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A STUDY OF DEMOGRAPHIC PROFILE AMONG PATIENTS WITH TRAUMATIC BRAIN INJURY

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ABSTRACT
Background
Traumatic brain injury remains a significant public health challenge with varying patterns of injury and outcomes depending on the severity and type of trauma. Surgical decompression is a critical intervention aimed at reducing intracranial pressure and improving patient outcomes. This study investigated demographic profiles and outcomes among patients with traumatic brain injury.
Methods
This was a prospective observational study wherein the type of traumatic brain injury was noted down, data was analyzed, and the patterns of different traumatic brain injuries were assessed based on gender, age group, and the relation to outcome assessed.
Results
A total of 336 patients were assessed. Subdural hemorrhage was found to be most common in the general population, with an incidence of 37 %. Patients in the 0-20 age group were more frequently affected by DAI (Diffuse Axonal Injury) and EDH (Epidural Hematoma), while SDH (Subdural Hematoma) is more prevalent in the 41-60 age group. Male patients are more frequently affected by all types of TBI compared to female patients. The p-value of 0.001 indicates a statistically significant result. The p-value of 0.285 indicated that there was no statistically significant difference between genders in survival rates.
Conclusion
Younger patients were more frequently affected by DAI and EDH, while SDH was more prevalent in middle-aged individuals. The type of injury was not uniformly distributed across age groups, highlighting the need for age-specific management strategies. Males were more commonly affected by all types of TBI compared to females. Outcome was affected by age, but not gender.

Keywords: Traumatic Brain Injury, Demographic Profile.

INTRODUCTION

"Traumatic Brain Injury" is a significant public health issue worldwide, with profound medical, social, and economic implications. It is one of the leading causes of morbidity, mortality, and disability, particularly among young adults. The WHO (World Health Organization) estimates that TBI will become the third leading cause of global disease burden by 2030, largely due to the increasing incidence of road traffic accidents, falls, and violence. TBI is a complex injury with a broad spectrum of symptoms and disabilities, ranging from mild concussion to severe, life-threatening conditions. The consequences of TBI can be devastating, leading to long-term cognitive, physical, and emotional impairments, which not only affect the patients but also place a substantial burden on their families and the healthcare system.[1]

Despite significant advances in the surgical management of TBI, several challenges persist. The heterogeneity of TBI patterns, the unpredictability of secondary injury processes, and the variability in patient responses make it difficult to develop universal treatment guidelines. Moreover, the decision to perform surgical decompression is often influenced by factors such as the availability of neurosurgical expertise, resources, and accessibility. The patient's demographic status also leads to disparities in care and outcomes. This study was therefore carried out to assess the demographic profile of patients with traumatic brain injury and its influence on the outcome.

MATERIALS & METHODS

This was a prospective observational study conducted over a period of one year involving 336 patients older than 12 years of age who were admitted with traumatic head injuries and were willing to give consent to participate in the study. Institutional Research committee and Human Ethics committee approval were obtained. For patients with a low GCS (Glasgow Coma Scale) score, consent was obtained from a first-degree relative. Patients from whom consent could not be obtained were excluded. Each patient was clinically assessed and managed according to the ABC protocol. After stabilizing the patient, sociodemographic data, including age and sex, data pertaining to the mechanism of trauma and related injuries were also collected. A CT scan of the head was performed as part of the secondary survey to assess the type of traumatic brain injury. Quantitative variables were expressed as proportions, while qualitative variables were expressed as means and standard deviations. The data collected were entered into Excel sheets and analyzed using SPSS 27 software.

RESULTS

DAI predominantly affected younger individuals, with 37.1% of cases occurring in the 0-20 age group, sharply decreasing in older age groups. This contrasts with **EDH**, which showed a significant prevalence in the 0-20 age group (49.1%) but is notably absent in the 81-90 age group. **IPH (Intracerebral Hemorrhage)** exhibited a more balanced distribution across age groups, though it is slightly more common in the 41-60 age range (29.3%). **SAH (Subarachnoid Hemorrhage)** also showed a relatively even distribution, with a slight decrease in the 81-90 age group. Finally, **SDH** was most common in the 41-60 age range (48.0%) and less prevalent in younger and older age groups. There was a significant age-related variation in the type of TBI, with a p-value of .003 indicating a statistically significant association between age and the type of "traumatic brain injury."

