Epidemiology of major trauma in Malaysia: Preliminary findings from the Malaysian Trauma Registry

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ABSTRACT

Introduction: Epidemiological data regarding major trauma in Malaysia is limited due to the unavailability of a sustainable trauma registry (TR). Recognising its importance, a national TR known as the Malaysian Trauma Registry (MTR) was established in 2020. This study aims to investigate the epidemiology of major trauma in Malaysia utilising data from the MTR.

Materials and Methods: A retrospective analysis of the MTR data from 1st January 2021 to 30th April 2024 was conducted. This study focused on major trauma patients who presented at the participating hospitals or were transferred from other healthcare facilities and met the MTR enrolment criteria. A total of 2774 patients were included in the analysis.

Results: The most frequently affected group by major trauma was young males aged 15-44. Road traffic accidents (RTAs) were the leading cause of injury, followed by falls. More than half of the patients arrived at the hospital via ambulance, with a median time of 45 minutes from the emergency call to hospital arrival. In the emergency department (ED), nearly 80% of the patients were treated in a shared resuscitation bay, and the trauma team was activated for only one-third of cases. The most common type of Computed Tomography (CT) performed was CT brain. The median time from arrival to first CT was 95 minutes. Approximately 19.5% of patients were directly sent from the ED to the operating theatre for emergency surgery, while 19.6% required admission to the intensive care unit. The head and neck were the most frequently injured body regions (31.7%), with the head and thorax having the highest severity according to the Abbreviated Injury Scale. The median Injury Severity Score was 13 (IQR 7-19), and the median length of hospital stay was 4.4 days (IQR 1.9-10.6 days). The in-hospital mortality rate was 10.9%, with the highest rates observed among young males aged 15-44 and those involved in RTAs.

Conclusion: This study has highlighted the burden of major trauma and provided insight into the current quality of trauma care in Malaysia. The information gathered will be used to understand the standard of the existing trauma system and assist in designing trauma care enhancement plans.

KEYWORDS:
Epidemiology, trauma registry, major trauma, Malaysia

INTRODUCTION

The World Health Organization (WHO) stated that 4.4 million people die every year due to trauma worldwide.[1] The majority of trauma-related deaths occur in developing countries and commonly involve the young population.[1] The rate of trauma mortality is inversely related to the economic level of a country.[2] Approximately one-third of mortalities can potentially be avoided with a better trauma care system and effective preventive measures.[3] Evidence shows that trauma puts a significant burden on the developing nation's economy due to substantial loss of productivity years and financial capital due to high medical care costs.[1] Malaysia is a developing Southeast Asian country with a total population of 33.4 million.[4] Trauma is the sixth leading cause of hospital admissions, and road traffic accidents (RTA) have been identified as one of the top five causes of death in Malaysia.[5,6] It is the principal cause of total disease burden for children between 5 and 14 years old and young adults between 15 and 29 years old, with Disability-Adjusted Life Years of 9.3%(21 913) and 23.5% (180 031) respectively.[7]

A trauma registry (TR) is a structured database that records information regarding injured patients, including demographics, injury events, prehospital care, in-hospital care, diagnosis, and outcomes.[8,9] It is an effective tool to study injury surveillance, implement preventive strategies, strategise resource allocation, and develop quality improvement programs through clinical research and audits.[9,10] High-income countries (HICs) have proven that information gathered from comprehensive TR has greatly impacted the development of a better trauma care system, leading to a reduction in mortality and morbidity.[11] Establishing TR in a few developing countries has brought positive changes in trauma care.[12,13] An ideal TR should have a specified population, a dedicated management team, and a comprehensive data collection system to enable accurate data analysis, reporting, and validation.[14] Most developing countries do not have a structured nationwide TR.[15] One of the main obstacles is the high maintenance cost.[16] Lack of support from the stakeholders, human resource limitations, limited infrastructure, and lack of awareness regarding the importance of TR are among the other problems.[10] In

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developing countries, trauma-related data are commonly extracted from hospital-based patient information systems or short-term databases set up for research purposes.[17,18] Among the 115 countries that regularly report health statistics to the WHO, only 29 were found to have a national TR.[19,20] A literature review revealed that almost all the publications derived from TR originated from HICs, while the Southeast Asia region, where Malaysia is located, had the least number of publications.[21]

