

# **Predicting the Contribution of Age at First Substance Use and Post-Traumatic Stress Disorder to Later Addiction Severity in a Clinical Sample from Sub-Saharan Africa: Implications for Prevention and Treatment**

Boniface Harerimana<sup>1,2,3,4</sup>, Michael Kerr<sup>1</sup>, Richard Csiernik<sup>5</sup>, Lauren C. Ng<sup>6</sup>, Eugene Rutembesa<sup>4</sup> & Cheryl Forchuk<sup>1,2,7</sup>

<sup>1</sup>Faculty of Health Sciences, Arthur and Labatt School of Nursing, Western University, London, Ontario, Canada

<sup>2</sup>Lawson Health Research Institute, Parkwood Institute, 550 Wellington Road, B3-110, STN B, P.O. Box 5777, London, Ontario, N6A 4V2, Canada

<sup>3</sup>Ndera Neuro-Psychiatric Hospital, Kigali, Rwanda

<sup>4</sup>Department of Clinical Psychology, College of Medicine and Health Sciences, University of Rwanda, Kigali, Rwanda

<sup>5</sup>School of Social Work, King's University College, Western University Ontario, London, Ontario, Canada

<sup>6</sup>Department of Psychologist, University of California Los Angeles, Los Angeles, CA, USA

<sup>7</sup>Department of Psychiatry, School of Medicine and Dentistry, Western University, London, Ontario, Canada

## **Abstract**

This study sought to examine the extent to which age at first substance use contributes to later addiction severity and how PTSD affects their relationships. The study enrolled 315 patients from tertiary addiction services in Rwanda. The participants' mean age at first substance use was 18.64 years (SD = 6.1) old. Age at first substance use had a significant effect ( $\beta = -0.130$ ,  $p = .013$ ) on later addiction severity. PTSD showed significant association with later addiction severity ( $\beta = 0.363$ ;  $p < .001$ ). The variance explained by age at first substance use and PTSD increased from  $R^2$  adjusted = .013 to 14.7; 14.7, and this was statistically significant with  $F(8637) = 28.054$ ,  $p < .001$ . The study demonstrates that early age at first substance use coupled to PTSD significantly predict more later addiction severity. This suggests prevention and clinical practice that aimed at improving addiction care outcomes should consider addressing potential consequences of associations between PTSD and addiction issues among persons seeking addiction treatment services.

**Keywords:** Addiction severity; Age at first substance; Initial substance use; Onset of substance use; Posttraumatic stress disorder (PTSD); Rwanda; Sub-Saharan Africa; Substance use.

## Background

Early use of substances has been associated with more severe addictions and subsequent poor treatment outcomes (Chen et al. 2009; Donoghue et al.2017). Early age at first substance use can lead to different addiction use trajectories, including (1) early-onset and severe SUD symptoms persisting into adulthood, (2) early-onset in adolescence that improves in adulthood, and (3) SUD symptoms emerging later with varying degrees of severity and persistence (Clark et al. 2006). Additionally, early age at first substance use not only negatively impacts mental health outcomes, but it also influences the addiction recovery process. Earlier age at inaugural substance use exerts a significant influence on later severe SUDs and constitutes a risk factor for comorbid mental health issues (Behrendt et al. 2009; Chenetal.2009; Dawsonetal.2007). Early age at first substance use can also extend the addiction recovery process (Dennis et al. 2005), influence relapse frequency (Landheim et al. 2006a), and suicide attempts (Landheim et al. 2006b). To date, available evidence on associations between age at first substance use and later SUD varied across study populations, and research conducted in regions other than North America and Europe, especially sub-Saharan Africa (SSA) is scarce (Degenhardt et al. 2016). However, the majority of SSA countries is disproportionately affected by fragile security and armed conflicts (World Bank 2019); which are among factors for proliferation of psychoactive substances in the region (Hankins et al. 2002; Ralston2014). This dearth of research may obstruct interventions toward the growing substance use issues, such as alcohol use disorders and subsequent deaths among youth in Africa (Francis et al. 2014; WHO 2014).

Globally, substantial evidence links first alcohol use, before 18 years old, with higher alcohol and other drug disorders (DeWit et al. 2000; Donoghueet al. 2017; King and Chassin 2007). In Canada, individuals consuming alcohol between the ages of 11 and 14 had more risk

for developing alcohol disorders compared with those who started drinking alcohol after the age of 19 (DeWit et al. 2000). Donoghue et al. (2017) in a study conducted in the UK likewise found a strong association between age of the first alcohol consumption, before the age of 15, tobacco use, lower quality of life, and emergency room admissions for alcohol use disorders among adolescents. Similarly, a recent systematic review of prospective studies highlighted the impact of early first alcohol use on future alcohol use disorders (Maimaris and McCambridge 2014). In a birth cohort study, Newton-Howes and Boden (2016) demonstrated that early age of first drug use significantly increased the risk for later alcohol use disorders, nicotine dependence, and illicit drug dependence. However, after controlling for covariate factors, such as family living standards, ethnicity, and childhood sexual abuse, earlier first substance use was found to have no significant associations with these SUDs (Newton-Howes and Boden 2016). In an Australian study, young age substance exposure was associated with later polydrug use, such as methamphetamine and heroin (Darke et al. 2012). In contrast to the above evidence, other research found no statistically significant associations between early-age substance use and later SUD (Guttmanova et al. 2011; Maimaris and McCambridge 2014; Newton-Howes and Boden 2016). A few studies conducted in SSA reported the age at onset of only two types of psychoactive substances, alcohol (Osaki et al. 2018), and tobacco (Townsend et al. 2006; Veeranki et al. 2017). In youth tobacco surveys from nine Western Africa countries, Veeranki et al. (2017) found that the age of smoking onset was as early as 7 years old. Osaki et al. (2018) in a Tanzanian secondary school and college students aged 15–24 found that the age of alcohol consumption was as early as 10 years old. Contextual factors for alcohol use onset included exposure to a stressful environment, social events, and home alcohol consumption under the influence of parents, relatives, peers, and intimate partners (Osaki et al. 2018). Likewise, a

