunnelling work	23	17	40	0.74 (0.39 to 1.38)	3.6 (1.82 to 7.13)
transporting construction material/object	29	19	48	0.66 (0.37 to 1.17)	3.19 (1.69 to 6.05)
masonry work including plastering, flooring, roof work and installing a false ceiling	175	71	245	0.41 (0.31 to 0.53)	1.98 (1.34 to 2.91)
steel cutting/bending	3	3	6	1.00 (0.20 to 4.95)	4.87 (0.96 to 24.7)
erecting/removing shuttering or scaffolding	12	12	24	1.00 (0.45 to 2.22)	4.87 (2.09 to 11.34)
Painting	20	22	42	1.10 (0.60 to 2.01)	5.36 (2.76 to 10.41)
fixing door/window or other carpentry work	5	2	7	0.40 (0.78 to 2.06)	1.94 (0.37 to 10.27)

glass work	6	2	8	0.33 (0.07 to 1.65)	1.62 (0.32 to 8.23)
Aluminium work	2	0	2	0.00	-
plumbing work	9	5	14	0.56 (0.19 to 1.66)	2.71 (0.88 to 8.35)
electrical or other cabling or fixing work	18	11	29	0.61 (0.29 to 1.29)	2.98 (1.34 to 6.61)
working on a machine or equipment	16	31	47	1.94 (1.06 to 3.54)	9.44 (4.87 to 18.29)
driving a vehicle or moving machinery		0		0.00	-
cleaning work;	6	5	11	0.83 (0.25 to 2.73)	4.06 (1.2 to 13.72)
Demolition of an old structure/building	71	23	94	0.32 (0.20 to 0.52)	1.58 (0.92 to 2.72)
Erection of tent/dome	14	3	17	0.21 (0.06 to 0.74)	1.04 (0.29 to 3.74)
Other	19	1	20	0.05 (o.01 to 0.39)	0.26 (0.34 to 1.95)
*The information activity when injured was available in case of 1024 out of 1227 workers					

5.5 Discussion

5.5.1 Principal findings

During the study period, 360 fatal and 867 non-fatal construction site injuries were registered with the Delhi Police due to 939 construction site incidents. These injuries were equivalent to approximately 16 fatal and 38 non-fatal construction site injuries per 100,000 workers per year. The greatest numbers of incidents and workers injured were reported in new constructions. Over a tenth of injuries sustained was head injuries. Injury rates were highest during 12:00 to 15:59 hours and were lowest during 04:00 to 07:59 hours. Injury rates were higher in the Rainy season than in Winter. The most common mechanisms of injuries were: falls, the blunt force of a moving object, and electrocution. Unpowered hand tools and building material were the most common objects and substances causing injuries.

Two-thirds of people injured were residents of Delhi and the remaining one third was migrants from other states of India. Three-quarters of people injured on construction sites were aged 15-44 years. Most people injured were male and were unskilled. The non-fatal injury rate per 100,000 workers per year was approximately 3 times higher in females than in males. Building work was the most common type of construction work during which injuries were sustained. The most frequent construction activities during which injuries were sustained were: masonry work (including plastering, flooring, roof work and installing a false ceiling), demolition, transporting construction material/objects, working on a machine or equipment, and excavation work. A third of injuries occurred when the person was not doing any construction work. Masons and electricians were the largest trade groups to be injured.

The odds of a fatal construction site injury among migrants from other states of India were approximately twice those among workers native to Delhi. Unskilled workers accounted for two-thirds of all fatalities on construction sites. Compared with unskilled workers, fatal injury rates were 8 times higher in electricians, and were over 70% lower in carpenters and masons. The odds of a fatal construction site injury were higher among people working on a machine or equipment, painting, erecting or removing shuttering or scaffolding, and doing cleaning work. Fatal construction site injuries were more likely in sites owned by government companies. The odds of a fatal construction site injury were highest in sites where construction was being executed through a construction company. Compared with self-construction sites, the odds of a construction site injury being fatal were almost double in sites where construction was being executed through a construction company. The greatest number of incidents and the greatest number of workers injured were at sites where construction was being executed through individual contractors. The odds of a fatal construction site injury were highest in the Metro district. Compared with the Central district of Delhi, the odds of a fatal injury were significantly higher in the Dwarka, Rohini, South West and West districts. The Outer district of Delhi and the South East, West and North West districts contributed the greatest proportion of the incidents. The geographical distribution was similar for both fatal and non-fatal injuries.

5.5.2 Strengths and weaknesses of the study

5.5.2.1 Strengths

Epidemiological evidence serves as a foundation for the planning of safety interventions, however, until this study, insufficient evidence on construction injuries in India was available. This is the first comprehensive study on construction site injuries in Delhi, providing information on construction site injury rates, trends, demographic characteristics, and risk factors. A major strength of this study is that it has covered the entire city of Delhi and it has studied injuries reported over a three-year period. Another strength of the study is the exhaustive list of variables on which information was extracted, analysed and presented.

The results of this study will inform policy makers and stakeholder on various risk factors for preventive interventions leading to healthier construction sites. Although some studies have previously provided information on the magnitude of the problem, few have provided detailed data on many variables. This study has thus advanced the knowledge of the injury profile of construction workers in Delhi, India and quantified the burden of work-related injury in construction workers in Delhi. It has also established a baseline for comparing results of future years' injury reports. Moreover, this is the first time that police records have been used for studying the epidemiology of construction injuries.

5.5.2.2 Weaknesses

A major limitation of this study is that FIRs only ascertain around one third of all construction injuries in Delhi. This means that I have under-estimated the true magnitude of construction injury rates in Delhi. Furthermore, in Appendix-10 (Assessment of a potential reporting bias according to gender) I have shown that the ascertainment of construction injuries in Delhi using FIRs is lower for males than for females, therefore my finding that the non-fatal injury rate per 100,000 construction workers per year was three times higher in female workers than in male workers may well be due to this reporting bias. Furthermore, I estimated population denominators of construction workers in Delhi based on the proportion of male and female workers in the construction sector in the whole of India. The proportion and gender distribution of construction workers in Delhi could be different from the proportion and gender distribution of the whole country which may have led to incorrect denominators and consequent confounding.

FIRs did not contain complete information on some of the variables like type of construction, cause of injury, and body part injured. I had intended to use multiple imputation to impute missing data, but I encountered difficulties due to the large number of categorical variables with many categories, and so I switched to a complete case analysis. My complete case analyses are likely to be valid under weaker assumptions typically than missing completely at random. My complete case analyses will have resulted in a reduced sample size, which will have led to wider 95% CIs and increased the potential for bias.

The total number of people injured in the incidents at construction sites include children of construction workers who may not be engaged in construction work. There were 24 children below 5 years of age and 61 children between 5 to 14 years of age who were most likely not construction workers. Moreover, there is also a possibility that some of the injured were the neighbours or visitors to construction sites. This could have led to slight overestimation of the fatal and non-fatal injury rate.

5.5.3 Strengths and weaknesses in relation to other studies

My study covered the entire population of construction workers in Delhi over a three-year period and included both fatal and non-fatal injuries sustained by them. The epidemiology of injuries to construction workers has been reported by other studies from India in the past but these studies have often been limited to cases reported from a single hospital or from a limited number of construction sites. There was only one such study in Delhi which was based on autopsy reports of a single hospital during the period from1996 to 2002.[87] It reported that 93.8% of the victims were male, 73.8% of the victims were in the age group 21 to 40 years, head and neck were injured in 64.8% of the cases, and 60.7% of the victims died as a result of falling from height.[87] In my research I found similar results regarding the gender and age of fatally injured workers (93.3% of workers killed were male and 69.7% of the victims were in the age group 21 to 44 years).

5.5.4 Meaning of the study: possible mechanisms and implications for policymakers

About two-thirds of all injuries were sustained by the workers who were native of Delhi while migrant workers accounted for the rest. The risk of a fatal injury was higher in migrant workers. This could be due to a lack of training of migrant workers who migrate seasonally to Delhi, more pressure on them to perform, completion of work in shortest possible time due to lumpsum remuneration per work rather than per day, and less reporting of non-fatal injuries to the police by them due to a lack of access to police and pressure from contractors not to report injuries to the police.

Injury rates were highest during 12:00 to 15:59 and were lowest during 04:00 to 07:59. This finding likely reflects differences in the numbers of workers working at these times. However, another important finding was that the injury rate was high from 4 pm to 9.59 pm and this could be an indicator of higher injury risk at the far end of the day on account of a lack of proper light or tiredness of workers or pressure to meet the target of work set for the day.

The geographical distribution of injuries highlighted the peripheral districts of Delhi as those reporting greater numbers of incidents and injuries than the districts located towards the centre of the city. This is not surprising as the city is expanding and new developments, especially unauthorised developments, are arising in the peripheral areas of Delhi where the enforcement measures need to be directed.

The number of construction site injuries and injury rates in Delhi, both fatal and non-fatal, showed a declining trend during the study period. This could be due to a decline in construction activities in Delhi or due to an improvement in the safety environment. Fatal injuries accounted for about 30% of the total injuries. However, the proportion of injuries that was fatal showed an increasing trend during the study period. This could be both due to less reporting of non-fatal injuries to the police or because construction incidents are becoming more fatal over time.

I found that the injury rate per 100,000 workers for non-fatal injuries was three times higher in females than in males. This could be due to a reporting bias in registration of FIRs. Moreover, it could also be due to a higher percentage of female construction workers in Delhi as compared to the national average. A small sample study conducted in Delhi and its surrounding regions had found that 24% of the construction workers were females as compared to the national average of 4.1%, assumed in my study denominator. Female workers could also sustain more injuries due to less use of Personal Protective Equipment like helmets and boots leading to more injuries from falling objects and slipping. They could be more exhausted and stressed and consequently more prone to injuries due to their dual responsibilities since before and after working hours, they have to shoulder the entire burden of household responsibilities like cooking, cleaning, and taking care of children.

Gender difference in injuries was also found positively associated with type of construction work. It was also found that the female workers suffered a higher proportion of injuries from blunt force of a moving object followed by fall. Female construction workers sustained a higher proportion of injuries due to collapse of building or wall, followed by accidental fall of bricks or other construction material material/equipment and a lack of barricade or railing. Moreover, the proportion of head injuries suffered by females were higher. All these findings point towards unsafe nature of construction sites and a lack of use of helmets and other personal protective equipment by the female workers.

India, especially Delhi is the land of multiple seasons. I found that workers were most prone to injuries in the rainy season while the winter season stands out as the healthiest as far as construction site injuries are concerned. The fatal injury rate was found to be the highest in the summer season while the non-fatal injury rate was found to be the highest in the rainy season. The reason for this could be a harsher weather in the summer season but could be also due to seasonal variation in the number of construction workers in Delhi; this needs further investigation.

Trade-wise analysis of injuries showed that although unskilled workers accounted for the highest proportion of injuries, electricians and plumbers were the most prone to fatal and non-fatal injuries. Carpenters and masons were found to be least prone to fatal and non-fatal injuries. I did not find any significant association between trade and body part injured and between trade and type/nature of injury.

In terms of absolute numbers, more incidents were reported from construction sites of private individuals and the least from the construction site of private companies. The difference could be due to higher number of construction sites belonging to private individuals. However, construction sites of government companies followed by private companies were found to be more dangerous with higher odds of fatal injuries. The odds of a construction site injury being fatal were also the highest in the case of construction through a construction company.

But an important finding is that the odds of a construction site injury being fatal were found to be high in works related to water supply, construction of roads/street and power generation and distribution works and calls for appropriate policy interventions. Moreover, a number of incidents were reported in erection of temporary structures which happens a lot in Delhi due to requirement of such structures for marriage and other social functions and calls for implementation of preventive measures.

Hand tools and building materials were found responsible for a large proportion of injuries. Again, this points towards a lack of personal protective equipment and safety measures at construction sites. This is reinforced by the next findings that almost one third of the total injuries were inflicted upon people at construction site but not doing any construction related work at the time of incident. Moreover, maximum injuries were sustained during masonry work, roof work and false ceiling work indicating inflicting of injuries by fall of material or person. Painting, steel bending/cutting, erecting/removing shuttering or scaffolding and working on machine or equipment had a higher chance of sustaining a fatal injury again underscoring a lack of use of proper safety precautions and equipment.

In a large proportion of FIRs, the body part injured is not clearly specified. Analysis of information where bodily location of injury is specified revealed that head (including face and eyes) was most prone to injuries followed by legs. Moreover, higher number of injuries proved to be fatal when no external injury was visible. This could be due to falls leading to internal injuries which were not visible to the police personnel or people recording the FIR.

Young workers in the age group of 20 to 44 years suffered most of the injuries reported. In the absence of breakup of population of construction workers by age group, it cannot be concluded that the workers in this age group are at a higher risk of injuries or not. This could be due to “exposure” of young workers to construction site injury risk. According to a small sample study of 250 workers in Delhi and adjoining areas, 90% of the construction workers were in the age group of 18 to 45 years.[85]

5.5.5 Unanswered questions and future research

Although this study has provided valuable information on the epidemiology of injuries of construction workers in Delhi, there are many questions which need to be answered by future research. My research has pointed towards a higher rate of non-fatal injuries in female construction workers. Whether this was due to higher risk of injuries in female construction workers or due to a reporting bias or due to a higher number of female construction workers in Delhi needs to be further investigated. Besides this, injury incidence rate for different age groups, and nativity of the workers (resident of Delhi or migrant from outside) could not be estimated due to the non-availability of age-wise and nativity-wise population figures of construction workers and needs to be investigated in future studies. Moreover, in my research I had assumed that same number of construction workers were working in Delhi in all the seasons and at all times of the day which may not be correct. There could be seasonal variations in the population of construction workers as a substantial proportion of workers are seasonal migrants to Delhi. Similarly, very a smaller number of workers could be deployed during the night time. Future studies may investigate the differences in injury rates further after ascertaining the denominators for calculating injury incidence rates.

5.6 Conclusion

In Delhi there are approximately 16 fatal and 38 non-fatal construction site injuries per 100,000 workers per year. The risk of construction site injury seems to be higher in migrants and females. Similarly, the risk of injuries is higher during the rainy season, between 12:00 to 15:59 hours, in new constructions and among electricians and plumbers. Injuries were commonly caused by falls, blunt force of a moving object, and electrocution. Government construction sites and execution of construction work by a construction company had higher odds of fatal injuries. Peripheral districts of Delhi reported higher number of injuries than the districts located more centrally.

6. Discussion and Conclusion

6.1 Statement of principal findings

The ascertainment of unintentional injuries by police records has received the attention of researchers in many countries. The capture-recapture method has been a popular choice of method of ascertainment, especially in studies from LMICs. Ascertainment of fatal injuries has been found to be higher than that of non-fatal injuries. In capture recapture analyses from HICs, studies have used hospital records, trauma registries and data from injury surveillance systems for the second (recapture) sample whereas studies from LMICs and LICs have used secondary data sources of injury information such as newspaper reports for the recapture sample.

MDS for injury surveillance systems have been prescribed by national and international guidelines: there are 12 data items which are considered to be the minimum required. Information on these data items can be reliably extracted from the FIRs registered by the Delhi Police using a data extraction tool. However, some items (e.g., name, occupation, cause, activity, residence, and age) may occasionally be missing from the FIRs.

Just over one third of the people who sustained unintentional injuries at construction sites in Delhi 2017 was ascertained by FIRs. A higher percentage of fatal than non-fatal injuries was ascertained. Gender wise analysis of injury ascertainment had revealed that the percentage of ascertainment of total injuries was higher for the female workers as compared to the male construction workers. However, the gender differences in ascertainment of fatal and non-fatal injuries varied more widely with the FIRs ascertaining higher percentage of fatal injuries in male workers as compared to female workers (27.8%) while for non-fatal injuries, ascertainment was complete in female workers yet under one third complete in male workers.