Epidemiological data on major trauma in Malaysia are scarce and inconsistent due to the absence of a sustainable TR. It was last reported in the year 2009.[22] The report was generated from the National Trauma Database (NTrD), which had to be discontinued in the year 2010 due to a lack of financial support.[23] The data collected were from 5 hospitals located within the same state; thus, it did not represent the overall epidemiology in Malaysia. Only essential variables which concentrated on in in-hospital management were included in the NTrD. This is typical of developing country registries, which collect fewer variables and are less stringent on inclusion criteria.[21] Several other temporary hospital-based registries existed, but the data collected only represented the hospital's locality.[24] Due to various setbacks, data regarding trauma in Malaysia heavily depend on the Royal Police Force and Malaysian Institute of Road Safety Research databases, which only include data regarding RTA and do not contain clinical information. Recognising the importance of a TR, the Ministry of Health Malaysia (MOH) launched a new initiative in late 2020 to establish a nationwide TR known as the Malaysian Trauma Registry (MTR). Initially involving eight public hospitals, it was later expanded to 31 hospitals.

The overall aim of this study is to investigate the epidemiology of major trauma in Malaysia by utilising the information from the MTR, which has never been reported before. The specific objectives are: to define the demographics and injury characteristics of major trauma patients; to identify the clinical interventions and resources utilised to manage major trauma patients; and to describe the outcomes associated with major trauma patients. The primary outcome is to determine the rate of in-hospital major trauma-related mortality. The secondary outcome is to determine the in-hospital morbidity associated with major trauma.

MATERIALS AND METHODS

Study design

This was a retrospective analysis of the MTR database between 1st January 2021 and 30th April 2024 involving 31 participating hospitals. Ethical approval for this study was granted by the Medical Research and Ethics Committee (MREC) of the MOH (NMRR ID: IF-23-03616-LWA).

Study setting and population

This study included all major trauma patients who presented to the Emergency Department Critical Zone (EDCZ) of the participating hospitals or were transferred from other health facilities and fulfilled the criteria for enrolment into the MTR. The criteria for enrolment in this study require the presence of any one of the following inclusion criteria: trauma patients who were triaged to the EDCZ, trauma patients who required mechanical ventilation, trauma patients admitted to the Intensive Care Unit (ICU) or High Dependency Unit (HDU) for > 24 hours, or trauma patients with an Injury Severity Score (ISS) >12. On the other hand, patients meeting any of the exclusion criteria will not be enrolled. These include trauma patients who are first admitted to the hospital >24 hours after the injury, trauma patients declared dead before arrival at the hospital, or trauma patients who arrive at the hospital with no signs of life and fail to respond to initial resuscitation efforts.

Data collection

MTR is an online web-based registry that was developed and managed by the Health Informatics Centre (HIFC), MOH. The registry consists of eight sections: demographics, injury event, out-of-hospital care, emergency trauma care, further management, injury pattern, outcome, and submission validation. MTR data is stored in a secure online cloud storage. Data entry is carried out by trained personnel at each hospital. Trained personnel trace the medical records of all trauma patients triaged to EDCZ, select eligible patients, extract the required information, and enter them into the registry. Centralised training is held annually. Additional technical support is provided through email and messaging application groups. A request for data transfer with details of the required variables was submitted to the HIFC. Upon approval, the HIFC released and shared the data. The shared data was filtered by removing duplicates and incomplete data before being enrolled in this study.

Statistical analysis

Data variables were arranged and analysed using International Business Machines Statistical Package for the Social Sciences version 29. Descriptive statistics were used to summarise the sociodemographic characteristics of subjects. Categorical data were expressed as percentages and evaluated using the Pearson chi-square test, where all tests were conducted at an α-level of 0.05.

RESULTS

A total of 2,774 completed data points were included for final analysis. Among 31 participating hospitals, Hospital Bintulu, located in East Malaysia, contributed the highest number of completed data (n=397,14.3%) (data not shown).

Demographics

Overall, 82.5% (n=2289) of the patients were males, and 17.4%(n=483) were females. The vast majority, 90.8% (n=2517), were Malaysian citizens. Specifically, the young population was most affected, with a median age of 32 (IQR 21-49) (Table I).

Type, Intention, Mechanism and Location of Injury

The dominant type of injury was blunt injury (95.6%,n=2615) in comparison to penetrating injury (4.4%, n=120). Most of the injury occurred unintentionally (84.6%, n=2328). The top three mechanisms of injuries in descending order were RTA (78.3%, n=2161), falls (9.8%, n=273), and injury by sharp objects (3.0%, n=85) (Table I). RTA was the

most common among the age group 15-44 in both genders (Fig 1A). Fall was frequently seen in males within the age group of 30-44, while in females, it was prevalent among the older age group (Fig 1B). The most typical location of injury was road (80%, n=2196), followed by home (9.8%, n=270), industrial factories (2.4%, n=66) and others.