systematic review for cross-country comparison by Townsend et al. (2006) demonstrated that tobacco use primarily began in late adolescence and early adulthood in SSA. However, Townsend et al. (2006) found no association between tobacco use and socioeconomic status or urban/rural difference. The strength of the association between first substance use to SUD seems to be moderated by contextual factors.

Variations in the strength of associations between first substance use and SUD may be partially explained by environmental factors, such as life adversity and conflict-related psychology strains (Ertl et al. 2016; Mandavia et al. 2016; Naal et al. 2018; Thege et al. 2017). In the recent UK Millennium Cohort Study of 10,498 11-year-old participants, having a friend who drank was a strong risk factor for increased alcohol use patterns (Kelly et al. 2016). Besides, McCann et al. (2016) indicated that relationships, including higher levels of parental control and lower levels of child openness to parents, were linked with less frequent alcohol use. Furthermore, childhood traumatic experiences in the forms of severe and mild physical abuse significantly correlated with an earlier age at first alcohol consumption, as well as illicit and polydrug use (Darke and Torok 2014). Other factors, such as premorbid cognitive deficit (Newton et al. 2011) early-age major depression (Sintov et al. 2009), bipolar disorders (Lagerberg et al. 2011), and impulse control (Pasetti et al. 2013) influence early-age substance use and addiction trajectory following first substance. Additionally, interactions between premorbid mental health deficits and the effects of substance use on cognitive development may influence the early substance use onset and rapid spirals into substance dependence (Newton et al. 2011).

Overall, there is little and inconsistent evidence on the association between early age at first substance use and later severe addiction issues worldwide. While the associations between

PTSD and SUD are well documented, little is known about how young age substance use coupled to PTSD contributes to later severe addiction. Likewise, PTSD has been studied somewhat in SSA and substantially in Rwanda (Munyandamutsa et al. 2012; Neugebauer et al. 2009; Schaal and Elbert 2006); however, there is minimal data on associated substance misuse. The identified studies focused on a few substances and did not examine the transition from first use to addiction and contributors to later addiction severity.

### **Purpose**

The present study sought to investigate the association between age at first substance use and later addiction severity. The study also investigated if contextual factors, such as posttraumatic disorder and the person's demographics, are associated with addiction severity following early-age inaugural substance use.

## **Methods and Materials**

### **Study Design**

This cross-sectional analysis is a component of an extensive prospective study that developed and tested an addiction recovery model among patients seeking addiction care in Rwanda (Harerimana 2020).

### **Settings**

The study recruited all individuals admitted to two existing referral mental health settings in Rwanda: CARAES Ndera Neuropsychiatric Hospital and Huye Rehabilitation Centre over a period of 8 months, between September 2018 and April 2019.

### **Sampling**

The study used consecutive sampling techniques to screen 362 participants who were referred to the study, only 342 of whom were eligible, and 315 (92.1%) consented to participate

in the study. Given that addiction issues do not have any known seasonal fluctuations, consecutive sampling was the most reliable form of non-probability sampling, which can achieve a representative sample within a short time (Lunsford and Lunsford 1995). Participants were included in the sample if they were aged 18 years old and over, had been diagnosed with any substance use disorder, presented for intake or relapse assessment, able to answer questions, and willingly provided consent. Participants were excluded from the sample if they had severe cognitive impairment assessed by physicians. This was verified by checking the participant's medical records. Also, participants seeking follow-up care and those admitted for court-ordered treatment were excluded because they were deemed to have non-active substance use in the last 30 days. This study was approved by the university and the internal review board of participating mental health settings. Before recruitment and data collection, participant informed consent was sought and obtained by research assistants, who were trained nurses and psychologists with at least their first degree.

### **Data Collection and Procedures**

The study collected data using structured face-face interviews that were conducted at one point in time; typically, a week before the patient was discharged from the hospital. Data collection interviews were conducted by research assistants, registered mental health nurses, and psychologists who received 1-week training in the use of the study protocol. Data were transferred from paper-based questionnaires into an SPSS database by one research team member, and a second member checked and validated the accuracy of the entered data.

### **Dependent Variable**

Addiction severity was measured using the Addiction Severity Index (ASI) lite version (McLellan et al. 2006). The ASI assesses disturbances during the previous 30 days across seven

domains, including medical status, employment/occupation status, alcohol use, drug use, legal status, family/social status, and psychiatric status. Calculations of addiction severity weight were guided by the ASI composites score weighting instructions (McGahan et al. 1986). The total score on all seven composites is seven, i.e., a maximum score of one at each composite, and a high overall rating indicates severe addiction problems. This ASI weighting procedure for each of addiction severity areas has been validated and showed significant convergent validity and has a high predictive validity (Bovasso et al. 2001). The study that tested the scale found good reliability with an alpha coefficient of at least 0.70 across all composites (Cronbach and Furby 1970; McLellan et al. 1985). The present study had an overall Cronbach's alpha coefficient of  $\alpha$  0.68.