In Chapter-5 of this thesis I found that 360 fatal and 867 non-fatal construction site injuries were registered with the Delhi Police during the study period due to 939 construction site incidents. These injuries were equivalent to approximately 16 fatal and 38 non-fatal construction site injuries per 100,000 workers per year. The greatest numbers of incidents and workers injured were reported in new constructions. Over a tenth of injuries sustained was head injuries. Injury rates were highest during 12:00 to 15:59 hours and were lowest during 04:00 to 07:59 hours. Injury rates were higher in the Rainy season than in Winter. The most common mechanisms of injuries were: falls, the blunt force of a moving object, and electrocution. Unpowered hand tools and building material were the most common objects and substances causing injuries.

Two-thirds of people injured were residents of Delhi and the remaining one third was migrants from other states of India. Three-quarters of people injured on construction sites were aged 15-44 years. Most people injured were male and were unskilled. The non-fatal injury rate per 100,000 workers per year was approximately 3 times higher in females than in males. Building work was the most common type of construction work during which injuries were sustained. The most frequent construction activities during which injuries were sustained were: masonry work (including plastering, flooring, roof work and installing a false ceiling), demolition, transporting construction material/objects, working on a machine or equipment, and excavation work. A third of injuries occurred when the person was not doing any construction work. Masons and electricians were the largest trade groups to be injured.

The odds of a fatal construction site injury among migrants from other states of India were approximately twice those among workers native to Delhi. Unskilled workers accounted for two-thirds of all fatalities on construction sites. Compared with unskilled workers, fatal injury rates were 8 times higher in electricians, and were over 70% lower in carpenters and masons. The odds of a fatal construction site injury were higher among people working on a machine or equipment, painting, erecting or removing shuttering or scaffolding, and doing cleaning work. Fatal construction site injuries were more likely in sites owned by government companies. The odds of a fatal construction site injury were highest in sites where construction was being executed through a construction company. Compared with self-construction sites, the odds of a construction site injury being fatal were almost double in sites where construction was being executed through a construction company. The greatest number of incidents and the greatest number of workers injured were at sites where construction was being executed through individual contractors. The odds of a fatal construction site injury were highest in the Metro district. Compared with the Central district of Delhi, the odds of a fatal injury were significantly higher in the Dwarka, Rohini, South West and West districts. The Outer district of Delhi and the South East, West and North West districts contributed the greatest proportion of the incidents. The geographical distribution was similar for both fatal and non-fatal injuries.

6.2 Strengths and weaknesses of the studies

The strength of this thesis is the innovation of the research area. For the first time in India, police records have been assessed for their suitability to form the basis of an injury surveillance system. Injury research is predominantly focused on road traffic injuries, so, another strength of this research is that it has focused on the availability of information from police records for the surveillance of other types of injuries like injuries sustained by construction workers, and industrial workers.

A major weakness of my research in the use of police records for injury surveillance is that it was confined to Delhi, the capital of India. Thus, it has not provided a pan-India assessment of the suitability of FIRs for the surveillance of construction site injuries in India. As Delhi is a big metropolis and a capital city of India, the ascertainment of injuries by police records may be higher due to better education and training of police personnel. People in Delhi may be more aware of the need to report injuries and may have better access to the police compared to people from other parts of the country. Another potential weakness of the research could be reporting biases in police records due to differences among different sections of society in the accessibility of the police for registration of FIRs.

Another weakness of my research was that it focused solely on assessing the suitability of FIRs for setting up an injury surveillance system by considering the feasibility of extracting information on the MDS mandated for injury surveillance and assessing the proportion of ascertainment of injuries by FIRs. However, a good quality injury surveillance system is required to have several attributes, including: simplicity, flexibility, data quality, acceptability, sensitivity, positive predictive value, representativeness, timeliness, completeness, accuracy, reliability of data, objectivity and stability.[227-229] I did not assess all of these attributes for the proposed injury surveillance system founded on FIRs .

The strengths and weaknesses of the individual studies which constitute my thesis are discussed next.

6.2.1 Systematic review

A strength of my systematic review was that I used a very sensitive search strategy, which led to a broad-based search of the literature. Consequently, 36 studies were included in the review that present a comprehensive picture of the proportions of fatal and non-fatal unintentional injuries that are ascertained by police records and of the use of police records in injury surveillance systems worldwide. One limitation of the systematic review was that, due to paucity of time and resources, I restricted the search to the period from 1st January 2000 to July 2020 and the number of databases searched was also limited (searches were made in only four databases: Medline, EMBASE, PubMed and Google Scholar). Furthermore, studies not having an abstract or full text available were excluded and I only included studies published in the English language. There is, therefore, a possibility that my review missed one or more eligible studies. However, as the majority of the world injury control literature arises in the United States, Australia and Europe, and is therefore published in English and likely to be indexed in one of these popular databases, I do not consider this possibility to be high.

6.2.2 Evaluation of FIRs of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation

A major strength of this study was that it was based on the systematic extraction of data from police records using a data extraction tool, which was probably done for the first time in India. Moreover, the tool was used for data extraction only after its reliability had been assessed and been found to be "almost perfect". Another strength of this study was that a systematic literature search was first undertaken to identify the MDS recommended for injury surveillance.

A weakness was that the study was based on a random sample of only 50 FIRs; although this led to estimation of percentage availability of data items with reasonable precision, a larger sample size would have produced more precise estimates of percentage availability of data items. Due to this relatively small sample size, I could not analyse missingness of data according to gender or the type of incident leading to injury.

One limitation comes from use of the classification of Landis and Koch (1977) for classification of Kappa values to indicate strength of agreement.[174] This classification is arbitrary, as Landis and Koch (1977) did not provide any evidence in their support. However, over the years their classification has become incorporated into the literature as the standard for the interpretation of Kappa values.[233]

Cohen's Kappa, although widely used, has many critics.[176,234] Kappa can yield unexpected results in situations known as the paradoxes of kappa.[235,236] These are prevalence (skewed distributions of categories), and bias (the degree to which the data extractors differ in their assessment of frequency of occurrence of a condition).[237,238] In my study neither of these situations applied and so I do not have concerns that my results are unexpected. Despite its criticism, Kappa remains the *de facto* standard for estimating inter-rater reliability and therefore I placed reliance upon Kappa for assessing inter-rater reliability in my study.[238]

A further limitation of my study concerns the development of my data extraction tool: the tool was reviewed by people qualified in public health and was not reviewed by police personnel or by injury experts, who may have provided other important insights from policing and injury prevention perspectives for improving the tool.

6.2.3 Completeness of ascertainment of construction site injuries using FIRs

The key strength of the study reported in Chapter-4 of this thesis, is that the completeness of police records for the ascertainment of construction injuries has been studied for the first time. Although the number of fatal incidents in the construction sector in Delhi has been estimated in a previous study, my study is the first to provide information on construction injury morbidity in Delhi.

Possible weaknesses of my study are: the relatively short study period of one year; and if injuries sustained by construction workers in motor vehicle crashes at the construction sites were misclassified by the police as road traffic injuries, such injuries will have been excluded from my FIR data, which may have induced a reporting bias leading to an underestimation of construction injuries.

The capture-recapture method used in my study is based on a set of assumptions.[194,195] Although all efforts were made to fulfil these assumptions, there could still be certain weaknesses preventing assumptions to hold true.

6.2.4 Epidemiology of construction site injuries in Delhi, India

This is the first comprehensive study of construction site injuries in Delhi. A major strength of this study is that it covered the entire city of Delhi and it studied injuries reported over a three-year period. Detailed data on injuries sustained were extracted in a systematic manner using a data extraction tool.

A major limitation of this study was that FIRs only ascertain around one third of all construction injuries in Delhi (as I showed in chapter 4). This means that I have under-estimated the true magnitude of construction injury rates in Delhi by a factor of approximately 3. Other limitation of the study could be that while registering FIRs, police officers may have misclassified some construction site incidents like incidents involving vehicles, as other types of incidents. Besides this during the reading of FIRs to identify construction site incidents, I may have misclassified some construction site incidents as other types of incidents.

6.3 Strengths and weaknesses in relation to other studies

6.3.1 Systematic review

No systematic review has previously been undertaken on the proportion of unintentional injuries ascertained by police records nor on the use of police records for injury surveillance.

6.3.2 Evaluation of FIRs of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation

The problem of missing data in police records has also been reported in other studies in India. In a study of road traffic accidents in police records in Chandigarh, data were reported missing in several variables: Name of injured, Age of injured, Sex, and Address.[240] Compared to these findings, missingness was lower in my study for: sex, Name and address, but it was slightly higher for age of injured. For the Date, Time, and Place of accident, information was available in both studies. The Chandigarh study was confined to road traffic injuries and the data were sourced from a road traffic accident register at the traffic police department, Chandigarh.[239] Data were collected on only 8 variables: name, age, gender, address, date, time, place of accident and type of vehicle involved.[239] In my study, I collected data on several other variables found in the FIRs. Whereas the Chandigarh study was confined to injuries sustained in road traffic accidents, my study included injuries due to other causes as well.

Missingness of data is not unique to Indian police FIRs. Misreporting and incompleteness have been reported as serious issues in road traffic injuries.[240] A study on homicides found that the data was missing on victim's age, race and sex.[241] Missingness was higher in cases of offenders with no information about the perpetrator and in circumstance of the injury event.[241] In my study, in the case of fatal injuries, there were no missing data on victim's gender, while data on race were not collected. I found data to be missing only for unique identifier, occupation, residence and nature of activity in fatal injuries.

Analysis of data at the National Injury Surveillance Trauma Registry and Capacity Building Centre (NISTRCBC) in Delhi revealed that data were missing for 17% of the fields. Similar challenges have been found in other surveillance systems.[243] In China, an emergency department injury surveillance system found rates of incomplete forms ranging from 24% to 50%.[242]

6.3.3 Completeness of ascertainment of construction site injuries using FIRs

My literature search yielded only one pan-Delhi study on estimation of injuries suffered by construction workers. The study focused only on estimating the total number of fatal incidents in a year.[6] Using a linear extrapolation method, the study estimated that 256 fatal injuries would have occurred at construction sites in Delhi per year in Delhi between 2008 to 2012. This was close to the 258 (95% CI: 221 to 295) fatal injuries estimated in my study using the capture-recapture method. Moreover, I estimated the burden of both fatal and non-fatal injuries on construction workers.

Ascertainment of injuries by police records has been studied in many previous studies. My systematic review of the literature, presented in Chapter-2 revealed that ascertainment of fatal injuries by police records is higher than of non-fatal injuries. I also reached the same conclusion in my study reported in Chapter-4. Ascertainment of non-fatal injuries in my study was found to be better than the ascertainment reported in the past from LMICs and LICs. Ascertainment of fatal injuries was comparable with the reports of past studies from LMICs and UMICs.

6.3.4 Epidemiology of construction site injuries in Delhi, India

My study has covered the entire population of construction workers in Delhi over a three-year period and included both fatal and non-fatal injuries sustained by them. The epidemiology of injuries to construction workers has been reported by other studies from India in the past but these studies have often been limited to cases reported from a single hospital or from a limited number of construction sites. There was only one study in Delhi which was based on autopsy reports of a single hospital during the period from 1996 to 2002.[87] It reported that 93.8% of the victims were male, 73.8% of the victims were in the age group 21 to 40 years, head and neck were injured in 64.8% of the cases, and 60.7% of the victims died as a result of falling from height.[87] In my research I found similar results regarding the gender and age of fatally injured workers. However, I found that the percentages of fatal injuries due to falls and head injuries were lower in workers who sustained fatal injuries. The proportion of deaths due to falls estimated in my study was closer to the percentage of deaths reported from falls in a study from Kerala which was based on a questionnaire survey of construction workers of a few construction sites.[84] My study showed that maximum number of fatal injuries were caused by collapse of building or platform followed by injuries due to a lack of barricade, fall of building material or equipment, electric shock and fire. Death due to electric shock were higher as compared to other studies [84] while deaths due to falling objects were comparable with other studies.[84,87]

Although some previous studies have provided information on the magnitude of the problem, very few have provided detailed data on many variables. My study has thus advanced the knowledge of the injury profile and quantified the burden of work-related injury in construction workers in Delhi, India. It has also established a baseline for comparing results of future years' injury reports. Moreover, this is the first time that police records have been used for studying the epidemiology of construction injuries. One weakness of this research as compared to other studies was that it is based on information extracted from police records and thus suffers from the weaknesses inherent in police records. Another weakness is its retrospective design: The dynamics of work-related injuries and associated factors could be studied better by using a prospective study.[243,244]

Injury incidence rate in construction workers arrived at in this study was 15.85 (95% CI: 14.26 to 17.58) per 100,000 construction workers per year for fatal injuries, 38.17 (95% CI: 35.68 to 40.8) per 100,000 construction workers per year for non-fatal injuries, and 54.03 (95% CI: 51.04 to 57.14) per 100,000 construction workers per year for total injuries. The estimated injury rate was much lower than the injury rate reported in previous studies from India but was lower than the fatality rate reported by previous studies.[6,87,245] In my study I found that the injury incidence rate was 3 times higher for non-fatal injuries in females when compared to male workers. A study from Iran has also reported injury incidence rates that were higher in female workers than in male workers.[246]

6.4 Meaning of the study: possible mechanisms and implications for policymakers

My research can help policy makers in India to explore the creation of an unintentional injury surveillance system based on police FIRs. The existing Crime and Criminal Tracking Network & Systems (CCTNS) into which FIRs from almost the entire country are being uploaded is a potential source of country-wide information on injuries.[184]

Although a few of the MDS items (e.g., name, occupation) were found to be missing, these missing items are less important in simple epidemiological investigations of distributions of construction injuries by person, place and time. So, even though information on some MDS items was found to be less complete in FIRs, the information obtained can still form the basis of an injury surveillance system. In addition, such an injury surveillance system can be improved further if the missing data are imputed and linkages with other databases are built over time to obtain additional information.

Furthermore, hospital records in India are manual and fragmented and are not amenable to nationwide, state-wide, or city-wide analysis.

Training of police personnel may help to improve the recording of injury information and to create awareness and better access to police can help to increase the percentage of injuries ascertained by FIRs. The system could be strengthened subsequently by building linkages with other injury data sources like hospital records, ambulance records, etc. The National Injury Surveillance Trauma Registry and Capacity Building Centre (NISTRCBC) set up by the Government of India in New Delhi might take a lead role in such efforts.[242]

My research will also inform policy makers in Delhi of the actual burden of injuries on construction workers and the epidemiology of such injuries. It has pointed towards gaps in the present policy and enforcement measures for appropriate corrective measures. My research has shown that despite the legal stipulation for the reporting of all injuries, the combined data of ESIC and Commissioners of Workmen Compensation ascertained less than one tenth of the estimated total injuries sustained by construction workers in Delhi. Reporting of non-fatal injuries sustained by female construction workers to ESIC and the Commissioners of Workmen Compensation was zero; the situation is likely to be similar in other States. Thus, my research not only provides an estimate of the injury burden on construction workers in Delhi but extrapolation of the figures of injuries reported to ESIC and Commissioners of Workmen Compensation can also provide a broad idea of the burden of injuries on construction workers in other states of India as well as the overall national picture. This will help policy makers realise the burden of injuries on construction workers and the need for policy corrections and enforcement measures.

Ascertainment of 100% non-fatal injuries by FIRs in female workers could be due to strong reporting bias in the accident reports filed with the ESIC and compensation claims filed with the Commissioners of Workmen Compensation. This may lead to identification of the reasons for the same by the policy makers and strengthen measures to improve reporting including awareness generation, better enforcement etc.