Prehospital Care (PHC)
The most common mode of arrival to the hospital was via ambulance (n=1790,65.2%). Non-ambulance mode of arrival was 19% (n=523). Approximately one-third of the patients were attended by a Level III Advanced Life Support (ALS) provider (n=841,31.1%). Only half (53%, n=1437) of the prehospital triagings were to EDCZ. The median time interval between an emergency call and ambulance arrival at the hospital was 45 minutes (IQR 30-63 minutes).

Emergency Department (ED) Care
Direct admission from the scene comprised approximately two-thirds (63.3%, n=1726) of total admissions and the remaining were transferred cases. There was minimal variation in the rate of admission on different days of the week. Upon arrival, almost all patients (99.3%, n=2754) were triaged to EDCZ.

More than three-quarters of patients were treated at the shared resuscitation bay (78.7%, n=2151), followed by the dedicated trauma bay (8.5%, n=233), dedicated trauma service (7.4%, n=201) and unknown/unavailable (5.4%, n=189). Trauma team activations were initiated for 873 (32%) patients. Only 897 (33.2%) patients were attended by specialists or consultants upon arrival.

First ED Vital Signs
Median systolic blood pressure was 91 mmHg (IQR 78-108), median heart rate (HR) was 75 beats per minute (IQR 64-86), median respiratory rate was 20 per minute (IQR 18-22), median oxygen saturation was 99% (IQR 97-100) and median Glasgow Coma Scale (GCS) was 15 (IQR 12-15).

ED Intervention
Five most common interventions in ED were cervical collar application (62.9%, n=1746), tranexamic acid administration (45.6%, n=1266), rapid sequence intubation (28.6%, n=791), limb immobiliser application (22.9%, n=635) and blood transfusion (20.4%, n=567).

Radiological Imaging in ED
Extended Focused Assessment Sonography in Trauma (eFAST) was the most common imaging done in the ED, comprising 2496 (90%) patients. The most frequently performed X-ray was Chest X-ray (n=2429, 87.6%). The most common Computed Tomography (CT) performed was CT brain (n=1842, 66.4%). Only 121 (4.4%) patients underwent Whole-Body CT (WBCT).

Time Interval Between Hospital Arrival and First CT
Median time elapsed between hospital arrival and first CT was 95 minutes (IQR 50-163 minutes).

Emergency Surgical or Interventional Radiology (IR) Intervention
Overall, 19.5% (n=414) of patients were sent directly from ED to operation theatre (OT) for emergency surgical intervention. In contrast, only 0.6% (n=16) of patients were sent to the IR suite. The most common emergency surgical intervention performed in OT was pelvic external fixation (n=215, 8.1%), followed by damage control laparotomy (n=77, 2.9%), craniotomy (n=59, 2.9%) and others (n=63, 2.5%).

ED Length of Stay (LOS)
Median ED LOS was 6 hours (IQR 3 hours 58 minutes – 8 hours 50 minutes).

Level of In-Patient Care
During their hospital stay, 612 (22.1%) patients required surgery in OT, 146 (5.3%) required admission to HDU and 545 (19.6%) required admission to ICU.

Injury Severity
The five most frequently injured body regions were head and neck (51.8%), extremities and pelvic girdle (40.2%), thorax (28.7%), face (23.3%) and abdomen (16.9%). The majority of patients had mild to moderate injuries defined as Abbreviated Injury Scale (AIS) scores 1 and 2. The highest proportion of severe injuries (AIS 3 and above) was observed in the head, thoracic and lower extremity regions (Fig 2).

Overall, the median Injury Severity Score (ISS) was 13 (IQR 7-19) and the median New ISS was 16 (IQR 9-24). The greatest proportion of patients had an ISS of less than 16 (n=1362, 59.8%) (Fig 3).

Hospital LOS
Overall, the median hospital LOS was 4.4 days (IQR 1.9-10.6 days). Median hospital LOS was found to be directly proportional to the ISS.

Patient Outcome
In total, 86.3% (n=2395) of patients survived to discharge, while 10.9% (n=301) died (Fig 4A). The highest mortality was seen in the age group 15-44, and mortality was consistently higher among males across all age groups (Fig 4B). RTA recorded the highest mortality (76.4%, n=230) followed by fall (10.6%, n=32). Mortality due to RTA was most pronounced in the age group 15-44, whereas mortality due to fall was highest in those who were 60 years old and above. Mortality rate was found to be directly proportional to ISS (Fig 4C).

