P-ISSN: 1412-3746
E-ISSN: 2549-6557

JURNAL KESEHATAN
FAKULTAS KESEHATAN
UNIVERSITAS DIAN NUSWANTORO
Volume 24. No.1, April 2026

Patterns of Fracture - Causing Traffic Injuries and Accuracy of ICD-10 External Cause Coding: A Case Study at a Type B Hospital in Semarang

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Received *: 06-04-2026*
Accepted *: 06-04-2026*
Available online by *: 30-04-2026*

Abstract . Traffic accidents, particularly motorcycle crashes, constitute a leading cause of musculoskeletal fractures in urban Indonesia, yet inaccurate ICD-10 external cause coding undermines epidemiological surveillance and injury prevention efforts. This study aimed to analyze patterns of accident causes leading to fractures and evaluate the accuracy of external cause coding in medical records at a Type B hospital in Semarang. A quantitative descriptive study was conducted using retrospective observation of 88 inpatient medical record documents for fracture cases in 2022, sampled via the Slovin formula from a population of 757 cases. Data on accident patterns (type, location, activity) and coding accuracy were extracted per ICD-10 guidelines (V01-Y98), with conformity assessed descriptively based on completeness to the fifth character and alignment with clinical chronology. Motorcycle accidents dominated (58.8%), primarily traffic-related driver injuries (72.0%), followed by falls (31.8%); non-traffic incidents frequently occurred at home (74.3%). Fracture coding accuracy reached 69.3%, but external cause coding was critically low at 19.3%, with major discrepancies in accident type (56.3%), location (33.8%), and activity (9.9%). These findings highlight systemic coding deficiencies that distort injury epidemiology data. Enhanced coder training, standardized chronology documentation, and hospital policies for external cause coding are recommended to improve data quality for public health interventions.

Keywords: external cause coding; ICD-10 accuracy; motorcycle trauma; injury surveillance

INTRODUCTION

Globally, traffic accidents cause 1.35 million deaths annually, with fractures accounting for 30–50% of non-fatal injuries in Southeast Asia, where motorcycles dominate 70% of cases. In Indonesia, fracture prevalence reaches 5.8 cases per 1,000 population in Central Java,[1] driven by 113,000 motorcycle accidents This underscores the need for accurate ICD-10 external cause coding (V01–X59) for epidemiological surveillance and prevention. However, coding inaccuracies hinder spatial-temporal risk mapping, BPJS resource allocation, and traffic policy development, making it a critical issue at Type B hospitals in Semarang, which reported 757 fracture cases in 2022.

Studies from 2017–2024 confirm the dominance of motorcycle accidents in lower extremity fractures (60–80%), alongside low external cause coding accuracy.[2,3] At RSUD Ngawi (2024), 72% of fractures stemmed from falls or motorcycles, yet coding accuracy was only 19% due to incomplete activity and place details. Research at RS Jasa Kartini (2023) reported 58% of cases as motorcycle-related (V20–V29), with 0% external cause accuracy from errors in the 4th/5th characters.[4] In Semarang, RS Tugurejo (2017) found 70% of male fractures aged 20–40 years traffic-related, with coding precision at 33%.[5] Internationally, verified variability in ICD-10 external cause validity for motor trauma ($\kappa = 0.65$)**.** Trends indicate consensus on motorcycle dominance but disparities in accuracy (0–33%), influenced by coder training.[6]

Prior research is limited to descriptive accuracy analysis without integrating specific accident pattern epidemiology (e.g., 72% driver traffic accidents coded as V24.4), particularly at RSD Semarang, where 80.7% of external causes mismatch due to ambiguous chronologies. Inconsistencies arise from lacking quantitative analysis of motorcycle patterns (58.8%) with demographic/location factors (e.g., 74.3% home-based non-traffic), and the absence of post-2020 studies validating implications for Central Java national trends. No studies focus on external cause epidemiology at Type B hospitals in Semarang.[7]

In 2026, with a projected 15% post-pandemic rise in motorcycle accidents (Polri), this research is urgent to support the new Traffic Law through accurate ICD-10 data. Its novelty lies in a quantitative approach integrating epidemiological patterns (motorcycle-dominant) with coding accuracy, contributing theoretically to regional ICD-10 surveillance models and practically via chronology audit recommendations for coders.[8]

This study aims to analyze accident patterns causing fractures (focusing on motorcycle crashes) and ICD-10 external cause coding accuracy in inpatient medical records at Type B in Semarang, to identify epidemiological factors and data improvement recommendations.