The high proportion of head injuries identified by my study and of injuries sustained while a person was not engaged in a construction activity point towards a lack of safety precautions at construction sites and a lack of use of personal protective equipment. The higher rate of injuries during the rainy season, also identified by my study, could be due to collapses of walls or structures and due to slipping of persons or material and these suggest a need to review safety policy and for additional safety precautions during the rainy season. The higher injury rate in electricians identified by my study calls for better training and an audit of safety precautions mandated in the rules. Similarly, the increased odds of fatal injuries in workers engaged in water supply, construction of roads/street and power generation and distribution works identified by my study warrants attention of policy makers and other stakeholders. The finding that a sizeable proportion of injuries was reported from the work of erection of temporary structures like tents and domes (which is very common in India for marriage and other functions and rallies/public meetings) underscores the need for appropriate policy interventions in this area and stricter enforcement measures.

My research can also help policy makers to revise the FIR format to facilitate recording of a higher proportion of MDS data in the FIRs. Alternatively, a separate tool may be designed to be completed by police personnel at the time of registration of FIRs and conducting subsequent investigations into injury cases. The information collected through the tool may be uploaded on CCTNS through a separate module. It also makes a case for the training of police personnel in recording information on injuries while registering FIRs of accident cases and during subsequent investigations. Further, it may also help them in carrying out necessary changes in the law to enable use of the information from the “Charge-Sheet” of accident cases without the need to obtain approval of the Court.

6.5 Unanswered questions and future research program

My research has answered some important questions using the information extracted from FIRs registered by Delhi police. It is important to have a country wide picture of the burden of injuries on construction workers in order to stimulate appropriate policy responses at the national level as well as by the respective state governments. Moreover, India is a diverse country with different languages being used in police records by different states and with possible differences in the skillsets of police personnel recording FIRs. So, my research could be repeated in the more remote parts of India to improve the national picture as well as to confirm the results in this thesis, both regarding the recording of information in minimum data sets by FIRs as well as estimating the proportion of total injuries to construction workers ascertained by FIRs.

For my capture-recapture analysis, I used a combined data set of injury reports filed with the Employee State Insurance Corporation (ESIC) and Commissioners of Workmen’s Compensation. Further studies, using different data sources, such as hospital records, ambulance records, population surveys, accidents reports filed with the Department of labour and employment of the states, etc., may be used for capture-recapture analyses to confirm the percentage ascertainment of injuries to construction workers by FIRs. Moreover, there are other occupational unintentional injuries such as injuries to workers in different industries, hospital staff, agricultural injuries, etc. The burden of these injuries might also be usefully studied using information extracted from FIRs in addition to estimating its real burden using the capture-recapture method.

Another source of information on injuries that might be considered in future research is the ‘Charge sheet’ of an incident filed by the police in a court. One of the documents submitted with the Charge Sheet is the *Medico Legal Report* which contains details of injuries sustained including the nature of injury, severity of injury, body part injured etc. The charge sheet also includes information on injured people who die after the registration of a FIR. The suitability of the charge-sheet for injury surveillance could therefore also be the subject of future research for injury surveillance in India.

In my research, I have not assessed other qualities of the proposed injury surveillance system based on police FIRs. Future research could therefore evaluate other attributes of the proposed surveillance system, for example: simplicity, flexibility, data quality, acceptability, sensitivity, predictive value positive, representativeness, timeliness, completeness, accuracy, reliability of data, objectivity and stability.

The influence of new technologies and the emerging social media platforms for collecting injury data could also be part of future injury research studies. In addition, research may also be commissioned to investigate the reasons for a higher injury incidence rate in rainy season reported in this research.

6.6 How the Research questions have been answered

The three separate and interrelated studies which comprise Chapter-3 to 5 of the thesis have provided answers to the four questions posed in this research. The first question was - *"Do the First Information Reports (FIRs) registered by Delhi Police contain sufficient information to describe the epidemiology of construction site injuries in Delhi?"* This has been answered by study-1 (Chapter-3) which showed that FIRs do capture information on all the 12 Minimum Data Sets (MDS) prescribed for injury surveillance. However, for some of the MDS, FIRs do not always contain complete information. Study-3 (Chapter-5) which has described epidemiology of construction injuries in Delhi, answers this question further.

Answer to the second research question- "*Whether FIRs are a complete record of all construction site injuries."* has been provided by the second study (Chapter-4). It showed that the FIRs are not a complete record and capture a little over one third of all construction site injuries – 37% of the total, 42.6% of the fatal, and 30.2% of the non-fatal injuries. The first (chapter-3) and the second study (chapter-4) combined answer the third research question – "*Can we use FIRs for construction site injury surveillance?"* Besides informing that FIRs contain information on the 12 MDS for injury surveillance, the first study also showed that information on injuries can be reliably extracted from FIRs. The data missing in the FIRs can be handled by either imputing the missing data or using complete case analysis. The second study (chapter-4) informed that the estimates made using the FIR data must be adjusted to allow for the approximately two-thirds of injuries not reported to the police. A lack of other comprehensive data source on injuries in India and availability of FIRs from the whole country in a centralized computer system further strengthens the case for use of FIRs for injury surveillance. Moreover, ascertainment of injuries by FIRs can be improved, missingness in data can be reduced and the surveillance system can be improved further by measures like training of police persons, creating awareness on need to report injuries to the police, enhancing enforcement measures to push for higher reporting of incidents and supplementing the injury information from other police records and hospital records. The fourth research question – *"what do FIRs tell us about the epidemiology of construction site injuries in Delhi?"* was answered in Study-4. The study (Chapter-5) described the epidemiology of construction site injuries in Delhi. Using the data extracted from FIRs, injury incidence rate, segregated by gender, season, and trade of construction workers was estimated, geographical spread of injuries was discerned and risk factors for injuries to construction workers were identified.

6.7 Conclusion

First Information Reports (FIRs) of Delhi police contain information on the 12 MDS data items prescribed for injury surveillance and are a potential source of information on unintentional injuries. FIRs are available for almost the entirety of India in the Crime and Criminal Tracking Network & Systems (CCTNS) and could form the basis of an Indian unintentional injury surveillance system. FIRs do not ascertain all construction injuries. The surveillance system can be made more robust subsequently by: imputing missing data; linking with other systems to get additional information on injuries;

training police personnel in recording information on MDS when registering FIRs and during subsequent investigations; creating awareness among people to report unintentional injuries to the police; and better enforcement of existing legal provisions regarding reporting of incidents and injuries to the police and other authorities.

One third of construction injuries resulted in death. Migrant construction workers are more prone to fatal injuries. Injuries are more likely in the rainy season and in the peripheral districts of Delhi, and during works related to water supply, construction of roads/street and power generation and distribution. Appropriate policy interventions and increased enforcement of existing legal provisions may help to reduce the burden of injuries on construction workers.

6.8 Recommendations:

On the basis of the findings of the systematic review and the three studies which constitute this DrPH research, I would like to make the following recommendations to the policy makers and other stakeholders:

i. **Need for ascertainment of burden of construction injuries at the national level:** On the lines of this research, a comprehensive nationwide project for ascertaining the magnitude of the injury burden on construction workers in all the states of India should be untaken, using police records and other available data sources like ESIC reports, hospital records, ambulance records, and compensation claims filed with the Commissioners of Workmen Compensation. In view of underreporting and unreliability of official injury statistics, capture–recapture analysis may be used as a tool to provide affordable and reliable estimates of injuries sustained by the construction workers. This would help in ascertaining true magnitude of construction site injuries at state and national levels and would highlight the problem of injuries to policy makers at the federal and state level. Information on the amount of missing data should also be presented when reporting this information.

ii. **Use of police records by the National Injury Surveillance Trauma Registry and Capacity Building Centre:** Setting up of the National Injury Surveillance Trauma Registry and Capacity Building Centre (NISTRCBC) by the government of India is a welcome step. But the centre is currently focussing on road traffic injuries alone and is trying to get data from a handful of hospitals linked to it. As hospital operations in India are not computerized and electronic medical records are not available, it is suggested that the National Centre may consider basing its system on country wide information on injuries from police records through CCTNS and augment it with additional information from hospitals and other sources.

iii. **Injury data collection tool for police personnel and a module in CCTNS:** The government of India may consider providing a small data collection tool to police personnel for recording information on the MDS while registering FIRs and during further investigations in injury cases. A small module may be developed in the CCTNS to enter data from this tool which should then be transmitted to the National Injury Surveillance Trauma Registry and Capacity Building Centre for integrating with their data from hospital and other sources and further analysis and dissemination of reports. A unique identifier for an injured person may be created at the registration stage in the police station/hospital which should be subsequently used for integration of data from different sources. The 12-digit Aadhar number issued by the Unique Identification Authority of India or a Unique Health Identification Number under consideration by the Ministry of Health and Family Welfare may be a suitable identifier. The police personnel may be paid a small monetary incentive to complete this form correctly and upload it through the CCTNS.

iv. **Training of police personnel on collection of injury information:** The Ministry of Health and Family Welfare, Ministry of Labour and Employment and the Ministry of Home Affairs should come together to design a suitable module, both for classroom-based training and e-learning for imparting training to police personnel in capturing minimum data sets (MDS) for injury surveillance while recording FIRs, Charge Sheets and during investigations of the case. This training could help to reduce the extent of missing data in the police reports and help to improve data quality.

v. **Injury Surveillance Information System with multiple linked data:** Single-source systems do not record all injury data. Moreover, a manual surveillance system won't be able to handle the quantum of data to be collected from police records and other sources. Linkage of different data bases can provide rich data on injuries. In the present era of information technology, digitisation of information and web-based systems for collection, analysis and presentation of information are commonly used. Therefore, the NISTRCBC should design an Injury Surveillance Information System with electronic and smooth linkage with different and diverse injury data sources.

vi. **Use of Geographical Information Systems:** The integration of a Geographical Information System (GIS) with the injury surveillance system could add value to the system by helping to identify the locations of injury events and at-risk populations. It could help to identify geographical clusters prone to different types of injuries, and to therefore help in the investigation of the reasons for such incidents and to help identify preventive steps to be taken.

vii. **Use of mobile technology:** Mobile devices have revolutionised the way information is collected and transmitted today. Use of mobile technology can help police personnel in capturing the location of incidents more accurately, as well as to collect and transmit data to an electronic system from the incident site itself. Capturing and uploading of photographs of incident sites using mobile phones could provide useful details on the circumstances of an injury. Therefore, it is recommended that the NISTRCBC should also develop a mobile app for the collection of injury information from incident sites and integrate it with its injury surveillance system.

viii. **Security and confidentiality of data collected:** Data on injuries are private data. Therefore, the injury surveillance system planned should have a robust system for security of this data and privacy protection protocols. Apart from anonymisation, hiding of other information which could lead to identification of victims would be necessary.

ix. **Single authority on injuries:** A lack of a defined and unified authority in India for injury prevention and mitigation is resulting in a dilution of responsibility for safety and a lack of ownership of the injury problem. This is also the cause of the poor availability and under-utility of information on injuries in India. All types of injuries including occupational injuries should be brought under the fold of the Ministry of Health and Family Welfare who should have a dedicated division to look after this public health problem.

x. **National injury prevention policy:** In India, the health policies lack a focus on injuries. The National Health policy-2017 made a single mention of the word injury and that was in the context of agricultural injuries.[247] There has been limited mention of injuries as a public health issue. The National Multi-Sectoral Action Plan for Prevention and Control of Common Non-Communicable Diseases (2017-2022) of the Ministry of Health and Family Welfare, Government of India also does not make any mention of injuries.[248] India has a National Programme for Prevention & Management of Trauma and Burn Injuries but its focus is exclusively on road traffic injuries.[249] Therefore, a national injury prevention policy should be formulated taking a comprehensive view of the injury problem in India, delineating responsibility of various stakeholders. A focused national strategy for injury prevention and control, inclusive of trauma care and rehabilitation is also needed. A national program on injury prevention should be launched by the Ministry of Health and Family Welfare and may be made a part of the ongoing National Health Mission.

xi. **Promotion of research on injuries:** Research on injuries is lacking in India. A more proactive role needs to be played by the academic and research sectors in reducing the injury burden through intervention studies and operations research. The NISTRCBC, the National Crime Records Bureau, and the Ministry of Health and Family Welfare should make anonymised data on injuries available to research institutions and should also commission research studies on injuries in India. Periodic population surveys also need to be conducted or alternatively, the surveys conducted by the National Statistical Survey Organisation under the Ministry of Statistics and Program Implementation could include the collection of information on injuries. Besides this, the evaluation of the effectiveness and implementation of various legal provisions, rules and policies aimed at injury prevention should also form part of injuries research.

Such evaluations should also provide recommendations for improving quality, efficiency, and usefulness of various policy interventions.

xii. **Awareness raising and creating a demand for safety:** Injuries should not be merely treated as events that cannot be prevented but should be treated as a public health problem that is predictable and preventable. The National Program on Prevention of Injuries should include building awareness of injuries as an integral component to change inappropriate behaviours and create a strong demand for safety. Research data and data from an injury surveillance system should also be widely disseminated to enhance the visibility of the injury problem. This may be done through putting the anonymized, analysed data into the public domain on a website, issue of regular press releases, newsletters and bulletins, publication of annual reports and papers in scientific, peer reviewed journals, posters and oral presentations in professional and community meetings.

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Appendices

Appendix-1:

Sample FIR

आई०पी०फार्म नं0 24.5(1)
(तारांकित कालम अवश्य भरें)
पृष्ठ संख्या :

FIRST INFORMATION REPORT

प्रथम सूचना रिपोर्ट

822171

(Under Section 154 Cr. P.C.)