Type of TBI	0-20	21-40	41-60	61-80	81-90	Total
DAI	13(37.1%)	7(20.0%)	9 (25.7%)	5(14.3%)	1(2.9%)	35(100.0%)
EDH	26(49.1%)	7(13.2%)	11(20.8%)	9(17.0%)	0(0.0%)	53(100.0%)
IPH	20(26.7%)	13(17.3%)	22(29.3%)	17(22.7%)	3(4.0%)	75(100.0%)
SAH	13(26.0%)	11(22.0%)	14(28.0%)	12(24.0%)	0(0.0%)	50(100.0%)
SDH	19(15.4%)	23(18.7%)	59(48.0%)	18(14.6%)	4(3.3%)	123(100.0%)
Total	91(27.1%)	61(18.2%)	115(34.2%)	61(18.2%)	8(2.4%)	336(100.0%)
P-Value						**.003**

Table 1: Age Group and Type of TBI Wise Distribution

Male patients are more frequently affected by all types of TBI compared to female patients. Specifically, **DAI** was seen in 74.3% of males and 25.7% of females. **EDH** followed a similar pattern, with 71.7% of cases in males and 28.3% in females. **IPH** also showed a predominance in males (73.3%) compared to females (26.7%). **SAH** was observed in 64.0% of males and 36.0% of females. **SDH**, the most common type of TBI in the sample, affected 66.7% of males and 33.3% of females.

Overall, males constituted a higher percentage of TBI cases across all types, with a total of 69.3% males versus 30.7% females. However, the p-value of 0.701 suggested that there is no statistically significant gender difference in the type of "traumatic brain injury."

Type of TBI	Male	Female	Total
DAI	26 (74.3%)	9 (25.7%)	35 (100.0%)
EDH	38 (71.7%)	15 (28.3%)	53 (100.0%)
IPH	55 (73.3%)	20 (26.7%)	75 (100.0%)
SAH	32 (64.0%)	18 (36.0%)	50 (100.0%)
SDH	82 (66.7%)	41 (33.3%)	123 (100.0%)
Total	233 (69.3%)	103 (30.7%)	336 (100.0%)
P-Value			**.701**

Table 2: Gender and Type of TBI-Wise Distribution

"GCS score" 3 was more common in younger patients, with 19.4% in both the 0-20 and 21-40 age groups, and was less frequent in older age groups. **"GCS score" 4** shows a relatively even distribution but was notably higher in the 0-20 age group (30.4%) and lower in the 21-40 age group (4.3%). **"GCS score" 5** was observed most frequently, particularly in the 0-20 age group (28.9%) and the 41-60 age group (34.9%). **"GCS score" 6** was distributed across all age groups with no cases in the 81-90 age group. **"GCS score" 7** and **"GCS score" 8** both showed a relatively even distribution across age groups, though "GCS score" 8 was absent in the 81-90 age group.
Overall, the distribution of pre-operative GCS scores appears relatively balanced across different age groups, with no significant age-related patterns. The p-value of 0.535 suggests that there is no statistically significant association between age group and preoperative "GCS scores.

