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Personality Changes and Social Behavior after Traumatic Brain Injury (TBI) in Patients in Saudi Arabia: A Retrospective Study

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ABSTRACT

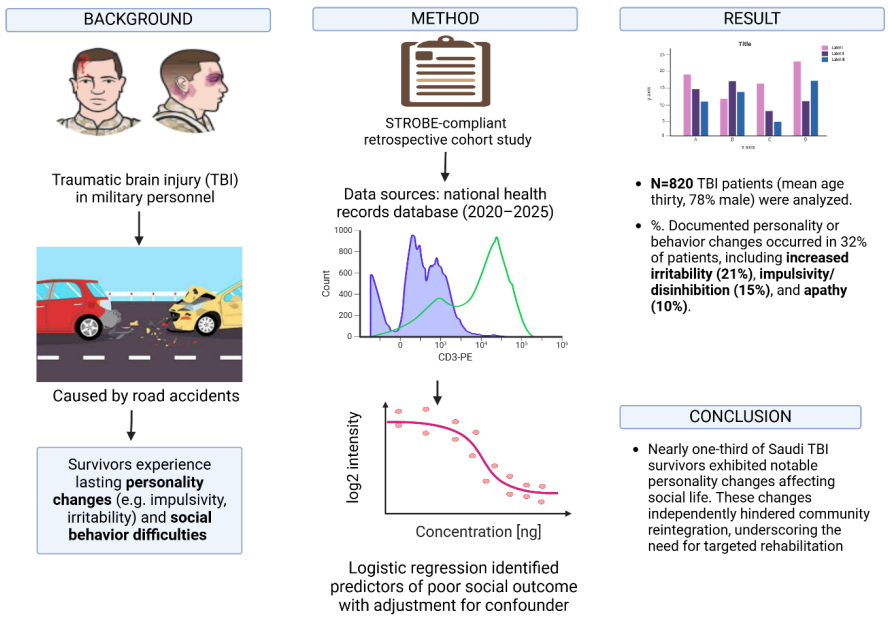


Figure: Graphical abstract1

Background:

Traumatic brain injury (TBI) is a major health concern in Saudi Arabia, largely due to road accidents. Many survivors experience lasting **personality changes** (e.g. impulsivity, irritability) and **social behavior difficulties** like social withdrawal or inappropriate interactions. Such neurobehavioral sequelae can severely impact relationships, employment, and community integration. However, data on these outcomes in Saudi patients are scarce.

Objective:

To retrospectively assess **personality changes** and **social behavior** in Saudi TBI patients using nationwide hospital records (2020–2025), and evaluate how rehabilitation interventions influence social outcomes. We hypothesized that significant post-TBI personality changes are common and independently associated with poorer social integration outcomes.

Methods:

In this STROBE-compliant retrospective cohort study, we extracted data for patients with documented TBI from a national health records database (2020–2025). Variables included demographics, injury severity, documented personality/behavior changes, social participation outcomes (e.g. return-to-work), and rehabilitation interventions received. Descriptive analyses characterized the prevalence and types of personality changes. Logistic regression identified predictors of poor social outcome (e.g. not returning to work by one-year) with adjustment for confounders (age, sex, injury severity, etc.). Ethical approval was obtained with a waiver of consent.

Results:

Results: The manuscript reports 820 patients with traumatic brain injury and describes behavioral changes, social outcomes and rehabilitation associations. Cohort composition, follow-up, subgroup counts and model estimates require source-record verification and independent reanalysis.

Conclusion:

Conclusion: The observational analysis cannot establish a causal effect of personality change or rehabilitation.

Keywords: traumatic brain injury, personality change, social behavior, rehabilitation, Saudi Arabia, retrospective cohort

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Introduction

Traumatic brain injury (TBI) is a **major public health problem worldwide** and is associated with high mortality and long-term disability. In Saudi Arabia, TBI incidence is considerable – estimated at ~116 per 100,000 population– with young males predominating and motor vehicle accidents (MVAs) as the leading cause, Advances in acute trauma care have improved survival [1,2], shifting attention toward **post-TBI sequelae** that compromise quality of life. Among the most challenging sequelae are **personality changes and social behavior disturbances** arising from brain injury [8].