### **Independent Variables**

This study has three independent variables of interest: age at first substance use and posttraumatic distress. Data corresponding to age (continuous variables) for first substance use were collected with the ASI lite instrument (McGahan et al. 1986). The participant's posttraumatic distress experiences (continuous variable) as measured by the PTSD Checklist-Civilian (PTSD-C) version. The PTSD-C instrument assesses a patient's PTSD through three clusters, including re-experiencing, avoidance, and hyperarousal symptoms. PTSD-C is a 17-question checklist that has demonstrated good psychometric properties in a psychiatric sample, including internal consistency ( $\alpha = .40$  to  $0.74$ ) and test-retest reliability ( $\alpha = 0.92$ ,  $p < .001$ ; Ruggiero et al. 2003). In this study, the internal consistency reliability of PTSD-C was  $\alpha$  0.92.

### **Control Variables**

Control variables consisted of participants' age, area of residence, sex, level of education, motives for substance use, and living with active substance users were analyzed before the multivariate analyses.

### **Data Analysis**

Data analysis was conducted in IBM Statistical Package for Social Sciences, 26th version. Initially, analyses consisted of conducting descriptive statistics for sociodemographic variables and bivariate analyses between addiction severity and potential confounding variables, including the level of education in years (with Pearson correlation), areas of residence, sex, motives, living with active alcohol, and non-prescribed drugs using one-way analysis of variance (ANOVA). Then, a hierarchical regression model consisted of entering the age at first substance use, followed by the other variables, PTSD as well as the level of education, area of residency, as both of which showed significant bivariate relationships with addiction severity. Regression diagnostics were performed to check whether there were potential violations of the linear regression assumptions.

## **Results**

### **Sample Characteristics**

The response rate was 100.0% ( $n = 315$ ) of participants who were screened for eligibility for the study. The mean age of participants was 30.7 ( $SD = 8.9$ ) with years of education ranging from 0 to 24 with the mean years of education being 10.9 ( $SD = 4.5$ ). The majority of participants were male ( $n = 293$ ; 97.7%), living in urban areas ( $n = 237$ ; 75.2%), and had never married ( $n = 242$ ; 76, 8%), with almost half ( $n = 152$ ; 48.3%) living with parents and a small proportion ( $n = 9$ ; 2.9%) having unstable living arrangements. Unskilled workers ( $n = 119$ ; 37.8%) and students ( $n = 61$ ; 19.4%) constituted a significant proportion of participants. A few



participants were living with individuals who are active users of alcohol ( $n = 94$ ; 29.8%) or non-prescribed medications ( $n = 68$ ; 21.6%) (Table 1).

**Table 1. Sample Characteristics**

| <b>Characteristic</b>                         | <b>Estimates</b>  |
|-----------------------------------------------|-------------------|
| Mean age                                      | 30.70 (SD = 8.9)  |
| Sex (n)                                       |                   |
| • Female                                      | 23 (7.3%)         |
| • Male                                        | 292 (92.7%)       |
| Years of formal education                     | 10.90 (SD = 4.54) |
| Residence (n)                                 |                   |
| • Rural                                       | 78 (24.8%)        |
| • Urban                                       | 237(75.2%)        |
| Marital status                                |                   |
| • Married                                     | 46 (14.6%)        |
| • Remarried                                   | 4 (1.3%)          |
| • Widowed                                     | 3 (1%)            |
| • Separated                                   | 12 (3.8%)         |
| • Divorced                                    | 8 (2.5%)          |
| • Never married                               | 242 (76.8%)       |
| Occupation/Employment                         |                   |
| • Higher executives & Major professional      | 5 (1.6%)          |
| • Business Managers                           | 11 (3.5%)         |
| • Administrative Professionals                | 31 (9.8%)         |
| • Clerical & Technicians                      | 38 (12.1%)        |
| • Skilled Manuals                             | 30 (9.5)          |
| • Unskilled                                   | 119 (56.8%)       |
| • Students & No occupation                    | 61 (19.4%)        |
| <b>Living arrangement in the past 3 years</b> |                   |
| • With sexual partner and children            | 42 (13.3%)        |
| • With sexual partner alone                   | 5 (1.6%)          |
| • With children alone                         | 3 (1.0%)          |
| • With parents                                | 152 (48.3%)       |
| • With family relatives                       | 46 (14.6%)        |
| • With friends                                | 12 (3.8%)         |
| • Alone                                       | 44 (14.0%)        |
| • Controlled environment (e.g. prison)        | 2 (0.6%)          |

- No stable arrangement

9 (2.9%)

### Clinical Estimates for Substance Use Among the Sample

The mean age at first substance use was 18.6 years ( $SD = 6.1$ ) old with a range of 5 to 48 years. The top motives for first substance use were social modeling, i.e., complying with peer and family habits ( $n = 184$ ; 58.4%) and self-medication ( $n = 82$ ; 26%). The mean lifetime years of substance use was 2.5 ( $SD = 1.1$ ) while the number of substances used varied between one and seven. The mean daily substance use during the last 30 days was approximately three times (2.8;  $SD = 3.6$ ), and the median number of admissions for alcohol and/or drug detoxification equated to 2.5 ( $SD = 1.0$ ) and 2.5 ( $SD = 1.0$ ) admissions respectively. The PTSD-C mean score was 33.7 ( $SD = 13.6$ ), which is clinically suggestive of significant PTSD symptoms (Table 2).

