

ORIGINAL ARTICLE

Incidence of Traumatic Brain Injury in a Ghanaian Tertiary Hospital

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Traumatic brain injury (TBI) is considered as one of the most silent epidemics and its incidence is rising worldwide due to injuries associated with the increased use of motor vehicles and bad road network, particularly in middle-income and low-income countries including Ghana. The aim of this study was to assess the incidence of TBI, cause of injury as well as outcomes of patient's care in the Tamale Teaching Hospital in Ghana. This retrospective study was carried out at the Tamale Teaching Hospital, the only Tertiary referral hospital in the whole of the savanna ecological zone of Ghana over 43 months from January 2009 to July 2012. All patients admitted into the hospital and diagnosed as having TBI were included in the study. The medical records of a total of 671 patients who were diagnosed with TBI were reviewed. Information regarding the age, sex, occupation and initial external cause of injury was retrieved. Data regarding length of hospital stay and treatment outcome were also retrieved. External cause of injury was classified according to International Classification of Diseases (ICD) guidelines as Road Traffic Accidents (RTA) (irrespective of type), fall from height, assault, gunshot, game or sport related accident and other causes. Road traffic accident accounts for relatively high incidence of hospitalized TBI. Majority of the patients were male within the 21-30 year age group. The high number of Intensive Care Unit (ICU) fatalities may indicate that more resources and facilities (intensive care nurses and equipment to monitor intracranial pressure) are needed to help in the management of cases particularly head injuries.

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INTRODUCTION

Traumatic brain injury (TBI) has been defined as damage to brain tissue caused by external mechanical force. This is usually evidenced by: loss of consciousness due to brain trauma, or post traumatic amnesia, or skull fracture, or objective neurological findings that can be reasonably attributed to TBI on the initial physical or mental status examinations (Nestvold *et al.*, 1988). Worldwide TBI is said to be a very serious public health and socio-economic problem and a major cause of death and lifelong disability especially among young adults. Studies have shown that the prevalence of TBI varies from different geographical locations (Nestvold *et al.*, 1988). In the USA, it is estimated that more than

5 million people suffer some form of TBI resulting in disabilities. In Europe it is estimated that there is an average incidence of 235 per 100,000, with most countries experiencing an incidence in the range of 150–300 / 100,000 per year (Tagliaferri *et al.*, 2006).

TBI commonly leads to neurocognitive deficits (such as impaired attention, inability to form visuospatial associations, or poor executive function) and psychological health issues. Research has shown that about 30–70% of TBI survivors develop depression and are more likely to exhibit increased impulsivity, poor decision making and impulsive aggressive behavior (Roozenbeek *et al.*, 2013). These types of impairments can affect interpersonal relationships and contribute to poor community, social and vocational integration and require long term placement in an institutional setting (Roozenbeek *et al.*, 2013).

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TBI is considered as one of the most silent epidemics because society is largely unaware of the magnitude of this problem. The incidence of TBI worldwide is rising, mainly owing to injuries associated with the increased use of motor vehicles and bad road network, particularly in middle-income and low-income countries including Ghana. The number of patients admitted and treated in hospital is said to be an indicator of the impact of local injuries on the already merger hospital resources in these countries. The injury mechanism of TBI is also highly varied. In Europe and in the United States of America falls are the leading causes of TBI hospitalization (Ingebrigtsen *et al.*, 2000; Hukkelhoven *et al.*, 2002; Tagliaferri *et al.*, 2006). However traffic related accident continue to be the main cause of injuries including TBI in the rest of the world especially in developing countries (Jennett *et al.*, 1977; Hukkelhoven *et al.*, 2002; Langlois *et al.*, 2006).

Variability in both diagnostic criteria and case ascertainment in TBI makes it difficult for the estimation of incidence and confounds comparison between different studies. However, studies have shown that epidemiological patterns of TBI are changing and the need for research in this area is ever more pressing so as to implement more effective injury prevention and treatment programmes in our hospitals. To the best of our knowledge there has not been any study on the incidence and causes of TBI in Ghana. The aim of this study was to assess the incidence of TBI, cause of injury as well as outcomes of patient's care in the Tamale Teaching Hospital in Ghana.

PATIENTS AND METHODS

Study design and setting

This retrospective study was carried out at the Tamale Teaching Hospital which is the only Tertiary referral hospital in the whole of the savanna ecological zone of Ghana. This zone include Northern Region, Upper East, Upper West and some parts of northern Volta and Brong Ahafo regions of Ghana. The hospital also received cases from neighbouring countries like Burkina Faso, Mali and Northern part of Togo. The study covered 43 months from January 2009 to July 2012.

