Exploring Mental Health and Drinking Pattern Profiles of Traumatic Brain Injury Patients in Tanzania

by

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Thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science in the Duke Global Health Institute
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ABSTRACT

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Abstract

Background: Globally, traumatic brain injury (TBI) accounts for the highest burden of deaths and disabilities globally. Studies suggest a complex relationship between injury, mental health, and alcohol. Though hazardous alcohol use and TBI exert heavy burdens in Tanzania, their interaction with mental health is largely unknown. This study aims to explore the mental health and alcohol use profiles of TBI patients in a low-income country.

Methods**:** Secondary data analysis of a registry of adults (≥ 18) with TBI of any severity presenting to the Kilimanjaro Christian Medical Center (KCMC) Emergency Department (ED) within 24 hours of injury. Patient data were collected at ED arrival and at three months follow-up. Variables included measures of functional independence, psychiatric health, quality of life, and alcohol use. Hazardous alcohol use was defined as an Alcohol Use Disorder Identification Test (AUDIT) score greater than seven. We conducted a latent profile analysis (LPA) to determine pre-injury mental health profiles of patients and logistic regression to assess association of patient profile with hazardous drinking at three months after injury.

Results**:** Of 190 participants, 51 (26.8%) were hazardous drinkers. The majority of the sample was male (83.7%) and the median age was 29.5 years. The LPA model with the strongest fitness revealed five profiles of mental health and drinking patterns. The

"Poor Mental Health Drinkers" (9.4%) profile had worse quality of life and higher depression and hazardous drinking scores. The "Disabled Non-drinkers" (11.4%) profile had worse motor functional independence and low hazardous drinking scores. The "Non-drinkers" (53.5%) had good quality of life, little to no depression, good functional independence and low hazardous drinking scores. The "Drinkers" were similar to the "Non-drinkers" profile, except with high hazardous drinking scores. Predictors of hazardous drinking three months post-injury included disability and being a hazardous drinker before injury.

Conclusions**:** This study provides insight into the possible mental health and drinking pattern profiles for TBI patients. The categorization of patients may help in resource allocation of alcohol interventions for those who are at the highest risk for hazardous alcohol use. Limitations included recall bias for pre-injury information.

Dedication

This thesis is dedicated to my family whose loving presence keeps me grounded. A special thank you to my parents for believing in me and encouraging me to achieve my dreams. Without you, this opportunity would not have been possible.

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I am particularly thankful for our collaborators at the Kilimanjaro Christian Medical Center who made this research possible and demonstrated what a strong research partnership looks like. A special thanks to our local Tanzanian team who embraced me warmly and worked hard to produce high quality data. I would also like to acknowledge all the research participants for their voluntary contribution to science.

Finally, I would like to thanks my peers for their unrelenting support and encouragement. Sahar offered invaluable social support in accompanying me to write this thesis at countless coffee shops in both Moshi and North Carolina. Similarly, I will forever be indebted to Cyrus for the countless hours he dedicated to sitting with me and answering my coding, clinical, and life questions. This thesis would not have been possible without everyone acknowledged here

1. Introduction

Injuries, mental health disorders, and alcohol use disorders account for 18.6% of disability adjusted life years (DALYS) worldwide (Murray et al., 2012). While we know these three poor health outcomes are typically associated with one another, the interactions between them are not well-known, especially in low- and middle-income countries (LMIC).

1.1 Traumatic Brain Injury Burden

Injury and violence account for about 10% of the global annual mortality, which translates to over 5 million deaths (Lozano et al., 2012). The global injury burden has been augmented by a recent rise in death due to falls and road traffic injuries (RTI), which cause 1.4% and 27% of injuries, respectively (Lozano et al., 2012)(Murray et al., 2012). Estimates indicate that every year sixty-nine million people sustain a traumatic brain injury (TBI) globally (Dewan et al., 2018).

TBI has been defined by the Center for Disease Control (CDC) as a head injury due to blunt or penetrating trauma (Thurman, 1999). TBI may result in physical, cognitive, behavioral, or social impairments (Benedictus, Spikman, & van der Naalt, 2010). Major cognitive defects include impaired memory, mental speed, and concentration (Benedictus et al., 2010). Behavioral problems include irritability and loss of initiative (Benedictus et al., 2010). The negative effects of TBI can be so severe that some patients are not able to return to work long after the initial injury (Benedictus et

al., 2010).