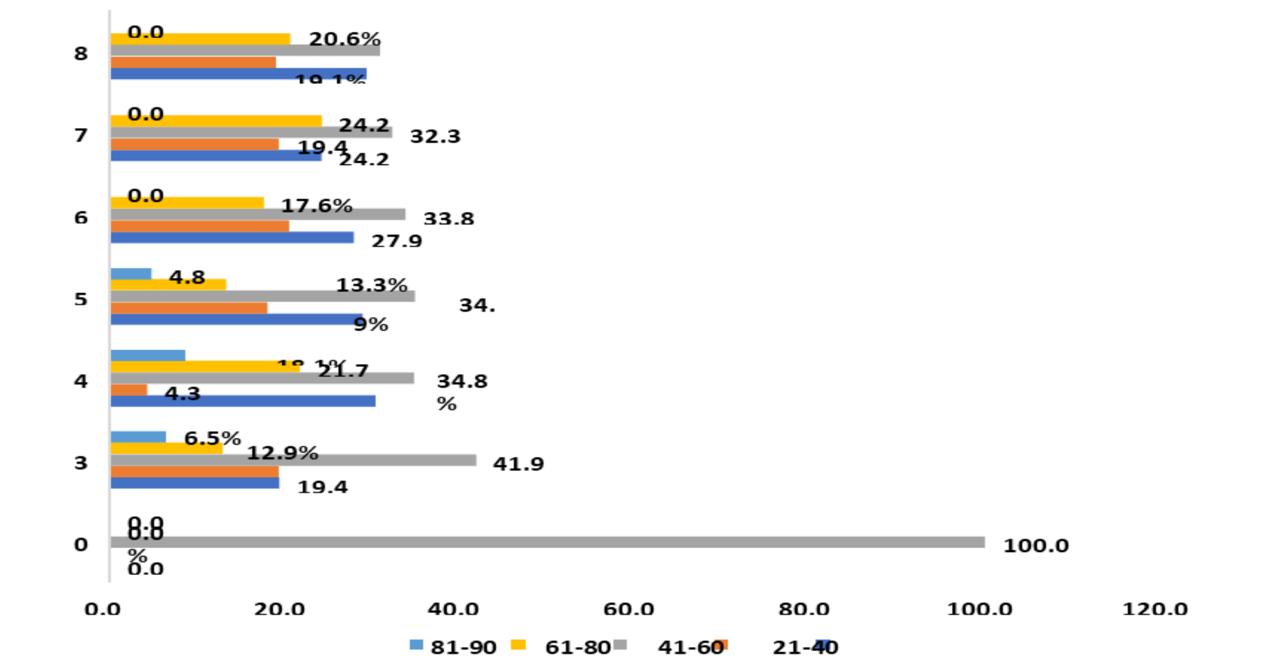

Figure 1: Age Group and Pre-Operative GCS-Wise Distribution

"GCS score" 3 was predominantly found in males (74.2%) compared to females (25.8%). **"GCS score" 4** showed a similar trend, with a higher prevalence in males (82.6%) compared to females (17.4%). **"GCS score" 5** was the most common overall, with 68.7% of cases in males and 31.3% in females. **"GCS score" 6 was** observed in 76.5% of males and 23.5% of females. **"GCS score" 7** and **"GCS score" 8** both showed a higher prevalence in males, with 61.3% and 64.7%, respectively, compared to females (38.7% and 35.3%).
Overall, males represented a larger proportion of cases, with a total of 69.3% males compared to 30.7% females. The p-value of 0.189 indicated that there is no statistically significant association between gender and pre-operative GCS scores.

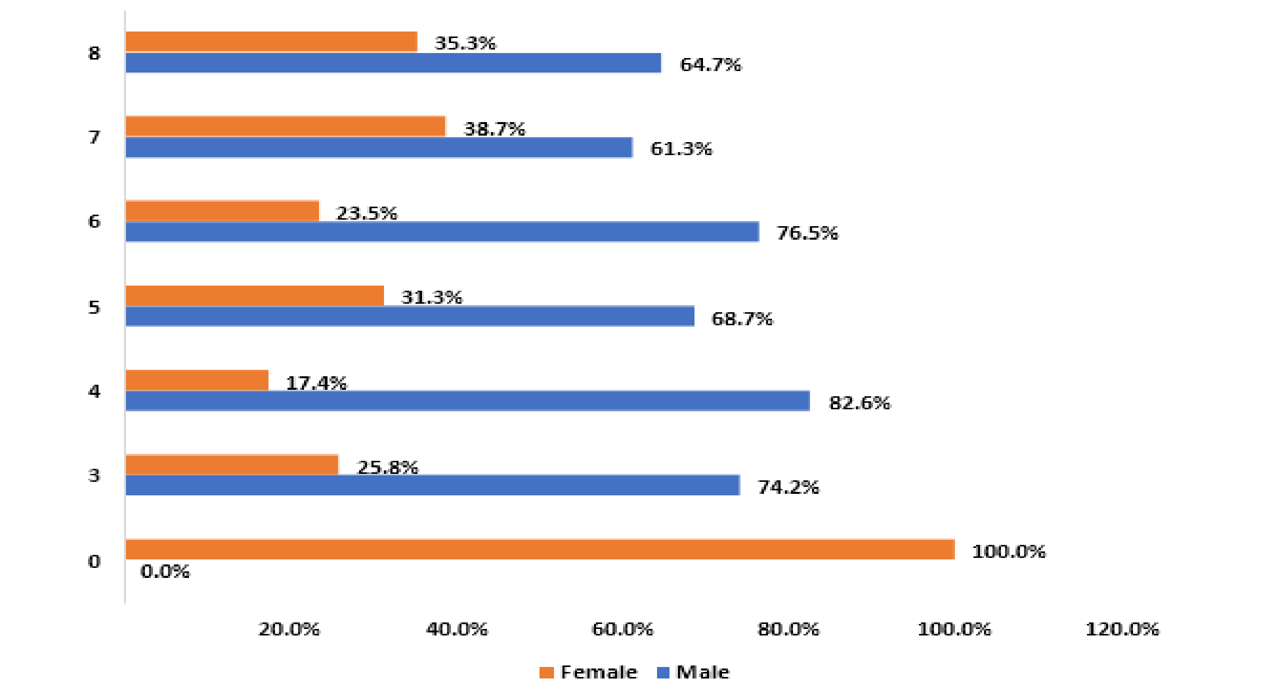

Figure 2: Gender and Pre-Operative GCS-Wise Distribution

The p-value of 0.628 suggests that there was no statistically significant association between age group and GCS scores post 72 hours. While males consistently showed higher proportions in most GCS categories, the difference in GCS scores post 72 hours by gender was not statistically significant, with a p-value of 0.061 indicating a trend but no strong evidence of gender-based differences in recovery outcomes.

