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Research Article

Epidemiology of Polytrauma at a Teaching Hospital in Northern Ghana: A Cross-Sectional Study

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Background. Polytrauma refers to multiple life-threatening injuries to more than 2 bodily regions with some significant physiologic derangement. It is a major cause of morbidity and mortality globally. This study aimed to evaluate the epidemiological profile of polytrauma and outline the distribution of extremity fractures among cases in Northern Ghana. *Methods*. A retrospective cross-sectional study was conducted at the Accident and Emergency Department of Tamale Teaching Hospital. Data were extracted using a data collection tool onto MS Excel, cleaned, and exported onto SPSS version 26 for analysis. Descriptive statistics was used to present data in tables and charts. Analysis of variance (ANOVA) was used to assess whether there was a significant difference in the mean ISS and mean length of stay of the direct causes of death. *Results*. About 186 out of 5413 attendants to the emergency department were polytrauma, period prevalence of 3.4%. The male-to-female ratio was 1.9 : 1. Young adults (21–40 years) contributed 64% of the participants. The mean age of participants was 32.9 ± 15.4 years, and the mean ISS was 40.6 ± 13.1. Road traffic accidents (68.8%) were the most common cause of polytrauma. The mortality was 33.0%. Traumatic brain injury (TBI) was the most common direct cause of mortality (54.1%). There was a significant mean difference (MD) in the length of stay between multiple organ failure (MOF) and TBI (MD = 3.169, 95% C.I. = 0.48–5.86) and between MOF and hemorrhage (MD = 6.212, 95% C.I. = 2.62–9.80). Most fractures were closed (75.3%) and affected the lower limbs (61.5%). Open reduction and internal fixation were the most common surgery for extremity fractures. *Conclusion*. We recommend a concerted multidisciplinary policy framework geared towards promoting road safety and reducing accidents in Ghana. We also recommend a tailored robust treatment algorithm for managing traumatic brain injury in our settings to reduce mortality thereof.

1. Introduction

A traumatic injury is any form of physical insult to a body region. It may range from mild to severe. Polytrauma is a severe form of traumatic injury. It is a subject area that traverses every specialty in surgery. The definition of polytrauma has evolved since the first attempt was made in the 1960s. A recent definition, known as the Berlin definition, was formulated in 2014 by a panel of experts from the major trauma societies in Europe, North America, and Australia [1]. The Berlin definition defines polytrauma as a life-threatening injury involving at least 2 bodily regions (each with an AIS ≥3) as well as at least one positive physiologic parameter. The physiologic parameters include the elderly (age ≥70 years), low systolic blood pressure, Glasgow coma score ≤8, coagulopathy, and acidosis [1]. Trauma scoring systems are objective scoring systems that quantify the severity of traumatic injuries [2]. They do so with the use of anatomic trauma scores, physiologic trauma scores, or a combined score in some instances. The common anatomic trauma scores used include AIS (Abbreviated Injury Score), ISS (Injury Severity Score), NISS (New Injury Severity Score), PATI (Penetrating Abdominal Trauma Index), and TMPM (Trauma Mortality Prediction Model) [3, 4]. The physiologic trauma scores are GCS (Glasgow Coma Score), APACHE (Acute Physiologic and Chronic

Health Evaluation), and SOFA (Sequential Organ Failure Assessment). Examples of a combined model are TRISS (Trauma Score -Injury Severity Score), and ASCOT (A Severity Characterization of Trauma) [5]. Although most of these scoring systems are used in polytrauma, the ISS is the most used [2–4, 6, 7]. An overwhelming majority of clinical studies have employed the ISS because of its simplicity, accuracy, and easy applicability. A systematic review by Xu et al. [6] noticed that out of 321 studies on polytrauma, 86.3% based their definition on ISS [1]. The case definition, however, varies from one study to the other. Different studies have used cutoffs ranging from ISS >15 [2, 3], ISS >16 [4], ISS >17 [5], ISS >18 [6], and ISS >25 [7]. However, the common ISS cutoffs in the literature are 15 and 17 [2, 3, 5].

The majority of studies have shown polytrauma is common among young people under the age of 40 [8, 9]. It is disproportionately common among men in almost all available studies. The male-to-female ratio in previous studies ranged from 2 : 1 to 19 : 1 [1, 8, 10, 11]. The proportion was higher in Asian and Middle Eastern studies because of the different gender roles and cultures in those regions [11, 12]. Polytrauma is caused by several factors such as gunshots, road traffic accidents (RTAs), assault, occupational injuries, falls, and explosions. RTAs are the most common cause, followed by falls and assaults in HICs and LMICs [9, 11, 13]. In politically unstable regions, gunshots and explosions are the most common cause of polytrauma [14, 15]. The consensus is that the prevalence of these etiologies varies from one region to the other. Extremity fractures are the most common injury among polytrauma victims [9]. They accounted for prolonged hospital stays among 52.4% of participants and disability-adjusted life years (DALYs) of victims [16]. Closed fractures were more common than open fractures. Lower limb fractures (68.5%) were twice as common as upper limb fractures (31.3%). Of all the fractures, tibia fractures were the commonest, followed by femur fractures [8]. The findings above are similar to findings in African studies [17, 18].

The global incidence of traumatic injuries has surpassed that of both communicable and noncommunicable diseases [19]. Garcia et al. reported it as the leading cause of morbidity and mortality globally [20]. In a systemic review by Liu et al. 2022, on the global causes of death among children 5–19 years, out of 1.5 million deaths, traumatic injuries (7.8%) had surpassed malaria (5.5%) and neoplasm (6.4%) as the leading cause of death [21]. There is a high burden of traumatic injuries in sub-Saharan Africa. There was an increase from 40.7 to 92.9 per 100,000 between 2010 and 2015 [22]. Kotagal et al. [23] reported over 2 million trauma-related deaths in LMICs every year. Also, about 49–52 million disability-adjusted life years (DALYs) could be obviated if traumatic injuries are reduced [24]. Despite these palpable statistics, trauma-related injuries have not received the needed global attention. In Ghana and Africa, polytrauma has been sparingly studied with a gross paucity of data. This study will provide baseline data on the epidemiological profile of polytrauma in Northern Ghana. It may also stimulate the need for a national trauma registry to understand the true burden of trauma-related injuries. This study aims to evaluate the epidemiological profile and outline the distribution of extremity fractures among polytrauma cases in Northern Ghana.