METHODS

This study adopted an analytical observational design with a retrospective approach. The retrospective design was selected to enable the analysis of secondary data derived from previously documented medical records of trauma patients involved in road traffic accidents in 2022, without direct clinical or experimental intervention. This methodological approach facilitated the identification of fracture patterns associated with road traffic injuries and the evaluation of the accuracy of ICD-10 external cause coding. Coding accuracy was assessed by systematically comparing the external cause codes recorded in the medical records with the codes

that should have been assigned in accordance with the World Health Organization (WHO) ICD-10 classification guidelines.[9]

Conducted at a Type B hospital in Semarang City. The study population comprised all medical records of patients with fracture diagnoses and documented external causes of injury in 2022, totaling 757 records. The study sample consisted of medical records that met the inclusion criteria and was selected using purposive sampling. Inclusion criteria were: (1) medical records with fracture diagnoses classified under ICD-10 codes S00–S99; (2) documented traffic-related injury information in the anamnesis or injury chronology; and (3) complete recording of both the primary diagnosis and external cause codes. Exclusion criteria included: (1) incomplete medical records with unclear anamnesis or injury chronology; (2) fracture cases unrelated to traffic injuries (e.g., domestic falls or interpersonal violence); and (3) damaged or illegible medical records. Data were analyzed using descriptive statistical methods, simple cluster pattern analysis, and cross-tabulation, performed with SPSS software.

The stages of research implementation go through several processes which are outlined in the following diagram:

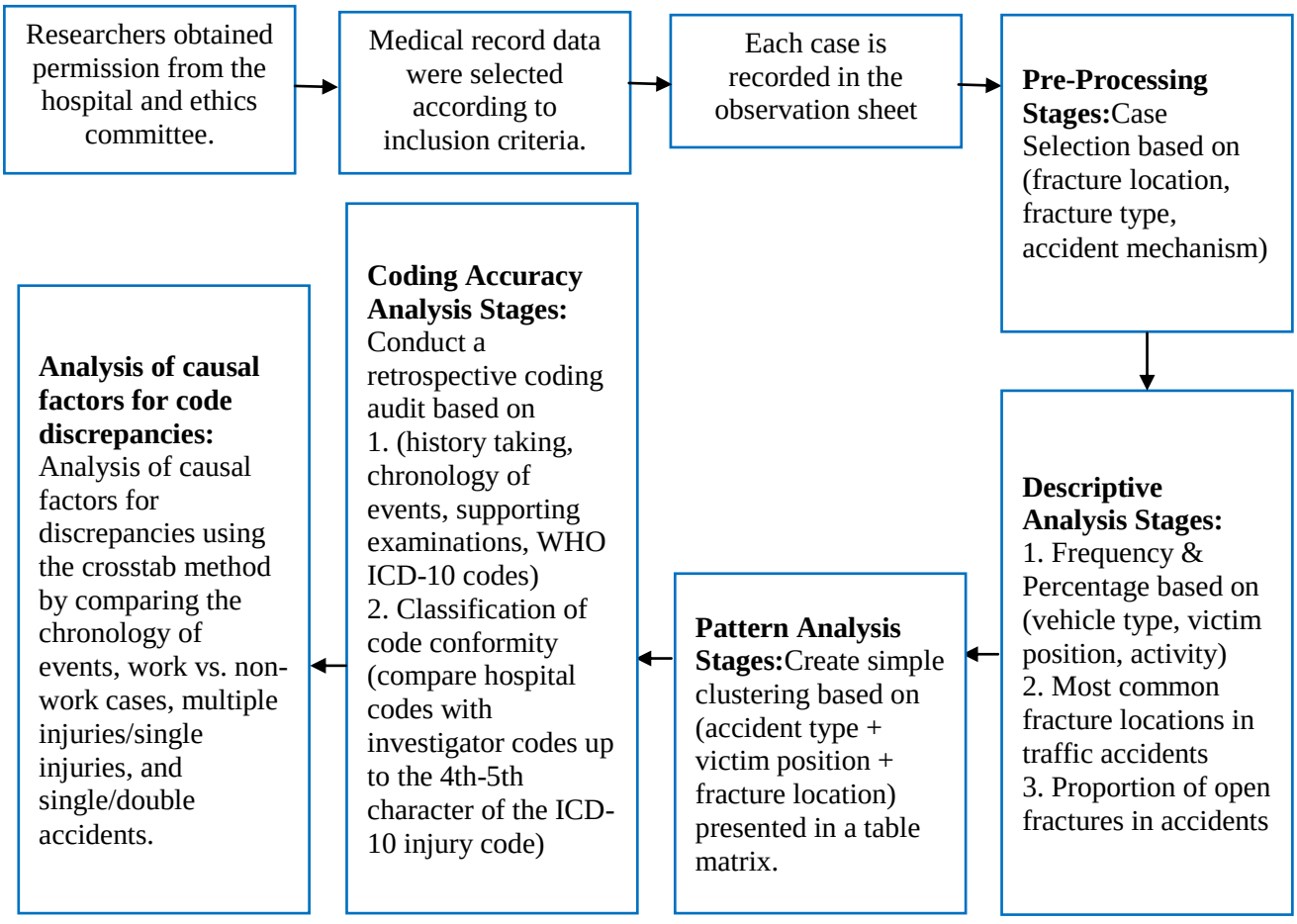

Figure 1. Research Stages

From Figure 1, it can be seen that the stages of this research include several stages as follows:

Stage 1. Ethical approval was obtained from the institutional research ethics committee, along with formal permission to access medical record data related to fracture cases resulting from traffic injuries, prior to study implementation.

Stage 2. Medical records of patients with fracture cases due to traffic-related injuries were accessed and screened to identify documents that met the predefined inclusion criteria.

Stage 3. Data from each eligible case were recorded using a structured observation form and subsequently prepared for data processing and analysis using SPSS software.

Stage 4. Data pre-processing involved case selection and classification based on fracture location, fracture type, and injury mechanism, including single-vehicle accidents, motorcycle-to-motorcycle collisions, motorcycle-to-car collisions, collisions with fixed objects, and work-related or non–work-related accidents.

Stage 5. Descriptive analysis was conducted by calculating frequencies and percentages according to vehicle type, victim position, and victim activity at the time of injury, identifying the most frequent fracture locations in traffic injuries, and analyzing the proportion of open fractures.

Stage 6. Pattern analysis was performed through case grouping based on combinations of accident type, victim position, and fracture location, with results presented in matrix tables.

Stage 7. Coding accuracy analysis involved a retrospective coding audit based on clinical and administrative data, including anamnesis, injury chronology, diagnostic examinations, and the ICD-10 WHO guidelines. Coding agreement was classified by comparing hospital-assigned codes with researcher-assigned codes up to the fourth and fifth characters of ICD-10 for injury cases.

Stage 8. Analysis of factors associated with coding discrepancies was conducted using cross-tabulation methods, comparing the completeness of injury chronology, work-related versus non–work-related cases, injury type (single versus multiple injuries), and accident type (single versus multiple-vehicle accidents).

RESULT

From the 88 inpatient medical records of musculoskeletal fracture patients at a Type B hospital in Semarang during 2022, motorcycle accidents emerged as the predominant etiology, accounting for 58.8% (n=52) of cases. Within this subgroup, 72.0% (n=37) involved drivers sustaining injuries in traffic-related contexts, underscoring the dominance of two-wheeled vehicles in urban trauma epidemiology. These findings align with national data indicating that motorcycles comprise over 80% of registered vehicles in Indonesian cities, thereby elevating collision risks amid high traffic density.

Falls contributed 31.8% (n=28) of all fracture cases, with the majority (74.3%; n=21) occurring in domestic settings such as homes. The remainder transpired in public spaces. This distribution highlights households as the primary locus of non-traffic injuries, particularly among vulnerable groups including the elderly and manual laborers.

Location analysis revealed that traffic accidents predominantly occurred on roadways (85.6%; n=44 of 52 motorcycle cases), whereas falls were concentrated in residential areas. This pattern, derived from ICD-10 external cause classification (V01–Y98), reinforces roadways as high-risk zones for vehicular trauma and homes as the principal site of domestic injuries within Semarang's urban environment.