LMICs are disproportionately affected by TBI, where injuries account for 90% of deaths (World Health Organization, 2010). TBI burden is especially high in northwestern Tanzania with about 1,000 patients presenting to the outpatient and casualty departments at Kilimanjaro Christian Medical Center (KCMC) annually (Staton et al., 2017). A study done in the Mwanza region of Tanzania reports 55.2% of motorcycle injuries are head injuries, and those with head injuries have a significantly longer hospital stay (Chalya et al., 2010). Mortality is about 10% for TBI patients in the casualty department at KCMC. At least 68% of the 500 patients admitted to the intensive care unit are TBI patients (Staton et al., 2017).

1.2 Alcohol-related Injuries

The fifth leading risk factor for disease and injury worldwide is alcohol use (Murray & Lopez, 2013). Studies show positive blood alcohol concentration and self-reported alcohol use within the six hours prior to injury is associated with an increased risk of injury (Vinson et al., 1995)(Watt, Purdie, Roche, & McClure, 2004). Recurrent injuries among those treated in an emergency department (ED) after a motor vehicle crash is often associated with alcohol use (Fabbri et al., 2005). Self-reported drinking any amount of alcohol within the last 12 months lead to higher odds of sustaining a TBI among adolescents (Ilie et al., 2015).

The risk for alcohol-related injury is magnified among those with lower

educational levels and socioeconomic status (SES) (World Health Organization & Management of Substance Abuse Unit, 2014). As SES is an important predictor of alcohol-related mortality, understanding the burden within LMIC context is essential (Makela, 1999). Tanzania is one of the poorest African nations with a gross national income per capita below 500 USD (Booysen, van der Berg, Burger, Maltitz, & Rand, 2008). In the northwestern region of Tanzania alone, 26.8% of TBI patients were alcohol positive (admitted to using alcohol within 6 hours of injury or tested positive for alcohol use by breathalyzer) on arrival at the ED for treatment (Staton et al., 2017).

1.3 Alcohol Use Disorders

Alcohol use disorders include hazardous drinking (exceeding the recommended alcohol consumption thresholds) and harmful drinking (experiencing physical, social, or psychological harm due to excessive drinking) (Whitlock, Polen, Green, Orleans, & Klein, 2004). Alcohol use disorders put people at risk for disease and injury (Rehm et al., 2009). Alcohol-attributable deaths makeup 5.3% of all mortality in people under the age of 60 (Rehm et al., 2009).

Alcohol use disorders have a disproportionate effect on LMICs. Increased rates of smoking, obesity, and bingeing on top of poorer nutrition and access to healthcare lead to higher risk for alcohol-related harm for drinkers in LMICs (World Health Organization & Management of Substance Abuse Unit, 2014) (Bellis et al., 2016). Africa had as many as 70.6 alcohol-attributable deaths per 100,000 people in the year

2016 (World Health Organization, 2019). According to the World Health Organization, the prevalence of heavy episodic drinking (consuming more than 59 grams of pure alcohol in a single occasion at least once monthly) is 17.4% among those older than 15 years in Tanzania (World Health Organization, 2019).

1.4 Alcohol and Psychological Well-being

Hazardous drinking has been associated with depressive symptoms, anxiety, and poor quality of life in HICs (Mäkelä, Raitasalo, & Wahlbeck, 2015). In Iceland, heavy alcohol users, as compared to the general population, had double the morbidity risk for mental disorders (Helgason & Tómasson, 1996). Many mental health disorders may take a larger toll on role functioning than many other physical chronic diseases and have a significantly negative impact on patients' quality of life (Kessler, Greenberg, Mickelson, Meneades, & Wang, 2001) (Ormel et al., 1994) (Wells et al., 1989). Psychiatric disorders that are comorbid with alcohol use disorders are typically more severe than those occurring independently from harmful or hazardous drinking (Berglund & Ojehagen, 1998). Most studies on alcohol use disorders do not include those with psychiatric comorbidities (Schuckit, 2009).

1.7 Gap in the Literature

Currently there is little data defining the relationship between alcohol use and psychological well-being, cognitive ability, or functionality among injury patients in LMICs (Jané-Llopis & Matytsina, 2006). Although we have data from HICs, these results

cannot necessarily be generalized to other settings. Without data from Tanzania or similar LMICs, we cannot properly conclude the magnitude of the burden of alcohol use and mental health disorders among TBI patients in their unique setting. Knowing the underlying burden of mental health and alcohol use among TBI patients could support the development of locally relevant interventions for quality of care improvement in Tanzania. Likewise, understanding which sub-groups of the population are at higher risk of hazardous drinking after a TBI may help providers better allocate limited resources and target interventions to reduce post-injury alcohol use.