2. Methods

The study was conducted at the Accident and Emergency Department of Tamale Teaching Hospital (TTH). It is the tertiary hospital in Northern Ghana serving the health needs of about 7 out of 16 regions, thus, about 6 million people in Ghana. The hospital has an 840-bed capacity and is the only referral site for polytrauma in Northern Ghana. The hospital is in the Tamale metropolis. The people are mostly farmers, and the most common means of transport is the motorcycle. It is a retrospective cross-sectional study that was conducted from 1st November 2020 to 31st October 2022. The study population constituted patients diagnosed with polytrauma at the emergency department of TTH within the study period. All patients who met the operational definition were included. Patients who had more than 30% of their medical data incomplete were excluded. Patients who were brought in dead, died on arrival, or died before investigations were initiated were excluded from the study. This cohort was excluded because the investigator could not fully ascertain the full extent of their injuries. The study employed a total population sampling technique. The selection process for the study cohort is illustrated in a STROBE flowchart in Figure 1. The sample size for the study was 186. About 12 cases were excluded because they did not meet the eligibility criteria.

2.1. Operational Definition

(i) Polytrauma is a life-threatening injury to at least 2 of the 9 anatomic body regions with an ISS ≥17. The anatomic regions include the face, head, neck, abdomen and pelvis, thorax, spine, upper limbs, lower limbs, and the external.

(ii) Abbreviated Injury Scores (AIS): these are predetermined anatomic injury scores given to the 9 body regions, usually from 0 to 6 (0 = no injury, 1 = minor injury, 2 = moderate injury, 3 = serious injury, 4 = severe injury, 5 = critical injury, and 6 = fatal injury)

(iii) Injury Severity Score (ISS): it is the sum of the squares of AIS of the 3 most injured body regions. Thus, $ISS = AIS^2 + AIS^2 + AIS^2$. ISS ≥17 is polytrauma.

2.2. Data Collection and Analysis. Archived electronic medical records from the emergency department within the study period were examined, and the participants were identified. A structured data extraction tool as shown in Appendix 1 was used to retrieve the data. The data points were coded and recorded into Microsoft Excel Spreadsheet. The data were then exported onto SPSS version 26. Analysis of proportions was done using descriptive statistics, frequencies, and percentages. This was depicted by tables and

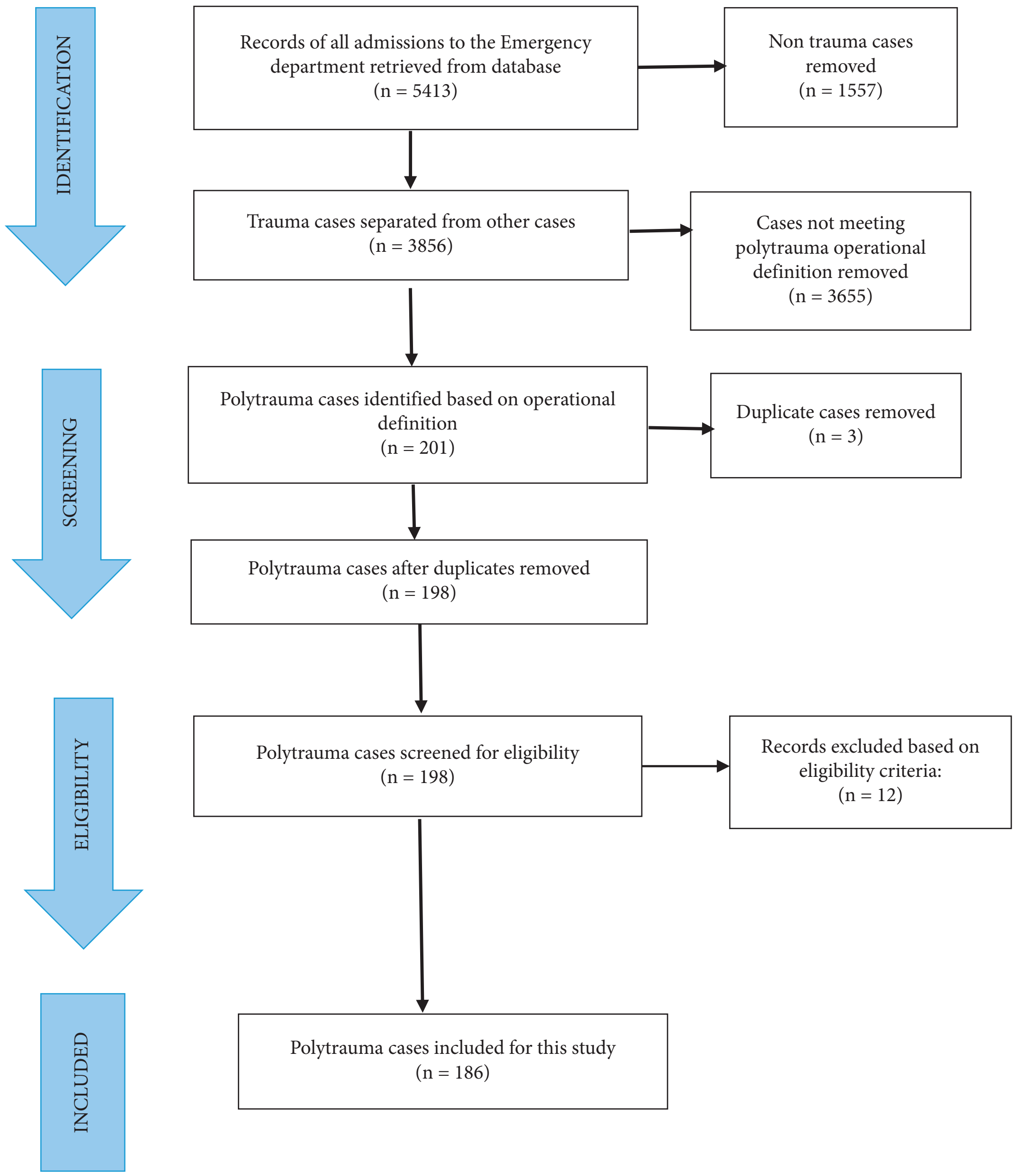

Figure 1: STROBE flowchart showing how the study cohort was selected.

charts to illustrate the characteristics of participants, distribution of extremity fractures, outcome of polytrauma, etc. Analysis of variance (ANOVA) was used to assess whether there was a significant difference in the mean ISS and mean length of stay of the direct causes of death.