Survival rates were highest in the 41-60 age group and lowest in the 81-90 age group, with significant differences across age groups. The p-value of 0.001 indicated a statistically significant association between age and outcome, suggesting that age plays a critical role in survival following "traumatic brain injury."

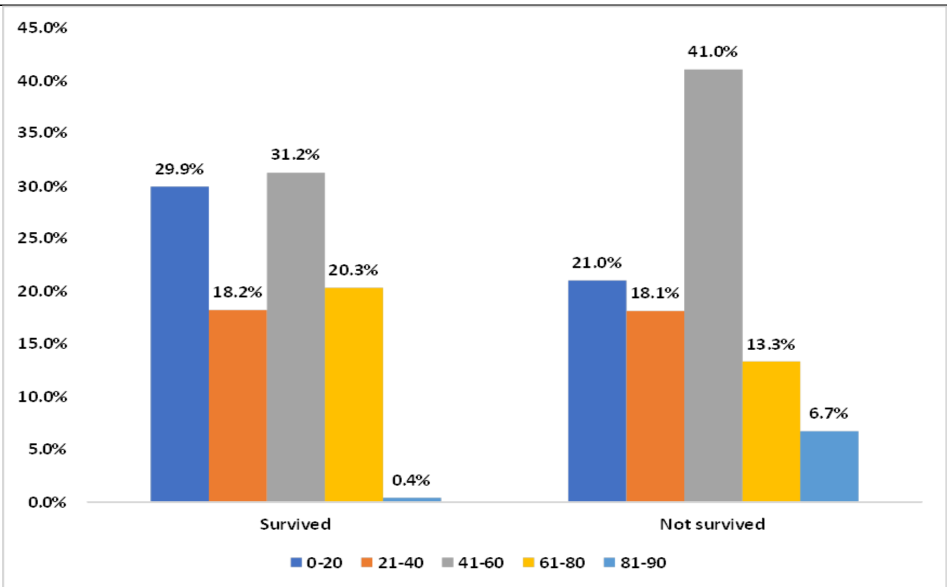

Figure 3: Age Group and Outcome-Wise Distribution

Although males accounted for a larger proportion of both survival and non-survival groups, a p-value of 0.285 indicated that there was no statistically significant difference between genders in terms of survival rates following "traumatic brain injury," suggesting that gender does not have a strong impact on survival outcomes in this sample.