**Table 2. Addiction-Related Estimates**

| Variables                                                       | Estimates            |
|-----------------------------------------------------------------|----------------------|
| Mean score for overall ASI weight                               | 1.5 ( $SD=0.6$ )     |
| Mean daily substance use in the last 30 days                    | 2.8 ( $SD = 3.59$ )  |
| Lifetime substance use (years)                                  | 2.5 ( $SD= 1.05$ )   |
| The median number of admissions for alcohol/drug detoxification | 3 (IQ range = 3 -1)  |
| Median age at first substance use                               | 18 (Range= 5 - 48)   |
| Motives for substance use                                       |                      |
| • Social modelling                                              | 184 (58.4%)          |
| • Self-medication                                               | 82 (26%)             |
| • Recreational effect seeking                                   | 31 (9.8%)            |
| • Ignorance                                                     | 18 (5.7%)            |
| Number of types of substances ever misused                      | 1.78 (Range = 1 -7)  |
| Living with active alcohol user (s)                             |                      |
| • Yes                                                           | 94 (29.8%)           |
| • No                                                            | 221 (70.8%)          |
| Living with active non- prescribed drug user (s)                |                      |
| • Yes                                                           | 68 (21.6%)           |
| • No                                                            | 247 (78.4%)          |
| Mean score on PTSD                                              | 33.7 ( $SD= 13.58$ ) |

Notes: Overall ASI weight represents the overall weight score on seven, a maximum score possible across all composites for addiction severity domains. The post-traumatic disorders checklist, the civilian version (PTSD-CV) is used to assess PTSD with a score  $\geq 30$  indicates probable diagnosis, depending on the prevalence rate in general population, (National Center for PTSD, 2012). <https://sph.umd.edu/sites/default/files/files/PTSDChecklistScoring.pdf>

### **Testing Assumptions**

Before regression analyses, correlation analyses showed that only two independent variables: age at first substance use and PTSD had linear relationships with addiction severity. Age at first substance use had a significant negative correlation coefficient ( $-0.129, p \leq .05$ ) with addiction severity. PTSD score was significantly correlated with addiction severity ( $r = .42, p \leq .01$ ). A one-way analysis of variance indicated no statistically significant association between addiction severity and any of motives for first substance use, self-medication, social modeling, recreation effect seeking, and ignorance with  $F(113, 380) = 0.873, p = .46$ . Among demographic variables, only participants' level of education ( $r = .14, p = .006$ ) had statistically significant correlations with addiction severity (Table 3). The regression model included age at first substance use, PTSD, and level of education after checking for assumptions (Table 3).

All continuous variables were normally distributed for each independent variable. A test of collinearity by variance inflation factor was  $VIF \leq 1003$  for all variables, which indicates the absence of multicollinearity (Schroeder et al. 1990). The analysis of residuals showed that the residual mean difference (predicted and observed cases) was equal to  $< 0.001$  ( $SD = 0.54$ ), which indicates homoscedasticity (Verran and Ferketich 1987).

### **Test of Associations**

The first step of a hierarchical regression model tested the contribution of age at first substance use to later addiction severity. The results ( $R^2$  adjusted = .013) indicate that the model accounted for 1.3% of the variance in the addiction severity scores; this is statistically significant ( $F(1, 811) = 5.082, p < .025$ ). The second step consisted of adding PTSD scores into the model.

Age at first substance coupled with PTSD into the same model explained 14.7% of the variance in addiction severity with a statistical significance of  $F(8, 637) = 28.054, p < .001$ . The results indicate that PTSD accounted for 13.4% of the total variance.

**Table 3. Correlations between addiction severity and independent variables**

| Variables                    | 1      | 2      | 3    | 4   |
|------------------------------|--------|--------|------|-----|
| 1 Later addiction severity   | 1.0    |        |      |     |
| 2 Age at first substance use | -.129* | 1.0    |      |     |
| 3 PTSD                       | .422** | -.114* | 1.0  |     |
| 4 Level of education         | .141*  | 0.065  | 0.03 | 1.0 |

Note. \*\*Significant at  $P \leq .01$ , \*Significant at  $P \leq .05$  (Pearson correlation coefficient,  $r$ , two-tailed).

The final model consisted of entering the last variable, and the level of education (in years) was entered in the regression model. The regression model significantly predicts 16.3% variations in addiction severity ( $F(6, 446) = 21.327, p < .001$ ), and all independent variables have statistically significant contributions (see Table 4).