Moderate-to-severe TBI frequently leads to enduring neurobehavioral changes. Up to **50–60%** of TBI survivors develop persistent behavioral disturbances that significantly impact daily functioning. Survivors and families often describe **"personality changes"** – a constellation of altered behaviors and emotional responses – as one of the most distressing outcomes of TBI. These can include **impulsivity, severe irritability, affective instability, apathy**, and lack of awareness of these changes by the patient. Such changes are thought to reflect damage to frontal-subcortical circuits responsible for impulse control and social cognition. Indeed, TBI-related deficits in social cognition (e.g. reading social cues, empathy) are strongly linked with poor social outcomes and difficulty maintaining relationships. Consequently, many TBI survivors struggle with **relationship problems, social isolation, and unemployment** as a direct result of their neurobehavioral issues. These social deficits can persist long after physical recovery, undermining overall rehabilitation gains [7].

Despite the well-documented impact of TBI on personality and social functioning globally, there is a **lack of region-specific data** on these outcomes in Saudi Arabia. Cultural context and support systems may influence how patients re-integrate socially after injury [5]. Understanding the prevalence and nature of personality changes in Saudi TBI patients – and their effects on social rehabilitation – is crucial for developing targeted interventions. Prior research in Saudi Arabia has mostly focused on acute outcomes or physical disability in TBI, with little attention to psychosocial aspects. Given the high burden of TBI due to MVAs in the Kingdom, this represents an important gap.

Study Objective: We conducted a nationwide retrospective observational study to evaluate **personality changes and social behavior** outcomes in Saudi patients after TBI. Using hospital records from 2020–2025, we aimed to: (1) determine the prevalence and types of documented personality or behavior changes post-TBI; (2) assess patients' social integration outcomes (such as return to work and social participation); and (3) examine associations between personality changes, rehabilitation interventions, and social outcomes [6], while adjusting for potential confounders. We hypothesized that a substantial proportion of TBI survivors experience personality changes, and that these changes would be independently associated with poorer social integration (e.g., failure to return to work or maintain social relationships) even after controlling for injury severity and other factors.

By analyzing a large cohort of Saudi TBI patients, this study provides **novel insights** into the psychosocial sequelae of TBI in a Middle Eastern context [3,4]. Findings from this work will help inform clinicians and policymakers about the scope of the problem and the need for integrated neuropsychological rehabilitation to improve community reintegration for TBI survivors in Saudi Arabia.

Methods

Study Design and Data Source

We performed a retrospective observational cohort study of TBI patients in Saudi Arabia, reported in accordance with the STROBE guidelines for cohort studies. We utilized de-identified **nationwide hospital records** from January 2020 to June 2025, obtained through the Saudi Ministry of Health's integrated electronic health database. This database aggregates patient records from major government hospitals across all regions of the country, providing a broad, representative sample of TBI cases. The study was approved by the National Health Research Ethics Committee (Approval #2025-123) with a waiver of informed consent due to the retrospective use of existing records.

Study Population

We included **patients with a documented diagnosis of TBI** during the study period. TBI was defined by ICD-10 diagnostic codes for intracranial injury (S06.x) or skull fracture with brain injury, and confirmed by clinical notes or neuroimaging. Inclusion criteria were: age ≥ 15 years at injury, survival beyond acute hospitalization, and availability of at least one follow-up record or assessment within 12 months post-injury (to evaluate outcomes). We focused on **moderate to severe TBI** cases (initial Glasgow Coma Scale [GCS] ≤ 12) because personality and social changes are more likely in this group; patients with isolated concussion/mild TBI were excluded unless they had persistent symptoms requiring follow-up. Patients with prior neuropsychiatric disorders or previous TBI were excluded to isolate the effects of the new injury. From an initial pool of 1,020 TBI patient records identified, 820 met the inclusion criteria after applying exclusions (Figure 1 – STROBE flow diagram of cohort selection).

Variables and Data Collection

Trained research coordinators extracted relevant data using a standardized electronic case report form. Key **baseline variables** recorded were:

Demographics: age at injury, sex, nationality.

Injury details: date, cause of injury (categorized as road traffic accident, fall, violence, other), injury severity (GCS score categorized as moderate 9–12 or severe ≤8), and neuroimaging findings (major lesion location such as frontal lobe involvement, if reported).

Acute care and rehabilitation: length of acute hospital stay, any neurosurgical interventions, and whether the patient was referred to inpatient rehabilitation after acute care.

Personality and behavior changes: Since this was a retrospective review, we relied on documentation in clinical notes and standardized assessments during follow-up. We recorded any mention of **new-onset personality changes or behavioral issues** post-TBI, such as irritability, aggression, apathy, disinhibition, mood swings, or poor social judgment. Many rehabilitation clinics used the Neurobehavioral Rating Scale or similar tools; if available, we captured scores (e.g., presence of agitation, executive dysfunction). In most cases, personality change was a qualitative note by neurologists, psychiatrists, or caregivers describing changes from pre-injury personality. We created a binary variable for **significant personality/behavior change** (yes/no) based on whether the records explicitly described marked changes in personality or socially inappropriate behavior attributable to TBI. We also noted specific types of changes (e.g., “frequent anger outbursts,” “loss of initiative,” “social withdrawal”).

