Completeness of ascertainment of construction site injuries using First Information Reports (FIRs) of Indian police: capture-recapture Study

Abstract:

Background & Objectives: *The construction industry is a leading contributor to occupational injuries. First Information Reports (FIRs) of Indian Police are a potential data source for construction injuries. The aim of this study was to estimate the completeness of ascertainment of construction site injuries by FIRs.*

Methods: *This was a two-sample capture-recapture study of construction site injuries sustained in the year 2017 in Delhi, India. The first capture sample was data extracted from FIRs. The second capture sample comprised data extracted from the Employee State Insurance Corporation (ESIC) and the Commissioners of Workmen Compensation. The Chapman estimator was used to estimate, with 95% confidence intervals, the total numbers of fatal and non-fatal injuries.*

Results: *FIRs ascertained 374 injuries (110 fatal and 264 non-fatal) whilst the combined data of ESIC and workmen compensation claims ascertained 80 injuries (48 fatal and 32 non-fatal). The capture-recapture analysis estimated that 1,011 (95% CI: 873 to 1149) injuries: 258 (95% CI: 221 to 295) fatal injuries and 873 (95% CI: 765 to 1053) non-fatal injuries were sustained in Delhi in 2017.*

Interpretation & Conclusions: *FIRs ascertain approximately one third of all construction site injuries. In the absence of any other data source, 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. 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

Keywords: *Capture-recapture method, construction injuries, Injury surveillance, police reports*

INTRODUCTION

Occupational injuries, which kill approximately 335,000 persons annually, are a serious public health concern.[1] With 30-40% share, the construction industry is the lead contributor to occupational injuries.[2,3] In India, construction is the second biggest cause of workplace accidents after mining, contributing 24.2% to total occupational accidents.[4] However, comprehensive data on construction site injuries are lacking, as India does not publish statistics on occupational injuries and illnesses.[5]

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).[6] In a previous study we found that information on injuries can be reliably extracted from FIRs using a data extraction tool.[7]

There is good evidence that police records tend to under-report injury cases.[8-14] However, many studies are 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.

MATERIALS & METHODS

Study design

This was a two-sample capture-recapture study. The Capture-recapture method has been used in epidemiology, to estimate morbidity and mortality using multiple, overlapping, but incomplete data sources.[15] The method has also been used to estimate injury morbidity and mortality.[9,13,16] We 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.[17]

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. 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).[18] 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.

Record linkage

We 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.