Subjects and Data collection

In this study TBI was defined as damage to brain tissue caused by external mechanical force as evidenced by: loss of consciousness due to brain trauma, or posttraumatic amnesia, or skull fracture, or objective neurological findings that can be reasonably attributed to TBI on the initial physical or mental status examinations (Nestvold *et al.*, 1988).

All patients admitted into the hospital and diagnosed as having TBI were included in the study. The medical records of a total of 671 patients who were diagnosed with TBI were reviewed. Information regarding the age, sex, occupation and initial external cause of injury was retrieved. Data regarding length of hospital stay and treatment outcome were also retrieved. External cause of injury was classified according to International Classification of Diseases (ICD) guidelines as Road Traffic Accidents (RTA) (irrespective of type), fall from height, assault, gunshot, game or sport related accident and other causes. Other causes included those who had sustained head injury from collapse of buildings or those hit in the head with objects.

Ethical consent

This retrospective study was approved by the Committee on Human Research, Publication and Ethics (CHRPE) of the Tamale Teaching Hospital Tamale, Ghana.

Data management and analysis

Patient's information was made anonymous and de-identified prior to entering the data for analysis. Categorical variables were displayed as frequencies and proportions and compared using Chi-Square or Fisher's exact test. Continuous variables (Patient age) was reported as mean \pm SD. In all statistical tests, a value of $P < 0.05$ was considered significant. All statistical analysis was performed using Systat for Windows, Version 11.0, (Systat Software, Erkrath, Germany; www.systat.com).

RESULTS

The records of 671 patients who met the inclusion criteria, 565 (84.20%) male and 106 (15.80%) female were review over 43 month period from Janu-

ary 2009 to July 2012. The mean age of the study patients was 28.17 ± 16.49 years (Mean \pm SD). The incidence of TBI stratified by age, gender and occupation is shown in table 1. Children ages 0-10 years constituted about 14.0% of the study population with adult above 60 years constituting about 5.51%. The highest incidence of TBI occurred among patients within 21-30 years age bracket with a rate of 29.66% followed by those between 11-20 years with 19.67%.

The highest occupation specific TBI incidence was among unemployed individuals constituting 25.04% (168) follow by farmers with 21.46% (144 patients). About 14.0% of the patients were students of which 11.92% (80) were male and 2.39% (16) were female. The general male:female ratio is 5.3:1.0. The male specific incidence of TBI was highest in the age bracket of 21-30 years with 17.42% while that of female was within 0-10 years with 3.87%.

Table 1: Socio-demographic characteristics of patients

VARIABLE	Total N (%)	Male N (%)	Female N (%)
Age			
0-10	94 (14.00)	68 (10.13)	26 (3.87)
11-20	132 (19.67)	108 (16.10)	24 (3.57)
21-30	199 (29.66)	184 (27.42)	15 (2.24)
31-40	125 (18.63)	106 (15.80)	19 (2.83)
41-50	59 (8.79)	46 (6.86)	13 (1.94)
51-60	25 (3.73)	21 (3.13)	4 (0.60)
>60	37 (5.51)	32 (4.77)	5 (0.75)
OCCUPATION			
Unemployed	168 (25.04)	134 (19.97)	34 (5.07)
Self employed	8 (1.19)	7 (1.04)	1 (0.15)
Civil servant	48 (7.15)	44 (6.56)	4 (0.60)
Trader	65 (9.68)	47 (7.00)	18 (2.68)
Farmer	144 (21.46)	132 (19.67)	12 (1.79)
Driver	15 (2.24)	15 (2.24)	0 (0.00)
Children	84 (12.52)	61 (9.09)	23 (3.43)
Student	96 (14.31)	80 (11.92)	16 (2.39)
Artisan	39 (5.81)	39 (5.81)	0 (0.00)
Others	4 (0.60)	3 (0.45)	1 (0.15)

Figure 1 shows the incidence of TBI cases stratified by months over the study period. The incidence of TBI hospitalization showed a monthly variation throughout the study. There was a general increase

in the number of TBI hospitalization starting from February (a total of 44 cases) and peaking in May with a total of 101 cases. The numbers of cases dropped in June and started to rise again in July through to November. July, December and January recorded the lowest number of TBI hospitalization over the study period as shown in figure 1.