2.3. Ethical Consideration. Ethical approval was obtained from Kwame Nkrumah University of Science and Technology Committee on Human Research, Publications, and Ethics (KNUST-CHRPE) with reference number CHRPE/AP/063/23. A letter of support was also obtained from the Research Department of Tamale Teaching Hospital to conduct the study.

3. Results

3.1. Features of Study Participants and Prevalence of Polytrauma. The total attendance to the accident and emergency department within the study period was 5413. The total number of polytrauma cases was 186; hence, the prevalence of polytrauma over the period was 3.4%. Table 1 illustrates the characteristics of the study participants and their admission history. The mean age of polytrauma cases was 32.9 ± 15.4 years, with an age range of 8–76 years. The age group 21–40 years (66.1%) formed the majority, while ≥61 years (10.2%) formed the least of the study participants. About two-thirds (66.1%) were males, with a male-to-female ratio of 1.95 : 1. More than half (55.9%) of the participants

Table 1: Characteristics of study participants and admission history.

		Frequency	Percentage (%)
Demographic characteristics			
Age grouped	20 years or less	26	14.0
	21–40 years	119	64.0
	41–60 years	22	11.8
	61 years or more	19	10.2
Sex	Male	123	66.1
	Female	63	33.9
Health insurance	Yes	82	44.1
	No	104	55.9
Injury and admission history			
Mechanism of injury	RTA	128	68.8
	Fall	18	9.7
	Assault	15	8.1
	Gunshot	15	8.1
	Gas explosion	10	5.4
Referral status	Brought in	88	47.3
	Referred	98	52.7
Length of time to hospital after injury	24 hours or less	95	51.1
	More than 24 hours	91	48.9

did not have any form of health insurance coverage. RTA (68.8%) was the commonest mechanism of injury, followed by falls (9.7%), assault (8.1%), and gunshots (8.1%). Gas explosion (5.4%) was the least mechanism of injury. Most of the participants were referred (52.7%). More than half of the participants reported to the hospital within 24 hours after the injury. The average length of time after injury to arrival at the hospital was 1.8 ± 1.1 days, with a range of 1 and 7 days.

There was an even monthly distribution of polytrauma cases with no peculiar pattern noticed over the study period. The highest and lowest proportion of cases was recorded in June (9.7%) and October (5.4%), respectively (Figure 2).

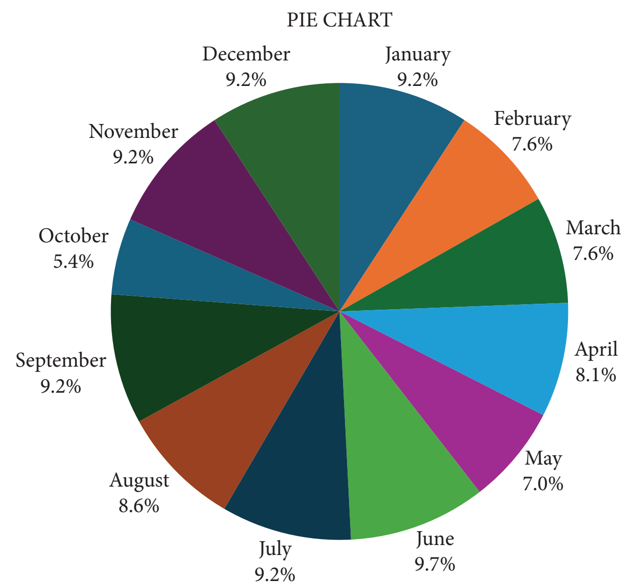

Figure 2: Monthly distribution of polytrauma cases.

3.2. Distribution of Extremity Fractures. Out of 186 polytrauma cases, a total of 356 extremity fractures were recorded. About 75.3% were closed fractures. Lower limb fractures (61.5%) were more common than upper limb fractures (38.5%). The tibia/fibula (27.2%) was the most fractured bone, followed closely by the radius/ulna (24.2%). The humerus was the least fractured extremity bone (6.5%) (Table 2).

3.3. AIS Classification of Extremity Injuries. Each extremity injury is classified and assigned an AIS score ranging from 0 (no injury) to 6 (fatal). The majority (31.2%) of tibia/fibula injuries were serious, and 2.2% of them were fatal. Pelvic and femur injuries ranged from minor to critical. Radius/ulna injuries ranged from minor to severe. The humerus, which is the least injured bone, ranged from minor to serious (Figure 3).

3.4. Management of Extremity Fractures. Out of 356 extremity fractures sustained by polytrauma patients, 38.5% of them underwent open reduction and internal fixation (ORIF), while 14.3% had external fixation. About 22.8% of them were managed conservatively with plaster of Paris (POP), and 23.9% of the patients refused surgical treatment of fractures (Table 3).

3.5. Associated Injuries of Polytrauma. Brain injury was the most common associated injury with about 81.2% of the participants affected, while spine injury was the least with only 17.7%. Traumatic brain injuries (TBI) range from minor to critical. Facial injuries were the second most common associated injury (73.1%). About half (49.5%) of the participants had some degree of thorax injuries. Less than a third (26.3%) of the participants had abdominal injuries (Table 4).

Table 2: Distribution of extremity fractures.