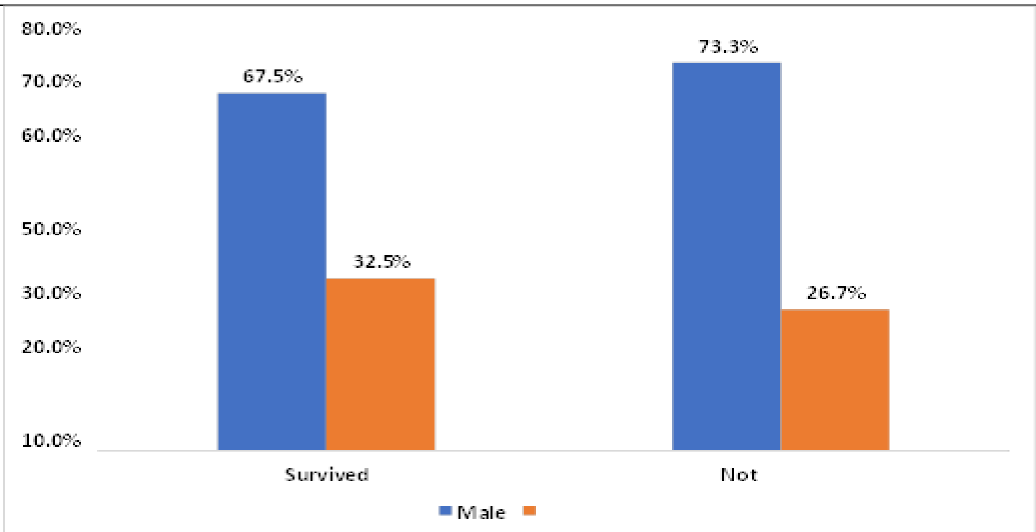

Figure 4: Gender and Outcome-Wise Distribution

DISCUSSION

Age Group and Type of TBI

Our study revealed age-related variations in the types of TBI and survival outcomes, aligning with the findings of Faul et al., where TBI incidence was notably high in children aged 0–4 years, adolescents aged 15–19 years, and the elderly aged 65 years and older. In our study, DAI was most prevalent in the 0-20 age group, which overlaps with the age range identified by Faul et al. Similarly, the high occurrence of EDH in this young age group aligns with the increased risk in adolescents, as reported by Faul et al.,[2] However, our study adds nuance by showing that certain types of TBI, such as SDH, are more common in middle-aged adults (41-60 years), a group not specifically highlighted by Faul et al. This suggests that while the younger and older populations are at higher overall risk for TBI, the type and severity of TBI can vary significantly within different age groups.[2]

The low survival rate observed in the 81-90 age group in our study is consistent with the higher vulnerability of the elderly, as discussed by Faul et al. The statistically significant association between age and TBI outcomes (p = 0.001) further emphasizes the critical role of age in determining both the type of injury sustained and the likelihood of survival.[2]

While our findings generally support the age distribution trends reported by Faul et al., they also underscore the importance of considering age-specific patterns in TBI types and outcomes. This highlights the need for targeted prevention strategies and age-appropriate medical interventions to address the diverse risks associated with TBI across the lifespan.

Age Group and Outcome

In our study, among patients aged 0-20, 29.9% survived, whereas 21.0% did not survive. In the 21-40 age group, 18.2% survived and 18.1% did not survive. The survival rate showed an increase in the 41-60 age group, with 31.2% surviving compared to 41.0% who did not. For the 61-80 age group, 20.3% survived and 13.3% did not. In the 81-90 age group, survival was very rare, with only 0.4% surviving and 6.7% not surviving. Overall, the data highlights that survival rates are highest in the 41-60 age group and lowest in the 81-90 age group, with significant differences across age groups. The p-value of 0.001 indicates a statistically significant association between age and outcome, suggesting that age plays a critical role in survival following "traumatic brain injury."

These findings align with and expand upon existing literature emphasizing the pivotal role of age as a prognostic factor in TBI outcomes. Previous studies have consistently identified age as a crucial determinant of prognosis. For instance, Hukkelhoven et. al.,[3] highlighted age as an important prognostic factor, reinforcing the notion that younger patients generally have better outcomes. However, many retrospective[4,5] and prospective studies[6] have limited their analyses to age groups up to 60-65 years, potentially overlooking important trends in older populations.

Our study distinguishes itself by encompassing a broader age range (15-90 years), similar to the approach taken by Williams et al.[7] Their findings indicated that younger patients within a wide age range exhibited significantly better outcomes, a trend that resonates with our observation of higher prevalence of certain TBI types in younger individuals. Tagliaferri et al.[8] also identified age as the most critical prognostic factor, noting that only 7% of patients over 65 years old achieved a good outcome. This is consistent with our data, which demonstrate a shift in TBI type prevalence with increasing age, potentially contributing to differing outcomes across age groups.

Moreover, mortality rates reported in our study align with those documented by Tagliaferri et al.[8] and De Bonis et al.[5] who observed high mortality rates in older populations with TBI. Specifically, Tagliaferri et al. found a 6-month mortality rate of 72%, and De Bonis et al. reported a 1-year mortality rate of 77% in patients over 65 years treated with DC (Decompressive Craniectomy). These findings underscore the adverse prognosis associated with advanced age in TBI cases, a pattern reflected in our study's distribution of TBI types across age groups.

However, discrepancies exist in the literature regarding the correlation between age and TBI outcomes following specific interventions like DC. While Tagliaferri et al.[8] emphasized age as a significant factor, other studies[4,5] did not observe a similar correlation. Our comprehensive age range may provide additional insights into these inconsistencies, suggesting that the impact of age on outcomes may be more pronounced when a wider age spectrum is considered.

In a study by Tang et al., a comparison was made between patients with a GCS score of less than 5 and bilateral dilated pupils who underwent decompressive craniectomy. The study included 94 patients, of whom 20 survived and 74 did not. The median age of the survivors was 33.5 years (IQR 21.5–47.5), which was significantly younger than the median age of the non-survivors, 47 years (IQR 38–59) (p = 0.002). Age proved to be a critical factor, with 34% of patients aged ≤39 years surviving, compared to only 11.7% of those aged >39 years.[9] Huang et al. reported a similar finding, where 40 years of age was identified as a critical threshold for predicting higher mortality rates following DC.[10] In their analysis of clinical data from 103 TBI patients treated with DC, Matthew et al., observed that outcomes were influenced by age, with the 35 to 49-year-old age group showing significantly poorer GOS (Glasgow Outcome Scale) scores.[11]

Our study, thus, corroborates the established understanding that age is a critical factor influencing both the type and prognosis of TBI. By demonstrating distinct age-related patterns in TBI types and aligning with existing research on age-related outcomes, our findings contribute to a more nuanced appreciation of how age impacts TBI epidemiology and prognosis. Future research should continue to explore these relationships across diverse and broader age populations to inform tailored therapeutic strategies and improve prognostic assessments in TBI patients.