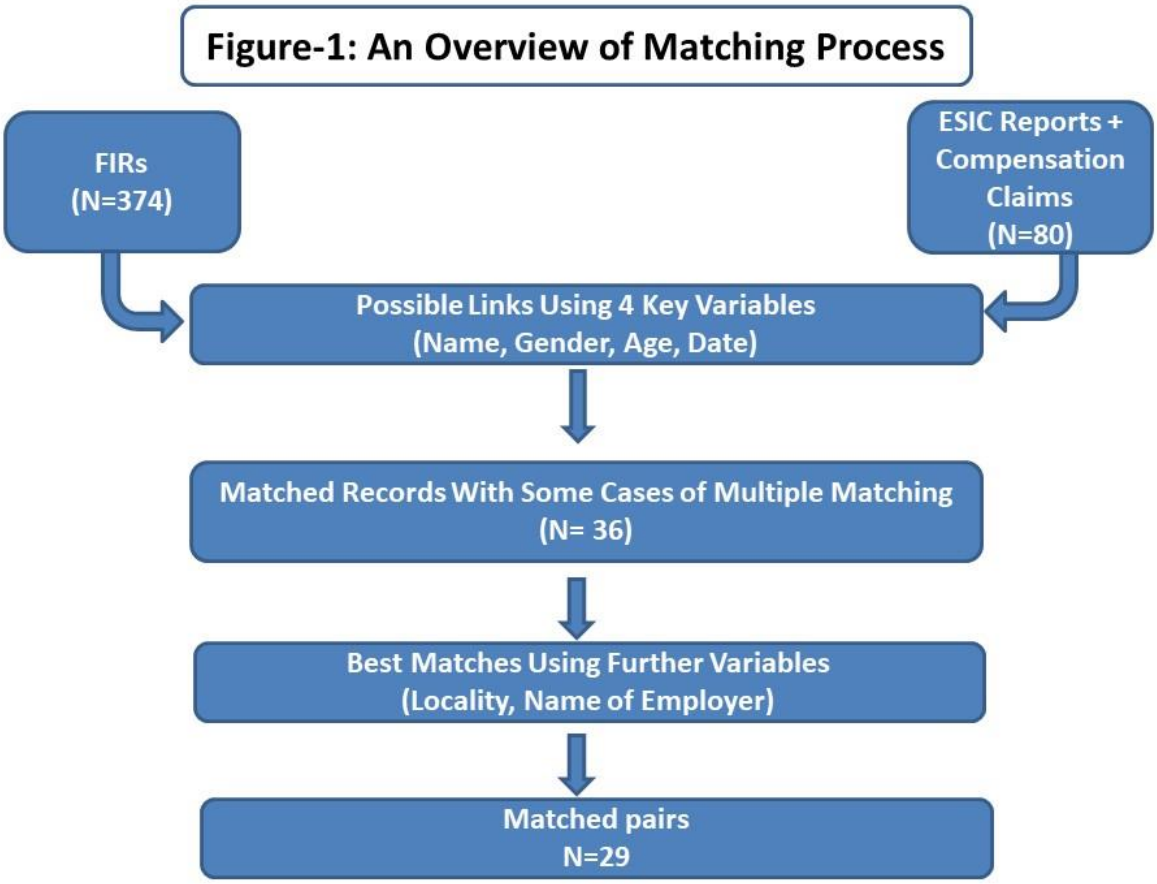
Linkage stage 1

In the first stage of linkage, we 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, we 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, we 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, we 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, we 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-1. After completing the matching process, names and localities were replaced by codes to anonymise the records.



Setting and Participants

This study was conducted in Delhi, which has over 600,000 construction workers.[4] 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.

Statistical methods

Estimation of total number of construction injuries in Delhi

The total number of construction injuries in Delhi was estimated using the Chapman estimator.[19,20] Estimation was done using the following formula:[21]

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

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).

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:[21]

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

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

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

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.

RESULTS

Participants

Analysis of FIR data indicated that 321 construction site accidents were reported in Delhi from 1st January 2017 to 31st December, 2017. In these incidents, 374 people were reported injured, 110 fatal and 264 non-fatal. The combined data of ESIC and the Labour Department indicated that 80 people were reported injured, 48 fatal and 32 non-fatal.

Record linkage of injured people in the two databases yielded 29 matched cases (20 fatal and 9 non-fatal). Using the Chapman estimator, we 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-1).

Table-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)

DISCUSSION

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.

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.[9,13,22,23] 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.[4]

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.[24,25] 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 fulfill this assumption, we 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.

Bias

As described above, efforts were made to eliminate bias from this study. We 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.

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).[26] 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.[27] Moreover, the hospital records do not classify injuries by type like construction injuries, road traffic injuries and other injuries.[27] 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.

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.

Ethics Approval

This study was approved by LSHTM Observational Research Ethics Committee vide LSHTM Ethics Reference number 15992 dated 26th November, 2018.

Conflict of interest: None

References

1 Herbert, R. and Landrigan, P.J., 2000. Work-related death: a continuing epidemic. American Journal of Public Health, 90(4), p.541.

2 Sunindijo, R.Y. and Zou, P.X., 2012. How project manager's skills may influence the development of safety climate in construction projects. International Journal of Project Organisation and Management, 4(3), pp.286-301.

3 Takala, J., 1999. Global estimates of fatal occupational accidents. Epidemiology, pp.640-646.

4 Patel, D.A. and Jha, K.N., 2016, September. An estimate of fatal accidents in Indian construction. In Proceedings of the 32nd Annual ARCOM Conference (pp. 5-7).

5 Hamalainen, P., Takala, J., Saarela, K.L., 2006. Global estimates of occupational accidents. Saf. Sci. 442, 137–156

6 India Code. 2019. Code of Criminal Procedure, 2017. [online] Available at: https://indiacode.nic.in/handle/123456789/1611?view_type=browse&sam_handle=123456789/1362 [Accessed 27 Jul. 2019].