1.8 Research Aims

The relationship between alcohol use, psyhcological well-being, cognitive ability, and functionality in TBI patients is currently poorly defined, especially in LMIC settings. This study aims to explore the baseline health and alcohol use profiles of TBI patients in Northern Tanzania, their relationship with sociodemographic factors, and their association with hazardous drinking after three months.

2. Methods

2.1 Ethical Consideration

The Ethics Committee at the Kilimanjaro Christian Medical Center and the Institutional Review Board of Duke University granted approval for the prospective TBI registry data collection and analysis.

2.2 Setting

This study took place at the Kilimanjaro Christian Medical Center (KCMC), the third largest hospital in Tanzania and referral center for the northwestern region of the country. This tertiary care center serves over 15 million people from both urban and rural areas. TBI patients make up 6% of all ED visits at KCMC and about one-third are alcohol positive on arrival (Staton et al., 2017).

2.3 Participants

The target population was acute TBI patients with injury of any severity. Inclusion criteria were being 18 years or older, being functional enough to answer survey questions, being able to speak Swahili or English, and agreeing to participate in the study before being discharged from the hospital. Participants were recruited from adults who were part of a TBI patient registry and post-hospitalization cohort study in Northern Tanzania.

2.4 Procedures

After admission, medical stabilization, informed consent, and being enrolled in the study, all survey instruments were administered to patients at their bedside and three-month follow-up data was collected over the phone. Patients who were unconscious or otherwise unable to answer survey questions were followed during their hospital stay until they were well enough to answer. While the prospective registry included data from patients' hospital stay, it did not require an informed consent as it was a quality improvement project. All patients who were going to follow-up with our research project consented to being enrolled and their data, which was collected during the registry, was then used to augment any follow-up data. Data from surveys collected on paper were kept anonymous by unique identifiers that were kept separately from personal identifiers. This data was entered into REDCAP, an online data system, and stored there behind the Duke firewall. Patients were aware that if they were found to have at-risk behavior or mental health issues, their confidentiality might be broken so they could be referred to a mental health professional for further treatment or care. This study is a secondary analysis of this de-identified dataset.

2.5 Measures

Psychological well-being of patients was measured by the Patient Health Questionnaire (PHQ-9), Kessler Psychological Distress (Kessler) and Short Form Health Survey (SF-8). Cognitive ability was measured by the Montreal Cognitive Assessment

(MoCA). Functionality was measured by the Functional Independence Measure and Functional Assessment Measure (FIM+FAM). Alcohol use was measured by the Alcohol Use Disorder Identification Test (AUDIT). To measure scale reliability we used Cronbach's alpha, with a coefficient above 0.7 considered acceptable (DeVellis, 2016). All scales were validated in for use in Tanzania.

2.5.1 Functional Independence Measure and Functional Assessment Measure

The FIM+FAM is a two-dimensional scale that is used to measure motor functionality and cognitive functionality. The cognitive subscale consists of 14 items with a response range from 1 to 7 for a maximum score of 98. The motor subscale consists of 16 items with a response range from 1 to 7 for a maximum score of 112. A total FIM+FAM score can range from 30 to 210. Our Tanzanian validated version has a Cronbach's alpha of 0.97, indicating strong reliability (Pestillo De Oliveira, Barcenas, et al., n.d.). The higher a patient's FIM+FAM score, the more functionally independent he or she is considered.

2.5.2 Patient Health Questionnaire

The PHQ-9 is a scale that measures depression. It has nine items with a response range from 0 to 3 and a maximum score of 18. One example of a question is, "In the past two weeks, how often have you been bothered by little interest or pleasure in doing things?" with responses being: "not at all", "several days", "more than half the days", and "nearly everyday". Scores greater than nine are considered depressed (Kohrt,

Luitel, Acharya, & Jordans, 2016)(Volker et al., 2016). Our Tanzanian validated version had a Cronbach's alpha score of 0.81 demonstrating strong reliability (Vissoci et al., n.d.).

2.5.3 Short Form Health Survey

The SF-8, which measures quality of life, has eight items with either a five- or six-point response range for a maximum score of 34. Our Tanzanian validated version had a Cronbach's alpha score of 0.89, indicating strong reliability (Pestillo De Oliveira, Sakita, Mmbaga, Staton, & Vissoci, n.d.). The higher the SF-8 score, the poorer quality of life a patient has.