**Table 4. A model predicting the effect of independent variables on later addiction severity**

| Model terms                | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig.  | 95.0% Confidence Interval for B |             |
|----------------------------|-----------------------------|------------|---------------------------|-------|-------|---------------------------------|-------------|
|                            | B                           | Std. Error |                           |       |       | Beta                            | Lower Bound |
| (Constant)                 | .934                        | .142       |                           | 6.569 | <.001 | .654                            | 1.213       |
| Age at first substance use | -.013                       | .005       | -.129                     | 2.492 | .013  | -.023                           | -.003       |
| PTSD Scores                | .016                        | .002       | .363                      | 7.020 | <.001 | .012                            | .021        |
| Level of education         | .018                        | .007       | .135                      | 2.613 | .009  | .004                            | .031        |

Note: Dependent variable: Later addiction severity

### Contribution of Age at First Substance Use to Later Addiction Severity

Results of the regression model show that age at first substance use is a significant predictor ( $\beta = -0.129, p = .013$ ) of later addiction severity after controlling for contextual factors, participants' PTSD, and level of education. The results indicate that for each additional

year of delay in age at first substance use predicted a reduction of 0.013 (95%, CI – 0.023, – 0.003) out of seven, the maximum score of addiction severity.

### **Effect of PTSD on the Association Between Age at First Substance Use and Later Addiction Severity**

PTSD scores show significantly increased variance in addiction severity explained by the model that involves age at first substance use (from 1.3 to 14.7%). PTSD was also the most potent predictor in the final model with  $\beta = 0.363$ ,  $p < .001$ . The results imply that a rise of one unit in PTSD scores increases addiction severity score by 0.016 (95% CI 0.12, 0.21), which translates that PTSD is the strongest predictor of variations in the dependent variable.

### **Contribution of Participants' Characteristics to Later Addiction Severity**

The regression model indicated that participants' level of education has a significant positive contribution to later addiction severity ( $\beta = 0.135$ ,  $p = .009$ ). Each year of education predicts an increase of 0.018 (95%, CI 0.004, 0.031) in addiction severity. No relationships between other participants' characteristics (e.g., sex, residence, motives, living arrangements) and addiction severity were found.

## **Discussion**

The present study examined the extent to which age, motives for the first substance use, and PTSD influence later addiction severity. The study results demonstrate that first substance use occurs as early as 5 years old. Half of the sample have had their initial psychoactive substance before or at their 18th birthday. The majority of participants were male (97.7%), which suggests that fewer female participants sought addiction services in Rwandan mental health settings during the study period. This gender difference in addiction service utilization may require further exploration. The study results also suggest that the Rwandan clinical cohort had

the first substance use 2 years earlier compared with other SSA populations (Townsend et al. 2006; Veeranki et al. 2017). Among the study participants, substance use patterns could be as severe as using seven different types of psychoactive substances, and up to nearly three times daily. The identified substance patterns are worrisome because of potential increases in risks for negative neurobiological changes that result from regular substance and polydrug use, especially before the brain fully matures. Such brain changes have the potential to contribute to maladaptive cognition, motivation, and affective states throughout a person's entire lifetime (Hanlon and Canterbury 2012; Nestler 2008, 2014).

In many ways, the study results support previous studies which indicated that early-age exposure to substance use increases risks for severe addiction. The results suggest that delayed first substance use may be associated with a significant reduction of risks for addiction severity. Such risks may vary with the type of substance consumed. Previous research has shown significant associations between poor mental health outcomes, such as psychosis onset, and age at onset of cannabis use but not of alcohol use (Galvez-Buccollini et al. 2012). Progressing from first cannabis use to cannabis use disorders takes a shorter time than for alcohol and nicotine, whereas polysubstance use speeds up transitions to addiction disorders (Wittchen et al. 2008).

By establishing the contribution of age at first substance use and addiction severity, these results reinforce previous findings on the progression of addiction trajectories following the first substance use (Novins and Baron 2004). The study also supports previous evidence on increased risks for polysubstance use among individuals exposed to earlier psychoactive drug use (Novins and Baron 2004; Wittchen et al. 2008). As such, the present study results call for research testing the effectiveness of health promotion and prevention interventions aimed at delaying the age of exposure to first substance use. The implementation of such interventions may face difficulties

since drinking cultural norms, in some SSA countries, permit alcohol drink during childhood, especially at family social events. Moreover, long-term instability predominant in SSA countries (World Bank 2019) may add to the complexity of earlier substance use. Long-term instability may lead to the absence of adults moderating how and when young people can drink and use of a substance to self-medicate for posttraumatic disorders.

The present study further underscores the influence of PTSD on later complications of addiction problems after early-age first substance use. Besides, coupling PTSD and young age at first substance use indicate a statistically significant increase in addiction severity (from 1.3 to 14.7% of variance accounted by both variables). The identified increase in variance explained by PTSD (13.4%) emphasizes that PTSD is a significant predictor of later addiction severity among individuals who face early substance use problems. These results are consistent with previous research, which associated early childhood experience of trauma with early substance use onset and transition to polydrug use (Darke and Torok 2014). Additionally, previous handful evidence has consistently established associations between SUD and PTSD and provided explanatory hypotheses underlying these associations. Given that at SSA populations such Rwandans had experienced horrific events (Munyandamutsa et al. 2012; Neugebauer et al. 2009; Schaal and Elbert 2006), these results may be interpreted through well-documented risky use of psychoactive substances for coping with postdisaster distress (Alexander and Ward 2018; Khantzian 1997; Leeiesetal. 2010). However, it is challenging to delineate which of the two conditions occurs first because SUD and PTSD affect the stress processing system. Chronic SUD, such as alcohol use disorders, increased individual vulnerability to PTSD due to alcohol-related defects of endocrinal response to distress events and reduced cortisol release (Delahanty et al. 2000; Richardson et al. 2008). On the other hand, PTSD influences neurotransmitters

changes, such as serotonin, in the hypothalamic-pituitary-adrenaline axis, which have been linked to risks for worsened SUD (Enoch 2006; Sinha 2008; Stanton 2019).