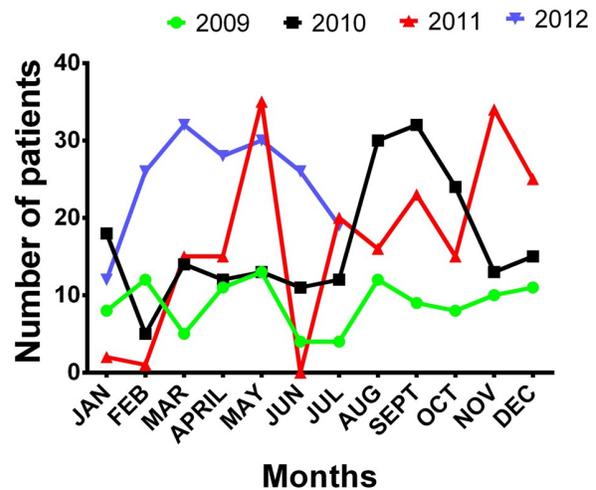


Figure 1: Monthly incidence of TBI cases over the study period

Over the study period there was a rise in the number of TBI hospitalization from 2009 to 2011. In 2009 a total of 101 TBI cases were recorded with 85 male and 16 female. This number increased to 196 in 2010 comprising of 164 males and 32 female representing a 95.1% increase. In 2011 the number of TBI hospitalization remained very high at 197 cases per year. It is worth mentioning that data for 2012 was just for the first seven months of the year and the number of TBI case recorded for 2012 was 177 as shown in Figure 2.

When the external mechanism of injury was analyzed, road traffic related accidents was the highest cause of TBI occurring in over 90% of the patients, followed by fall from height with 3.43% and assault (2.24%). Gunshot accounted for 2.09% of the causes of TBI with game related and other causes of injury occurring in 0.30% and 0.75% of the patients respectively as shown in Table 2. The cause of injury varied with respect to the occupation of the pa-

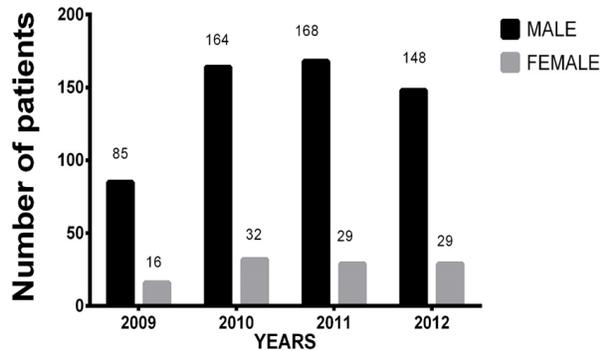


Figure 2: Gender incidence of TBI cases over the study period

tients. The highest incidence of TBI hospitalization associated with RTA occurred among the unemployed (26.47 %) and among children (26.00%) followed by farmers (21.57%) and traders (9.80%) (Table 3). Fall from height occurred mostly among farmers and children accounting for about 39.13% and 30.43% respectively. Assault cases were also highest among children (46.67%) and traders (20.00%). Gunshot injuries were predominantly among children who accounted for over 70.00% of all gunshot related cases as shown in Table 3.

Mechanism of injury varied with age as shown in table 4. The incidence of assault was highest in the age group of 11-20 years and 21-30 years. Fall from height was commonest in the age group of 31-40 years and 0-10 years. The incidence of TBI hospitalization as a result of gunshot was highest among the

Table 2: Initial cause of injury

Case	N	%
Assault	15	2.24
Fall from height	23	3.43
Playing game	2	0.30
Gunshot	14	2.09
RTA	612	91.21
Others	5	0.75

under 20 years. Road traffic accidents were the most common causes of TBI in the age group of 21-30 years followed by 11-20 years group as shown in Table 4.

Case fatality

Seventy six patients died due to TBI hospitalization during the study period constituting about 11.3% of all cases. More than half of this death occurred in ICU. The injury mechanism of over 90% of the deceased patients was through RTA. The rest of the deaths had gunshot and fall from height as the injury mechanism. The mean age of the deceased patients was 34.0 ± 20.69 (mean \pm SD). The median age was 30.0 years, 25% percentile, 22.00 and 75% percentile as 43.75. The age range was 2 – 90 years. Of those who died, 36.84% were unemployed, 26.32% were farmers and about 17.10% were students.