2.5.4 Montreal Cognitive Assessment

The MoCA is a tool used to measure attention, executive function and memory. We used a version validated for Tanzania with a total of 10 items, a maximum score of 30, and a Cronbach's alpha score of 0.78, indicating strong reliability (Vissoci, Leonardo Pestillo De Oliveira, et al., n.d.). A higher MoCA score indicates better cognitive function.

2.5.5 Kessler Psychological Distress

The Kessler Psychological Distress scale is a two-dimensional instrument that measures both depression and anxiety. The depression subscale has six items with a response range of 0 to 4 for a maximum score of 24, while the anxiety subscale has four items with a maximum score of 16 (Vissoci, 2018). The total scale ranges from 0 to 40 and

7 is considered an optimal cut-off point when classifying patients' overall depression or anxiety (Tesfaye, Hanlon, Wondimagegn, & Alem, 2010). No cut-off points have been determined at the sub-scale level. A higher Kessler Psychological Distress score indicates higher risk of depression or anxiety.

2.5.6 Alcohol Use Disorders Identification Test

Substance abuse will be measured by the Alcohol Use Disorders Identification Test (AUDIT) instrument. The AUDIT has 10 items with a response range from 0 to 4 and a Cronbach's alpha of 0.85, showing strong reliability (Vissoci et al., 2018). A score above 7 out of a possible 40 is used to indicate hazardous alcohol use (Vissoci, Friedman, et al., n.d.).

2.6 Analysis

All observed variables used to measure psychological well-being, cognitive ability, functionality, and alcohol use were converted to factor scores. Factor scores were calculated by the weighted dimension according to the factor loadings that were derived using confirmatory factor analysis. We conducted a latent profile analysis (LPA) to identify any distinct sub-groups of TBI patients based on the variables we collected at baseline. Individuals with a similar distribution of observed variables were grouped together creating a latent variable that cannot be directly measured, which we call a profile. We ran models with numbers of profiles varying from 3 to 6 and assessed model

fitness through: a) model interpretability, or the extent to which a model may represent a theoretical hypothesis b) profile size, with only profiles containing greater than 5% of the sample considered true profiles, and c) Bayesian information criteria (BIC) and log-likelihood.

We then assessed the association between each profile and hazardous drinking three months post-injury using logistic regression. All analyses were conducted using RStudio (Team, 2017).

3. Results

3.1 Patient Demographics

A total of 190 patients were initially enrolled, out of which 76 were followed-up after three months. Table 1 shows the demographic and mental health characteristics of the sample at baseline. The majority of the sample was male (83.7%). The most common mechanism of injury was RTI (65.9%) and patients were alcohol positive in 38.5% of injuries. Most of the sample population sustained mild injury severity (85.6%).

Table 1: Sample Demographics and Injury Characteristics

		Baseline
Age median (IQR)		29.5 (24, 45)
Sex N (%)	Male	158 (82.3%)
Mechanism of Injury N (%)	RTI	87 (65.9%)
	Assault	15 (11.4%)
	Other	30 (22.7%)
Alcohol Positive N (%)	Yes	50 (38.5%)
Injury Severity N (%)	Mild	113 (85.6%)
	Moderate	16 (12.1%)
	Severe	3 (2.3%)
TBI Surgery N (%)	Yes	34 (26.4%)
Other Surgery N (%)	Yes	25 (19.4%)

Though we had a wide range in age from 18 to 73 years, the median age was 29.5 years (see Figure 1). While females make up a much smaller percentage of the sample, the prevalence of females was relatively consistent across age with younger males far

outnumbering younger females.