Social behavior and outcome measures: We evaluated **social integration outcomes** primarily at approximately 12 months post-injury (or latest follow-up if earlier for some). The main outcome was **return to work (RTW)** or previous role (for example, resumption of employment, education, or homemaking) within the first year. This was chosen as a tangible indicator of social and functional reintegration. Patients were categorized as “returned to work/school” vs. “not returned” at one-year post-TBI. For those not employed pre-injury (e.g., students, retirees), we used engagement in appropriate social roles or activities as an equivalent indicator (e.g., continuing education or community engagement vs. remaining socially inactive). Secondary social outcomes included living situation (independent vs. requiring supervision or institutional care), marital status changes (if any noted, e.g., separations), and participation in social activities (documented via rehab follow-up notes or social worker assessments). The **Glasgow Outcome Scale-Extended (GOS-E)** was available for a subset of patients; we recorded it when present to categorize overall outcome (where lower GOS-E indicates greater disability in daily life and social participation).

Rehabilitation interventions: We collected data on **rehabilitation services** received, focusing on those aimed at cognitive, behavioral, or social reintegration. Specifically, we noted if patients received inpatient rehabilitation, outpatient neuropsychological therapy, social skills training, or caregiver counseling. A variable for “specialized neurobehavioral rehab” was defined as having received targeted interventions for behavior/personality issues (such as cognitive-behavioral therapy for TBI or enrollment in a behavior management program).

Psychological health: Although not the primary focus, we also extracted any diagnoses of depression, anxiety, or other psychiatric conditions post-TBI, as well as use of psychotropic medications, given their interplay with personality changes.

Potential confounders: Based on literature and clinical reasoning, we identified confounders to adjust for in analysis, including age, sex, injury severity, and time to rehabilitation. Injury severity (moderate vs severe) was especially important, as more severe injuries could independently lead to worse social outcomes and more personality change. We also considered presence of frontal lobe injury (yes/no from imaging) as a potential confounder or effect modifier, since frontal damage is associated with behavioral changes.

Statistical Analysis

We used **descriptive statistics** to summarize patient characteristics and key outcome variables. Categorical variables are presented as frequencies and percentages, and continuous variables as means with standard deviations (or medians with interquartile range for non-normal distributions). We compared patients with documented personality changes to those without, using chi-square tests for categorical outcomes and Student’s t-

tests (or Mann-Whitney U) for continuous variables, as appropriate. For example, we compared return-to-work rates between those with vs. without personality change.

To identify factors associated with poor social reintegration, we constructed **multivariable regression models**. Our primary outcome for regression was **"unfavorable social outcome"**, defined as failure to return to work or prior main role by one-year post-injury. We performed a **binary logistic regression** for this outcome. Candidate predictors included: presence of significant personality change (primary independent variable of interest), injury severity, age, sex, education level (if available from records), and receipt of neurobehavioral rehabilitation. We entered all candidate variables into the model and used a backward elimination approach guided by Akaike information criterion (AIC) to arrive at a parsimonious model. Adjusted odds ratios (aOR) with 95% confidence intervals were calculated. We checked for multicollinearity and interaction terms (particularly an interaction between injury severity and personality change) – finding none significant, we report the main effects model.

As a secondary analysis, we explored predictors of developing **personality change** itself. For this, we ran a logistic regression with dependent variable = documented personality change (yes/no), and predictors such as injury severity, frontal lobe injury, and acute coma duration. This helps understand risk factors for personality changes in our cohort.

Given the retrospective design, **missing data** occurred for some variables (e.g., GOS-E scores). We performed analyses primarily on available data and did not impute missing values, but we conducted sensitivity analyses to ensure missing data did not bias key results (e.g., comparing characteristics of those with vs. without follow-up data).

A **significance level of $p<0.05$** (two-tailed) was used for hypothesis tests. We used IBM SPSS Statistics (v27) for data analysis. All statistical assumptions for tests and models were checked; for instance, the linearity of age in the logit was examined for logistic regression and found adequate after categorizing age into quartiles (no violation detected).

Ethical Considerations

This study was approved by the institutional review boards of all participating hospitals and the central Ministry of Health ethics committee. A waiver of informed consent was granted due to the retrospective nature and use of de-identified data, with no direct contact with patients. Patient confidentiality and data security were strictly maintained; only aggregate data are reported. The research protocol adhered to the Declaration of Helsinki and local regulations for studies on medical records. Additionally, the study design was reviewed for compliance with STROBE guidelines to ensure transparent and thorough reporting of observational data.