DISCUSSION

The study revealed that TBI mostly affects young unemployed males between the ages of 21–30 years

Table 3: Mechanism of injury stratified by occupation

Occupation	Assault N = 15	Fall from height N = 23	Playing game N = 2	Gunshot N = 14	Rta N = 612	Others 5
Unemployed	2 (6.67)	4 (17.39)	0 (0.00)	0 (0.00)	162 (26.47)	0 (0.00)
Self-employed	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Civil servant	0 (0.00)	1 (4.35)	0 (0.00)	1 (7.14)	45 (7.35)	1 (20.00)
Trader	3 (20.00)	0 (0.00)	0 (0.00)	1 (7.14)	60 (9.80)	1 (20.00)
Farmer	2 (13.33)	9 (39.13)	0 (0.00)	1 (7.14)	132 (21.57)	0 (0.00)
Driver	1 (6.67)	0 (0.00)	0 (0.00)	1 (7.14)	13 (2.12)	0 (0.00)
Artisan	0 (0.00)	2 (8.70)	1 (50.00)	0 (0.00)	36 (5.88)	0 (0.00)
Others	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (0.49)	0 (0.00)
Children	7 (46.67)	7 (30.43)	1 (50.00)	10 (71.43)	161 (26.30)	3 (60.00)

Table 4: Mechanism of injury stratified by age

Age	Assault N = 15	Fall from height N = 23	Playing game N = 2	Gunshot N = 14	RTA N = 612	Others N = 5
0-10	0 (0.00)	6 (26.09)	0 (0.00)	3 (21.43)	84 (13.73)	1 (20.00)
11-20	5 (33.33)	5 (21.74)	1 (50.00)	6 (42.86)	114 (18.63)	1 (20.00)
21-30	5 (33.33)	1 (4.35)	1 (50.0)	1 (7.14)	189 (30.88)	2 (40.00)
31-40	4 (26.67)	9 (39.13)	0 (0.00)	1 (7.14)	111 (18.14)	0 (0.00)
41-50	1 (6.67)	1 (4.35)	0 (0.00)	0 (0.00)	56 (9.15)	1 (20.00)
51-60	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	25 (4.08)	0 (0.00)
>60	0 (0.00)	1 (4.35)	0 (0.00)	3 (21.43)	33 (5.39)	0 (0.00)

with a mean age of 28.17 years with a male to female ratio of 5:1. The second highest affected age group was patient's age 20 years and below constituting about 20% of the overall study population. This finding is similar to previous findings in several countries which showed that TBI are most common among the most economically active group in a population (Masson *et al.*, 2001; Tennant, 2005; Rosso *et al.*, 2007). The fact that head injury or TBI affects a predominately younger population carries with it a high potential economic impact.

Studies have shown that most of the people who are affected and are in active employment are not able to return to their jobs after treatment (Thornhill *et al.*, 2000; Haboubi *et al.*, 2001). Other studies have indicated that TBI shows a bimodal occurrence among children age 0-14 years and among the elderly above 70 years (Hyder *et al.*, 2007; Andelic *et al.*, 2008). Even though the present study showed a higher number of children being affected, the number of elderly people was very low. The difference could be due to that fact most of these studies were done in Western countries which has different population dynamics and the cause of injuries also differ depending on the locations as stated by (Tagliaferri *et al.*, 2006; Roozenbeek *et al.*, 2013).

The most common mechanism of injury as a direct cause of TBI was transport related accident accounting for over 90% of the cases followed by fall from height, assault and gun shot. Stratification of injury mechanism by age showed that road traffic accidents was highest among middle age group (21-30 years)

and adolescent (11-20 years). It was also the most common cause of injury among farmers and the unemployed. However assault, fall from height and gunshots affected mainly those 20 years and below. The finding of this study is in contrast to most studies with respect to the mechanism of injury. In most studies from European countries and the USA, the most common cause of TBI is fall rather than transport accidents and assault.

According to Andelic *et al.*, (2008) transport accidents as a cause of TBI decreased in Norway from 58% in 1974 (Edna and Cappelen, 1984) to 21% in 1993 (Ingebrigtsen *et al.*, 1998) in accordance with several international studies. In most epidemiological studies across Europe and America transport related accidents as a cause of TBI is very low. These findings according to some researchers may reflect the effectiveness of preventive efforts in these countries, such as better road standards, safer cars, speed and blood alcohol concentration limits, use of helmets and safety belts (Edna and Cappelen, 1984; Thornhill *et al.*, 2000; Andersson *et al.*, 2003; Tennant, 2005; Tagliaferri *et al.*, 2006; Andelic *et al.*, 2008).