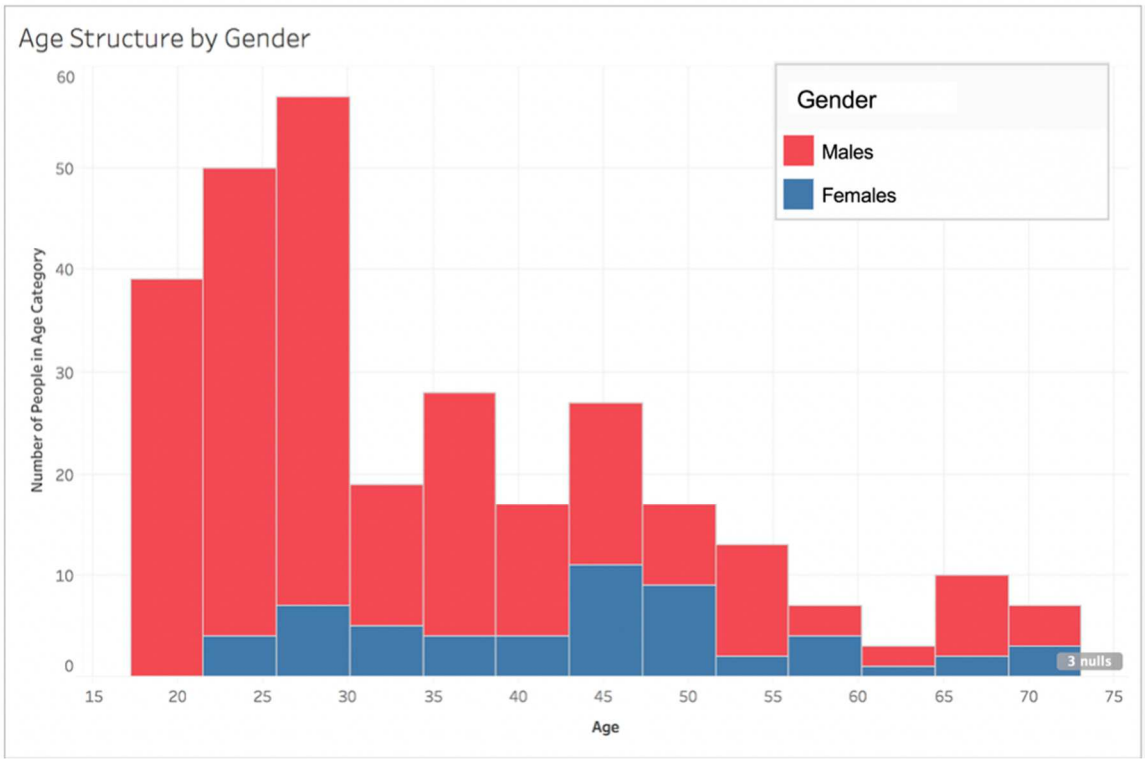

Figure 1: Age structure of the study population colored by gender

Overall, the sample population had low depression and anxiety scores at both baseline and three-month follow-up. According to the PHQ-9 scale, one person was considered depressed at baseline, and three people endorsed feeling bothered by feeling like a failure or letting their family down nearly everyday. Two people were considered depressed based on the PHQ-9 at three month follow-up. On the depression sub-scale of the Kessler, two people responded that in the last four weeks they felt hopeless all the time, and three people said that they felt everything was an effort all the time. The most highly endorsed items on the anxiety sub-scale of the Kessler included "in the last four

weeks how often did you feel nervous?" and "in the last four weeks how often did you feel so restless that you could not sit still?", which each had one response of "all the time" and two of "most of the time".

Patients had overall good quality of life, functionality, and cognitive ability at baseline and three months follow-up. Two people rated their overall health in the last four weeks as "very poor", while 151 rated it as excellent at baseline on the SF-8. One person reported physical health limiting their physical activities "quite a lot" over the past four weeks and 177 patients said "not at all". On the motor sub-scale of the FIM+FAM, eleven patients reported neededing total assistance (or contributing less than 25% of effort) with bathing and showering, while 127 were fully independent. Locomotion and transfers made up the greatest source of poor motor functional independence, with ---% needing any assistance walking, --- % needing any assistance using stairs, and -- % needing any assistance being transferred to a bed or chair. On the cognitive sub-scale of the FIM+FAM, only one patient needed assistance with expression and comprehension. Patients had the worst cognitive functionality when it came to reading and writing with --% and --% needing total assistance, respectively. According to the MoCA, 33.9% of the sample could not repeat a list of 5 digits, 34.7% could not repeat a list of 3 digits backwards, and 65.6% could not name more than 11 words that start with the letter "F" in one minute.