(दण्ड प्रक्रिया संहिता धारा 154 के अन्तर्गत)

1.* District(जिला)________ *P.S.(थाना)________ *Year(वर्ष) ______* F.I.R. No.(प्र.सू.रि.सं.)________ *Date (दिनांक)________

2. (i) *Act (अधिनियम)________ *Sections (धाराएँ)________

(ii) *Act (अधिनियम)________ *Sections (धाराएँ)________

(iii) *Act (अधिनियम)________ *Sections (धाराएँ)________

(iv) *Other Acts & Sections (अन्य अधिनियम एवं धाराएँ) ________

3. *(a) (क) *Occurrence of offence (घटना का) Day (दिन)________ *Date from (दिनांक से)________ Date to (दिनांक तक) ________ *Time Period (पहर)________ *Time from (बजे से)________ *Time to (बजे तक)________

*(b)(ख) Information received at P.S. (थाने पर प्राप्त सूचना की) :*Date (दिनांक)________ Time (समय) ________

*(c) (ग) General Diary Reference (रोजनामचा संदर्भ) Entry No. (प्रविष्टि संख्या) ________ Time (समय) ________

4. Type of Information (सूचना कैसे प्राप्त हुई) Written / Oral (लिखित/मौखिक) :

5. Place of Occurrence (घटना स्थल का ब्यौरा) : (a) (क) Direction and distance from P.S. (थाने से दिशा एवं दूरी)________ Beat No. (बीट सं०)________

(b) (ख) *Address (पता) ________

(c) (ग) In case, outside the limit of this Police Station, then (यदि इस थाने की सीमा से बाहर हो, तब उस)

Name of P.S. (थाने का नाम) ________ District (जिला) ________

6. Complainant/informant (शिकायतकर्ता/इत्तला देने वाला) :

(a) (क) Name (नाम)________ (b)(ख) Father's/Husband's Name (पिता/पति का नाम)________

(c) (ग) Date/Year of Birth (जन्म तिथि वर्ष) ________ (d)(घ) Nationality (राष्ट्रीयता)________

(e) (ड) Passport No. (पासपोर्ट सं0)________

Date of Issue (जारी करने की तिथि)________ Place of Issue (जारी करने का स्थान) ________

(f)(च) Occupation (व्यवसाय)________ (g)(छ) Address (पता)________

7. Details of known/suspected/unknown accused with full particulars (ज्ञात/संदिग्ध/अज्ञात अभियुक्तों का पूर्ण विवरण) Attach separate sheet, if necessary) (यदि आवश्यक हो तो अलग पृष्ठ संलग्न करें)

1. ________
2. ________
3. ________

-1/3-

Attachment to Item 7 of First Information Report
(प्रथम सूचना रिपोर्ट की मद संख्या 7 की संलग्नक)

Physical features deformities and other details of the suspect accused (if known seen)
संदिग्ध अभियुक्त की शारीरिक बनावट, विकृतियाँ तथा अन्य विवरण (यदि ज्ञात हो/देखे गए हों)

Sl. No क्र.सं०	Sex *लिंग	Dated/Year of Birth *जन्म तिथि/वर्ष	Build *शारीरिक बनावट	Height (cms.) *कद (से.मी.में)	Complexion *रंग	Identification Mark(s) *पहचान के चिह्न
1	2	3	4	5	6	7

Deformities/ Percuiarities *विकृतियाँ/विशिष्टियाँ	Teeth *दांत	Hair *बाल	Eyes *आंखें	Habit(s) *आदतें	Dress Habit(s) *पहनावा
8	9	10	11	12	13

Language/Dialect *भाषा	PLACE OF शरीर के किस हिस्से पर, निम्नलिखित चिह्न मौजूद है				
	Burn Mark *जले हुए का	Leucoderma *धवल रोग	Mole *मस्सा	Scar *घाव	Tattoo *गुदे हुए का
14	15	16	17	18	19

These fields will be entered only if complainant/informant gives anyone or more particulars about the suspect/accused.
इन मदों में प्रविष्टि तभी की जाएगी यदि शिकायतकर्ता/ इत्तला देने वाला व्यक्ति संदिग्ध/अभियुक्त के बारे में एक या एक से अधिक विवरण देता है।

8. Reasons for delay in reporting by the complainant/informant (शिकायतकर्ता/इत्तला देने वाले द्वारा सूचना देने में देरी का कारण)

9. Particulars of properties stolen (चोरी हुई सम्पत्ति का विवरण) / (Attach separate sheet, if necessary) यदि आवश्यक हो, तो अलग पृष्ठ संलग्न करें)

10. *Total value of property stolen (चोरी हुई सम्पत्ति का कुल मूल्य)

-2/3-

11. *Inquest Report (मृत्यु समीक्षा रिपोर्ट)/U.D. case No. (अप्राकृतिक मृत्यु मामला सं०) if any, (यदि कोई हो तो) ____________

12. F.I.R. contents (प्र.सू.रि. की विषय वस्तु) (attach separate sheet, if required) (यदि आवश्यक हो, तो अलग पृष्ठ संलग्न करें)

13. Action taken (की गई कार्यवाही): Since the above information reveals commission of offence(s) u/s as mentioned at item No. 2
चूंकि उक्त सूचना द्वारा, मद सं० 2 पर उल्लिखित धाराओं के अन्तर्गत अपराध होने का पता चलता है :

1. Registered the case and took up the investigation or (मामला पंजीकृत किया और जाँच आरम्भ की गई या)
2. Directed Sh./Smt./Km. (Name of I.O.) श्री/श्रीमती/कु. (जाँच अधिकारी का नाम) ____________ Rank (पद)
   No. (सं०) ____________ to take up the investigation or (को जाँच आरम्भ करने के निर्देश दिये गये या)
3. Refused investigation due to (जिन कारणों से जाँच करने से इनकार किया गया) ____________
   ____________ Or (या)
4. Transferred to P.S. (मामला स्थानान्तरित किया गया, थाने का नाम) ____________ District
   (जिला) ____________ on point of jurisdiction (क्षेत्राधिकार की दृष्टि से)

F.I.R. read over to the complainant/informant, admitted to be correctly recorded and a copy given to the complainant/informant, free of cost. (प्र०सू०रि० शिकायतकर्ता/इत्तला देने वाले को पढ़कर सुनाई गई, जिसने सही लेखन की पुष्टि की और शिकायतकर्ता/इत्तिला देने वाले को एक प्रति नि:शुल्क प्रदान की गई।)

R.O.A.C. (पढ़कर सुनाया और सही पाया गया)

Signature of Officer incharge, Police Station
(थाना प्रभारी के हस्ताक्षर)

Name (नाम) ____________
Rank (पद) ____________ No. (संख्या) ____________

14. Signature/Thumb impression of the Complainant/informant
(शिकायतकर्ता/इत्तला देने वाले के हस्ताक्षर/अंगूठे का निशान)

15. Date and time of dispatch to the court
(न्यायालय को भेजने की तिथि और समय) ____________

—3/3—

Appendix-2

Letter of approval from LSHTM Observational/Interventions Research Ethics Committee

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: +44 (0)20 7636 8636

www.lshtm.ac.uk

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Observational / Interventions Research Ethics Committee

Mr Sajjan Yadav
LSHTM

26 November 2018

Dear Sajjan,

Study Title: Public Health Surveillance of Construction Site Injuries in Delhi, India Using the First Information Reports (FIRs) Registered by Delhi Police

LSHTM Ethics Ref: 15992

Thank you for responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

The committee do have some concerns about data security given the form of data given to the applicant contains identifiers. He needs to be very careful to ensure the data he keeps in the secure drive, encrypted, on his lap top does not include identifiers - safer not to store any data which has identifiers on since ID numbers can be assigned on receipt of the data.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Protocol / Proposal	Public Health Surveillance of Construction Site Injuries in Delhi	17/07/2018	1
Investigator CV	Curriculum Vitae July 2018	17/07/2018	1
Covering Letter	Revised Methodology document Sajjan Yadav	03/11/2018	1
Protocol / Proposal	Revised Methodology document Sajjan Yadav	03/11/2018	1
Covering Letter	Cover Letter to LEO for clarifications Sajjan Yadav	16/11/2018	1

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

An annual report should be submitted to the committee using an Annual Report form on the anniversary of the approval of the study during the lifetime of the study.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

[redacted]

Page 1 of 2

Professor John DH Porter
Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

Improving health worldwide

Appendix-3

Local ethics approval from the Ethics Committee of Dr Baba Saheb Ambedkar Medical College and Hospital, Delhi, India

DR. BABA SAHEB AMBEDKAR MEDICAL COLLEGE & HOSPITAL
ROHINI, SECTOR-6, DELHI-110085
GOVT. OF NCT OF DELHI

F.NO. 11(45)/2018/BSAMCH/ACAD/ 502 **Dated:-** 24/12/1

Minute of Meeting

A meeting of ethical committee was held on 13/12/2018 at 12 noon in the Council Room of Dr. BSA Medical College.

The meeting was chaired by Dr. A.K.Agarwal former Additional Director General, Dean & Director Principal ENT, GNCTD.

The meeting was attended by following members:-

S.No.	Name	Designation
1.	Dr. P.S.Nayyar	Medical Superintendent, Sanjay Gandhi Memorial Hospital
2.	Dr. Anmol Arora	Medical Director, Ashtavakra Institute of Rehabilitation Sciences & Research
3.	Dr. J.M.Kaul	Academic Coordinator , Prof. & Head of Dept. of Anatomy
4.	Dr. N.S.Hadke	Professor, Dept. of Surgery
5.	Dr. Chitralekha Khatti	Professor & Head of Dept. of Gen. Medicine
6.	Dr. Kusum Lata Gupta	Associate Professor, Dept. of Pathology
7.	Dr. Shelesh Kumar Goel	Professor, Dept. of Community Medicine
8.	Dr. Jyoti Maria	Assoc. Prof., Dept. of Pharmacology

Mr. Praveen Khatter Legal expert & Mr. S.N.Sinha member press council of India could not attend meeting, due to previous engagements.

The Agenda for the meeting was:
Ethical Clearance for the following project- **"Public Health Surveillance of Construction Site Injuries in Delhi, India Using the First Information Reports (FIRs) Registered by Delhi Police".**

Principal Investigator – Mr. Sajjan Singh Yadav officer of IAS under Global Health and Development Department, London School of Hygiene and Tropical Medicine (LSHTM), London.

The protocol of the project was presented by Sh. S.S.Yadav and a discussion ensued on various aspects of it. It was decided to grant ethical approval in principle subject to the submission of the following documents:

1. Since the project didn't carry the name of the Supervisor and co-supervisor, it was requested to submit the same.
2. A copy of the letter of permission from police for sharing F.I.R. data and from ESIC for sharing the requisite data may be submitted to this institution.
3. A midway review of the study may be submitted to this institution.
4. As per suggestion of the committee to include an advisor from Dr. BSA Medical College on the said project, Dr. Achal Gulati, Director Principal, Dr. BSA Medical College be included on advisory capacity on the project.

The meeting ended with a vote of thanks to the chair.
This issues with the permission of Director Principal.

[redacted]

(Dr. J.M.Kaul)
Academic Coordinator

Appendix-4

Letter of approval from Delhi police

OFFICE OF THE DEPUTY COMMISSIONER OF POLICE : CRIME (CRO): DELHI
POLICE HEADQUARTERS, MSO BUILDING, ITO, NEW DELHI-110002
Telephone No.011-23490466, Fax No.011-23722065, Email dcpcro@gmail.com

No. 2359 /S&R dated New Delhi the 29/9 /2018

To

Sh. Sajjan Yadav, IAS
Adviser to Administrator
Daman and Diu and Dadra and Nagar Haveli

Subject:- Research on construction site fatal and non-fatal injuries

Sir,

Please refer to your email dated 19.07.2018 on the matter cited above.

I am directed to inform you that the competent authority has approved your request for conducting the study on 'Research study on fatal and non- fatal injuries at construction sites in Delhi'.

[redacted]

(Rajan Bhagat)
Dy. Commissioner of Police
Crime (CRO): Delhi

Appendix-5

Letter of approval from Employee State Insurance Corporation

EMPLOYEE'S STATE INSURANCE CORPORATION
PANCHDEEP BHAWAN, CIG MARG, NEW DELHI-110002
An ISO Certified office: 9001:2008, (WEBSITE: www.esic.nic.in), PH: 011-23701358
email: dir-sys@esic.nic.in / sanjay.sinha@esic.in

No. ESIC/A.C.-(ICT)/Mis. **Dated: 27.09.2018.**

To,
Dr. Sajjan Singh Yadav,
Dr PH Candidate,
London School of Hygiene & Tropical Medicine,
Keppel Street, London WC 1E 7HT.

SUB : Request for providng details of construction site accident reports.

Sir,

Please refer to your letter dated 20.07.2018 on the above subject. In this reference, I wish to inform you that we are ready to provide the details of the accident reports filed by employers for accidents that happened in Delhi during the year 2017 and any other information that may be helpful to you in ascertaining fatal and non-fatal injuries to construction workers in Delhi in the year 2017.

[redacted]

(SANJAY SINHA)
ADDITIONAL COMMISSIONER-(ICT).

संजय सिन्हा/SANJAY SINHA
अपर आयुक्त (सू.स.प्रौ.प्र.)/Addl. Commissioner (ICTD)
क.रा.बी.नि. (मु.)/E.S.I.C. (H.Q.)
श्रम एवं रोजगार मंत्रालय, भारत सरकार
Ministry of Labour & Employment, Govt. of India
पंचदीप भवन, सी. आई. जी. मार्ग, नई दिल्ली-2
Panchdeep Bhawan, CIG Marg, N. Delhi-2

Appendix-6

Approval and data sharing email from Labour Department, Delhi Government

Gmail

sajjan yadav <sajjan95@gmail.com>

Data of Compensation Cases for the last 02 Years (2017 and 2018)

Rajender Dhar <addlc.delhi@gov.in> Wed, Jul 10, 2019 at 6:03 PM
To: sajjan95@gmail.com

Dear Sir,

Emailing you data of Compensation Cases for the last 2- Years in respect of 08- Districts of Labour Deptt. GNCTD in the prescribed format sent by you.

Thanks & Regards

(Dr.Rajender Dhar)
Addl.Labour Commissioner

8 attachments

CECNorth.xls
46K

COMPENSATION DATAILS 2017-2018 DISTT.N.East.doc
197K

EAST - compensation detail2017-18 (1).doc
139K

NE- COMPENSATION DATAILS 2017-2018 .doc
202K

new delhi compensation list.doc
66K

North West 2017-2018.xls
2928K

South West.pdf
4229K

West distt year 2017 - 2018.doc
167K

Appendix-7

Confidentiality Agreement

1. This agreement was signed between **Dr Sajjan Singh Yadav, a DrPH candidate of the London School of Hygiene of Hygiene and Tropical Medicine (LSHTM)**, hereinafter referred to as the **First party**

AND

2. **Dr Ankush Sanghai, State Veterinary Consultant**, Integrated Disease Surveillance Program (IDSP), Dadra and Nagar Haveli, India, hereinafter referred to as the **Second Party**.
3. AND WHEREAS the first party is conducting a research entitled "**Public Health Surveillance of Construction Site Injuries in Delhi, India Using the First Information Reports (FIRs) Registered by Delhi Police**" which involves extraction of information from the FIRs registered by Delhi Police.
4. AND WHEREAS one of the studies as part of the research involves extraction of information from a random sample of 50 FIRs by a person other than the First party to test the inter-rater reliability of the Data Extraction Tool developed by the First party.
5. AND WHEREAS the Second party has agreed to do the data extraction from a sample of 50 FIRs free of cost as a gesture to help the First party in the research.
6. AND WHEREAS the information contained in the FIRs is of private nature and the victims of incidents leading to injury to a person or a property can be identified from that information.
7. Therefore, this agreement is signed between the two parties to keep the information shared strictly confidential.
8. Duties and obligations of the parties to the agreement

Duties and obligations of the First party:

i. The First party will provide the FIR documents of 50 randomly selected FIRs to the Second party in electronic Pdf format after masking the names of victims, address of incident site, address of the victims and other details which may lead to the identification of the person or the incident site.

ii. The First party will also provide the Second party with a data extraction tool and instructions for extraction of the data from the FIRs using the tool.

Duties and obligations of the Second party

i. The Second party will extract the data from the 50 FIR documents using the tool and instructions provided in a Microsoft Excel file and email it to the First Party.

ii. The Second party shall keep the FIR documents, the Microsoft Excel file containing the extracted information or any other details relating to this research strictly confidential in a password protected folder and shall not share them with anyone.

iii. After extracting the information from 50 FIRs and sending the information in a Microsoft Excel file to the First party, the Second Party shall delete the FIR folder and the Microsoft Excel Sheet file containing the extracted information from his email, computer and any other device having that information.

iv. The Second party shall NOT keep a copy of the information shared with him or the information extracted by him

v. The Second party shall NOT share the information provided to him by the First party or the information extracted by him from the FIRs with anyone.

9. Signed on 1st December, 2018 by the two parties mentioned below:

First Party

[redacted]

Dr Sajjan Singh Yadav
DrPH Candidate, London School of Hygiene and Tropical Medicine

Second Party

[redacted]

Dr Ankush Sanghai
State Veterinary Consultant, Integrated Disease Surveillance Program (IDSP), Dadra and Nagar Haveli, India

Appendix-8

Acceptance Letter from the Indian Journal of Medical Research

[IJMR]:Article provisionally accepted.:IJMR_442_20

Dear Dr. Yadav,

We are pleased to inform that your manuscript “Evaluation of First Information Reports (FIRs) of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation& rdquo; is provisionally accepted. You would receive an edited version of article in due course after copy and technical editing for a final check and correction.

We thank you for submitting your valuable research work to Indian Journal of Medical Research.