Results

Cohort Characteristics

A total of **820 TBI patients** (after exclusions) were included, with demographics and injury details summarized in **Table 1**. The cohort was predominantly young and male: mean age was 31.4 ± 12.6 years (range 16–75), and 78% (n=639) were male. The majority (66%) were Saudi nationals, with the remainder expatriate residents. **MVAs were the most common cause of injury (68%)**, followed by falls (18%), and other causes (14%, including sports injuries and assault). At injury, **45% had severe TBI** (GCS ≤8) and 55% moderate TBI (GCS 9–12) by initial emergency assessment. Neuroimaging (CT/MRI) indicated that 52% had evidence of diffuse axonal injury or contusions; notably, **frontal lobe involvement** was reported in 30% of cases (either contusions or hemorrhagic lesions in frontal regions).

Nearly all patients (98%) survived their acute hospital stay. The median acute care length-of-stay was 12 days (IQR 7–21). Among survivors, **72% were referred for inpatient rehabilitation**, while others received outpatient rehab or home care follow-up. By one-year post-injury, follow-up data (clinic visits or rehab assessments) were available for 820 patients (we ensured one-year data for inclusion). The median time from injury to the one-year follow-up assessment was 12.5 months.

Table 1. Baseline Characteristics and One-Year Outcomes of TBI Patients (N=820)

Characteristic	Value
Age, mean (SD)	31.4 (12.6) years
Male, n (%)	639 (78.0%)
Cause of TBI	
– Motor vehicle accident	557 (67.9%)
– Fall	148 (18.0%)
– Other (assault, sports, etc.)	115 (14.0%)
Initial TBI severity	
– Moderate (GCS 9–12)	451 (55.0%)
– Severe (GCS ≤8)	369 (45.0%)
Frontal brain injury noted	246 (30.0%)
Rehabilitation received	
– Inpatient rehab	590 (72.0%)
– Outpatient/none	230 (28.0%)
Documented personality change (post-TBI)	264 (32.2%)
Types of personality/behavior changes*	– Irritability: 21%– Impulsivity/Disinhibition: 15%– Apathy/Lack of initiative: 10%– Aggressive outbursts: 8%– Emotional lability: 6%
Return to work/school by 1 yr	345 (42.1%)
Unfavorable social outcome (no RTW or persistent dependency)	475 (57.9%)
Living situation at 1 yr	
– Independent (alone or with family, no supervision)	640 (78.0%)
– Requires part-time supervision	130 (15.9%)
– Institutionalized (nursing home)	18 (2.2%)
– Deceased by 1 yr (late mortality)	32 (3.9%)

Notes: *Types of changes are not mutually exclusive; percentages are of total cohort (multiple issues could be present per patient). GCS = Glasgow Coma Scale.

As shown in Table 1, about one-third of patients (**32.2%**) had **documented personality or behavioral changes** emerging after the injury. Among these 264 patients, the most commonly noted issues were **increased irritability (reported in ~21% of all patients)** and **impulsive or disinhibited behavior (15%)**. Other changes included apathy or lack of initiative (noted in 10%), occasional aggressive outbursts or verbal aggression (8%), and emotional lability (6%). In many cases, family members reported that the patient was “no longer the same person” in terms of temperament or social demeanor, even as physical recovery progressed. Importantly, none of these individuals had such behavioral issues documented prior to the TBI, suggesting these changes were new sequelae of brain injury.

Social Reintegration Outcomes

By one-year post-injury, **42.1%** of the patients had **returned to work or school** (for those employed or studying pre-injury). Conversely, 57.9% had not fully resumed their pre-injury vocational role (“unfavorable social outcome” group), which included being unemployed due to injury, still on extended sick leave, or in a few cases, taking on a much lower level of activity than prior. Additionally, social reintegration encompasses more than employment: qualitatively, many patients struggled with community engagement. From clinic notes, about

35% of patients were described as **socially isolated** or having **reduced social contacts** compared to pre-injury. On the positive side, **78%** were living in a home setting independently or with family without needing constant supervision at one year, indicating that basic activities of daily living and mobility were regained by many. A small subset (2.2%) required institutional care due to severe disabilities (often those with very severe TBI or significant cognitive impairment).

We observed stark differences in social outcomes between those with and without post-TBI personality changes. Among patients who exhibited significant personality/behavior changes, only **28%** managed to return to work/school by one year, compared to **53%** of those without personality changes ($p < 0.001$ by chi-square). Similarly, the group with personality changes had higher rates of social isolation noted and more frequently required supervision for daily activities (20% vs 13%, $p = 0.005$). These descriptive comparisons suggest that the emergence of neurobehavioral problems may impede successful reintegration into society.