Victim activities at the time of injury were primarily motorcycle driving in traffic (72.0%; n=37), followed by household activities in fall cases (67.9%; n=19). However, documentation of the fifth ICD-10 character for activity remained incomplete in 82.1% of records, thereby constraining behavioral risk factor analysis. This underscores the elevated mobility risks associated with motorcycle-dependent commuting in urban settings.

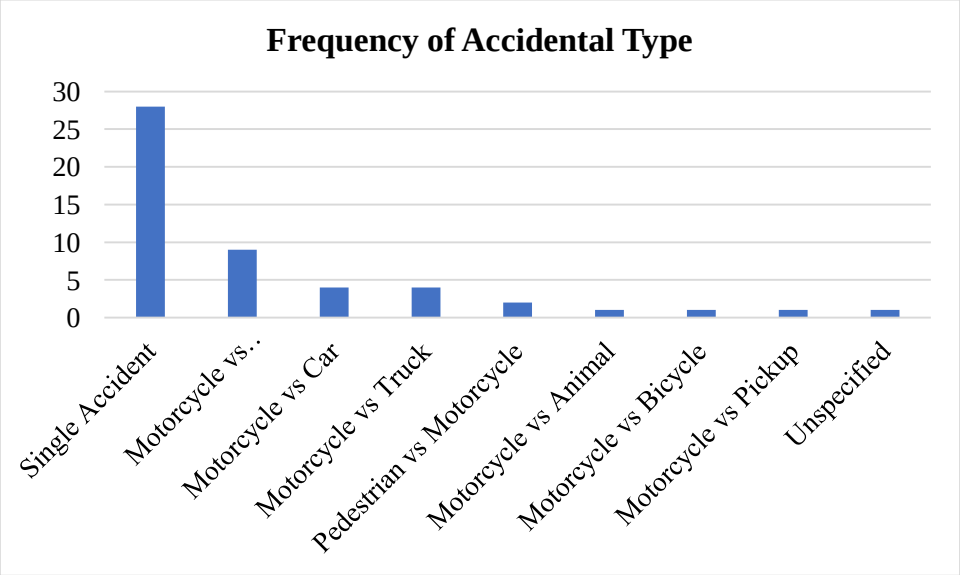

Figure 2. Frequency of Accidental Type

Overall fracture coding accuracy reached 69.3% (n=61/88), assessed by completeness up to the fifth ICD-10 character and alignment with clinical chronology within the S00-T88 block. Injury code assignment (S-T) was moderately proficient, although inter-case variability remained high due to inconsistent diagnostic specificity in source documents.

Table 1. Fracture Coding Accuracy

Category	Frequency (n)	Percentage(%)	Valid (%)
Consistent	61	69,3	69,3
Inconsistent	27	30,7	30,7
Total	**88**	**100,0**	**100,0**

External cause coding accuracy (V01-Y98) was markedly low at 19.3% (n=17/88), with primary deficits in accident type identification (discrepancy rate of 56.3%, n=31/55 evaluated). Only 22% of medical records achieved full fifth-character compliance, undermining epidemiological utility.

Table 2. External Cause Coding Accuracy

Category	Frequency (n)	Percentage(%)	Valid (%)
Consistent	17	19,3	19,3
Inconsistent	71	80,7	80,7
Total	**88**	**100,0**	**100,0**

Accident type descriptions mismatched in 56.3% (n=31), often misaligning clinical narratives such as "motorcycle collision" with nonspecific codes (e.g., V27.99 vs. V27.42). Descriptive analysis confirmed this as a principal driver of inaccuracy, frequently stemming from abbreviated anamneses.

Table 3. Accident Type Description Accuracy

Category	Frequency (n)	Percentage(%)	Valid (%)
Consistent	24	43,7	43,7
Inconsistent	31	56,3	56,3
Total	55	**100,0**	**100,0**

Location coding errors affected 33.8% (n=20/59), commonly employing generic terms like "unspecified place" instead of precise descriptors ("highway" or "home"). Non-traffic cases exhibited higher rates (41.7% vs. 28.9% for traffic), per individual medical record audits.