With warm personal regards,

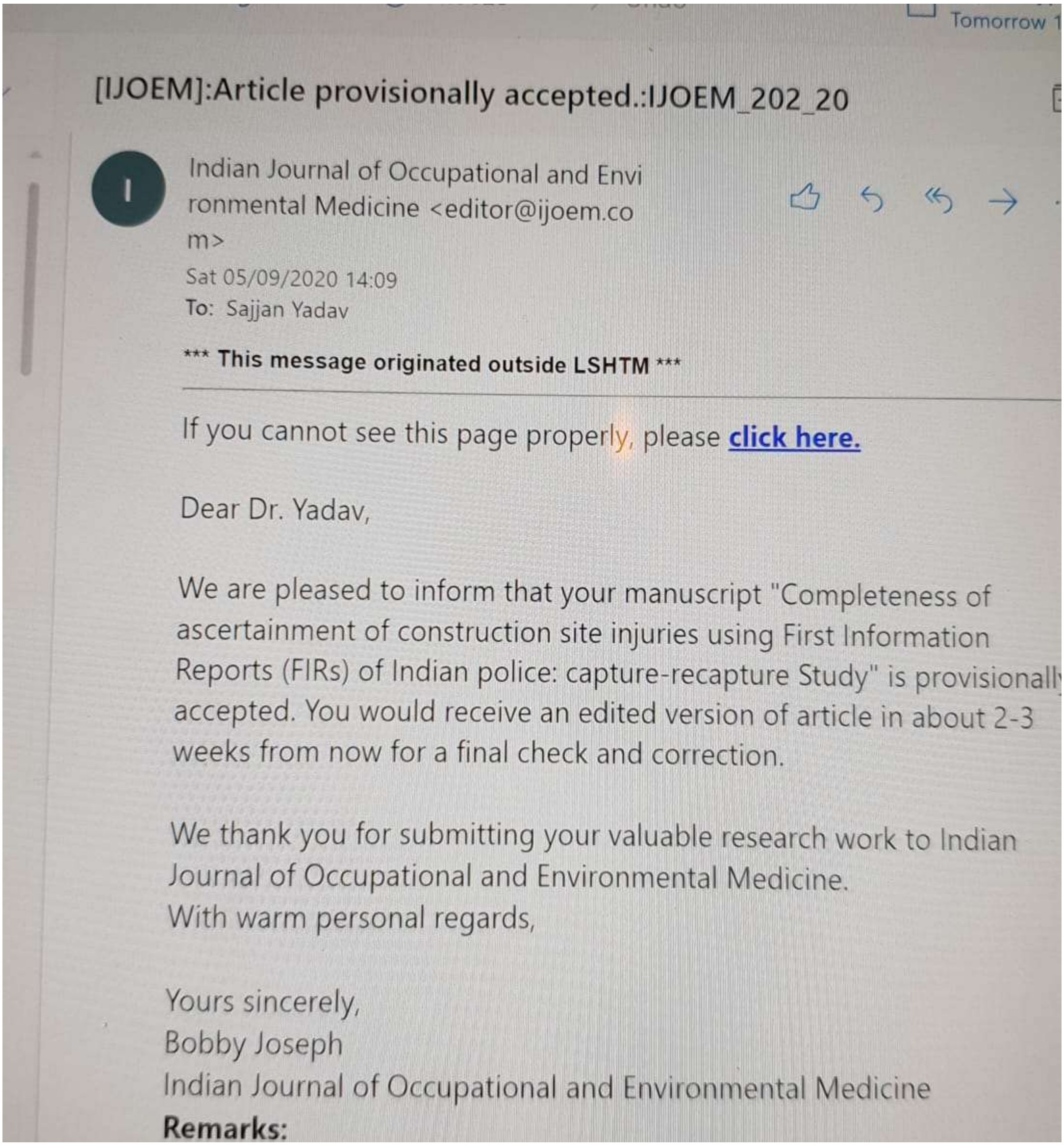
Yours sincerely,

Anju Sharma

Indian Journal of Medical Research

Appendix-9

Acceptance Letter from the Indian Journal of Occupational and Environmental Medicine



Tomorrow 1

[IJOEM]:Article provisionally accepted.:IJOEM_202_20

Indian Journal of Occupational and Envi
ronmental Medicine <editor@ijoem.co
m>
Sat 05/09/2020 14:09
To: Sajjan Yadav

*** This message originated outside LSHTM ***

If you cannot see this page properly, please click here.

Dear Dr. Yadav,

We are pleased to inform that your manuscript "Completeness of ascertainment of construction site injuries using First Information Reports (FIRs) of Indian police: capture-recapture Study" is provisionall[y] accepted. You would receive an edited version of article in about 2-3 weeks from now for a final check and correction.

We thank you for submitting your valuable research work to Indian Journal of Occupational and Environmental Medicine.
With warm personal regards,

Yours sincerely,
Bobby Joseph
Indian Journal of Occupational and Environmental Medicine
Remarks:

Appendix-10

Assessment of a potential reporting bias according to gender in injuries to construction workers ascertained by the First Information Reports (FIRs) of Delhi Police

1. Introduction:

In chapter-2 of this thesis, I estimated the completeness of ascertainment of construction site injuries using the First Information Reports (FIRs) of police in Delhi, India. I found that FIRs ascertained 42.6% of the total fatal injuries and 30.2% of the total non-fatal injuries estimated to have been suffered by construction workers in all incidents at construction sites from 1st January to 31st December, 2017.

In chapter-5 of this thesis, I estimated the injury rate per 100,000 construction workers per year. I found that the injury rate was higher in female workers than in male construction workers. The non-fatal injury rate per 100,000 workers per year was almost 3 times higher in female workers (98.55; 95% CI 82.52 to 116.8) than in male workers (34.36; 95%CI 31.92 to 36.94). This is potentially an important finding which requires further investigation, as it may be due to FIRs being more likely to ascertain injuries to female workers than to male workers (i.e., a reporting bias).

2. Aim:

The aim of this study was to assess any evidence that FIRs are more likely to ascertain injuries to female workers than to male workers (i.e., a reporting bias according to gender).

3. Methods

The study was conducted in Delhi, India, using a two-sample capture recapture method. The study was based on the data of incidents at construction sites reported to the Delhi police, Employee State Insurance Corporation (ESIC), and Commissioners of Workmen Compensation of Delhi Government from 1st January 2017 to 31st December 2017. The first sample was data on construction site injuries extracted from FIRs. The second 'recapture' sample comprised data on construction injuries reported to the ESIC, combined with data on claims for compensation filed with the Commissioners of Workmen Compensation. Only construction workers who suffered fatal or non-fatal unintentional injuries in the incidents were included in the study. Victims of intentional injuries, including intentional self-harm, sexual assaults etc. were excluded.

3.1. Gender wise estimation of the number of construction workers who suffered fatal and non-fatal injuries

The gender wise number of construction workers who suffered fatal or non-fatal injuries in all incidents at construction sites in 2017 was estimated using the Chapman estimator.[1,2] Estimation was done using the following formula:[3]

$$Number\ of\ workers\ injured\ (N_t) = \frac{(P_t + 1)(E_t + 1)}{(m + 1)} - 1$$

Where P_t is number of construction workers injured as per police FIRs (first sample); E_t is the number of construction workers injured as per the combined database of the ESIC and the Commissioners of Workmen Compensation (second sample); m is the number of construction workers injured who were identified in both databases (i.e. where data linkage resulted in a match).

3.1.1. Precision of the estimate

The precision of the estimate was quantified by a confidence interval calculated through a variance-based approach using the following formula:[3]

$$Variance = \frac{(P_t + 1)(E_t + 1)(P_t - m)(E_t - m)}{(m + 1)^2\ (m + 2)}$$

An approximate 95% confidence interval (CI) for the estimate of N_t was calculated using the following formula:

$$95\%\ CI = N_t \pm 1.96\ \sqrt{\text{Variance}}$$

Where N_t is the estimated number of construction workers injured.

After estimating the total number of fatal and non-fatal injuries suffered by the construction workers, the percentage of injuries captured by FIRs as well as by the combined data base of the ESIC and the Commissioners of Workmen's compensation for male and female workers was calculated. This provided a gender wise estimate of the completeness of ascertainment of fatal and non-fatal injuries by FIRs and the combined data base.

4. Results

Analysis of FIR data indicated that 264 construction workers suffered non-fatal injuries during the study period of which 244 (92.4%) were males and 20 (7.6%) were females (table-1). Of the total 110 fatal injuries reported to the police, 105(95.5%) were males and 5 (4.5%) were females. The combined data of the ESIC and the Commissioners of Workmen's Compensation showed that 48 workers died and 32 suffered non-fatal injuries. Of the 32 non-fatal injuries, all workers were male. No report of a non-fatal injury to a female construction worker was received either by the ESIC or the Commissioners of Workmen Compensation. In case of deaths, of the 48 construction workers who died in the incidents reported at construction sites, 46 (95.8%) were male construction workers and 2 (4.2%) were female. Record linkage of injured male workers in the two samples yielded 20 matches in the case of fatal injuries and 9 matches in the case of non-fatal injuries. There were no matches of female construction workers (table-1).

Using the Chapman estimator, I estimated that the total number of male construction workers that sustained a non-fatal injury in 2017 was 807 (95% CI: 517 to 1,197) and the total number of male construction worker that died due to injuries at construction sites was 236 (95% CI: 170 to 302). In the case of female construction workers, the total number of non-fatal construction injuries was estimated to be 20 (95% CI: -8 to 48) and the estimated number of female construction workers that died in the incidents was 17 (95% CI: -2 to 36) (table-1).

Based on these estimates of the total numbers of construction workers injured in Delhi in 2017, the FIRs thus correctly ascertained 44.5% of the total number of male construction workers who suffered a fatal injury and 30.2% of the total number of male construction workers who suffered a non-fatal injury; the FIRs correctly ascertained 29.4% of the female construction workers who suffered a fatal injury and 100% of the female construction workers who suffered a non-fatal injury. Overall FIRs ascertained 349 (34.5%) of all injuries to male workers and 25 (68%) of all injuries to female workers. There is therefore evidence for differences in the percentage ascertainment by FIRs of both fatal and non-fatal injuries according to gender. Similarly, the combined data of the ESIC and the Commissioners of Workmen's Compensation correctly ascertained 19.5% of the male and 11.8% of the female construction workers who suffered fatal injuries and 4% of the male and 0% of the female construction workers who suffered non-fatal injuries in the incidents at construction sites during the study period (table-1).

Table-1: Gender wise construction workers injured in Delhi in 2017									
Source	**Number of workers injured**								
	Fatal			non-fatal			All injuries		total
	m	f	total	m	f	total	m	f	
FIRs (% ascertainment)	105 (44.5%)	5 (29.4 %)	110 (42.6%)	244 (30.2 %)	20 (100 %)	264 (30.2%)	349 (34. 5%)	25 (68 %)	374 (37.0 %)
ESIC and Commissioner s of Workmen Compensation combined	46 (19.5%)	2 (11.8 %)	48 (18.6%)	32 (4%)	0 (0%)	32 (3.7%)	78 (7.4 8%)	2 (5.4 0%)	80 (7.9%)
Matched records	20	0	20	9	0	9	29	0	29
Capture-recapture analysis estimate of total numbers (95% CI)	236 (95% CI: 170 to 302)	17 (95% CI: -2 to 36)	258 (221 to 295)	807 (95% CI: 517 to 1197)	20 (-8 to 48)	873 (765 to 1053)	104 3	37	1031 (873 to 1149)

These results show that for fatal injuries, the distribution of injuries by gender was almost the same in the two samples (FIRs and combined data of the ESIC and workmen compensation): According to the FIRs, 95.5% of the workers who died were males and 4.5% were females; In the combined data of ESIC and Workmen Compensation 95.8% of the dead were male construction workers and 4.2% were female workers.

5. Discussion

5.1. Principal findings

There is evidence for differences in the percentage ascertainment by FIRs of both fatal and non-fatal injuries according to gender: FIRs ascertained a greater proportion of all injuries to female workers than to male workers. There was 100% ascertainment of non-fatal injuries by FIRs for female workers.

5.2. Strengths and weaknesses

5.2.1. Strengths

In this study, for the first time, the total numbers of fatal and non-fatal injuries suffered by construction workers in Delhi have been estimated by gender.

5.2.2. Weakness

If one of the sources of data captures very few cases, the capture-recapture methods are likely to produce a biased estimate of the population size.[4] As the number of non-fatal injuries reported by female construction workers to the ESIC and the Commissioners of Workmen Compensation was zero, the capture-recapture method is likely to have under estimated the number of non-fatal injuries suffered by female construction workers.

6. Conclusion

There is evidence of a gender bias in the reporting of non-fatal injuries to the ESIC and the Commissioners of Workmen Compensation against female construction workers. FIRs ascertain a greater proportion of all injuries to female workers than to male workers. In chapter-5 of this thesis, the non-fatal injury rate per 100,000 construction workers for females has likely been affected by this reporting bias such that the injury rate to male workers has been underestimated.

References

1 Chapman, D.G., 1951. Some properties of hyper-geometric distribution with application to zoological census. University of California Publications Statistics, 1, pp.131-160.

2 Brittain, S. and Böhning, D., 2009. Estimators in capture–recapture studies with two sources. AstA Advances in statistical analysis, 93(1), pp.23-47.

3 Hook, E.B. and Regal, R.R., 1995. Capture-recapture methods in epidemiology: methods and limitations. Epidemiologic reviews, 17(2), pp.243-264.

4 Kate Tilling, Capture-recapture methods—useful or misleading?, International Journal of Epidemiology, Volume 30, Issue 1, February 2001, Pages 12–14, https://doi.org/10.1093/ije/30.1.12

Appendix-11

Stata command that used to obtain this 85% power

According to the available data, in the year 2017, there were 411,517 unskilled workers and 3553 electricians among the construction workers in Delhi. I hypothesised that the injury rates among these two categories of construction workers were 100 per 100,000 workers versus 300 per 100,000 workers (i.e., 0.001 versus 0.003 respectively). I assumed that I wish to detect a difference in injury rates between groups by trade. **I used the following command in Stata to estimate the power of my study:**

“. power twoproportions 0.001 0.003, n1(411517) n2(3553)”

In response to the command, Stata produced the following results regarding estimated power for a two-sample proportions test

Pearson's chi-squared test

Ho: p2 = p1 versus Ha: p2 != p1

Study parameters:

alpha = 0.0500

N = 415,070

N1 = 411,517

N2 = 3,553

N2/N1 = 0.0086

delta =   0.0020 (difference)

p1 =   0.0010

p2 =   0.0030

Estimated power:

power =   0.8492

Appendix-12
Two Filled up Samples of Data Extraction tool

Sample-1

FIR Details	FIR No	**388**	Date of FIR	DD	MM	Year	Police Station Name	**XXXXX**	District	**XXXXXX**
				16	**12**	**2017**				

Time and Date of incident				Address of incident site (Please enter 99 if information of any data field is not available)			
HH:MM	DD	MM	YYYY	House No	Locality (Colony) Name	Legal status of colony (01-Authorized; 02-unauthorized; 99-Information not available, 100-government project, legal status not applicable)	District
11:00	**16**	**12**	**2017**	**XX**	**XXXXXXX**	**01**	**CENTRAL**

Details of owner of incident site (Please enter 99 if information of any data field is not available)					
Name	Address				
	House No	Locality (Colony) Name	District	State	Country
XXXXXXX	**XXXX**	**XXXXXXXXX**	**XXXX**	**DELHI**	**INDIA**

Ownership Category of incident site 01-Government Department; 02-Government Company/Board; 03-Private Company; 04- Private individual; 98 Other (specify); 99-Information not available	**04**
Mode of execution of work 01- Self construction; 02- Construction through a construction company; 03- Construction through an individual contractor; 98 Other (specify); 99-Information not available	**03**
If not self-construction, details of individual contractor/construction company engaged	