Among the survivors, 75.5% (n=1866) had a good recovery upon hospital discharge based on the Glasgow Outcome Scale Score. Most of the survivors (83.4%,n=2063) were discharged home, 8.0% (n=197) were transferred to another health facility, and only 1.0% (n=24) were referred to a rehabilitation centre.

Table I: Demographics and mechanism of injury

Demographics and mechanism of injury	Frequency (n)	Percentage (%)
Sex		
Male	2517	82.5
Female	483	17.4
Age Group		
0-14	220	7.9
15-29	1041	37.6
30-44	656	23.7
45-59	435	15.7
60-74	304	11.0
>75	113	4.1
Type of Injury		
Blunt	2615	96.6
Penetrating	120	4.4
Mechanism of Injury		
Road Traffic Accidents	2161	78.3
Falls	273	9.8
Injury by sharp objects	85	3.0
Injury by blunt object	55	2.0
Self-harm	40	1.4
Industrial/Construction	32	1.2
Unknown	34	1.2
Others	28	1.0
Blast/Explosion Injury	20	0.7
Animal Inflicted	17	0.6
Recreation related injury	9	0.3
Firearms injury	4	0.1
Electrocution	3	0.1

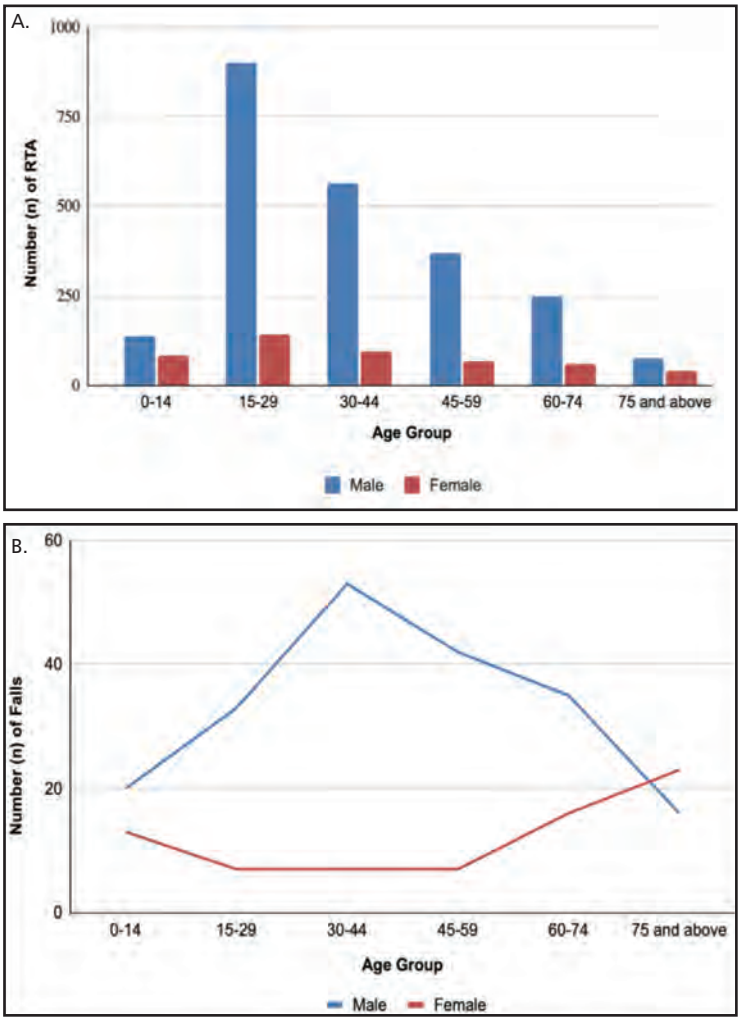

Fig. 1: A. Frequency of RTA by age group and gender. B. Frequency of fall by age group and gender.