	Frequencies	Percentage of all fractures (%)
Bone fracture		
Clavicle	28	7.9
Humerus	23	6.5
Radius/ulna	86	24.2
Pelvis	42	11.8
Femur	80	22.5
Tibia/fibula	97	27.2
Total	356	100.0
Type of fracture		
Closed fracture	268	75.3
Open fracture	88	24.7
Total	356	100.0
Body region		
Upper limb	137	38.5
Lower limb	219	61.5
Total	356	100.0

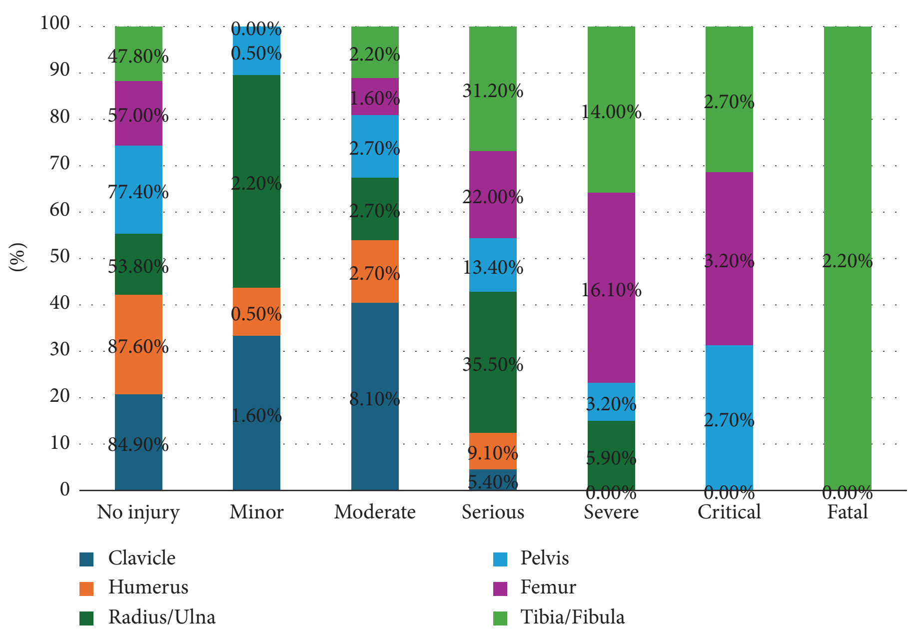

Figure 3: Stack bar showing AIS of extremity injuries.

Table 3: Management options of extremity fractures.

Management option	Frequency	Percentage (%)
External fixation	51	14.3
Open reduction and internal fixation (ORIF)		
Intramedullary nail	89	25.0
Plates and screws	38	10.7
Dynamic hip screws	10	2.8
Hemiarthroplasty	2	0.6
Conservative	81	22.8
Refused treatment	85	23.9
Total	356	100

Table 4: AIS classification of severity of associated organ injuries.

	No injury Percentage (%)	Minor Percentage (%)	Moderate Percentage (%)	Serious Percentage (%)	Severe Percentage (%)	Critical Percentage (%)	Fatal Percentage (%)
Brain	18.8	1.1	14.0	34.4	24.2	7.5	0.0
Neck	46.8	24.7	21.5	0.5	0.5	0.5	5.4
Spine	82.3	6.5	2.7	2.2	0.5	2.2	3.8
Thorax	50.5	4.8	12.4	11.8	9.1	11.3	0.0
Face	26.9	15.6	18.8	32.3	5.9	0.5	0.0
External	62.4	14.5	15.6	2.2	1.1	4.3	0.0
Abdomen	73.7	3.8	9.7	2.7	4.8	5.4	0.0

3.6. Parameters of Polytrauma Cases. The ISS range of the study was 22–75 with a mean ISS of 40.6 ± 13.1. ISS was classified as mild (<9) moderate (9–15), severe (16–25), and profound (>25). Given an operational definition of ISS ≥17, polytrauma cases will fall either under severe or profound ISS. An overwhelming majority (91.4%) of the polytrauma cases had a profound ISS. Most of the participants had moderate TBI (35.7%), followed by mild TBI (22.2%) (Table 5).

3.7. The Outcome of Polytrauma Admissions. The mortality of polytrauma over the study period was 33.0%. About 54.6% of participants were satisfactorily discharged, while 11.9% of participants requested discharge against medical advice (DAMA). Only 0.5% of the participants were referred (Figure 4). Of those that died, traumatic brain injury was the predominant direct cause of death with a mean ISS of 47.2 and a mean LOS of 5.5 days. Multiple organ failure (MOF) was the second common direct cause of death with a mean ISS of 44 ± 15 and a mean LOS of 14.9 days. Hemorrhage contributed to 16.4% of mortalities with a mean ISS of 54 ± 14 and a mean LOS of 3.2 days. Sepsis was the least common direct cause of death (Table 6).

Variation of mean ISS and mean length of hospital stay with direct causes of death in polytrauma injuries.

The mean ISS for the various causes of death were TBI 47 ± 13, MOF 44 ± 15, and hemorrhage 54 ± 14. Also, the mean length of hospital stays for the various causes of death was TBI 6 ± 3 days, MOF 9 ± 5 days, and hemorrhage 3 ± 2 days. There was only one death from sepsis (Table 6). Analysis of variance (ANOVA) was performed for the mean difference of ISS scores and length of stay between the direct causes of death as shown in Table 7. Sepsis as a direct cause of death was excluded from the mean-variance analysis since there was only one death caused by sepsis and hence no mean scores. The mean difference in length of stay among the various causes of death was significant ($P < 0.05$). The mean length of stay before death was averagely longer for those with MOF as compared to those with TBI (MD = 3.169, 95% C.I. = 0.48–5.86). Additionally, the mean length of stay before death was higher for those with MOF as compared to those with hemorrhage as a cause of death (MD = 6.212, 95% C.I. = 2.62–9.80). There was no statistical significance of the mean ISS differences of the various causes of death ($P > 0.05$). However, those with MOF recorded a lower mean ISS as compared to TBI and hemorrhage. Those with hemorrhage on average recorded higher ISS as compared to those with TBI as a cause of death.

3.8. Length of Hospital Stay. The length of stay of participants ranged from 2 to 47 days with a mean length of stay being 23.2 days. About 80.1% of the participants were discharged at week 3 and beyond. Few participants (4.0%) were discharged within week 1, 15.5% in week 2, 80.1% after week 3, and about 28.7% of discharges were after week 4 (Figure 5).