(Please enter "99" if information of any data field is not available; enter "NA" if it is self-construction)					
Name	**Address**				
XXXXXX	House No	Locality/ colony name	District	State	**Country**
	XX	**XXXXXXX**	**99**	**DELHI**	**INDIA**
Nature of Construction work 01-New construction; 02-Alteration/additional construction; 03-Maintenance (including repair, painting); 04-Demolition; 05-Dismantling of old building/structure; 06-Erection/dismantling of tent/domes/shamiayana or other temporary structures; 98 Other (specify); 99-Information not available					**01**
Legality of construction 01-Authorized; 02-Unauthorized; 98 Other (specify); 99-Information not available					**99**
Type of construction work 01-Building;02-Flyover/bridge/underpass; 03-Road/street; 04-Railway works; 05-Metro Rail works 06-Airport/airfield; 07-Irrigation canals, channels/embankment/flood control works; 08- Work related to generation, transmission and distribution of power including towers and lines; 09- water works including water treatment plant, water pumping station, tanks and distribution line; 10-Sewerage line or sewerage treatment plant or sewerage pumping station; 11- Oil and gas installations; 12- Wireless (including cellphone), radio, television, telephone and telegraph towers lines and other related works; 13-Erection of a tent/shamiyana/dome; 14-Landscaping/horticulture work; 98 Other (specify); 99-Information not available					**01**
In case of buildings, type of building 01- Residential; 02- Cattle/agriculture related; 03- Commercial (Includes malls, shopping complex/restaurants etc); 04- Institutional (includes offices, schools, colleges/hospitals); 05-Factory/Industries; 98 Other (specify); 99-Information not available; 100- Not a case of building					**01**
Cause of accident 01- Collapse of old building or part thereof; 02-Collapse of scaffolding/platform; 03-Collapse of roof/wall/part of under construction building/building material 04-Collapse of surrounding earth of a pit/basement/tunnel; 05-Break of rope/harness; 6- Lack of barricade/railing/cover; 7-Slipping of ladder 8-Gap in building/stairs, 09-Accidental fall of bricks/building material; 10-Accidental fall of other object/equipment 11-stepping on sharp					**09**

object; 12-Electric shock; 13 Accidental hit by vehicle or moving machine ; 14- Accidental injury by stationery machine/equipment, 15-Lifting of heavy object, 16-Contact with chemical hazardous substance; 17-Presence/release of harmful gases; 18-Accidental fall in water; 19-Fire; 20- Slipping of person 98 Other (specify) 99-Information not available	
Mechanism of Injury 01-Sharp force; 02- Blunt force of static object; 03-Blunt force of a moving object; 04- Fall; 05-Drowning/submersion; 06- Burn (smoke/fire/flames); 07- Burn (contact with heat/scald); 08-Poisoning; 09-corrosion by chemical/other substance; 10-Suffocation/choking,; 11-Electrocution; 12. Explosive blast; 13. Exposure to sound, vibration; 98 Other (specify) 99-Information not available	**03**
In case of fall, Object from which the fall occurred 01-Stairs; 02-Tree; 03-Roof; 04-Balcony; 05-Ladder; 06-scaffolding/platform; 07-Through lift shaft; 08-Vehicle; 09-fall from tower; 10-Fall in a pit/hole 98-Other (specify); 99-Information not available; 100- Not a case of fall	**100**
What height did the victim(s) fell from? 01-Same level as he/she was standing; 02-Height less than 2 metres; 03-Height greater than 2 metres but less than or equal to 6 meters (2 floors);04-Height more than two floors; 99-Information not available; 100-not a case of fall	**100**
Wasthe time duration between start of work on the day of accident and time at which accident happened, more than 5 hours? 01-Yes; 02-No; 99-Information not available; 100- if victim is not construction site worker	**100**
In the 6 hours before accident, did the victim(s) have any alcohol to drink (even one drink)? 01-Yes; 02-No; 99-Information not available; 100-if victim is not construction site worker	**100**
No. of persons injured in the incident(Write "NA" if information is not available)	**1**
Details of injured persons(Write "99" if information is not available)	

Name	Age	Sex[A]	Trade[B]	Nativity[C] 01-Delhi;	Body part injured[D]	Type/ Nature of	Disability[F] caused	First	Type of health facility	Length of stay in	In case of hospital	Object/Substance/Product involved	Association of victim with	Activity when

				02-/Other state (Pl specify); 03-Other Country; (Pl specifiy) 99-Informaton not available)		Injury[E]		Aid at site[G]	to which victim was taken for treatment	hospital	admission, whether declared unfit for statement in the first instance 01-Yes; 02-No; 99-information not available); 100-not-admitted	in the injury[J]	construction site[K]	injured[L]
XXXX	**29**	**1**	**98 (Press worker)**	**1**	**1**	**99**	**99**	**99**	**2**	**99**	**2**	**5**	**5**	**1**

A- 01-Male; 02-Female; 09-Unknown or undetermined; 99-Information not available

B- 01-Labourer; 02- Mason (Mistri); 03- Painter; 04-Welder; 05- Electrician; 06- Pump operator; 07-Plumber; 08- Carpenter; 09-Aluminium worker; 10- Centring & shuttering; 11-Glass worker 12- Mechanic; 13- Truck/tractor driver; 14-Driver of other vehicle (JCV/Hitachi etc); 15- Security guard; 16-Supervisor; 17-Owner; 98-Other (Please specify); 99-Information not available

C- If from other state, write name of the state. If from other country, write name of the country; 99-Information not available

D- 01-Head (excludes face); 02-Face (excludes eye); 03-eye; 04-Neck; 05-Thorax; 06-Lumbar spine; 07-Abdomen; 08-Internal organs; 09-Lower back (includes loin); 10-Pelvis (includes perineum, anogenital area and buttocks); 11-Shoulder; 12-Upper arm; 13-Elbow; 14-Forearm; 15-Wrist; 16-Hand; 17-fingers (including thumb); 18-Hip; 19-Thigh; 20-Knee; 21-Lower leg; 22-Ankle; 23-Foot; 24-Toes; 25-Unspecified bodily location; 26-Multiple injuries (involving more than one bodily location); 98- Other (please specify); 99-Information not available

E-01-Contusion/bruise/abrasion/superficial injury; 02-cut/open wound; 03-Fracture; 04-Dislocation and subluxation; 05-Sprain and strain; 06-Concussion/brain injury; 07- Crushing injury; 08-Poisoning; 09- insertion of foreign body; 10 Burns and scalds; 11-Injury to muscle and tendon, blood vessels and nerves; 12 Injury to internal organs; 13-Poisoning; 14-Corrosion (chemical); 15- Electrocution ; 16-suffocation; 17 loss of hearing;.98-Other (specify) 99-Information not available

F- 01-Unable to use hand or arm; 02-Difficulty using hand or arm; 03-Walk with a limp; 04-Loss of hearing; 05-Loss of vision; 06-Weakness or shortness of breath; 07-Inability to remember things; 08-Inability to chew food; 98-Other (specify); 99-Information not available

G- 01-No first aid given at site; 02-Site supervisor; 03-Another worker from site; 04-Family member; 05-Ambulance personnel; 06-Doctor; 07-Nurse 08-Fire brigade personnel; 09-Police 98-Other (specify); 99-Information not available

H- 01-Not taken to hospital; 02-Government Hospital; 03-Private hospital; 04-Multiple hospitals; 04-Traditional practitioner/healer/bone setter; 05-Pharmacy/drug store; 98-Other (specify); 99-Information not available

I- 01-discharged on the same day after treatment; 02-admitted for more than a day; 03-victim absconded from hospital; 98-Other (specify); 99-Information not available

J- 01-Vehicle/moving machinery; 02- stationary machines; 03-powered hand tool/equipment; 04- unpowered hand tool/equipment; 05-building material (like brick/aggregate, stone/cement/concrete blocks) 06-Timber/wood/boards/furniture 07-steel rods/girder; 08-scaffolding/shuttering material; 09-aluminium/tin; 10-glass; 11-loose earth; 12-nail or small piece of metal; 13-nacked wire; 14-overhead electric wire; 15-pipe; 16-lime or other chemical; 17-gas (including smoke); 18-fire/hot object or construction material; 19-material used for erection of a tent/shamiyana/dome; 98-Other (specify); 99-Information not available

K- 01-Construction site worker (including owner/engineer/ contractor/ supervisors etc); 02- Children of construction site workers; 03-neighbour(including Children); 04-visitor(including Children); 05-passer-by(including Children); 98-Other (specify); 99-Information not available

L- 01-Not doing any construction related work (just standing or walking at construction site); 02-excavation/tunnelling work; 03-transporting construction material/object; 04- masonry work including plastering, flooring, roof work and false ceiling; 05-steel cutting/bending; 06-removing shuttering or scaffolding; 07-painting; 08-fixing door/window or other carpentry work; 09-glass work; 10-Aluminium work; 11- plumbing work; 12-electrical or other cabling or fixing work; 13- -working on a machine or equipment; 14-driving a vehicle or moving machinery; 15-cleaning work; 16- Demolition old structure /building 98 Other (specify) 99-Information not available

No. of persons died in the incident(Write “99” if information is not available)	**0**
Details of persons died (Write “99” if information is not available)	

Name	Age	Sex[A]	Trade[B]	Nativity[C] 01-Delhi; 02-	Body part injured[D]	Type/Nature of Injury[E]	First Aid at site[F]	Type of health facility to which	Place of death[H]	Object /Substance /Product involved in the injury[I]	Association of victim with constru	Activity when injured[K]

				/Other state (Pl specify) ; 03-Other Country ; 99-Informat on not availabl e)				victim was taken			ction site[J]	

A- 01-Male; 02-Female; 09-Unknown or undetermined; 99-Information not available

B- 01-Labourer; 02- Mason (Mistri); 03- Painter; 04-Welder; 05- Electrician; 06- Pump operator; 07-Plumber; 08- Carpenter; 09-Aluminium worker; 10- Centring & shuttering; 11-Glass worker 12- Mechanic; 13- Truck/tractor driver; 14-Driver of other vehicle (JCV/Hitachi etc); 15- Security guard; 16-Supervisor; 17-Owner; 98-Other (Please specify); 99-Information not available

C- If from other state, write name of the state. If from other country, write name of the country; 99-Information not available

D- 01-Head (excludes face); 02-Face (excludes eye); 03-eye; 04-Neck; 05-Thorax; 06-Lumbar spine; 07-Abdomen; 08-Internal organs; 09-Lower back (includes loin); 10-Pelvis (includes perineum, anogenital area and buttocks); 11-Shoulder; 12-Upper arm; 13-Elbow; 14-Forearm; 15-Wrist; 16-Hand; 17-fingers (including thumb); 18-Hip; 19-Thigh; 20-Knee; 21-Lower leg; 22-Ankle; 23-Foot; 24-Toes; 25-Unspecified bodily location; 26-Multiple injuries (involving more than one bodily location); 98- Other (please specify); 99-Information not available

E-01-Contusion/bruise/abrasion/superficial injury; 02-cut/open wound; 03-Fracture; 04-Dislocation and subluxation; 05-Sprain and strain; 06-Concussion/brain injury; 07- Crushing injury; 08-Poisoning; 09- insertion of foreign body; 10 Burns and scalds; 11-Injury to muscle and tendon, blood vessels and nerves; 12 Injury to internal organs; 13-Poisoning; 14-Corrosion (chemical); 15- Electrocution ; 16-suffocation; 17 loss of hearing;.98-Other (specify) 99-Information not available

F- 01-No first aid given at site; 02-Site supervisor; 03-Another worker from site; 04-Family member; 05-Ambulance personnel; 06-Doctor; 07-Nurse; 08-Fire brigade personnel; 09-Police 98-Other (specify); 99-Information not available

G- 01-Not taken to hospital; 02-Government Hospital; 03-Private hospital; 04-Multiple hospitals; 04-Traditional practitioner/healer/bone setter; 05-Pharmacy/drug store; 98-Other (specify); 99-Information not available
H- 01--brought dead to hospital; 02-died in the hospital on the same day; 03-died in hospital after a day; 98-Other (specify); 99-Information not available

I- 01-Vehicle/moving machinery; 02- stationary machines; 03-powered hand tool/equipment; 04- unpowered hand tool/equipment; 05-building material (like brick/aggregate, stone/cement/concrete blocks) 06-Timber/wood/boards/furniture 07-steel rods/girder; 08-scaffolding/shuttering material; 09-aluminium/tin; 10-glass; 11-loose earth; 12-nail or small piece of metal; 13-nacked wire; 14-overhead electric wire; 15-pipe; 16-lime or other chemical; 17-gas (including smoke); 18-fire/hot object or construction material; 19-material used for erection of a tent/shamiyana/dome; 98-Other (specify); 99-Information not available

J- 01-Construction site worker (including owner/engineer/ contractor/ supervisors etc); 02- Children of construction site workers; 03-neighbour (including Children); 04-visitor(including Children); 05-passer-by(including Children); 98-Other (specify); 99-Information not available

K- 01-Not doing any construction related work (just standing or walking at construction site); 02-excavation/tunnelling work; 03-transporting construction material/object; 04- masonry work including plastering, flooring, roof work and false ceiling; 05-steel cutting/bending; 06-removing shuttering or scaffolding; 07-painting; 08-fixing door/window or other carpentry work;

09-glass work; 10-Aluminium work; 11- plumbing work; 12-electrical or other cabling or fixing work; 13- -working on a machine or equipment; 14-driving a vehicle or moving machinery; 15-cleaning work; 16- Demolition old structure /building 98 Other (specify) 99-Information not available	
Who transported the victim to health facility/health personnel 01-Self; 02-Co-worker; 03-Relative/friend; 04-Owner of construction site; 05-Construction site manager/supervisor/security staff; 06-Police personnel; 07-Ambulance staff; 08-Passer by; 09-Not taken to a health facility/personnel; 98 Other (specify) 99-Information not available	**06**
Mode of transport of victim to health facility/health personnel 01-Ambulance; 02-private vehicle; 03- Taxi/Rickshaw 04- police vehicle; 05-on foot; 98 Other (specify) 99-Information not available; 100-Not taken to a health facility/Personnel	**04**
Were personnel protective gears/safety equipment provided to victim by owner/contractor 01-Yes; 02-No; 98 Other (specify) 99-Information not available; 100-Victim is not a construction site worker	**100**
Were personnel protective gears/safety equipment used by victims at the time of incident 01-Yes; 02-No; 98 Other (specify) 99-Information not available; 100-Victim is not a construction site worker	**100**
Were the victims asked to work without safety equipment despite demand of safety equipment by them 01-Yes; 02-No; 98 Other (specify) 99-Information not available 100-Victim is not a construction site worker	**100**
Was there damage to property due to the incident 01-Yes; 02-No; 98 Other (specify) 99-Information not available; 100-Not a case of damage to property	**02**
Whose property was damaged 01- Construction site (other than building/structures being constructed/repaired); 02- Neighbour; 03- Visitor to construction site; 04- Passer-by; Other (specify) 99-Information not available; 100- Not a case of damage to property	**100**
If yes, nature of damaged property 01- Immovable property (roof, wall, house); 02- movable property; 03- vehicles; 98 Other (specify) 99-Information not available; 100-Not a case of damage to property	**100**
Who informed the police?	**01**

01-Victim; 02-Relative of victim; 03-Other person from construction site; 04-Owner/manager/supervisor of site; 05-security personnel of construction site; 06-Neighbour; 07-Passer-by; 08-Hospital staff; 09-Police staff ; 10-Staff of other government department/agency; 11-Call to police control room by unknown person; 98 Other (specify) 99-Information not available	
Mode of information to police 01- In person verbal information in police station; 02-In person written information to police station; 03- telephone call to police station; 04-Telephone call to police control room; 05- Verbal information to a nearby police van; 06-Telephonic/in person information to control room of other government agency; 98 Other (specify) 99-Information not available	**04**
Details of complainant in the FIR	