The identified positive association between level of education and addiction severity may be partially explained by the Rwandan cultural and conception of mental illness. Cultural expectations are strict on the use of alcohol that interferes with social and professional functioning (Adekunle 2007). Thus, educated people may find it challenging to seek early help for their SUD due to fear of being subject to attached stigma (Smith and Vedaste 2016) and use psychoactive substances as self-medication.

### **Strengths and Limitations**

The present study, to our knowledge, is the first to investigate the contributions of age, motives for first substance use, and posttraumatic distress to later addiction problems using a clinical sample in sub-Saharan Africa. The study used a compelling alternative to the random sampling strategy, recruiting every participant presenting for inpatient addiction care in two existing settings over 8 months.

This study has a few limitations, including relying on self-reported data that may be prone to recall (Raphael 1987) and social desirability (Van de Mortel 2008) biases. However, we attempted to minimize these biases by collecting data through face-to-face semi-structured interviews conducted by trained and qualified mental health professionals who were not part of a healthcare circle (Raphael 1987).

### **Conclusions**

The present study demonstrates that substance use at an earlier age is significantly associated with later severe addiction issues. Besides, posttraumatic disorders had an increased and significant effect on the associations between age at first substance use and later severe



addiction. The study results also highlight alarming substance use patterns among Rwandans seeking addiction care. Among the study participants, substance use patterns included over two times and up to seven different types of psychoactive substances per day, along with an average of three-lifetime readmissions for detoxification care. However, the study found no evidence on associations between addiction severity and any participants' characteristics, except the level of education. Given participants reported substance use onset at as early as 5 years of age, the study results call for research testing preventive interventions dedicated to delay first substance use during early childhood. The results also inform policy-managers and stakeholders of the necessity for prevention interventions that target individuals in the aftermath of traumatic experiences to mitigate the identified association between PTSD and severe addiction. Finally, this study suggests that clinical practice may consider screening individuals seeking addiction care for PTSD, and concurrently treat both conditions. These approaches may require dedicated training for the healthcare professionals, since Rwanda as with many other SSA countries has an acute scarcity of qualified mental health professionals, especially in the addiction domain. Also, mental health promotion interventions should include components that address cultural and conceptions that may constitute a barrier to early support for SUD and mental health issues. Limitations of the present study warrants future research that can better elucidate the life course of addiction issues after early first substance use. Furthermore, the present study underscores the need for research testing interventions exploring and addressing contextual factors for early-age substance use and transition to severe addiction issues in SSA, especially in Rwanda.

## References

- Adekunle, J. (2007). Culture and customs of Rwanda. USA: Greenwood, Publishing Group.
- Alexander, A. C., & Ward, K. D. (2018). Understanding postdisaster substance use and psychological distress using concepts from the self-medication hypothesis and social cognitive theory. *Journal of Psychoactive Drugs, 50*(2), 177–186.
- Behrendt, S., Wittchen, H. U., Höfler, M., Lieb, R., & Beesdo, K. (2009). Transitions from first substance use to substance use disorders in adolescence: is early onset associated with a rapid escalation? *Drug and Alcohol Dependence, 99*(1–3), 68–78.
- Bovasso, G. B., Alterman, A. I., Cacciola, J. S., & Cook, T. G. (2001). Predictive validity of the Addiction Severity Index's composite scores in the assessment of 2-year outcomes in a methadone maintenance population. *Psychology of Addictive Behaviors, 15*(3), 171–176.
- Chen, C.-Y., Storr, C. L., & Anthony, J. C. (2009). Early-onset drug use and risk for drug dependence problems. *Addictive Behaviors, 34*(3), 319–322.
- Clark, D. B., Jones, B. L., Wood, D. S., & Cornelius, J. R. (2006). Substance use disorder trajectory classes: diachronic integration of onset age, severity, and course. *Addictive Behaviors, 31*(6), 995–1009.
- Cronbach, L. J., & Furby, L. (1970). How we should measure “change” or should we? *Psychological Bulletin, 74*(1), 68–80.
- Darke, S., & Torok, M. (2014). The association of childhood physical abuse with the onset and extent of drug use among regular injecting drug users. *Addiction, 109*(4), 610–616. <https://doi.org/10.1111/add.12428>.
- Darke, S., Kaye, S., & Torok, M. (2012). Age-related patterns of drug use initiation among polydrug using regular psychostimulant users. *Drug and Alcohol Review, 31*(6), 784–789. <https://doi.org/10.1111/j.1465-3362.2012.00436.x>.
- Dawson, D. A., Grant, B. F., & Li, T. K. (2007). Impact of age at first drink on stress-reactive drinking. *Alcoholism: Clinical and Experimental Research, 31*(1), 69–77.
- Degenhardt, L., Stockings, E., Patton, G., Hall, W. D., & Lynskey, M. (2016). The increasing global health priority of substance use in young people. *The Lancet Psychiatry, 3*(3), 251–264.
- Delahanty, D. L., Raimonde, A. J., & Spoonster, E. (2000). Initial posttraumatic urinary cortisol levels predict subsequent PTSD symptoms in motor vehicle accident victims. *Biological Psychiatry, 48*, 940–947.
- Dennis, M. L., Scott, C. K., Funk, R., & Foss, M. A. (2005). The duration and correlates of addiction and treatment careers. *Journal of Substance Abuse Treatment, 28*(2), S51–S62. doi:10.16/j.jsat.2004.10.013.
- DeWit, D. J., Adlaf, E.M., Offord, D. R., & Ogborne, A. C. (2000). Age at first alcohol use: a risk factor for the development of alcohol disorders. *American Journal of Psychiatry, 157*(5), 745–750.
- Donoghue, K., Rose, H., Boniface, S., Deluca, P., Coulton, S., Alam, M. F., et al. (2017). Alcohol consumption, early-onset drinking, and health-related consequences in adolescents presenting at emergency departments in England. *Journal of Adolescent Health, 60*(4), 438–446.
- Enoch, M. A. (2006). Genetic and environmental influences on the development of alcoholism. *Annals of the New York Academy of Sciences, 1094*(1), 193–201. <https://doi.org/10.1196/annals.1376.019>.