Table 4. Fracture Location Coding Accuracy

Category	Frequency (n)	Percentage(%)	Valid (%)
Consistent	39	66,2	66,2
Inconsistent	20	33,8	33,8
Total	59	**100,0**	**100,0**

Activity coding accuracy was merely 9.9% (n=5/51), with 78.4% omitting the fifth digit for specifics like "driving." This systemic gap impedes behavioral epidemiology, as "motorcycle operation" was rarely differentiated from generic transport codes.

Table 5. Activity Coding Accuracy

Category	Frequency (n)	Percentage(%)	Valid (%)
Consistent	5	9,9	9,9
Inconsistent	46	90,1	90,1
Total	51	**100,0**	**100,0**

Overall, this study reveals traffic accidents—particularly those involving motorcycles—as the leading cause of musculoskeletal fractures among inpatients at a Semarang type B hospital. Roadway riding predominated traffic events, while non-traffic incidents like falls occurred predominantly in domestic settings. These findings indicate distinct risk patterns by event type and location, reflecting urban mobility and environmental characteristics.

Clinically, fracture sites exhibited mechanistic patterns, with open fracture proportions indicating trauma severity. Descriptive analysis of event type, victim position, and fracture location revealed consistent associations, albeit not universally supported by statistical significance. Coding audit results indicate adequate fracture diagnosis accuracy, tempered by documentation incompleteness. Conversely, external cause and activity coding accuracy remained very low, particularly for ICD-10 fourth and fifth characters. These

discrepancies largely arose from incomplete event chronologies, nonspecific terminology, and insufficient details on location and activity.

Causal analysis identified anamnesis and medical documentation incompleteness as primary contributors to poor coding accuracy. Differences in error rates between traffic and non-traffic cases further highlight variations in recording quality by event type. Thus, while available data delineate general injury epidemiology, documentation and coding limitations hinder precise, comprehensive insights. Enhancing clinical recording quality and coder competency is essential to optimize medical record utility for care, reporting, and research.

DISCUSSION

Motorcycle-related accidents emerged as the leading cause of musculoskeletal fractures among hospitalized patients, accounting for 58.8% of cases. This finding reflects a broader global pattern in which road traffic injuries constitute a major public health burden, particularly in low- and middle-income countries. The World Health Organization (WHO) has consistently identified road traffic accidents as a leading cause of mortality and disability worldwide, with a disproportionately high impact in regions where motorcycles dominate the transportation system. [10] In the Indonesian context, where more than 80% of registered vehicles are two-wheeled,[11] the elevated contribution of motorcycle-related injuries is not only expected but also indicative of systemic exposure to road traffic risk within densely populated urban environments.

Within this broader epidemiological landscape, the predominance of motorcycle riders among the injured population (72.0%) warrants closer consideration. This pattern suggests that risk is not evenly distributed across road users but is instead concentrated among individuals with minimal structural protection and high exposure to traffic hazards. While prior studies have established the vulnerability of motorcyclists,[12] the present findings further underscore how behavioral and environmental factors may interact to amplify this risk. In particular, unsafe riding practices and inconsistent adherence to traffic regulations—highlighted in the WHO *World Report on Road Traffic Injury Prevention*—remain critical yet potentially modifiable determinants of injury occurrence.[13] These findings point toward the need to move beyond descriptive epidemiology and address the behavioral dimensions of injury prevention.

In contrast to traffic-related injuries, falls represent a distinct but substantial proportion of cases (31.8%), predominantly occurring within domestic environments. This divergence in injury mechanism highlights the dual burden of trauma in urban settings, where high mobility risks coexist with household-level hazards. Falls, particularly among older adults, are widely recognized as a leading cause of non-fatal injury,[14] and their predominance in residential settings suggests the presence of preventable environmental risk factors. The consistency of this finding with prior evidence,[15] indicating that most falls occur at home, reinforces the importance of targeted interventions that extend beyond public infrastructure and into private living spaces.

Taken together, the contrasting distribution of injury locations—roadways for traffic-related incidents and residential settings for falls—illustrates a context-specific pattern of injury epidemiology shaped by both mobility behaviors and environmental conditions. While classification systems such as ICD-10 (V01–Y98)

provide a framework for capturing these relationships, the utility of such systems is contingent upon the accuracy and completeness of underlying data. As emphasized by WHO, detailed documentation of injury circumstances is essential for translating epidemiological findings into effective prevention strategies.[11] However, the extent to which this potential is realized depends heavily on data quality.