4. Discussion

Traumatic injuries have not received the needed global attention even though the global and regional burden is high [21, 22, 24]. Polytrauma is a life-threatening traumatic injury that endangers the lives of both the young and old. The period prevalence of polytrauma in this study was 3.4%. This was high in comparison with a 2018 study in Mali which reported a prevalence of 1.3% [9]. This increase may be due to good health-seeking behavior, improved referral systems, and good record-keeping because of a shift to electronic medical records systems. The consensus from the literature is that traumatic injuries commonly affect the young [20, 25, 26]. In this study, the mean age of participants was 32.9 ± 15.4 with an age range of 8–76 years. The age group 21–40 years was the most affected. The average age of polytrauma cases in this study is similar to other African studies [9, 23, 26, 27] but lower as compared to European and Asian studies [1, 12]. Young people form most of the labor force, whence this could affect productivity in the long term if preventive measures are not put in place.

In this study, most of the participants were males. The male-to-female ratio was 1.95 : 1. Similar results are reported in most studies [8, 9, 13, 17, 26, 27]. Some outlier studies have reported very high M : F ratios (6 : 1 and 19 : 1) [11, 12]. These proportions may be due to differences in culture and gender roles in those regions. The consensus therefore is that polytrauma commonly affects males. Males are predominantly affected because they are adventurous and more likely to indulge in risky behavior patterns. The study noted that polytrauma is commonly caused by RTA, followed by falls, gunshots, and assault. RTA has been reported widely as the most common cause of polytrauma [8, 9, 11–13, 26]. Liu et al. [26] reported RTA as a leading cause of death among

Table 5: Parameters of polytrauma cases in Tamale Teaching Hospital.

	Severity	Frequency	Percentage (%)
Injury severity score (ISS) category	Mild	0	0.0
	Moderate	0	0.0
	Severe	16	8.6
	Profound	169	91.4
Glasgow coma score category	Normal	36	19.5
	Mild brain injury	41	22.2
	Moderate brain injury	66	35.7
	Severe brain injury	40	21.6
	Critical brain injury	2	1.1

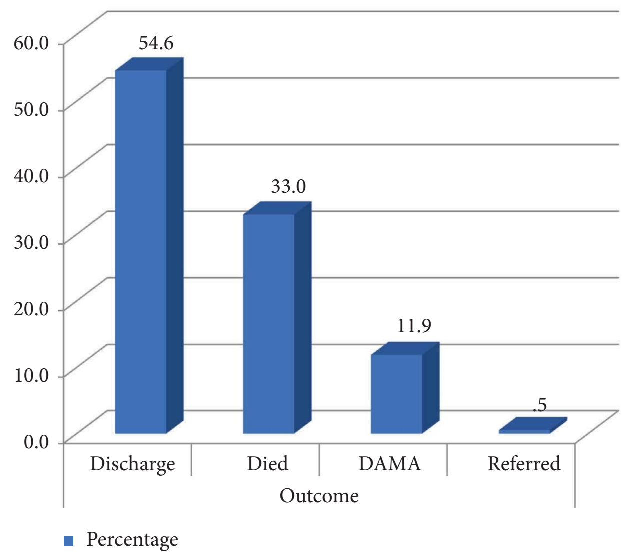

Figure 4: Outcomes of polytrauma admissions at Tamale Teaching Hospital.

Table 6: Direct causes of death from polytrauma.

Direct cause of death	Frequency	Percentage (%)	Mean ISS	Mean length of stay (days)
Traumatic brain injury (TBI)	33	54.1	47 ± 13	6 ± 3
Multiple organ failure (MOF)	17	27.9	44 ± 15	9 ± 5
Hemorrhage	10	16.4	54 ± 14	3 ± 2
Sepsis	1	1.6	34	16

children globally. They noted that trauma-related deaths had surpassed infections and neoplasms [21]. Globally, RTA has become the leading etiology of morbidity and mortality [21]. A systemic review in Africa noted that the burden of RTAs in LMICs in Africa had doubled between 2010 and 2015 [22]. The increase in burden may be due to the increasing urbanization and the constant need to commute from one point to the other. The increased usage of varied automobiles and the noncompliance to road regulations may be a contributory factor. Other causes such as falls, gunshots, and assaults are reported in other studies albeit with different frequencies of occurrence [9, 13, 29].

More than 50% of the participants in this study were referred from other healthcare facilities. The results here are similar to a study in another tertiary facility in India [13]. Given that our facility is the only tertiary facility serving the healthcare needs of about 6 regions of the country, this is not uncommon. Most polytrauma will ultimately be referred to tertiary facilities because primary and secondary healthcare facilities do not have the required resources to manage their injuries. We noticed a high mean ISS of 40.6 ± 13.1 in this study. This is very high in comparison with other studies in the literature with average ISS from 26.7 to 37.2 [8, 13, 17]. This could mean that the polytrauma injuries in our environment are a result of very high energy with serious injuries, thereby requiring more human resources and equipment for adequate care.

Over the study period, a high mortality rate of 33% was recorded. This is exponentially higher in comparison with studies in Europe and Asia that reported mortality rates of

Table 7: Mean difference ISS scores and length of hospital stay with direct causes of deaths in polytrauma injuries.

Cause of death (I)	Cause of death (J)	Mean difference (MD) (I-J)	P value	95% confidence interval	
				Lower	Upper
Injury severity score (ISS)					
Traumatic brain injury (TBI)	Multiple organ failure (MOF)	2.740	1.000	−7.42	12.90
	Hemorrhage	−6.948	0.505	−19.24	5.34
Multiple organ failure (MOF)	Traumatic brain injury (TBI)	−2.740	1.000	−12.90	7.42
	Hemorrhage	−9.688	0.250	−23.25	3.88
Hemorrhage	Traumatic brain injury (TBI)	6.948	0.505	−5.34	19.24
	Multiple organ failure (MOF)	9.688	0.250	−3.88	23.25
Length of stay (days)					
Traumatic brain injury (TBI)	Multiple organ failure (MOF)	−3.169*	0.016	−5.86	−0.48
	Hemorrhage	3.042	0.074	−0.21	6.29
Multiple organ failure (MOF)	Traumatic brain injury (TBI)	3.169 *	0.016	0.48	5.86
	Hemorrhage	6.212 *	<0.01	2.62	9.80
Hemorrhage	Traumatic brain injury (TBI)	−3.042	0.074	−6.29	0.21
	Multiple organ failure (MOF)	−6.212*	<0.01	−9.80	−2.62

*Indicates the p values associated with the Mean difference are statistically significant.