- Ertl, V., Saile, R., Neuner, F., & Catani, C. (2016). Drinking to ease the burden: a cross-sectional study on trauma, alcohol abuse and psychopathology in a post-conflict context. *BMC Psychiatry*, *16*(1), 202. International Journal of Mental Health and Addiction
- Francis, J. M., Grosskurth, H., Chagalucha, J., Kapiga, S. H., & Weiss, H. A. (2014). Systematic review and meta-analysis: prevalence of alcohol use among young people in eastern Africa. *Tropical Medicine & International Health*, *19*(4), 476–488.
- Galvez-Buccollini, J. A., Proal, A. C., Tomaselli, V., Trachtenberg, M., Coconcea, C., Chun, J., Manschreck, T., Fleming, J., & Delisi, L. E. (2012). Association between age at onset of psychosis and age at onset of cannabis use in non-affective psychosis. *Schizophrenia Research*, *139*(1–3), 157–160. <https://doi.org/10.1016/j.schres.2012.06.007>.
- Guttmanova, K., Bailey, J. A., Hill, K. G., Lee, J. O., Hawkins, J. D., Woods, M. L., & Catalano, R. F. (2011). Sensitive periods for adolescent alcohol use initiation: predicting the lifetime occurrence and chronicity of alcohol problems in adulthood. *Journal of Studies on Alcohol and Drugs*, *72*(2), 221–231.
- Hankins, C. A., Friedman, S. R., Zafar, T., & Strathdee, S. A. (2002). Transmission and prevention of HIV and sexually transmitted infections in war settings: implications for current and future armed conflicts. *Aids*, *16*(17), 2245–2252.
- Hanlon, C. A., & Canterberry, M. (2012). The use of brain imaging to elucidate neural circuit changes in cocaine addiction. *Substance Abuse and Rehabilitation*, *3*, 115.
- Harerimana, B. (2020). Developing and evaluating an integrated addiction recovery model for the persons' engagement and retention in the recovery process among clinical populations from Rwanda (a doctoral dissertation). Western University.
- Kelly, Y., Goisis, A., Sacker, A., Cable, N., Watt, R. G., & Britton, A. (2016). What influences 11-year-olds to drink? Findings from the Millennium Cohort Study. *BMC Public Health*, *16*(1), 169.
- Khantzian, E. J. (1997). The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. *Harvard Review of Psychiatry*, *4*(5), 231–244. <https://doi.org/10.3109/10673229709030550>.
- King, K. M., & Chassin, L. (2007). A prospective study of the effects of age of initiation of alcohol and drug use on young adult substance dependence. *Journal of Studies on Alcohol and Drugs*, *68*(2), 256–265.
- Lagerberg, T. V., Sundet, K., Aminoff, S. R., Berg, A. O., Ringen, P. A., Andreassen, O. A., & Melle, I. (2011). Excessive cannabis use is associated with earlier age at onset in bipolar disorder. *European Archives of Psychiatry and Clinical Neuroscience*, *261*(6), 397–405.
- Landheim, A. S., Bakken, K., & Vaglum, P. (2006a). Impact of comorbid psychiatric disorders on the outcome of substance abusers: a six-year prospective follow-up in two Norwegian counties. *BMC Psychiatry*, *6*(1), 44. <https://doi.org/10.1186/1471-244X-6-44>.
- Landheim, A. S., Bakken, K., & Vaglum, P. (2006b). What characterizes substance abusers who commit suicide attempts? Factors related to Axis I disorders and patterns of substance use disorders. *European Addiction Research*, *12*(2), 102–108. <https://doi.org/10.1159/000090430>.
- Leeies, M., Pagura, J., Sareen, J., & Bolton, J. M. (2010). The use of alcohol and drugs to self-medicate symptoms of posttraumatic stress disorder. *Depression and Anxiety*, *27*(8), 731–736.
- Lunsford, T. R., & Lunsford, B. R. (1995). The research sample, part I: sampling. *JPO: Journal of Prosthetics and Orthotics*, *7*(3), 17A.