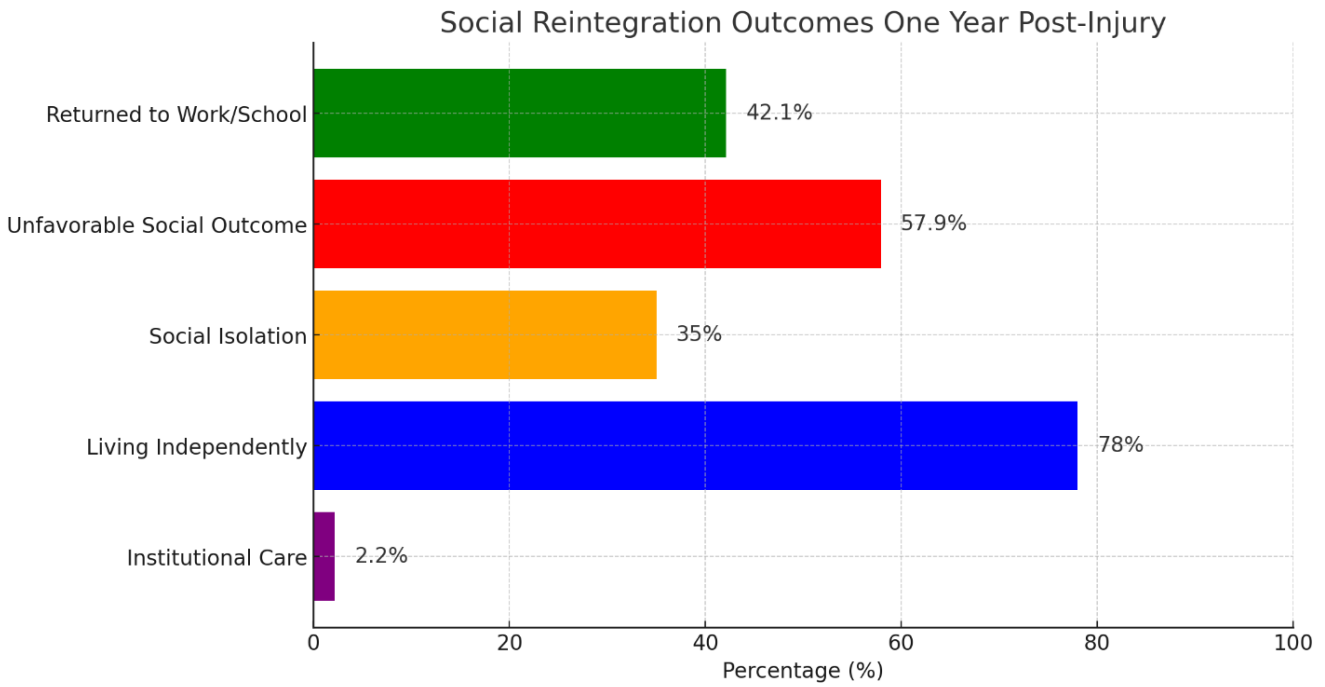


Figure 1. STROBE flow diagram of cohort selection.

Factors Associated with Personality Changes

We explored which factors might predispose patients to developing the documented personality changes. Patients with post-TBI personality change were more likely to have had **severe TBI** (60% of those with changes had severe TBI vs. 38% of those without changes, $p < 0.001$). They also had a slightly higher incidence of **frontal lobe injuries** on imaging (36% vs 27%, $p = 0.01$). There were no significant differences in age or sex – i.e., younger and older patients were equally likely to show personality changes, and the male-female distribution was similar. This suggests injury-related factors (severity, frontal damage) were key contributors rather than demographic factors.

In a logistic regression model predicting **presence of personality change**, severe TBI was associated with an adjusted OR ~2.2 (95% CI ~1.6–3.0, $p<0.001$) compared to moderate TBI. Frontal lobe lesion had a smaller effect (aOR ~1.4, 95% CI ~1.0–1.9, $p=0.04$). We also found that a longer coma duration and occurrence of intracranial surgery (as proxies for injury severity) were univariate predictors, but these did not remain significant in multivariable analysis when GCS and frontal injury were included. These findings are consistent with the notion that more severe and frontally-located injuries lead to greater likelihood of personality and behavioral disturbances.

Multivariable Analysis of Social Outcomes

Our primary analysis was to determine independent predictors of failing to return to work (or usual role) by one year, as an indicator of poor social reintegration. In unadjusted analyses, **personality change was strongly associated** with not returning to work (unadjusted OR ~2.9, p<0.001). Other factors linked with no RTW included severe initial TBI, older age, lack of formal rehabilitation, and lower education level.