On average, hazardous drinking scores were low at baseline and three-month follow-up. In terms of frequency of drinking at baseline, 21 people drink alcohol four or more times per week with two people drinking ten or more drinks, one person drinking 7-9 drinks, four people drinking 5-6 drinks, 35 people drinking 3-4 drinks, and 148 people drinking 1-2 drinks per sitting. Four people reported being injured or injuring someone due to their drinking in the last year

Table 2: Sample Characteristics of Psychological Well-being, Cognitive Ability, Functionality and Alcohol Use

	Baseline median (IQR)	3 months median (IQR)
PHQ-9	0 (0;0)	0 (0;0)
Kessler Depression	6 (6; 7)	6 (6; 8)
Kessler Anxiety	4 (4; 4)	4 (4; 4)
SF-8	0 (0;1)	2 (0;8)
FIM+FAM Motor	111 (88; 112)	112 (112; 112)
FIM+FAM Cognitive	96 (89; 98)	98 (98; 98)
MoCA	9 (7;11)	11 (9;13)
AUDIT	2 (0;9)	1.5 (0;4)

3.2 Profiles of TBI Patients

Latent profile analysis revealed four profiles of mental health among TBI patients in Tanzania at time of enrollment as shown in Figure 2 and detailed in Table 3. The "Non-drinkers", the largest group (53.5%), had a median AUDIT score of 0. The

"Drinkers" made up 25.5% of the sample and the median AUDIT score was 9.5. The "Poor Mental Health Drinkers" made up 13% of the sample and scored higher than other groups on depression (measured by the Kessler scale), anxiety, poor quality of life, and hazardous drinking. The "Disabled Non-drinkers" (11.4%) had low motor functional independence and low hazardous drinking scores.

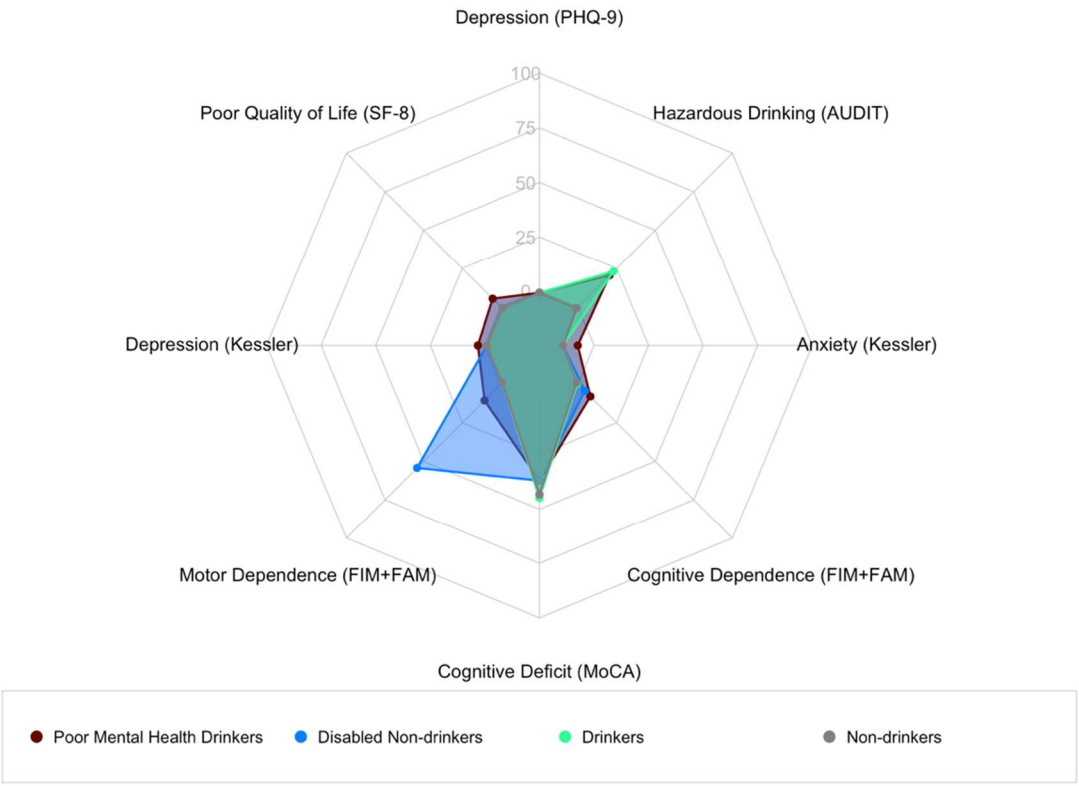

Figure 2: Four mental health profiles by median of each characteristic

Table 3: Mental Health Characteristics by Profile

	Overall	Poor Mental Health Drinkers	Disabled Non-drinkers	Drinkers	Non-drinkers	p-value