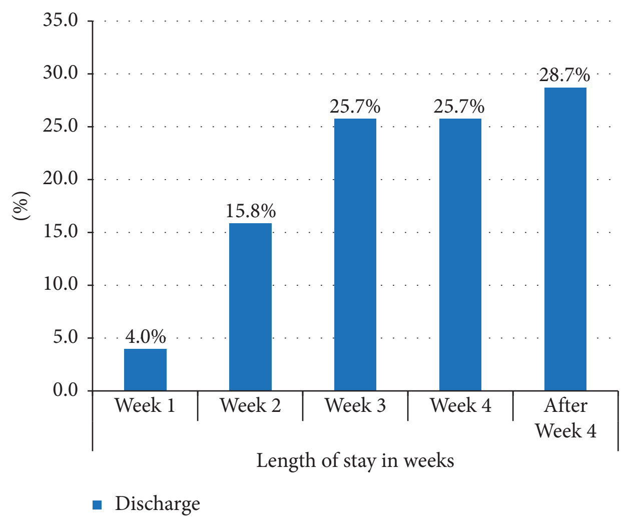

Figure 5: Relationship between discharges and length of hospital stay.

11-18.7% [1, 11, 12, 23, 30]. This high mortality rate rivals a study by Madane et al. [14] in Mali which recorded a mortality rate of 31% [9]. Another African study in a Nigerian tertiary hospital recorded a comparatively low mortality rate of 14%, but the mean ISS of that study was 37.2 ± 12.0 [23]. This indicates that the energy levels of injury in that study were relatively lower compared to ours (40.6 ± 13.1). The high mortality rate reflects a seemingly poor trauma care system. Notwithstanding, giant strides have been made over the years to improve the quality of care for trauma victims through the improvement of infrastructure and human resources. However, there is still room for improvement if gains are to be made to reduce the current mortality rate. TBI caused more than half of the mortalities in this study, followed by MOF and hemorrhage. Sepsis was the least common cause of death. TBI has been a major cause of death in polytrauma in many studies [31–33]. A systematic review by Van Breugel et al. [34] concluded that there is a decline in the overall mortality of polytrauma patients in the ICU. They also reported TBI as the most common cause of death in South America, Asia, and Europe, while MOF was the commonest in North America [35]. Van Wessem et al. [36] noticed a decline in MOF as a direct cause of mortality in polytrauma resulting in a reduction in the third peak of mortality. Hemorrhage contributed to a significant proportion of mortalities in this study. However, with the improvement in the usage of blood and blood products, death from hemorrhage has also been reduced in effective trauma care systems [37]. The use of red blood cells, plasma, and platelets in a 1 : 1:1 has been effective in securing hemostasis and reducing mortality among trauma patients [38]. TBI and hemorrhage together cause more than two-thirds of the mortality in this study; hence, efforts directed towards optimizing TBI management and improving blood and blood products services could significantly reduce the mortality rate in Northern Ghana.

Early trauma care research described a trimodal death distribution pattern with 3 peaks. The first is immediate death which occurs in the field and is a result of lethal injuries sustained by victims. The second is early death which occurs in the hospital as a result of hemorrhage when resuscitative efforts are not adequate or are delayed. The third is late death which occurs weeks after the injury, and it is mostly due to sepsis and multiple organ failure (MOF). However, with the improvement of trauma care systems in Western countries, modern-day mortality in trauma favors a bimodal distribution [36, 39]. This may be due to an in-depth understanding of trauma physiology, the use of quality antibiotics, and the improvement of critical care. A recent study in Ethiopia corroborates that trauma deaths from LMICs still follow the traditional trimodal death distribution [34]. Given the results presented in this study, our mortality pattern appears trimodal as well. This may suggest that trauma-related deaths still have a trimodal distribution in LMICs.

The morbidity among polytrauma participants is reflected in the length of hospital stay (LOS) of victims. In this study, very few participants (4.0%) were discharged in week 1, but most discharges happened after week 2 (80.1%). This connotes a prolonged hospital stay among polytrauma victims in Northern Ghana. Hamzawy et al. [21] in their study in Egypt reported a similar mean LOS but with a difference in the distribution of hospital stays [16]. Ghana has an ineffective national health insurance policy; hence, patients may have to pay out of pocket to supplement the cost of care if they do not have a private health insurance policy. For polytrauma patients, some definitive surgical interventions are withheld until patients can pay for the cost of such services. This may have contributed to the prolonged hospital stay or even mortality. The study found a statistically significant mean difference in length of stay between MOF and TBI and then between MOF and hemorrhage as direct causes of death. Thus, the length of stay of polytrauma patients with MOF was significantly longer than TBI and hemorrhage. Hence, with improved critical care management, some of these patients could be saved.

Extremity injuries are the most common injuries among polytrauma victims. The role of the orthopedic surgeon in trauma cannot be overemphasized. They play a key role in the restoration of the function of limbs to reduce DALYs among trauma victims. In this study, a total of 356 fractures were recorded. This gives nearly 2 fractures in each victim. About 7 out of 10 fractures were closed, and about two-thirds of them affected the lower limb. This agrees with findings reported by Kalsotra et al. [13] in Kashmir [8]. The tibia/fibula was the most fractured bone followed by radius/ulna and femur. The situation is the same in other studies within and outside Africa (14.23). A major limitation is that the study design does not allow for the predetermination of a sample size. Whilst this study may be generalized for the Ghanaian population, there is some limitation extrapolating it to the African subregion.