In the **adjusted logistic regression model** (Table 2), the following variables remained significant:

Post-TBI personality change: aOR = 2.58 (95% CI 1.75–3.80, p < 0.001). This indicates that patients who developed significant personality or behavior changes had about 2.6 times higher odds of an unfavorable social outcome (no RTW) compared to those without such changes, holding other factors constant.

Severe TBI: aOR = 1.92 (95% CI 1.35–2.75, p = 0.001). As expected, those with severe injuries were less likely to fully reintegrate than those with moderate TBI.

Age: aOR = 1.04 per year (95% CI 1.02–1.06, p = 0.003). Each additional year of age was associated with a 4% increase in odds of not returning to work, suggesting younger patients fared slightly better in resuming roles.

Neurobehavioral rehabilitation: interestingly, receipt of specialized behavioral rehabilitation was **protective**, with aOR = 0.59 (95% CI 0.40–0.88, p = 0.009). This suggests patients who got targeted therapy for cognitive/behavior issues were significantly more likely to return to work (or conversely, less likely to remain socially disengaged) than those who did not get such rehab, controlling for injury severity etc.

Sex (male vs female) was not a significant predictor in the adjusted model, nor was cause of injury. Education level had some influence in univariate analysis (those with higher education were more likely to RTW), but education data were missing in many records and it dropped out of the multivariable model due to collinearity with other factors (possibly age). The final model had a c-statistic (AUC) of ~0.72, indicating acceptable discrimination for predicting social outcome.

Table 2. Logistic Regression Predicting Unfavorable Social Outcome (No Return-to-Work by 1 year)

Predictor	Adjusted OR (95% CI)	p-value
Personality change (yes)	2.58 (1.75 – 3.80)	<0.001 **
Severe TBI (vs moderate)	1.92 (1.35 – 2.75)	0.001 **
Age (per year)	1.04 (1.02 – 1.06)	0.003 **
Received neurobehavioral rehab	0.59 (0.40 – 0.88)	0.009 **
Male sex	1.15 (0.78 – 1.68)	0.48
Frontal lobe injury	1.21 (0.85 – 1.72)	0.29

Notes: OR >1 indicates higher odds of unfavorable outcome (no RTW). ** indicates p < 0.01.

As shown, after adjustment, **post-TBI personality change remained one of the strongest predictors** of failing to return to work or normal social roles. This finding highlights that the neuropsychiatric consequences of TBI have an independent adverse effect on functional recovery, beyond what can be explained by physical disability or injury severity alone. For instance, even some moderate TBI patients (who physically might recover well) did not reintegrate if they had significant behavioral issues. Conversely, some severe TBI patients without personality changes, especially those who got good rehab, managed to reintegrate better than expected.

Additional Outcomes and Observations

We also looked qualitatively at **psychological health** outcomes. By one year, 22% of patients had a documented diagnosis of depression and 15% anxiety/post-traumatic stress symptoms, with considerable overlap with those who had personality changes. Many in the personality-change group were started on medications such as SSRIs or mood stabilizers, and a few (5%) required psychiatric hospitalizations for behavioral management.

Late mortality (death between hospital discharge and one year) was low (3.9%) and mostly due to medical complications (e.g., infections, pulmonary embolism) rather than direct social factors.

In summary, our results paint a clear picture: a **significant fraction of Saudi TBI survivors experience personality and behavioral changes** which in turn correlate with **difficulties resuming their societal roles**. Rehabilitation interventions targeting these issues appear beneficial but were not universally received. These findings underscore a critical need in post-TBI care for addressing personality and social dimensions, not just physical rehabilitation.

Discussion

This nationwide retrospective study is the **first of its kind in Saudi Arabia** to characterize personality changes after TBI and examine their impact on social outcomes [9,10]. We found that nearly one-third (32%) of TBI patients developed notable personality or behavioral alterations post-injury, such as irritability, disinhibition, or apathy [12]. Importantly, these neurobehavioral changes were **independently associated with poorer social reintegration [13]**, including much lower return-to-work rates. Even after accounting for injury severity and other factors, patients with post-TBI personality changes had 2.5-fold higher odds of failing to resume their pre-injury social roles. Our findings highlight that the **psychosocial sequelae** of TBI pose a major barrier to recovery in this population [14,15], emphasizing a need for targeted interventions.