N (%)	192 (100%)	18 (9.4%)	22 (11.4%)	49 (25.5%)	103 (53.5%)	
PHQ-9 median (IQR)	0 (0; 0)	0 (0; 1)	0 (0; 0)	0 (0; 1)	0 (0; 0)	0.001
Kessler Depression median (IQR)	6 (6; 7)	7 (6; 8)	6 (6; 6)	6 (6; 8)	6 (6; 6)	< 0.001
Kessler Anxiety median (IQR)	4 (4; 4)	6 (5; 7)	4 (4; 4)	4 (4; 4)	4 (4; 4)	<0.001
SF-8 median (IQR)	0 (0; 1)	1.5 (0;3)	0 (0; 0)	0 (0; 3)	0 (0; 0)	<0.001
FIM+FAM Motor median (IQR)	111 (88; 112)	101 (81; 112)	59.5 (38; 86)	112 (104; 112)	112 (94; 112)	< 0.001
FIM+FAM Cognitive median (IQR)	96 (89; 98)	90.5 (86; 98)	93.5 (91; 98)	97.5 (92; 98)	98 (89; 98)	0.29
MoCA median (IQR)	9 (7; 11)	10 (8; 10)	10 (7; 12)	9 (8; 11)	9 (6; 11)	0.82
AUDIT median (IQR)	2 (0; 9)	8.5 (0.5; 12)	0 (0; 3)	9.5 (2; 14)	0 (0; 3)	<0.001

Poor Mental Health Drinkers tended to be older (median = 40 years), more female, and have higher severity injuries. Disabled Non-drinkers tended to be older (median = 39 years) and had a high percentage of polytrauma (55%). Non-drinkers and Drinkers had lower median ages of 28 and 27 years, respectively.

		Overall	Poor Mental Health Drinkers	Disabled Non-drinkers	Drinkers	Non-drinkers	p-value
Sample Size N (%)		192 (100%)	18 (9.4%)	22 (11.4%)	49 (25.5%)	103 (53.5%)	
Age median (IQR)		29.5 (24; 42)	40 (36; 51)	39 (28; 53)	27 (24; 36)	28 (23; 38)	0.03
Sex N (%)	Male	159 (83%)	13 (72%)	16 (73%)	44 (90%)	86 (83%)	0.36
Mechanism of Injury N (%)	RTI	87 (66%)	9 (60%)	11 (85%)	23 (68%)	44 (63%)	0.25
	Assault	15 (11%)	4 (27%)	1 (8%)	3 (9%)	7 (1%)	
	Other	30 (23%)	2 (13%)	11 (8%)	23 (24%)	44 (27%)	
Alcohol Positive N (%)	Yes	50 (38%)	8 (53%)	1 (8%)	17 (52%)	24 (34%)	0.09
Injury Severity N (%)	Mild	113 (86%)	10 (67%)	13 (100%)	30 (88%)	60 (86%)	0.27
	Moderate	16 (12%)	4 (27%)	0 (0%)	4 (12%)	8 (11%)	
	Severe	3 (2%)	1 (7%)	0 (0%)	0 (0%)	2 (3%)	
TBI Surgery N (%)	Yes	34 (26%)	4 (27%)	3 (27%)	8 (24%)	19 (28%)	0.97

Other Surgery N (%)	Yes	25 (19%)	4 (27%)	6 (55%)	4 (12%)	11 (16%)	0.01

Table 4: Baseline Sample Characteristics by Profile

3.3 Profile Association with Hazardous Drinking at Three Months

Logistic regression reveals that profiles more likely to drink at baseline are still more likely to drink at three-month follow-up. We also see that those who became disabled were more likely to develop hazardous drinking than those who had more functional independence.

Table 5: Odds of Hazardous Drinking Three Months Post-injury

	Odds	CI	p-value
Poor Mental Health Drinkers	7.6	(1.2, 52.8)	0.03
Disabled Non-drinkers	5.4	(0.9, 35.2)	0.06
Drinkers	25.33	(6.1, 139.4)	<0.001
Non-drinkers	REF	REF	REF

4. Discussion

This is the first paper, to our knowledge, to examine the relationship between mental health, drinking patterns, and TBI in a LMIC setting. A greater understanding of the mental health and drinking patterns of TBI patients can improve resource allocation of alcohol interventions by helping providers identify groups of patients at a higher risk for hazardous drinking. We identified four profiles of mental health and drinking patterns among our sample, related patient profile at time of injury to sociodemographics, and showed that patients who already drink or developed a disability are more likely to drink three months post-injury.