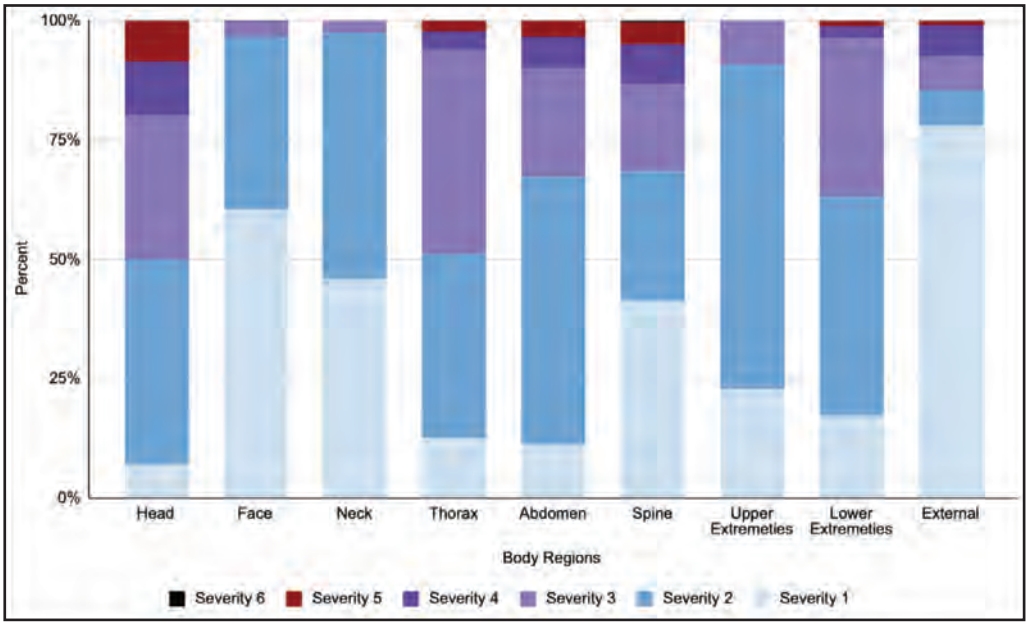

Fig. 2: AIS severity by body region

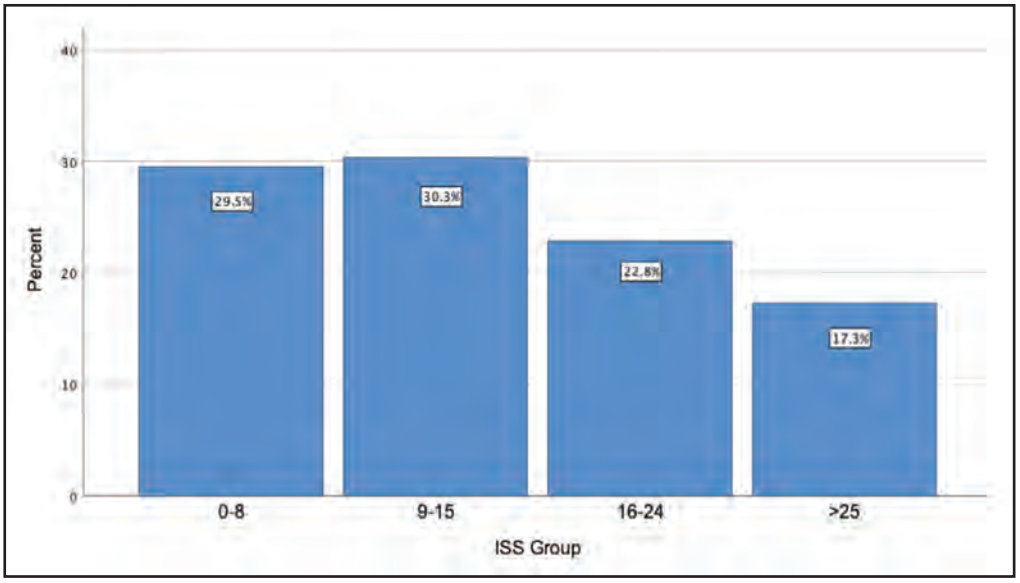

Fig. 3: Injury Severity Score (ISS) Distribution

DISCUSSION

This is the first report generated from the MTR database since it became operational in late 2020. The results provided an initial overview of the epidemiology of major trauma in Malaysia, detailing the demographics, injury mechanisms, injury characteristics, prehospital and in-hospital management, and patient outcomes.

Among the 31 hospitals participating in the MTR, only nine contributed a significant number of data. Fortunately, these hospitals are spread across different regions of the country, representing diverse populations and geographical variations. The disparity in data contribution is not unexpected, as most MTR personnel must multitask between clinical duties and managing the MTR database, significantly limiting their time for data entry. Additionally, managers typically prioritise clinical duties over non-clinical tasks, a common scenario in healthcare organisations within developing countries. Assigning a dedicated team for data management is not feasible in resource-limited settings, explaining the insufficient data entry volume among participating hospitals.