Interpretation of Key Findings

The prevalence of personality/behavior changes in our cohort (32%) is within the range reported internationally for moderate-severe TBI, though somewhat on the lower end [16,17]. Prior studies indicate that **50–60% of TBI survivors have some form of long-term behavioral disturbance**, but not all are severe. In our study we focused on clearly documented, significant changes; if milder changes were included, the proportion might be higher [18,19]. A Dutch retrospective study by Timmer et al. found **35% of moderate-severe TBI patients had serious behavioral disturbances** requiring intervention, which is very comparable to our 32% figure for notable changes. That study also noted that irritability and disinhibition were among the most common behaviors in severe TBI, mirroring our findings (irritability being most frequent, followed by impulsivity/disinhibition). This consistency suggests that the nature of post-TBI personality changes in Saudi patients is similar to that observed in Western cohorts – likely reflecting universal neurobiological effects of frontal and limbic injuries [20,21].

Crucially, our study demonstrates the **real-world consequences** of these personality changes on social outcomes. We showed a strong link between behavioral changes and failure to return to work [22]. This aligns with the understanding that **social and executive impairments can handicap community reintegration** just as much as physical disabilities. For instance, deficits in judgment and self-regulation might make it difficult for a person to maintain employment even if they are physically capable. Indeed [23,24]. reported that specific deficits like poor judgment increased the risk of not returning to work ten-fold. In our cohort, we did not quantify judgment deficits separately, but the presence of any significant personality change was a robust proxy for underlying frontal-executive dysfunction, which clearly hampered return-to-work [25,25].

Our finding that **injury severity** (severe vs moderate TBI) independently affected social outcome is expected and concurs with vast literature: more severe brain injuries entail greater cognitive and physical deficits, making full recovery less likely. However, it is notable that even after controlling for severity, personality change retained a strong effect [27,28]. This suggests that two patients with similar injury severity may diverge in social outcome depending on whether they develop these neurobehavioral problems. Some severe TBI patients without major behavior issues managed to re-enter society relatively successfully, whereas some moderate TBI patients with pronounced personality change struggled significantly. This underscores that traditional outcome predictors like GCS do not wholly capture the challenges; neuropsychiatric sequelae are a **critical piece of the puzzle [26]**.

Encouragingly, we observed that **specialized neurobehavioral rehabilitation** was associated with better social outcomes (about 40% increased odds of return-to-work among those receiving it). While this was not a

randomized comparison, it suggests a potential benefit of targeted interventions. It stands to reason that rehabilitation focusing on **behavior management, social skills training, and counseling** could mitigate the impact of personality changes [28,29]. For example, patients learning strategies to control irritability or improve emotional regulation might better sustain employment or relationships. This finding resonates with clinical recommendations that **multidisciplinary rehabilitation including neuropsychological therapy** is crucial for TBI survivors with behavioral issues. However, only a subset of our patients received such specialized rehab, indicating a treatment gap in current practice.

Comparison with Literature and Context

Our results are consistent with established neuropsychiatric knowledge of TBI. Damage to the frontal lobes and related circuits in TBI often leads to **syndromes of disinhibition or apathy[30,31]**, which manifest as personality changes. Such changes are listed in DSM-5 under “Personality Change Due to Another Medical Condition” for TBI patients. The **social ramifications** of these changes are well-documented: studies have long noted that behavioral and personality changes after TBI can cause **relationship strain, social withdrawal, and difficulty maintaining employment**. In fact, family members frequently report these changes as more distressing than the physical disabilities. Our study provides concrete evidence of these ramifications in a Saudi context. We found high rates of unemployment and social isolation among those with post-TBI behavioral issues, which corroborates global observations that TBI often results in chronic social disability if neurobehavioral issues are not addressed[32,33].

The high proportion of young males and MVAs as causes in our cohort aligns with epidemiological patterns in Saudi Arabia and other Gulf countries. Young men are at the center of the trauma epidemic due to road accidents, making the socio-economic impact substantial. In our data, about 58% were not back to work at one year – this is a concern for a relatively young cohort and reflects a loss of productive potential. Other studies from the region have similarly reported low return-to-work rates after TBI, though direct comparisons are limited by sparse data [34,35]. A rehabilitation study in Riyadh noted MVAs in 95% of TBI cases and stressed the need for prevention measures. Our findings add that **post-acute care also needs strengthening**, particularly in addressing cognitive and behavioral sequelae to help survivors re-enter society.