7 Yadav S.S., Edwards P., and Porter J. 2020. Evaluation of First Information Reports (FIRs) of Delhi Police for Injury Surveillance: Data Extraction Tool Development and Validation. Manuscript submitted for publication.

8 Sciortino, S., Vassar, M., Radetsky, M. and Knudson, M.M., 2005. San Francisco pedestrian injury surveillance: mapping, under-reporting, and injury severity in police and hospital records. Accident Analysis & Prevention, 37(6), pp.1102-1113.

9 Amoros, E., Martin, J.L. and Laumon, B., 2007. Estimating non-fatal road casualties in a large French county, using the capture–recapture method. Accident Analysis & Prevention, 39(3), pp.483-490.

10 Juillard, C., Ngamby, M.K., Monono, M.E., Mballa, G.A.E., Dicker, R.A., Stevens, K.A. and Hyder, A.A., 2017. Exploring data sources for road traffic injury in Cameroon: Collection and completeness of police records, newspaper reports, and a hospital trauma registry. Surgery, 162(6), pp.S24-S31.

11 Short, J. and Caulfield, B., 2016. Record linkage for road traffic injuries in Ireland using police hospital and injury claims data. Journal of safety research, 58, pp.1-14.

12 Watson, W.L. and Ozanne-Smith, J., 2000. Injury surveillance in Victoria, Australia: developing comprehensive injury incidence estimates. Accident Analysis & Prevention, 32(2), pp.277-286.

13 Abegaz, T., Berhane, Y., Worku, A., Assrat, A. and Assefa, A., 2014. Road traffic deaths and injuries are under-reported in Ethiopia: a capture-recapture method. PloS One, 9(7), p.e103001.

14 Ward, H., Robertson, S., Lester, T. and Pedler, A., 2002. Reporting of road traffic accidents in London: matching police STATS19 data with hospital accident and emergency department data. *Crowthorne: Transport Research Laboratory*.

15 Bordoni P.H.C., Bordoni L.S, Silva J.M.m and Drumond E.F., 2016. The use of the Catch-recapture method for improving the registry of fatal work accidents in the city of Belo Horizonte, state of Minas Gerais, Brazil. 2011. Epidemiol. Serv. Saúde, 25(1)

16 Yadav, S.S., 2019. How safe are industries in India? Ascertaining industrial injuries in Dadra and Nagar Haveli, India by capture-recapture method. Indian journal of occupational and environmental medicine, 23(1), p.15.

17 Delhipolice.nic.in. (2019). :: DELHI POLICE Shanti Sewa Nyaya ::. [online] Available at: http://www.delhipolice.nic.in/view-fir.html [Accessed 27 Jul. 2019].

18 Legislative.gov.in. 2020. Unorganised Workers' Social Security Act, 2008. [online] Available at: <http://legislative.gov.in/sites/default/files/A2008-33.pdf> [Accessed 25 June 2020].

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

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

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

22 Jeffrey, S., Stone, D.H., Blamey, A., Clark, D., Cooper, C., Dickson, K., Mackenzie, M. and Major, K., 2009. An evaluation of police reporting of road casualties. Injury prevention, 15(1), pp.13-18.

23 Tercero, F. and Andersson, R., 2004. Measuring transport injuries in a developing country: an application of the capture–recapture method. Accident Analysis & Prevention, 36(1), pp.13-20.

24 Assets.publishing.service.gov.uk. (2019). Linking Police and Hospital data on Road Accidents in England: 1999 to 2009 results. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/230598/hes-linkage.pdf [Accessed 28 Jul. 2019].

25 Razzak, J.A. and Luby, S.P., 1998. Estimating deaths and injuries due to road traffic accidents in Karachi, Pakistan, through the capture-recapture method. International journal of epidemiology, 27(5), pp.866-870

26 Ncrb.gov.in. 2020. Crime And Criminal Tracking Network & Systems (CCTNS) | National Crime Records Bureau. [online] Available at: <https://ncrb.gov.in/crime-and-criminal-tracking-network-systems-cctns> [Accessed 5 June 2020].

27 Niti.gov.in. 2018. Health System For A New India: Building Blocks. [online] Available at: <https://niti.gov.in/sites/default/files/2019-11/NitiAayogBook_compressed_1.pdf> [Accessed 2 February 2020].