Name	Designation	Organization[b]	Association with construction site[c]
XXXX	**98 (Press Worker)**	**98 (Passer By)**	**08**

a-Write official designation of the police or hospital staff if available; 98- Others (pl mention) else Write 99- Information not available

b- 01-Police; 02-construction site person; 03-hospital staff; 04-relative/friend; 05-Neighbour; 98 Other (specify) 99-Information not available

c-01-Victim of accident; 02-relative of victim, 03-other construction site worker; 04-Manager/owner of site; 05-Security guard at construction site; 06-neighbour; 07-visitor; 08-passer-by; 09-Police officer; 10-hospital staff; 98-Other (specify); 99-Information not available

Was the police informed after accident or due to a threat or apprehension of accident/damage 01- After actual accident; 02- threat or apprehension of accident (without any accident happening)	**01**

Sample-2

FIR Details	FIR No	**1385**	Date of FIR	DD	MM	Year	Police Station Name	**XXXXXX**	District	**XXXX**
				28	**12**	**2017**				

Time and Date of incident				Address of incident site (Please enter 99 if information of any data field is not available)			
HH:MM	DD	MM	YYYY	House No	Locality (Colony) Name	Legal status of colony (01-Authorized; 02-unauthorized; 99-Information not available, 100-government project, legal status not applicable)	District
11:30	**28**	**12**	**2017**	**A 636**	**XXXX**	**02**	**XXXX**

Details of owner of incident site (Please enter 99 if information of any data field is not available)					
Name	Address				
	House No	Locality (Colony) Name	District	State	Country
XXXX	**A 636**	**XXXX**	**XX**	**DELHI**	**INDIA**

Ownership Category of incident site 01-Government Department; 02-Government Company/Board; 03-Private Company; 04- Private individual; 98 Other (specify); 99-Information not available	**04**
Mode of execution of work 01- Self construction; 02- Construction through a construction company; 03- Construction through an individual contractor; 98 Other (specify); 99-Information not available	**03**
If not self-construction, details of individual contractor/construction company engaged (Please enter “99” if information of any data field is not available; enter “NA” if it is self-construction)	

Name	**Address**				
XXXX	House No	Locality/ colony name	District	State	**Country**

	XX	XXXX Delhi	XX	DELHI	INDIA
Nature of Construction work 01-New construction; 02-Alteration/additional construction; 03-Maintenance (including repair, painting); 04-Demolition; 05-Dismantling of old building/structure; 06-Erection/dismantling of tent/domes/shamiayana or other temporary structures; 98 Other (specify); 99-Information not available					**01**
Legality of construction 01-Authorized; 02-Unauthorized; 98 Other (specify); 99-Information not available					**02**
Type of construction work 01-Building;02-Flyover/bridge/underpass; 03-Road/street; 04-Railway works; 05-Metro Rail works 06-Airport/airfield; 07-Irrigation canals, channels/embankment/flood control works; 08- Work related to generation, transmission and distribution of power including towers and lines; 09- water works including water treatment plant, water pumping station, tanks and distribution line; 10-Sewerage line or sewerage treatment plant or sewerage pumping station; 11- Oil and gas installations; 12- Wireless (including cellphone), radio, television, telephone and telegraph towers lines and other related works; 13-Erection of a tent/shamiyana/dome; 14-Landscaping/horticulture work; 98 Other (specify); 99-Information not available					**01**
In case of buildings, type of building 01- Residential; 02- Cattle/agriculture related; 03- Commercial (Includes malls, shopping complex/restaurants etc); 04- Institutional (includes offices, schools, colleges/hospitals); 05-Factory/Industries; 98 Other (specify); 99-Information not available; 100- Not a case of building					**01**
Cause of accident 01- Collapse of old building or part thereof; 02-Collapse of scaffolding/platform; 03-Collapse of roof/wall/part of under construction building/building material 04-Collapse of surrounding earth of a pit/basement/tunnel; 05- Break of rope/harness; 6- Lack of barricade/railing/cover; 7-Slipping of ladder 8-Gap in building/stairs, 09-Accidental fall of bricks/building material; 10-Accidental fall of other object/equipment 11-stepping on sharp object; 12-Electric shock; 13 Accidental hit by vehicle or moving machine ; 14- Accidental injury by stationery machine/equipment, 15-Lifting of heavy object, 16-Contact with chemical hazardous substance; 17-Presence/release of harmful gases; 18-Accidental fall in water; 19-Fire; 20- Slipping of person 98 Other (specify) 99-Information not available					**03**

Mechanism of Injury 01-Sharp force; 02- Blunt force of static object; 03-Blunt force of a moving object; 04- Fall; 05-Drowning/submersion; 06- Burn (smoke/fire/flames); 07- Burn (contact with heat/scald); 08-Poisoning; 09-corrosion by chemical/other substance; 10-Suffocation/choking,; 11-Electrocution; 12. Explosive blast; 13. Exposure to sound, vibration; 98 Other (specify) 99-Information not available	**03**
In case of fall, Object from which the fall occurred 01-Stairs; 02-Tree; 03-Roof; 04-Balcony; 05-Ladder; 06-scaffolding/platform; 07-Through lift shaft; 08-Vehicle; 09-fall from tower; 10-Fall in a pit/hole 98-Other (specify); 99-Information not available; 100- Not a case of fall	**100**
What height did the victim(s) fell from? 01-Same level as he/she was standing; 02-Height less than 2 metres; 03-Height greater than 2 metres but less than or equal to 6 meters (2 floors);04-Height more than two floors; 99-Information not available; 100-not a case of fall	**100**
Wasthe time duration between start of work on the day of accident and time at which accident happened, more than 5 hours? 01-Yes; 02-No; 99-Information not available; 100- if victim is not construction site worker	**2**
In the 6 hours before accident, did the victim(s) have any alcohol to drink (even one drink)? 01-Yes; 02-No; 99-Information not available; 100-if victim is not construction site worker	**99**
No. of persons injured in the incident(Write "NA" if information is not available)	**0**
Details of injured persons(Write "99" if information is not available)	

Name	Age	Sex[A]	Trade[B]	Nativity[C] 01-Delhi; 02-/Other state (Pl specify)	Body part injured[D]	Type/Nature of Injury[E]	Disability[F] caused	First Aid at site[G]	Type of health facility to which victim was	Length of stay in hospital	In case of hospital admission, whether	Object/Substance/Product involved in the injury[J]	Association of victim with construction site[K]	Activity when injured[L]

				; 03-Other Country; (Pl specifiy) 99-Information not available)					taken for treatment		declared unfit for statement in the first instance 01-Yes; 02-No; 99-information not available); 100-not-admitted			

A- 01-Male; 02-Female; 09-Unknown or undetermined; 99-Information not available

B- 01-Labourer; 02- Mason (Mistri); 03- Painter; 04-Welder; 05- Electrician; 06- Pump operator; 07-Plumber; 08-Carpenter; 09-Aluminium worker; 10- Centring & shuttering; 11-Glass worker 12- Mechanic; 13- Truck/tractor driver; 14-Driver of other vehicle (JCV/Hitachi etc); 15- Security guard; 16-Supervisor; 17-Owner; 98-Other (Please specify); 99-Information not available

C- If from other state, write name of the state. If from other country, write name of the country; 99-Information not available

D- 01-Head (excludes face); 02-Face (excludes eye); 03-eye; 04-Neck; 05-Thorax; 06-Lumbar spine; 07-Abdomen; 08-Internal organs; 09-Lower back (includes loin); 10-Pelvis (includes perineum, anogenital area and buttocks); 11-Shoulder; 12-Upper arm; 13-Elbow; 14-Forearm; 15-Wrist; 16-Hand; 17-fingers (including thumb); 18-Hip; 19-Thigh; 20-Knee; 21-Lower leg; 22-Ankle; 23-Foot; 24-Toes; 25-Unspecified bodily location; 26-Multiple injuries (involving more than one bodily location); 98- Other (please specify); 99-Information not available

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F- 01-Unable to use hand or arm; 02-Difficulty using hand or arm; 03-Walk with a limp; 04-Loss of hearing; 05-Loss of vision; 06-Weakness or shortness of breath; 07-Inability to remember things; 08-Inability to chew food; 98-Other (specify); 99-Information not available

G- 01-No first aid given at site; 02-Site supervisor; 03-Another worker from site; 04-Family member; 05-Ambulance personnel; 06-Doctor; 07-Nurse 08-Fire brigade personnel; 09-Police 98-Other (specify); 99-Information not available

H- 01-Not taken to hospital; 02-Government Hospital; 03-Private hospital; 04-Multiple hospitals; 04-Traditional practitioner/healer/bone setter; 05-Pharmacy/drug store; 98-Other (specify); 99-Information not available

I- 01-discharged on the same day after treatment; 02-admitted for more than a day; 03-victim absconded from hospital; 98-Other (specify); 99-Information not available

<table>
<tr><td colspan="13">J- 01-Vehicle/moving machinery; 02- stationary machines; 03-powered hand tool/equipment; 04- unpowered hand tool/equipment; 05-building material (like brick/aggregate, stone/cement/concrete blocks) 06-Timber/wood/boards/furniture 07-steel rods/girder; 08-scaffolding/shuttering material; 09-aluminium/tin; 10-glass; 11-loose earth; 12-nail or small piece of metal; 13-nacked wire; 14-overhead electric wire; 15-pipe; 16-lime or other chemical; 17-gas (including smoke); 18-fire/hot object or construction material; 19-material used for erection of a tent/shamiyana/dome; 98-Other (specify); 99-Information not available

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<tr><td colspan="12">No. of persons died in the incident(Write “99” if information is not available)</td><td>01</td></tr>
<tr><td colspan="12">Details of persons died (Write “99” if information is not available)</td><td></td></tr>
<tr><td>Name</td><td>Age</td><td>Sex[A]</td><td>Trade[B]</td><td>Nativity[C] 01-Delhi; 02-/Other state (Pl specify) ; 03-</td><td>Body part injured[D]</td><td>Type/ Nature of Injury[E]</td><td>First Aid at site[F]</td><td>Type of health facility to which victim was taken</td><td>Place of death[H]</td><td>Object /Substance /Product involved in the injury[I]</td><td>Association of victim with construction site[J]</td><td>Activity when injured[K]</td></tr>
</table>

				Other Country ; 99- Informat on not availabl e)								
XXXX	**27**	**1**	**2**	**1**	**99**	**16**	**99**	**2**	**1**	**5**	**1**	**6**

A- 01-Male; 02-Female; 09-Unknown or undetermined; 99-Information not available

B- 01-Labourer; 02- Mason (Mistri); 03- Painter; 04-Welder; 05- Electrician; 06- Pump operator; 07-Plumber; 08-Carpenter; 09-Aluminium worker; 10- Centring & shuttering; 11-Glass worker 12- Mechanic; 13- Truck/tractor driver; 14-Driver of other vehicle (JCV/Hitachi etc); 15- Security guard; 16-Supervisor; 17-Owner; 98-Other (Please specify); 99-Information not available

C- If from other state, write name of the state. If from other country, write name of the country; 99-Information not available

D- 01-Head (excludes face); 02-Face (excludes eye); 03-eye; 04-Neck; 05-Thorax; 06-Lumbar spine; 07-Abdomen; 08-Internal organs; 09-Lower back (includes loin); 10-Pelvis (includes perineum, anogenital area and buttocks); 11-Shoulder; 12-Upper arm; 13-Elbow; 14-Forearm; 15-Wrist; 16-Hand; 17-fingers (including thumb); 18-Hip; 19-Thigh; 20-Knee; 21-Lower leg; 22-Ankle; 23-Foot; 24-Toes; 25-Unspecified bodily location; 26-Multiple injuries (involving more than one bodily location); 98- Other (please specify); 99-Information not available

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Corrosion (chemical); 15- Electrocution ; 16-suffocation; 17 loss of hearing;.98-Other (specify) 99-Information not available

F- 01-No first aid given at site; 02-Site supervisor; 03-Another worker from site; 04-Family member; 05-Ambulance personnel; 06-Doctor; 07-Nurse; 08-Fire brigade personnel; 09-Police 98-Other (specify); 99-Information not available

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J- 01-Construction site worker (including owner/engineer/ contractor/ supervisors etc); 02- Children of construction site workers; 03-neighbour (including Children); 04-visitor(including Children); 05-passer-by(including Children); 98-Other (specify); 99-Information not available

K- 01-Not doing any construction related work (just standing or walking at construction site); 02-excavation/tunnelling work; 03-transporting construction material/object; 04- masonry work including plastering, flooring, roof work and false ceiling; 05-steel cutting/bending; 06-removing shuttering or scaffolding; 07-painting; 08-fixing door/window or other carpentry work; 09-glass work; 10-Aluminium work; 11- plumbing work; 12-electrical or other cabling or fixing work; 13- -

working on a machine or equipment; 14-driving a vehicle or moving machinery; 15-cleaning work; 16- Demolition old structure /building 98 Other (specify) 99-Information not available	
Who transported the victim to health facility/health personnel 01-Self; 02-Co-worker; 03-Relative/friend; 04-Owner of construction site; 05-Construction site manager/supervisor/security staff; 06-Police personnel; 07-Ambulance staff; 08-Passer by; 09-Not taken to a health facility/personnel; 98 Other (specify) 99-Information not available	**06**
Mode of transport of victim to health facility/health personnel 01-Ambulance; 02-private vehicle; 03- Taxi/Rickshaw 04- police vehicle; 05-on foot; 98 Other (specify) 99-Information not available; 100-Not taken to a health facility/Personnel	**04**
Were personnel protective gears/safety equipment provided to victim by owner/contractor 01-Yes; 02-No; 98 Other (specify) 99-Information not available; 100-Victim is not a construction site worker	**99**
Were personnel protective gears/safety equipment used by victims at the time of incident 01-Yes; 02-No; 98 Other (specify) 99-Information not available; 100-Victim is not a construction site worker	**99**
Were the victims asked to work without safety equipment despite demand of safety equipment by them 01-Yes; 02-No; 98 Other (specify) 99-Information not available 100-Victim is not a construction site worker	**99**
Was there damage to property due to the incident 01-Yes; 02-No; 98 Other (specify) 99-Information not available; 100-Not a case of damage to property	**02**
Whose property was damaged 01- Construction site (other than building/structures being constructed/repaired); 02- Neighbour; 03- Visitor to construction site; 04- Passer-by; Other (specify) 99-Information not available; 100- Not a case of damage to property	**100**
If yes, nature of damaged property 01- Immovable property (roof, wall, house); 02- movable property; 03- vehicles; 98 Other (specify) 99-Information not available; 100-Not a case of damage to property	**100**
Who informed the police? 01-Victim; 02-Relative of victim; 03-Other person from construction site; 04-Owner/manager/supervisor of site; 05-security personnel of construction site; 06-Neighbour; 07-Passer-by; 08-Hospital staff; 09-Police staff ; 10-	**03**

Staff of other government department/agency; 11-Call to police control room by unknown person; 98 Other (specify) 99-Information not available				
Mode of information to police 01- In person verbal information in police station; 02-In person written information to police station; 03-telephone call to police station; 04-Telephone call to police control room; 05- Verbal information to a nearby police van; 06-Telephonic/in person information to control room of other government agency; 98 Other (specify) 99-Information not available				**04**
Details of complainant in the FIR				
Name	Designation	Organization[b]	Association with construction site[c]	
XXXX	**98 (Mason)**	**02**	**03**	
a-Write official designation of the police or hospital staff if available; 98- Others (pl mention) else Write 99- Information not available b- 01-Police; 02-construction site person; 03-hospital staff; 04-relative/friend; 05-Neighbour; 98 Other (specify) 99-Information not available c-01-Victim of accident; 02-relative of victim, 03-other construction site worker; 04-Manager/owner of site; 05-Security guard at construction site; 06-neighbour; 07-visitor; 08-passer-by; 09-Police officer; 10-hospital staff; 98-Other (specify); 99-Information not available				
Was the police informed after accident or due to a threat or apprehension of accident/damage 01- After actual accident; 02- threat or apprehension of accident (without any accident happening)				**01**

Appendix-13

Instructions for Data Extractors

Please read the following instructions carefully before starting data extraction from FIR documents. Please refer to them during the process of data extraction if there is any doubt. If any of the instructions is not clear, you are welcome to contact the researcher.