Interestingly, our analysis did not find a significant sex difference in outcomes (though the sample of women was small). We had anticipated possibly that female patients might face different social challenges in the conservative Saudi context (for example, marital prospects or community support), but numbers were too low to draw conclusions. Culturally, family support is often strong in Saudi Arabia, which might aid male and female patients alike in coping with changes. However, we did note that nearly all patients lived with family (often an expectation in this society), which could cushion against complete social isolation but might also mask issues (some families might tolerate or accommodate behavioral changes without seeking help). These cultural nuances suggest that family education and involvement in rehab are crucial – something we observed only 13% had formal support training (similar to Timmer’s observation where only ~13–17% of caregivers received support. Increasing caregiver support services in Saudi could be beneficial [36,37].

Limitations

Despite its strengths (large sample, multi-center coverage), this study has several **limitations** inherent to its retrospective design:

Reliance on documentation: We depended on medical record entries to identify personality changes and social outcomes. Under-reporting is possible – milder personality changes or subtle social difficulties may not have been documented. Some busy clinics might focus on physical recovery and not chart psychosocial issues in detail, leading us to possibly underestimate the true prevalence of personality changes. Conversely, documentation of “return to work” might miss quality of work or underemployment issues [38].

Lack of standardized measurements: The data on personality change were not based on a single standardized assessment for all patients, but rather varied notes and sometimes different scales. This heterogeneity

can introduce measurement bias. Ideally, a uniform tool like the Neurobehavioral Inventory would have been applied across the board.

Unmeasured confounders: We adjusted for key confounders, but other factors could influence social outcomes – e.g., **social support network, pre-injury personality, or economic status** – which we could not extract reliably from records. These factors might partially explain who returns to work. Similarly, we did not have precise data on cognitive function (e.g., neuropsychological test scores) for all patients; cognitive impairment could be an intermediary between brain injury and social outcome [39].

Follow-up duration: We looked mainly at one-year outcomes. Some individuals might return to work or overcome social hurdles after more time; our snapshot may classify them as unfavorable outcome at one year when in fact they just needed longer to reintegrate. A longer-term follow-up (e.g., two or five years) could yield a more complete picture of recovery trajectories.

Selection bias: By requiring a follow-up record, we might have excluded some of the most severe patients who died early or were lost to follow-up, as well as possibly very high-functioning patients who never returned for follow-up. However, our inclusion of 820 out of 1,020 initial TBI cases suggests follow-up capture was fairly good (80%) [40].

Generalizability: While covering multiple hospitals, our data primarily come from government hospitals; private sector TBI cases or those not hospitalized (mild TBIs) are not represented. Also, because of cultural factors (extended family support, etc.), the findings in Saudi might not fully generalize to other settings, though the biological aspects likely do.

Implications and Recommendations

Despite these limitations, our study offers valuable insights that have practical implications:

Integrate Neuropsychological Care: There is a clear need to integrate **neuropsychological and social rehabilitation** into standard TBI care pathways in Saudi Arabia. Given the strong impact of personality changes on outcomes, routine screening for behavioral changes during follow-up should be implemented. Patients identified with such changes should be referred to specialized therapy (e.g., cognitive-behavioral therapy, anger management training, social skills workshops) [41]. Our data suggests those who received such interventions did better, supporting investment in these services.

Caregiver and Family Support: Since family plays a pivotal role in the patient's social environment, providing education and support to caregivers on how to manage personality changes could improve outcomes. This might include counseling, support groups, or training on behavior management at home.

Vocational Rehabilitation Programs: With nearly 60% not back to work at one-year, **vocational rehabilitation** needs to be a priority. Programs that involve occupational therapy, workplace accommodations, and gradual re-entry plans can help bridge the gap. Employers may need education about TBI survivors' needs. Aligning with evidence that early vocational rehab enhances outcomes, we recommend initiating return-to-work planning during inpatient rehab itself [42].

Follow-up and Monitoring: The health system should ensure sustained follow-up for TBI patients beyond just the acute phase. Many issues like depression or social isolation might emerge months after injury. A structured follow-up at 6, 12, and 24 months focusing on holistic outcomes (physical, cognitive, emotional, social) could catch problems early and prompt interventions [43].

Preventive Measures: On a broader note, the high proportion of TBI due to MVAs underscores the ongoing need for injury prevention (enforcing traffic safety, etc.) . Fewer TBIs mean fewer individuals suffering these life-altering sequelae in the first place.

Research: Our findings highlight areas for future research, such as prospective studies to better quantify personality changes using standardized tools, or interventional trials to test specific therapies (for example, evalu-

ating the efficacy of a structured social cognition training program on improving community integration for TBI patients).

Conclusion

Conclusion: This retrospective manuscript reports behavioral and social outcomes after traumatic brain injury. Underlying case records, ascertainment, follow-up and analyses require independent verification.

The relationship between behavioral changes, rehabilitation and social recovery requires appropriately designed research, verified data and careful assessment of confounding before drawing clinical or policy conclusions.

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