In this regard, the present study identifies a critical gap between the theoretical value of injury surveillance systems and their practical implementation. The low accuracy observed in external cause coding (19.3%) and activity coding (9.9%) suggests that key contextual information is frequently lost, thereby limiting the interpretability and usability of the data. Rather than reflecting isolated technical errors, these deficiencies appear to be symptomatic of broader documentation challenges. As noted by the American Health Information Management Association (AHIMA), coding accuracy is fundamentally dependent on the quality of clinical documentation.[16] Incomplete or nonspecific descriptions of injury events compromise the ability to assign precise ICD-10 codes, particularly at more detailed levels of classification.

Importantly, the findings also support the argument that coding inaccuracies are primarily driven by upstream issues in clinical documentation rather than deficiencies in coder competency alone. Previous studies have demonstrated that ambiguous or incomplete medical records are a major source of coding error,[17] a pattern that is clearly reflected in the frequent use of abbreviated or nonspecific injury narratives observed in this study. Furthermore, the underutilization of activity-related coding elements despite their relevance for behavioral epidemiology suggests a missed opportunity to capture critical dimensions of injury risk.[18] This gap highlights a disconnect between data collection practices and the informational needs of injury prevention efforts.

Although the overall accuracy of fracture diagnosis coding (69.3%) indicates a moderate level of technical proficiency, the variability observed across cases underscores persistent inconsistencies in clinical documentation. From a systems perspective, this variability limits the reliability of morbidity data and reduces its value for surveillance and policy development. As emphasized by WHO, the effectiveness of health information systems depends on the alignment between clinical practice and standardized classification frameworks,[5] underscoring the need for integrated improvements across both domains.

Ultimately, these findings suggest that improving injury surveillance is not solely a matter of enhancing coding practices but requires a more comprehensive, system-level approach. Strengthening clinical documentation, standardizing reporting practices, and reinforcing collaboration between clinicians and coding professionals are essential steps toward improving data quality. Without such improvements, the ability of healthcare systems to generate actionable insights from routine data will remain constrained. Therefore, targeted interventions—such as structured training programs, routine documentation audits, and increased awareness of the epidemiological value of detailed clinical records—are critical to ensuring that medical record data can effectively support evidence-based decision-making and injury prevention strategies. [11,16]

CONCLUSION

This study identifies motorcycle-related road traffic accidents as the predominant cause of musculoskeletal fractures among hospitalized patients in an urban Indonesian setting. The observed injury

patterns reveal a dual burden, where road-based mobility risks coexist with domestically driven injuries, particularly among vulnerable populations. These findings emphasize the need for integrated, context-specific prevention strategies that address both traffic safety and household environmental risks. A key contribution of this study lies in its combined analysis of injury epidemiology and medical record coding accuracy within a single framework. Unlike previous studies that predominantly focus on either injury patterns or coding practices in isolation, this study demonstrates how deficiencies in clinical documentation and coding—particularly for external causes and patient activities—directly limit the interpretability and epidemiological utility of health data. By quantifying these gaps, the study provides empirical evidence of a critical disconnect between data generation and its potential use for injury surveillance and prevention.

Despite moderate accuracy in fracture diagnosis coding, substantial deficiencies were observed in the documentation and coding of external causes and activities. These limitations significantly constrain the analytical value of medical record data and hinder its application in evidence-based decision-making. The findings highlight that the effectiveness of health information systems is fundamentally dependent on the completeness, specificity, and standardization of clinical documentation. Addressing these challenges requires a system-level response, including the standardization of documentation practices, targeted training for both clinicians and coding professionals, and the implementation of routine data quality audits. Improving the accuracy of external cause and activity coding is particularly critical to enable more granular epidemiological analyses and to inform targeted, high-impact interventions.

In conclusion, this study not only advances the understanding of injury patterns in urban Indonesia but also highlights a crucial, yet often overlooked, dimension of health data quality. Strengthening clinical documentation and coding accuracy should be recognized as a strategic priority to enhance injury surveillance systems, support evidence-based policymaking, and ultimately reduce the burden of preventable injuries.

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