A. **Introduction:** these instructions have been drafted for extraction of data from the First Information Report (FIR) documents which are to be downloaded from the website of Delhi Police. The link for download is http://59.180.234.21:8080/citizen/firSearch.htm Extraction is to be done using the tool provided to you which has been specially designed for this purpose.

B. **Selection of FIRs for downloading**: Out of the total 279 FIRs of construction site injuries registered by Delhi Police during the period from 00.00 hrs on 1st January 2017 to 24.00 Hrs on 31stJanuary, 2017, FIR documents of only 50 FIRs are to be downloaded. These FIRs have been selected randomly from the list of total FIRs and a list of the same is placed atAnnexure-1 ofthis document. The list contains FIR No, Year, Name of Police Station where FIR was registered, and Name of District in which the police station falls.

C. **Procedure to download FIR data**: Open the link http://59.180.234.21:8080/citizen/firSearch.htm. Enter the compulsory fields -FIR No, Year, Police Station, and District and click search button. The selected FIR will be downloaded in PDF format.

D. **Extraction of data from FIR document**: Use the tool provided at Annexure-2 of this document for extraction of data from each FIRs. Enter the data extracted in an excel sheet in the same format. For entering data of injured and dead persons, use separate excel sheets. Following guidelines are provided to assist you in data extraction process:

1. **Serial No of record:** details extracted form one FIR comprises of one record. Each record should be serially numbered in the excel sheet from Sl.No.1 to Sl.No.50.

2. **FIR Details**: Pl enter prescribed details of each FIR from the FIR document

3. **Time and Date of incident:** For time use HH:MM (use 24-hour clock format). If the time is unknown or cannot be estimated then document as 99:99.Enter the date in DD/MM/YY format. Please enter 99/99/99 if information regarding date is not available

4. **Address of incident site:**enter house number and colony or locality name. Enter district name also. As the FIR pertaining to construction site accident is always registered in the concerned territorial police station, the district of locality where construction site accident occurred should be the same district in which the FIR was registered. Legal status of colony means whether the locality or colony where the incident site is located is a legal colony authorized by the local municipality or not. Please enter 99 if information of any data field is not available

5. **Details of owner of incident site**: Enter name of owner of incident site as mentioned in FIR. Owner could be an individual or a company or a government department or other government body. Address of owner could be the same as the address of the construction site if the owner lives at the incident site or it could be a different address. Enter house no of owner, locality or colony in which it is situated, name of district, state and country. Please enter 99 if information of any data field is not available.

6. **Ownership Category of incident site:** construction site could be owned by a Government Department or a-Government Company/Board or a Private Company; or a private individual. Write the appropriate code for owner ship category. If the ownership doesn't fall into any of these categories, write 98 and specify that category by writing it in text in the concerned field. Enter 99 if information regarding ownership category of incident site is not available in the FIR Document

7. Mode **of execution of work:** this means who is carrying out the construction work, the owner himself/herself i.e. self construction or someone else on his behalf. Enter the appropriate code given below this heading in the data extraction tool.

8. **Further details of person/company undertaking construction activity at incident site:** Information in this section is to be entered only if the owner of incident site has engaged some other person or company to carry out the construction work on his behalf. If that is the case enter details of such person or company. If owner is himself carrying out the construction work by engaging

workers directly, enter “NA” in all the fields of this section. Enter 99 if information of any data field is not available.

9. **Nature of Construction work:** this section has been devised to capture the nature of construction work going on at the incident site. Please enter appropriate code as mentioned below this section. In case the nature of construction work does’t fit into any of these codes, enter “98” and specify the nature of work. Ener “99” if information of any of the data fields is not available. If accident happened due to collapse of a building or a temporary structure in which no construction work was going, it is not a construction site accident and should be excluded from the list without extracting the data.

10. **Legality of construction:**Before construction, addition/alteration in any building, it is mandatory to obtain a building permit from the authority as per Unified Building Bye Laws-2013 and Development Control Regulations of Master Plan of Delhi, 2021. Construction work carried out without obtaining a building permit is called Unauthorized construction while the work carried out after obtaining the permit is termed “authorized construction. In certain types of construction work, no building permit is required and thus they become authorized constructions without a permit. Enter appropriated code accordingly. Enter 98 for any other type of construction and enter 99 if Information not availableNo building permit is required for following alterations which do not otherwise violate any provisions.

   - Plastering/cladding and patch repairs, except for the heritage buildings where Heritage Conservation Committee's permission is required

- Re-roofing or renewal of roof including roof of intermediate floor at the same height
- Flooring and re-flooring
- Opening and closing windows, ventilators and doors opening within the owner's plot. No opening towards other's property/ public property will be permitted.
- Rehabilitation/repair of fallen bricks, stones, pillars, beams etc.
- Construction or re-construction of sunshade not more than 75 cm in width within one's own land and not overhanging over a public street
- Construction or re-construction of parapet and construction or reconstruction of boundary walls as permissible under bye-laws
- Whitewashing, painting etc. including the erection of false ceiling in any floor at the permissible clear height provided the false ceiling in no way can be put to use as a loft /mezzanine etc.
- Erection or re-erection of internal partitions provided the same is within the preview of the Bye-laws.
- For the erection of lifts in existing buildings in residential plotted development (low –rise). Change/Installation/ re-arranging/relocating of fixture/s or equipment/s without hindering other's property/public property shall be permitted.
- Landscaping
- Public art, Public washroom, security room, Bank ATM, up to a maximum area of 9.0 sqmt only (permitted in setback area, provided it does not obstruct fire vehicles movement) in the plot more than 3,000 sqmt.
- Placing a portacabin up to 4.5 square metre or sqm within the plotline subject to free fire tender movement.

11. **Type of construction work :**Building and Other Construction Workers' (Regulation of Employment & Conditions of Service) Act, 1996 gives a broad definition of building or other construction work. On this basis type of construction work has been coded. Enter appropriate code. Enter 98 if type of construction work is not covered by any of the codes. Enter 99 if information about type of construction work is not available

12. **In case of buildings, type of building:** This field is to collect more information about accidents during construction of buildings. This information is to be entered only if type of construction is a building. If it is not a case of building construction, then enter "100"

13. **Cause of accident:** This field is designed to capture the reason behind the accident which led to injuries. How did the incident happen? What went wrong? - What were the circumstances? -

14. **Mechanism of Injury:** This field is designed to capture object, environmental event, condition or circumstance in which a person was injured i.e. how the person was injured. Sharp force is a piercing/penetrating force which leads to injuries like cutting, tearing, severing, scratching, puncturing, etc. Blunt force is generated by strike/hit by a person or animal or object. This includes being hit/struck by a moving object, pinching/crushing between objects,contact with static object, Falling, stumbling, Abrading, rubbing, struck by thrown or falling object, collision with another person,struck or kicked by animal or other unspecified blunt

mechanical force. In cases where the events, actions, object or substances involved in injury are multiple, it is important to code the appropriate mechanisms in the correct order

15. **In case of fall, Object from which the fall occurred:** this data field aims to get information to investigate into causes of fall. Enter appropriate codes for the objects from which the person fell from. Enter 98 if the object from which the fall occurred is not mentioned in the codes. Enter 99 if it is a case of fall but information on the object from which the fall occurred is not available. Enter 100 if mechanism of injury is not fall.

16. **What height did the victim(s) fell from:** again this data field is included to get more information on fall by finding out information about height from which the fall occurred. Enter the correct code. Enter 100 if the mechanism of injury is not fall.
17. **Was the time duration between start of work on the day of accident and time at which accident happened, more than 5 hours:** this data field is designed to get information related to association of injuries due to long working hours. This can be calculated if time of start of work and time of accident is available in FIR.
18. **In the 6 hours before accident, did the victim(s) have any alcohol to drink (even one drink):** this is to find out whether the victim was under the influence of alcohol at the time of accident.
19. **No. of persons injured in the incident:** it is a numeric field. Enter total number of persons who sustained non-fatal injuries in the incident.
20. **Details of injured persons:** this is meant to capture multiple data fields related to persons who sustained non-fatal injuries in the incident. A separate entry in the

table should be made for each victim. Data, as per the format given in the table given below this heading should be extracted in a separate excel sheet for ease of analysis.

- **Name:** Write name of victim if mentioned in the FIR document, else enter "99"
- **Age:** Write age of victim if mentioned in the FIR document, else enter "99"
- **Sex:** Write appropriate code for sex of victim if mentioned in the FIR document, else enter "99"
- **Trade:** Write appropriate code for trade of victim i.e. type of work for which victim is engaged at the incident site if mentioned in the FIR document, else enter "99"
- **Nativity:** the place of permanent residence of the victim. Please enter appropriate code as provided in the table.
- **Body part injured:**the part of the body whose injury is chiefly responsible for medical attention. Please write appropriate code for the body part of the victim injured in the incident as provided in the footnote of the table marked "D".
- **Type/Nature of Injury:** Superficial injuries include abrasions, blisters (non-thermal), contusions, puncture wounds (without major open wounds). Open wounds include cuts, lacerations, puncture wounds (with penetrating foreign body) & animal bites. Fractures include closed fractures, open fractures & other fractures. Dislocations, sprains and strains include avulsions, lacerations, sprains, strains, traumatic haemarthroses, and ruptures. if an incident caused more than one injury, each injury should be counted and described separately.Please write appropriate code for the body part of the victim injured in the incident as provided in the footnote of the table marked "E".

- **Disability:** Please write appropriate code as provided in the footnote of the table marked “F” if the victim has suffered from any disability due to injuries sustained in the incident.
- **First Aid at Site:** Please write appropriate code as provided in the footnote of the table marked “G” regarding whether the victim was given first aid at the site after the incident and who administered the first aid.
- **Type of health facility to which victim was taken for treatment**: Please write appropriate code as provided in the footnote of the table marked “H” regarding whether the victim was taken to a hospital or health facility for treatment of injuries sustained in the incident.
- **Length of stay in hospital**: Please write appropriate code as provided in the footnote of the table marked “I”
- **Whether found fit for recording statement in the first visit of police personnel to health facility:** When a victim of accident is admitted in a health facility, his/her statement is to be recorded by the police. Before recording the statement, the police inquires from the attending doctor whether the victim is fit for recording her/his statement. Write “Yes” or “No”, as the case may be and write “99” if information is not available in the FIR document. If a victim was not found fit in the first visit but was declared fit by attending doctor in the subsequent visit, please write “No”.
- **Injury severity:** Injury severity generally describes the impact of an injury in terms of the extent of tissue damage and/or physiologic response of the body to that damage. As per Abbreviated Injury Scale, injury is classified as minor, moderate, serious, severe, critical, and maximum injury virtually unsruvivable.

- **Object/Substance/Product involved in the injury:** Please write appropriate code as provided in the footnote of the table marked “J”.
- **Association of victim with construction site:**Please write appropriate code as provided in the footnote of the table marked “K”.
- **Activity when injured:**The type of activity the injured person was engaged in when the injury occurred. Please write appropriate code as provided in the footnote of the table marked “L”.

21. **No. of persons died in the incident:** it is a numeric field. Enter total number of persons who sustained fatal injuries in the incident.
22. **Details of dead persons:** this is meant to capture multiple data fields related to persons who sustained fatal injuries in the incident. A separate entry in the table should be made for each victim. Data, as per the format given in the table given below this heading should be extracted in a separate excel sheet for ease of analysis.

- **Name:** Write name of victim if mentioned in the FIR document, else enter “99”
- **Age:** Write age of victim if mentioned in the FIR document, else enter “99”
- **Sex:** Write appropriate code for sex of victim if mentioned in the FIR document, else enter “99”
- **Trade:** Write appropriate code for trade of victim i.e. type of work for which victim is engaged at the incident site if mentioned in the FIR document, else enter “99”
- **Nativity:** the place of permanent residence of the victim. Please enter appropriate code as provided in the table.

- **Body part injured:** the part of the body whose injury is chiefly responsible for medical attention. Please write appropriate code for the body part of the victim injured in the incident as provided in the footnote of the table marked “D”.
- **Type/Nature of Injury:** Superficial injuries include abrasions, blisters (non-thermal), contusions, puncture wounds (without major open wounds). Open wounds include cuts, lacerations, puncture wounds (with penetrating foreign body) & animal bites. Fractures include closed fractures, open fractures & other fractures. Dislocations, sprains and strains include avulsions, lacerations, sprains, strains, traumatic haemarthroses, and ruptures. if an incident caused more than one injury, each injury should be counted and described separately. Please write appropriate code for the body part of the victim injured in the incident as provided in the footnote of the table marked “E”.
- **First Aid at Site:** Please write appropriate code as provided in the footnote of the table marked “F” regarding whether the victim was given first aid at the site after the incident and who administered the first aid.
- **Type of health facility to which victim was taken for treatment**: Please write appropriate code as provided in the footnote of the table marked “G” regarding whether the victim was taken to a hospital or health facility for treatment of injuries sustained in the incident.
- **Place of death:** Please write appropriate code as provided in the footnote of the table marked “H” for place where the victim died due to injuries sustained in the incident.
- **Object/Substance/Product involved in the injury:** Please write appropriate code as provided in the footnote of the table marked “I”.

- **Association of victim with construction site:** Please write appropriate code as provided in the footnote of the table marked "J".
- **Activity when injured:** The type of activity the injured person was engaged in when the injury occurred. Please write appropriate code as provided in the footnote of the table marked "L".

23. **Who transported the victim to health facility/health personnel:** please write appropriate code out of the codes mentioned in the row below the heading.
24. **Mode of transport of victim to health facility/health personnel:** please write appropriate code out of the codes mentioned in the row below the heading.
25. **Were personnel protective gears/safety equipment provided by owner/contractor:** please write appropriate code out of the codes mentioned in the row below the heading.
26. **Were personnel protective gears/safety equipment used by victims at the time of incident:** please write appropriate code out of the codes mentioned in the row below the heading.
27. **Were the victims asked to work without safety equipment despite demand of safety equipment by them:** please write appropriate code out of the codes mentioned in the row below the heading.
28. **Was there damage to property due to the incident:** please write appropriate code out of the codes mentioned in the row below the heading.
29. **Whose property was damaged:** please write appropriate code out of the codes mentioned in the row below the heading.

30. **If yes, nature of damaged property:** entry in this field is to be made if there was a damage to the property due to the incident. Else write “100”.please write appropriate code out of the codes mentioned in the row below the heading.
31. **Who informed the police: P**lease write appropriate code out of the codes mentioned in the row below the heading.
32. **Mode of information to police:** How was the police informed of the incident. Please write appropriate code out of the codes mentioned in the row below the heading.
33. **Details of complainant in the FIR**: Please fill the appropriate codes under each heading in the table provided below this heading.

- **Name:** Write exact name of the complainant as mentioned in the FIR document
- **Designation:** Write official designation of the police or hospital staff if available; else write 99- Information not available
- **Organization:** Please write appropriate code for the organization of the person who informed the police
- **Association with construction site:** how is the complainant associated with the construction site where the incident happened.

34. **Was the police informed after accident or due to a threat or apprehension of accident/damage:** sometimes police is informed even before the incident by neighbours and passer byes due to a threat of an incident happening. Please write appropriate code out of the codes mentioned in the row below the heading.