The four profiles of mental health and drinking patterns were primarily shaped by the AUDIT and FIM motor scores as drinking habits and motor functional independence had the most variability among the sample population. Drinking patterns vary widely among the African population as one major religion, Islam, forbids alcohol use while Christianity, the other major religion, allows it (Odejide, 2006).We also see that the majority of people do not use alcohol in the African region, but those who do use alcohol drink heavily (World Health Organization, 2019). Mental health played a less significant role in creating the profiles, as there was less variation among the sample. A lower variance may be due in part to the lower prevalence of depression in LMIC settings or better mental health among young men, our primary population (Kessler & Bromet, 2013)(Angst et al., 2002)(Afifi, 2007).

The four profiles built on mental health and drinking characteristics also differed by sociodemographic characteristics. Both groups that contained more drinkers had higher percentages of males, as men have been found to be more likely to be drinkers (Francis et al., 2015). The "Poor Mental Health Drinkers" profile might have relatively higher severity of injury because the patient group has a higher median age. Older age has been linked to higher injury severity and increased mortality, possibly due to preexisting comorbidities (Demetriades et al., 2004) (Roozenbeek, Maas, & Menon, 2013). The "Poor Mental Health Drinkers" profile also contained the largest percentage of females. Though Tanzanian specific data is lacking, females in general report more depressive symptoms (Angst et al., 2002) (Dalgard et al., 2006). The "Disabled Non-drinkers" group had the highest percentage of other surgeries performed, indicating polytrauma. We suspect those with physical disabilities, having less motor control, may be more prone to polytrauma, however data on this subject is lacking. The "Drinkers" and "Non-drinkers" profiles made up larger percentages (25.5% and 53.5%) of the sample than the other two profiles and had lower median ages (27 and 28 years). Being that adolescents are more likely to drink and engage in risky behavior, younger people may be more prone to injury (Steinberg, 2004) (Francis et al., 2015).

Hazardous alcohol use at three-month follow-up was most strongly associated with those who were drinkers before the injury. Our results fit with previous evidence, collected in HIC settings, showing that alcohol use prior to injury is indicative of

problems with alcohol use post-injury (Bombardier, Temkin, Machamer, & Dikmen, 2003) (Jorge et al., 2005). Those with the highest risk for hazardous drinking post-injury in our sample were the "Drinkers" group, which aligns with evidence showing that the most likely to be hazardous drinkers post-injury were young, males who were hazardous drinkers pre-injury (Ponsford, Whelan-Goodinson, & Bahar-Fuchs, 2007) (Horner et al., 2005). We also see increased risk of hazardous drinking in the "Disabled Non-drinkers" group. Increased alcohol use after TBI and before full recovery has been seen before in HIC settings (Corrigan, Selassie, & Orman, 2010). An increase in drinking after three months could be because patients are using alcohol to manage the pain brought on by their injury (Zale, Maisto, & Ditre, 2015). While there is currently little data available to support that alcohol is commonly used as a coping mechanism for those with physical disabilities, greater levels of pain have been shown to be linked to greater alcohol use in HIC settings (Lawton & Simpson, 2009).

4.1 Implications for Policy and Practice

Knowing who has a higher risk of developing hazardous alcohol use after injury is important so that providers can target people who may benefit from drinking interventions that may not present as drinkers upon admission.

4.2 Implications for Further Research

Additional studies are needed to determine the prevalence of various mental health disorders in sub-Saharan Africa, as well as the link between disability and alcohol

use. Subsequent studies should focus on developing locally relevant alcohol reduction interventions targeted for injury patients with physical disabilities.

4.3 Limitations

Recall bias is one limitation of this study as patients were asked after their injury about the status of their pre-injury mental health and drinking patterns. Social desirability bias is another concern since patients may change their responses to be perceived as more socially acceptable by the researchers. For example, patients may be hesitent to admit that they cry or feel like a failure. Being that patients had to be well enough to answer survey questions, we are potentially missing a group of the most severe patients who could not speak or died. Another limitation is the loss to follow-up in our three-month data. If the loss to follow-up is differential to an unmeasured variable, it could introduce confounding in the logistic regeression.

5. Conclusion

Drinking and physical ability were the most important factors differentiating TBI patients. Sociodemographic factors such as age and gender are related to patient mental health and drinking classification. Hazardous drinkers and those with lower physical functionality before injury are more likely to experience hazardous drinking after injury.

This study provides insight into the possible mental health and drinking pattern profiles a TBI patient may fall into. Categorizing patients may help with resource allocation of alcohol interventions for those who are at the highest risk for hazardous alcohol use after injury.

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