Gender and Type of Traumatic Brain Injury

In our study, DAI was observed in 74.3% of male patients and 25.7% of female patients. Similarly, EDH occurred in 71.7% of males and 28.3% of females. IPH also showed a higher prevalence in males (73.3%) compared to females (26.7%). SAH was found in 64.0% of males and 36.0% of females, while SDH, the most common TBI type in our sample, affected 66.7% of males and 33.3% of females. Overall, males accounted for a greater proportion of TBI cases across all types, with 69.3% of the cases being male and 30.7% female. The p-value of 0.701 indicates that there is no statistically significant difference in TBI type between genders.

In the study by Ashok et al., female patients represented nearly 20% of TBI cases. Compared to males, female patients had higher rates of symptom manifestation (84.3% vs. 82.6%), injuries due to falls (32.1% vs. 24.4%), and surgical interventions (11.6% vs. 10.4%). Females were also more likely to have mild head injuries (76.8% vs. 69.5%, p = 0.016) and had a higher mortality rate (3.4% vs. 1.6%, p = 0.048). Among female patients, 60.4% had abnormal head CT findings, including parenchymal contusion (23.9%), extradural hematoma (7.8%), subdural hematoma (14%), subarachnoid hemorrhage (4.4%), cerebral edema (24.6%), petechial hemorrhage (1.7%), ventricular hemorrhage (1.4%), infarct (1.4%), skull fracture (20.8%), and pneumocephalus (3.4%).[12]

In the study by Eom et al., the most common diagnosis was ASDH (Acute Subdural Hematoma), accounting for 36.9% (n = 1,648) of cases, followed by cerebral contusion or TICH (Traumatic Intracerebral Hemorrhage) at 13.9% (n = 622). CSDH (Chronic Subdural Hematoma) made up 13.5% (n = 603) of diagnoses, while TSAH (Traumatic Subarachnoid Hemorrhage) accounted for 11.8% (n = 526), and cerebral concussion was observed in 11.1% (n = 494) of cases. AEDH (Acute Epidural Hematoma) was diagnosed in 8.4% (n = 374) of patients, skull fractures in 2.9% (n = 129), and other conditions in 0.7% (n = 30). Diffuse axonal injury (DAI) was seen in 0.6% (n = 29) of cases, while 0.3% (n = 13) were classified as not available. The study found no statistically significant difference in diagnoses between sexes (p = 0.419).[13] which was similar to our observation.

Gender and Pre-Operative GCS

In our study, GCS scores of 3 and 4 are more frequently observed in males, with 71.8% and 82.6% of these scores, respectively, being attributed to males, compared to 25.8% and 17.4% in females. “GCS score” 5 was the most common overall, with males representing 68.7% of these cases and females 31.3%. For “GCS score” 6, 76.5% of the cases were in males, while 23.5% were in females. “GCS score”s of 7 and 8 also showed a higher prevalence in males, with 61.3% and 64.7%, respectively, compared to 38.7% and 35.3% in females. Overall, males accounted for a greater proportion of cases across all pre-operative GCS scores, making up 69.3% compared to 30.7% for females. The p-value of 0.189 suggests no statistically significant association between gender and pre-operative GCS scores. Additionally, the mean pre-operative “GCS score” for males was 5.84 (SD = 1.54), slightly lower than the mean score of 6.08 (SD = 1.63) for females. The overall mean pre-operative “GCS score” was 5.91 (SD = 1.57). With a p-value of 0.194, there was no significant gender difference in pre-operative GCS scores.