5. Conclusion

The prevalence and mortality for polytrauma in Northern Ghana were remarkably high. Road traffic accidents (RTA) were the most common cause of polytrauma in Northern Ghana. Traumatic brain injury (TBI) was the most common cause of mortality. We recommend a concerted multidisciplinary policy framework geared towards promoting road safety and reducing accidents in Ghana. We also recommend a tailored robust treatment algorithm for managing traumatic brain injury in our settings to reduce mortality thereof.

Appendix

A. Data Collection Tool

Title: Epidemiology of polytrauma in a low-resource tertiary hospital in Northern Ghana: A 2-year retrospective study.

B. Detailed Description of the Study Variables in the Data Collection Tool

(i) Age: recorded in years
(ii) Sex: male/female
(iii) Health insurance: yes/no
(iv) Mechanism of injury: road traffic accident (RTA)/falls from height/gunshots/gas explosion
(v) Referral status: brought in/referred
(vi) Time from injury to hospital (days): <24 hrs, >24 hrs
(vii) EXTREMITY INJURIES (with AIS scores for each bone): clavicle, humerus, radius/ulna, pelvis, femur, tibia/fibula
(viii) ASSOCIATED INJURIES (with AIS scores for each bone): brain, neck, spine, thorax, face, external, abdomen
(ix) PREDICTORS OF MORBIDITY AND MORTALITY:

- (a) ISS score:
- (b) Glasgow coma score (GCS): 15 (normal), 13-14 (mild brain injury), 9–12 (moderate brain injury), 5–8 (severe brain injury), ≤5 (critical brain injury)
- (c) Blood pressure (BP): <90/60 mmHg (low), 90–140/60–90 mmHg (normal), >140/90 mmHg (high)
- (d) Oxygen saturation (SPO_2): ≥92% (normal), <92% (low)
- (e) Anemia: normal hemoglobin (Hb) for males (13–16 g/dl), females (11–15 g/dl)
- (f) Date of admission (DOA)
- (g) Date of discharge (DOD)
- (h) Length of hospital stay (days): <1 week, >1 week

(x) Outcome: dead, discharge, discharge against medical advice, transferred

Data Availability

The data of this study will be made available on request.

Conflicts of Interest

All authors declare that they have no conflicts of interest.

Authors' Contributions

ASS and ADBB conceptualized the study and designed the study protocol. ASS retrieved and curated the data. Data were analyzed by ARA with inputs from ASS and ADBB. ASS drafted the manuscript. It was edited and reviewed by ADBB for academic content. All authors reviewed and accepted the final manuscript.

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References

[1] H. C. Pape, R. Lefering, N. Butcher et al., "The definition of polytrauma revisited: an international consensus process and proposal of the new Berlin definition," *Journal of Trauma and Acute Care Surgery*, vol. 77, no. 5, pp. 780–786, 2014.
[2] L. Moore, H. Champion, P. A. Tardif et al., "Impact of trauma system structure on injury outcomes: a systematic review and meta-analysis," *World Journal of Surgery*, vol. 42, no. 5, pp. 1327–1339, 2018.
[3] N. Dehouche, "The injury severity score: an operations perspective," *BMC Medical Research Methodology*, vol. 22, no. 1, pp. 48–16, 2022.
[4] M. Yadollahi, A. Kashkooe, R. Rezaiee, K. Jamali, and M. H. Niakan, "A comparative study of injury severity scales as predictors of mortality in trauma patients: which scale is the best?" *Bulletin of Emergency and Trauma*, vol. 8, no. 1, pp. 27–33, 2020.
[5] A. G. Rapsang and D. Chowlek, "Scoring systems of severity in patients with multiple trauma," *Cirugia Espanola*, vol. 93, no. 4, pp. 213–221, 2015.
[6] D. Xu, Y. L. Shi, P. Luo, and W. J. Guo, "Application status of the definition of polytrauma in clinical research-a review of the past decade," *Signa Vitae*, vol. 17, no. 3, pp. 42–46, 2021.
[7] L. Mica, K. Rufibach, M. Keel, and O. Trentz, "The risk of early mortality of polytrauma patients associated to ISS, NISS, Apache II values and prothrombin time," *Journal of Trauma Management and Outcomes*, vol. 7, no. 1, 2013.
[8] L. Mica, C. Keller, J. Vomela, M. J. Keel, O. Trentz, and M. Plecko, "The influence of body mass index on injury pattern in polytrauma: thorax as the main source of complications," *Global Epidemic Obesity*, vol. 1, no. 1, p. 3, 2013.
[9] G. Aksamija, A. Mulabdic, I. Rasic, S. Muhovic, and I. Gavric, "Evaluation of standardized and applied variables in predicting treatment outcomes of polytrauma patients," *Medicinski Arhiv*, vol. 65, no. 4, pp. 233–238, 2011.
[10] P. F. Stahel, C. E. Heyde, and W. Ertel, "Current concepts of polytrauma management," *European Journal of Trauma*, vol. 31, no. 3, pp. 200–211, 2005.
[11] F. Hildebrand, P. Giannoudis, C. Kretteck, and H. C. Pape, "Damage control: extremities," *Injury*, vol. 35, no. 7, pp. 678–689, 2004.
[12] R. F. McLain, "Functional outcomes after surgery for spinal fractures: return to work and activity," *Spine*, vol. 29, no. 4, pp. 470–477, 2004.
[13] N. Kalsotra, V. Mahajan, G. Kalsotra, S. Sharma, P. Raina, and A. Gupta, "Epidemiology of polytrauma in a tertiary care centre," *Journal of Evolution of Medical and Dental Sciences*, vol. 5, no. 47, pp. 3021–3025, 2016.
[14] D. T. Madane, M. M. Issa, A. Abdoulhamidou et al., "The polytraumatized in the emergency hosting service and the service of resuscitation gabriel toure Mali," *Surgical Science*, vol. 09, no. 04, pp. 157–163, 2018.
[15] C. S. Rau, S. C. Wu, P. J. Kuo et al., "Polytrauma defined by the new berlin definition: a validation test based on propensity-score matching approach," *International Journal of Environmental Research and Public Health*, vol. 14, no. 9, p. 1045, 2017.
[16] Z. Matar, "The clinical profile of polytrauma and management of abdominal trauma in A general hospital in the central region of the kingdom of Saudi arabia," *The Internet Journal of Surgery*, vol. 14, no. 2, pp. 1–5, 2007.
[17] N. Clement, D. Regina, and K. P. Abhilash, "A retrospective study on the profile and outcome of polytrauma in the emergency department," *Current Medical Issues*, vol. 16, no. 2, p. 56, 2018.
[18] P. Payal, G. Sonu, G. A. K, and V. Prachi, "Management of polytrauma patients in emergency department: an experience of a tertiary care health institution of northern India," *World Journal of Emergency Medicine*, vol. 4, no. 1, pp. 15–19, 2013.
[19] A. Rahman, M. Yanni, L. Cukovic, L. Herrebout, K. Krzyzewski, and Y. Sahakian, "Trends of emergency department visits for gunshot victims in the United States," *J Emerg Crit Care Med*, vol. 6, no. 0, 2022.
[20] P. J. Garcia, "Global burden of injuries: it is time to understand the data in order to intervene," 2020.
[21] M. M. A. Hamzawy, F. F. Adam, K. M. M. Balam, and H. M. A. Abubeih, *Hospital Stay, Morbidity, and Mortality in Polytrauma Patients at Trauma Unit*, Assiut University Hospital during 2017, Asyut, Egypt, 2021.
[22] G. O. Enweluzo, S. O. Giwa, and D. C. Obalum, "Pattern of extremity injuries in polytrauma in Lagos, Nigeria," *The Nigerian Postgraduate Medical Journal*, vol. 15, no. 1, pp. 6–9, 2008.
[23] M. Kotagal, K. J. Agarwal-Harding, C. Mock, R. Quansah, C. Arreola-Risa, and J. G. Meara, "Health and economic benefits of improved injury prevention and trauma care worldwide," *PLoS One*, vol. 9, no. 3, pp. e91862–e91868, 2014.
[24] N. I. Omoke and F. O. Ekumankama, "Incidence and pattern of extremity fractures seen in accident and emergency department of a Nigerian teaching hospital," *Nigerian Journal of Surgery*, vol. 26, no. 1, p. 28, 2020.
[25] J. F. A. Murphy, "The global burden of disease," *Irish Medical Journal*, vol. 106, no. 1, p. 1, 2013.
[26] L. Liu, F. Villavicencio, D. Yeung et al., "National, regional, and global causes of mortality in 5–19-year-olds from 2000 to 2019: a systematic analysis," *Lancet Global Health*, vol. 10, no. 3, pp. e337–e347, 2022.
[27] D. Adeloye, J. Y. Thompson, M. A. Akanbi et al., "The burden of road traffic crashes, injuries and deaths in Africa: a systematic review and meta-analysis," *Bulletin of the World Health Organization*, vol. 94, no. 7, pp. 510A–521A, 2016.