Besides the volume of data entry, data completeness was another significant issue, with the MTR data completion rate at only 58.5%. This low rate is likely due to the difficulty in searching for and extracting the necessary information, stemming from incomplete documentation in clinical notes,

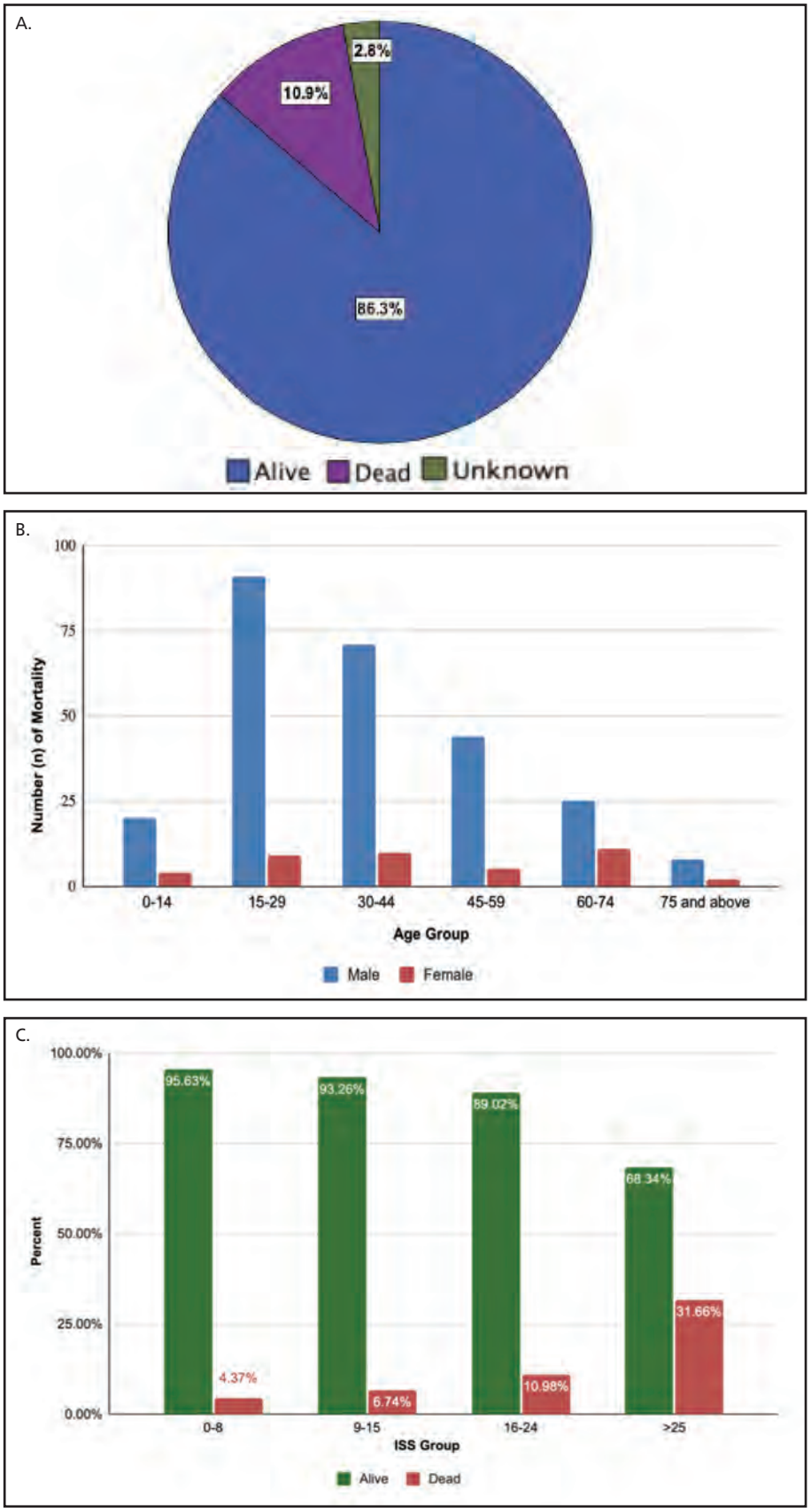

Fig. 4: A. Survival status B. Overall mortality by age group and gender (n=301) C. Outcome based on ISS

especially in hospitals without an Electronic Medical Record (EMR) system. To address these challenges, initiatives are underway to implement automated data extraction from EMR systems directly into the registry database. This integration aims to minimise manual data entry time for personnel while simultaneously improving data volume, completeness, and accuracy. Furthermore, hospitals currently utilising paper-based records, such as Hospital Kuala Lumpur are scheduled to transition to EMR systems in the near future, which will further streamline this process. Additionally, several errors within the MTR system were identified, requiring prompt rectification. A major error was the inability to download essential variables such as the types of vehicles involved in RTAs, safety devices used, and ICU length of stay. MTR administrators were notified of these issues during the study period.