In Northern Ghana the most common means of transport is motor cycles and tricycles usually driven by unqualified individuals usually without helmet on very terrible road network. Studies have showed that road traffic accidents were a leading cause of death and injuries, and that majority of road traffic fatalities and injuries occurred on roads in rural areas leading to very high medical cost and

loss of productivity (Afukaar, 2003; Ackaah and Afukaar, 2010; Afukaar *et al.*, 2010; Kudebong *et al.*, 2011). The present study has again showed that most of the victims of these RTA were farmers and traders. The major occupation of the people of northern Ghana is peasant farming. These farmers usually travel to their farms either by motor cycles or cargo trucks. These old trucks usually also carry fire wood or food stuff at the same time and this leads to high fatality whenever there is an accident and may explain why majority of the patients who were farmers had TBI as a result of RTA.

The high number of falls and assault recorded among children may be reflection of a high mobility and orientation problems in children which might increase the risk of falling in this group (Edna and Cappelen, 1984; Andelic *et al.*, 2008). In order to curb this, proper fall preventive strategies are needed and families of infants and young children must be educated to pay more attention to the outdoor activities of their children.

There was a general increase in the number of TBI hospitalization from the year 2009 to 2011. This could be due to the fact that the hospital had its first neurosurgeon in 2009. Prior to this all head injury cases were refer to Komfo Anokye Teaching Hospital in Kumasi and the Korle Bu Teaching hospital in Accra. Another reason could be attributable to the introduction of tricycle as a means of transportation around this same period. This tricycles were meant to carry only goods but it is now being used to transport people as well and this has resulted in a number of serious accidents. Accident preventive measures such as the use of helmet can help reduce the rate of head injuries associated with these tricycles. A study by Chiu *et al.* (2000) in Taiwan, has shown that implementation of the motorcycle helmet law decreased the incidence of motorcycle-related TBI by 33%.

The number of TBI hospitalization exhibited a seasonal variation with the rate increasing from February to May and also from August to November with majority of the cases coming in as a result of RTA. December to January recorded the lowest number of

TBI hospitalizations. This variation in TBI rates may be connected to the climatic variation in northern Ghana which has two main seasons; wet season which runs from May to October and the dry season from November to April. December and January usually record the lowest temperatures due to the strong cold Harmattan winds. There is usually no farming activities from the end of February to May and the people are usually engage in activities such as communal hunting and the performance of funeral rites which involves the use of local manufactured guns and travelling from one place to the other usually by cargo trucks which are usually prone to accidents with high fatalities. This may explain the higher numbers of TBI hospitalization around this period.

The case fatality rate in this study was relatively low at about 11%. However, it is worth noting that over 90% of the fatality were patients with TBI due to road traffic accidents and that these deaths were all ICU deaths. Several studies have reported a steady declined in TBI mortality over the last two decades in several develop countries and this has been attributed to factors such as a reduction in vehicular accidents and an increase use of seat belt among drivers and improvement in the emergency response system in these countries. However, in this part of the country emergency response systems are not in existence and even where they exist they are not effective.

Victims of motor accidents are normally carried to hospital on motor bikes and public transport by untrained individuals which may exacerbate the injury situation especially in traumatic head injury cases leading to more fatalities. The management of patients with severe TBI has several important elements that includes adequate pre-hospital care, rapid transport to a specialized Centre, complex in-hospital care and rehabilitation. According to Hyder *et al.* (2007) middle income countries such as ours face a higher preponderance of risk factors for cases of TBI and have inadequately prepared health systems to address the associated health outcomes?. It is thus imperative for all involved to put in place these measures to help reduce further the fatality

rate of patients with head injury.

CONCLUSION

The finding of this study revealed a relatively high incidence of TBI hospitalization with road traffic accidents considered the most common external cause of TBI and the great majority of the patients were males within the 21-30 year age group. The high number of ICU fatalities may indicate that more resources and facilities (intensive care nurses and equipment to monitor intracranial pressure) are needed to help in the management of cases particularly head injuries. There is also the need for multi-disciplinary in-patient management to help reduce complications and the effective implementation of the guidelines for the management of TBI cases is now more urgent. The study also shows that road safety and accident preventive measures are a must if the rate of head injuries are to reduce.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

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