[28] A. Z. Mohammed, S. T. Edino, O. Ochicha, and A. B. Umar, "Epidemiology of gunshot injuries in Kano, Nigeria," *Nigerian Journal of Surgical Research*, vol. 7, no. 3, pp. 296–299, 2006.

[29] L. N. Bulto, Y. Dessie, and B. Geda, "Magnitude, causes and characteristics of trauma victims visiting emergency and surgical units of Dilchora Hospital, Eastern Ethiopia," *The Pan African Medical Journal*, vol. 30, pp. 177–7, 2018.

[30] F. Alberdi, I. García, L. Atutxa, M. Zabarte, and Neurointensive Care Work Group of the SEMICYUC, "Epidemiology of severe trauma," *Medicina Intensiva*, vol. 38, no. 9, pp. 580–588, 2014.

[31] P. K. Blankson, J. K. A. Amoako, K. Asah-Opoku, F. Odei-Ansong, and M. Y. Lartey, "Epidemiology of injuries presenting to the accident centre of Korle-Bu Teaching Hospital, Ghana," *BMC Emergency Medicine*, vol. 19, no. 1, pp. 39–46, 2019.

[32] O. M and U. S, "The conundrum of polytrauma in sokoto, north-west Nigeria," *Journal of Trauma and Treatment*, vol. 5, no. 2, 2016.

[33] D. C. Obalum, O. Enweluzo, and S. O. Giwa, "Morbidity and mortality associated with polytrauma at a Nigerian tertiary hospital," *West African Journal of Medicine*, vol. 27, no. 2, pp. 97–100, 2008.

[34] J. M. M. Van Breugel, M. J. S. Niemeyer, R. M. Houwert, R. H. H. Groenwold, L. P. H. Leenen, and K. J. P. Van Wessem, "Global changes in mortality rates in polytrauma patients admitted to the ICU-A systematic review," *World Journal of Emergency Surgery*, vol. 15, no. 1, pp. 1–13, 2020.

[35] N. D. Clement, C. Tennant, and C. Muwanga, "Polytrauma in the elderly: predictors of the cause and time of death," *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, vol. 18, no. 1, p. 26, 2010.

[36] K. J. P. Van Wessem and L. P. H. Leenen, "Reduction in mortality rates of postinjury multiple organ dysfunction syndrome: a shifting paradigm? A prospective population-based cohort study," *Shock*, vol. 49, no. 1, pp. 33–38, 2018.

[37] H. Rupprecht, H. J. Heppner, K. Wohlfart, and A. Türkoglu, "The geriatric polytrauma: risk profile and prognostic factors," *Ulusal Travma ve Acil Cerrahi Dergisi*, vol. 23, no. 2, pp. 156–162, 2017.

[38] R. Pfeifer, I. S. Tarkin, B. Rocos, and H. C. Pape, "Patterns of mortality and causes of death in polytrauma patients--has anything changed?" *Injury*, vol. 40, no. 9, pp. 907–911, 2009.

[39] J. A. Evans, K. J. P. Van Wessem, D. McDougall, K. A. Lee, T. Lyons, and Z. J. Balogh, "Epidemiology of traumatic deaths: comprehensive population-based assessment," *World Journal of Surgery*, vol. 34, no. 1, pp. 158–163, 2009.