Demographic data indicate that male adults aged 15-44 constitute the largest group involved in major trauma, with RTA identified as the predominant mechanism. This trend may be attributed to the high proportion of young males among road users and the heavy reliance on private vehicles for commuting, which is exacerbated by limited connectivity in the national public transportation system.[25,26] Interestingly, the second most common mechanism of injury, which was falls, mainly affected men in the middle-aged group instead of the elderly group, as it was among women. This may be due to middle-aged men being involved in high-risk occupations such as construction site work and engagement in outdoor activities. These evidences strongly indicates that young males should be the primary target population for injury prevention interventions.

PHC services in Malaysia are still in the developing stage, evidenced by the low percentage of major trauma patients arriving at the hospital by ambulance. Furthermore, only about one-third of them received on-scene assessments by ALS providers. This may have resulted in inappropriate prehospital triaging and treatment by unqualified providers, as evidenced by nearly half of the patients not being initially triaged to the EDCZ before being upgraded upon arrival in the ED. Ideally, all major trauma patients should receive an appropriate on-scene assessment by at least an ALS provider to improve outcomes.[27] At present, this is unachievable due to an insufficient number of ALS providers and ambulances within the MOH organisation to provide nationwide coverage. MOH relies heavily on support from non-governmental organisations such as St. John's Ambulance Service, staffed by personnel who are trained only to the Basic Life Support level. These shortcomings need to be addressed promptly to improve the quality of PHC services in Malaysia. Currently, the MTR dataset does not capture specialised prehospital certifications that emphasise trauma-specific modules, such as Prehospital Trauma Life Support or Prehospital Care Advanced Life Support. Incorporating this data would significantly enhance the registry's value by providing insights into the specialised training levels of responding personnel and their potential impact on patient outcomes. Additionally, the median time from emergency call to hospital arrival was 45 minutes. While this could be improved, it is comparable with other developing countries.[28]

A coordinated trauma reception is crucial to ensure the seamless delivery of care for major trauma patients upon their arrival at the hospital.[29] Ideally, major trauma patients should be resuscitated in a dedicated trauma bay in the ED to ensure the best outcome. MTR data showed that most of the major trauma patients were resuscitated at a shared resuscitation bay. This is because most hospitals in Malaysia lack a dedicated trauma bay due to various obstacles. Recognising its importance, several newly renovated EDs have incorporated dedicated trauma bays in their architectural plans. Although trauma team activation offers various advantages, it is not routinely practised in Malaysia due to limited human resources, ineffective interdisciplinary collaboration, and a lack of awareness of its importance.[30]

Studies have shown that mortality and morbidity significantly decrease when a major trauma patient is attended by a consultant from the outset.[31,32] However, this analysis revealed that only one-third of the patients were attended by a consultant upon arrival at the ED. Although this is significantly higher than what was reported in a previous local study, efforts must be made to ensure that all major trauma patients are attended by consultants in the near future.[23] This is feasible since all the hospitals that contribute data to MTR currently have resident emergency physicians. Their presence can enhance initial management, expedite decision-making, and facilitate various lifesaving interventions to be carried out safely in the ED.

Ultrasonography is now a crucial tool in Malaysian EDs, allowing for the rapid screening of internal injuries in trauma patients through the incorporation of eFAST into primary surveys. In terms of advanced imaging, selective CT scans were more commonly conducted than WBCT scans, due to the fact that only three public hospitals in Malaysia, Hospital Kuala Lumpur, Hospital Sungai Buloh, and Hospital Selayang, have a formally established WBCT protocol. The WBCT protocol for major trauma was only introduced in Malaysia four years ago, thus more time is necessary for its nationwide implementation. Research indicates that WBCT, when compared to selective CT, lowers overall mortality rates, decreases missed injury occurrences, shortens time to diagnosis, and reduces ED LOS.[33] WBCT also demonstrates high specificity (97.5-99.8%) and sensitivity (85.7-86.2%) in identifying injuries in the abdomen and pelvis.[34] The median time between arrival and the first CT scan in the ED was 95 minutes, significantly surpassing the 60-minute timeframe recommended by international guidelines.[34,35] One clear factor is the unequal distribution of patients needing CT scans and the limited availability of CT scan machines. Additionally, CT suites in Malaysia are often situated away from the ED, causing further delays. It is crucial to conduct a thorough assessment to pinpoint essential factors that could potentially reduce this time lag, ultimately speeding up clinical decision-making processes and reducing ED LOS.