In contrast, Ashok et al. found that female patients had significantly higher percentages in the mild head injury group (76.8% vs. 69.5%, p = 0.016) and a higher mortality rate (3.4% vs. 1.6%, p = 0.048). Female patients also experienced higher injury severities in the pediatric and elderly age groups and there was a notable difference in mortality rates between females (3.4%) and males

(1.6%). This suggests that, contrary to our findings, female patients in their study faced greater injury severities and worse outcomes, highlighting variations in gender-based outcomes in traumatic brain injuries.[12]

Significant differences in injury severity between females and males have been documented, often in relation to specific risk factors.[14] A meta-analysis found that female patients with TBI reported a greater number of trauma symptoms compared to their male counterparts. In the study by Eom et al., significant differences in GCS scores-classified as mild, moderate, and severe—were observed between men and women, with p-values of 0.000, 0.013, and 0.004, respectively.[13]

Slewa-Younan et al., investigated the effect of sex on injury severity and outcome measurement of patients after TBI. Reflecting upon their lower "GCS score"s and longer post-traumatic amnesia duration. They showed that men have a higher severity of injury than women. There was no significant difference in measuring outcomes between men and women.[15]

Gender Group and GCS Post 72 Hours

In our study, the distribution of GCS scores measured 72 hours after injury showed a higher proportion of males in lower severity categories. Specifically, males accounted for 85.7% of cases with a "GCS score" of 4 and 100% of those with a score of 5. This trend continued with males representing 78.1% of "GCS score" 6, 71.4% of "GCS score" 7, 69.0% of "GCS score" 8, 67.8% of "GCS score" 9, and 75.0% of "GCS score" 10. Conversely, females were more represented in higher "GCS scores, with 51.5% of cases having a "GCS score" of 11 and 47.4% of those with a score of 14, indicating a more balanced distribution in these categories. While males dominated in most lower "GCS score" categories, the difference in "GCS scores between genders 72 hours post-injury was not statistically significant, with a p-value of 0.061 suggesting a trend but not a strong gender-based difference in recovery outcomes. Males had a mean "GCS score" of 8.88 (SD = 2.33), while females had a higher mean score of 9.61 (SD = 2.25). The overall mean post-72-hour "GCS score" was 9.10 (SD = 2.32), and the p-value of 0.008 indicated a statistically significant difference between genders, with females showing better recovery as measured by the GCS at 72 hours. This suggests that gender may influence recovery outcomes after 72 hours.

In the Ashok et al. study, the severity of brain injuries among female patients, as assessed by the Glasgow Coma Scale, revealed that 76.8% had mild injuries, 12.6% had moderate injuries, and 10.6% had severe injuries.[12] Rimel et al. found that a significantly higher number of men than women sustain mild traumatic brain injuries (TBI).[16] Similarly, Kraus and Nourjah reported that the incidence of mild TBI in males is approximately double that in females.[17] In contrast, Munivenkatappa et al. observed a higher proportion of women affected by TBI in the under-18 age group compared to men.[12] Additionally, mild TBIs were found to be more prevalent among women, particularly in the pediatric and elderly populations.

Gender and Outcome-Wise Distribution

Farace et al. highlighted that gender can significantly interact with various outcome variables in TBI and may be a crucial determinant of TBI outcomes.[18] However, gender was often overlooked as an important risk factor in many previous studies on TBI, either due to the higher overall incidence of TBI in men or because data were not analyzed or reported separately by gender.[13]

In our study, survival rates following TBI showed that 67.5% of males survived compared to 32.5% of females. Conversely, 73.3% of males did not survive; while 26.7% of females did not survive. Males represented a larger proportion of both survivors and non-survivors. The p-value of 0.285 indicated that there was no statistically significant difference between genders in survival rates, suggesting that gender does not significantly influence survival outcomes in this cohort.

In contrast, the study by Ashok et al. found a significant difference in mortality rates, with 3.4% of females and 1.6% of males experiencing mortality.[12] According to McMillan et al., a 1-year follow-up study in Scotland on TBI-induced death reported that the percentage of deaths was higher in females (13.5%, 21 out of 156) compared to males (8.5%, 52 out of 611).[19] In the study by Eom et al., of the 609 severe TBI patients, 302 (49.6%) survived while 307 (50.4%) died. The

difference in mortality rates between sexes was not statistically significant, with a p-value of 0.876.[13]
Kraus et al. investigated gender as an independent predictor of survival following TBI. Their findings indicated that women had a mortality rate 1.28 times higher than men after moderate to severe TBI. When controlling for variables such as age, admission GCS score, penetrating injury, and multiple traumas, women were found to be 1.75 times more likely to die from TBI compared to men. Additionally, women were 1.57 times more likely to experience severe disabilities or a persistent vegetative state than their male counterparts.[20] In contrast, Groswasser et al. reported that women exhibited better outcomes after severe TBI compared to men. They suggested that this improved outcome might be linked to the protective effects of gonadal hormones, particularly progesterone, which has been shown in experimental studies to offer neuroprotection.[21]
An important limitation of the present study was that we did not consider other demographic parameters such as socioeconomic factors, financial constraints, education level, and access to diagnosis and treatment, which may influence outcomes.