Overall, only one-fifth of the major trauma patients required immediate emergency surgical intervention, such as exploratory laparotomy. This aligns with the current global trend favouring non-operative management (NOM) as the primary treatment strategy. This shift is driven by the introduction of damage control resuscitation, improved

access to advanced imaging, and the availability of IR services. NOM has proven highly successful in managing haemodynamically stable isolated liver and splenic injuries, regardless of their grade.[36-38] IR services are currently available in only a few hospitals in Malaysia which is the main reason for the very low number of patients who underwent IR interventions. On another note, it was noted that only 545 patients were admitted to the ICU, despite 791 patients being intubated. This indicates a shortage of ICU beds, resulting in suboptimal care that can adversely affect patient outcomes.

Most patients sustained head and neck injuries, followed by injuries to extremities and pelvic girdle. In terms of severity based on AIS, head, thoracic and lower extremity injuries recorded the highest severity. These injuries are often linked to a high number of RTAs, particularly among motorcyclists who are at greater risk of sustaining such injuries. Despite the failure to demonstrate that the motorcycle is the most common vehicle involved in RTAs in this study, this is a well-documented fact and has been published in multiple literatures.[23,39] Preventive measures to address this issue include creating separate lanes for motorcycles, implementing effective speed management systems, developing road safety education programs, adopting new technologies to enhance vehicle safety standards, and ensuring safer roads for all users.[39]

The outcome analysis revealed an in-hospital mortality rate of 10.9%, significantly lower than the previous local report but comparable to other developing countries.[23,40] However, this low mortality rate should be interpreted with caution, as nearly 60% of the patients in this study had an ISS of less than 16. The highest mortality rate was among patients involved in RTAs, aligning with Malaysian death statistics.[6] It was also identified that 70.1% of mortalities occurred in patients with an ISS >15. These indicate those who are severely injured due to RTAs should be the target group to reduce mortality. In the geriatric population, most deaths resulted from falls. While most prevention programs in Malaysia focus on reducing RTAs, fall prevention measures receive little emphasis. Given the rising geriatric population, fall prevention is a critical area needing urgent attention from relevant departments. It was observed that very few patients were transferred to rehabilitation centres upon discharge, highlighting a neglected area of care. Currently, there is only one public rehabilitation hospital in the country, indicating a need for greater focus on rehabilitation to reduce morbidity.

The primary limitation of this study was the sample size, with only 2,744 completed datasets suitable for final analysis. Several crucial variables within the completed datasets had significant missing information, such as HR and GCS. Additionally, we were also unable to retrieve variables such as types of vehicles, safety devices used, and length of ICU stay due to a system error. Furthermore, data accuracy might be less reliable than expected because the MTR is relatively new, having only been in operation for three years. There is a geographic imbalance in registry participation relative to state size. Specifically, the Klang Valley is over-represented despite its smaller geographic footprint, which may lead to the misconception that the current data is fully representative of the entire nation. However, as the MTR is currently in the recruitment phase, participation is expected to expand shortly to include university hospitals and other regions.

CONCLUSION

This epidemiological study highlights the significant burden of major trauma in Malaysia and provides critical insights into the current quality of trauma care nationwide. The findings serve as a platform to identify strengths and weaknesses, offering a roadmap for targeted enhancements in trauma management. Furthermore, these results provide a substantive basis for stakeholders to prioritise investment in trauma quality improvement programs. It is anticipated that this report will foster a greater commitment to data integrity among participating hospitals and catalyse the technical evolution of the registry itself. However, the sustainability of the registry and the feasibility of annual audits remain dependent on continued financial and technical support from the MOH. As shifting demographics and urbanisation continue to alter injury patterns, regular analysis of MTR data will be crucial for adapting trauma systems to meet evolving clinical demands.

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ETHICS STATEMENT

Informed consent was waived by the MREC, MOH due to the retrospective nature of the study. The study conformed to the principles outlined in the Declaration of Helsinki.

FUNDING

This study was self-funded work.

DATA AVAILABILITY STATEMENT

Raw data are not attached. The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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