CONCLUSION

In the present study, age and type of TBI showed a clear pattern, with younger patients more frequently affected by DAI and EDH, while SDH was more prevalent in middle-aged individuals. The type of injury was not uniformly distributed across age groups, highlighting the need for age-specific management strategies. Gender differences in TBI types were evident, with males being more commonly affected by all types of TBI compared to females. However, the impact of gender on the type of TBI was not statistically significant, suggesting that other factors may be more influential in determining the type of injury. Further research inclusive of all the demographic factors would facilitate better triaging and faster management of this vulnerable group of patients.

Conflict of interest: Nil

REFERENCES

[1] Voss RM, Das JM. Mental Status Examination. In: Friedman HS, Markey CH, Encyclopedia of Mental Health. 3rd edn. Vol. 1-3 2024:V2-493-V2-502.
[2] Faul M, Wald M, Xu L, et al. Traumatic Brain Injury in the United States: emergency department visits, hospitalizations, and deaths, 2002-2006. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control 2010.
[3] Hukkelhoven CWPM, Steyerberg EW, Rampen AJJ, et al. Patient age and outcome following severe “Traumatic Brain Injury”: an analysis of 5600 patients. J Neurosurg 2003;99:666–73.
[4] Aarabi B, Hesdorffer DC, Ahn ES, et al. Outcome following decompressive craniectomy for malignant swelling due to severe head injury. J Neurosurg 2006;104:469–79.
[5] De Bonis P, Pompucci A, Mangiola A, et al. Decompressive craniectomy for the treatment of “Traumatic Brain Injury”: does an age limit exist? J Neurosurg 2010;112:1150–3.
[6] Cooper DJ, Rosenfeld JV, Murray L, et al. Decompressive craniectomy in diffuse “Traumatic Brain Injury”. N Engl J Med 2011;364:1493–502.
[7] Williams RF, Magnotti LJ, Croce MA, et al. Impact of decompressive craniectomy on functional outcome after severe “Traumatic Brain Injury”. J Trauma 2009;66:1570–4.
[8] Tagliaferri F, Zani G, Iaccarino C, et al. Decompressive craniectomies, facts and fiction: a retrospective analysis of 526 cases. Acta Neurochir (Wien) 2012;154:919–26.
[9] Tang Z, Yang R, Zhang J, et al. Outcomes of traumatic brain-injured patients with “Glasgow Coma Scale” < 5 and bilateral dilated pupils undergoing decompressive craniectomy. Front Neurol 2021;12:656369.
[10] Huang YH, Lee TC, Lee TH, et al. Thirty-day mortality in traumatically brain-injured patients undergoing decompressive craniectomy. J Neurosurg 2013;118:1329–35.
[11] Potts MB, Chi JH, Meeker M, et al. Predictive values of age and the “Glasgow Coma Scale” in “Traumatic Brain Injury” patients treated with decompressive craniectomy. Acta Neurochir

Suppl 2008;102:109-12.
[12] Munivenkatappa A, Agrawal A, Shukla DP, Kumaraswamy D, Devi BI. "Traumatic Brain Injury": Does gender influence outcomes? Int J Crit Illn Inj Sci 2016;6:70.
[13] Eom KS, Kim JH, Yoon SH, et al. Gender differences in adult "Traumatic Brain Injury" according to the "Glasgow Coma Scale": a multicenter descriptive study. Chinese Journal of Traumatology 2021;24:333.
[14] Amarasingha N, Dissanayake S. Gender differences of young drivers on injury severity outcome of highway crashes. J Safety Res 2014;49:113.e1-120.
[15] Slewa-Younan S, Green AM, Baguley IJ, et al. Sex differences in injury severity and outcome measures after "Traumatic Brain Injury". Arch Phys Med Rehabil 2004;85:376–9.
[16] Rimel RW, Giordani B, Barth JT, et al. Disability caused by minor head injury. Neurosurgery 1981;9:221–8.
[17] Kraus JF, Nourjah P. The epidemiology of mild, uncomplicated brain injury. J Trauma 1988;28:1637–43.
[18] Farace E, Alves WM. Do women fare worse: a metaanalysis of gender differences in "Traumatic Brain Injury" outcome. J Neurosurg 2000;93:539–45.
[19] McMillan TM, Teasdale GM. Death rate is increased for at least 7 years after head injury: a prospective study. Brain 2007;130:2520–7.
[20] Kraus JF, Peek-Asa C, McArthur D. The independent effect of gender on outcomes following "Traumatic Brain Injury": a preliminary investigation. Neurosurg Focus 2000;8(1):e5.
[21] Groswasser Z, Cohen M, Keren O. Female TBI patients recover better than males. Brain Inj 1998;12:805–8.