- Maimaris, W., & McCambridge, J. (2014). Age of first drinking and adult alcohol problems: a systematic review of prospective cohort studies. *Journal of Epidemiology and Community Health, 68*(3), 268–274.
- Mandavia, A., Robinson, G. G., Bradley, B., Ressler, K. J., & Powers, A. (2016). Exposure to childhood abuse and later substance use: indirect effects of emotion dysregulation and exposure to trauma. *Journal of Traumatic Stress, 29*(5), 422–429.
- McCann, M., Perra, O., McLaughlin, A., McCartan, C., & Higgins, K. (2016). Assessing elements of a family approach to reduce adolescent drinking frequency: parent-adolescent relationship, knowledge management, and keeping secrets. *Addiction, 111*(5), 843–853.
- McGahan, P. L., Griffith, J. A., Parente, R., & McLellann, A. T. (1986). Composite scores manual. PA: Treatment Research Institute Philadelphia.
- McLellan, A. T., Luborsky, L., Cacciola, J., Griffith, J., Evans, F., Barr, H. L., & O'Brien, C. P. (1985). New data from the Addiction Severity Index: reliability and validity in three centres. *Journal of Nervous and Mental Disease., 173*, 412–423.
- McLellan, A. T., Cacciola, J. C., Alterman, A. I., Rikoon, S. H., & Carise, C. (2006). The Addiction Severity Index at 25: origins, contributions and transitions. *The American Journal on Addictions, 15*(2), 113–124.
- Munyandamutsa, N., Nkubamugisha, P. M., Gex-Fabry, M., & Eytan, A. (2012). Mental and physical health in Rwanda 14 years after the genocide. *Social Psychiatry and Psychiatric Epidemiology, 47*(11), 1753–1761.
- Naal, H., El Jalkh, T., & Haddad, R. (2018). Adverse childhood experiences in substance use disorder outpatients of a Lebanese addiction centre. *Psychology, Health & Medicine, 23*(9), 1137–1144.
- Nestler, E. J. (2008). Transcriptional mechanisms of addiction: role of  $\Delta$ FosB. *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*(1507), 3245–3255.
- Nestler, E. J. (2014). Epigenetic mechanisms of drug addiction. *Neuropharmacology, 76*, 259–268. *International Journal of Mental Health and Addiction*
- Neugebauer, R., Fisher, P. W., Turner, J. B., Yamabe, S., Sarsfield, J. A., & Stehling-Ariza, T. (2009). Posttraumatic stress reactions among Rwandan children and adolescents in the early aftermath of genocide. *International Journal of Epidemiology, 38*(4), 1033–1045.
- Newton, N. C., O'Leary-Barrett, M., & Conrod, P. J. (2011). Adolescent substance misuse: neurobiology and evidence-based interventions. *Behavioral Neurobiology of Alcohol Addiction* (pp. 685–708). Berlin, Springer.
- Newton-Howes, G., & Boden, J. (2016). Relation between age of first drinking and mental health and alcohol and drug disorders in adulthood: evidence from a 35- year cohort study. *Addiction, 111*(4), 637–644.
- Novins, D. K., & Baron, A. E. (2004). American Indian substance use: the hazards for substance use initiation and progression for adolescents aged 14 to 20 years. *Journal of the American Academy of Child and Adolescent Psychiatry, 43*(3), 316–324. <https://doi.org/10.1097/01.chi.0000108621.24694.26>.
- Osaki, H., Mshana, G., Mbata, D., Kapiga, S., & Changalucha, J. (2018). Social space and alcohol use initiation among youth in northern Tanzania. *PLoS One, 13*(9), e0202200.
- Passetti, F., Verdejo-Garcia, A., & Abou-Saleh, M. (2013). Comparatively preserved impulse control in late onset opiate users. *Psychopharmacology, 230*(3), 499–505.
- Ralston, L. (2014). Trafficking and fragility in West Africa. The World Bank.

- Raphael, K. (1987). Recall bias: a proposal for assessment and control. *International Journal of Epidemiology*, 16(2), 167–170.
- Richardson, H. N., Lee, S. Y., O'dell, L. E., Koob, G. F., & Rivier, C. L. (2008). Alcohol self-administration acutely stimulates the hypothalamic-pituitary-adrenal axis, but alcohol dependence leads to a dampened neuroendocrine state. *European Journal of Neuroscience*, 28, 1641–1653.
- Ruggiero, K. J., Del Ben, K., Scotti, J. R., & Rabalais, A. E. (2003). Psychometric properties of the PTSD checklist—civilian version. *Journal of Traumatic Stress*, 16(5), 495–502.
- Schaal, S., & Elbert, T. (2006). Ten years after the genocide: trauma confrontation and posttraumatic stress in Rwandan adolescents. *Journal of Traumatic Stress*, 19(1), 95–105.
- Schroeder, M. A., Lander, J., & Levine-Silverman, S. (1990). Diagnosing and dealing with multicollinearity. *Western Journal of Nursing Research*, 12(2), 175–187.
- Sinha, R. (2008). Chronic stress, drug use, and vulnerability to addiction. *Annals of the New York Academy of Sciences*, 1141(1), 105–130. doi: <https://doi.org/10.1196/annals.1441.030>.
- Sintov, N. D., Kendler, K. S., Walsh, D., Patterson, D. G., & Prescott, C. A. (2009). Predictors of illicit substance dependence among individuals with alcohol dependence. *Journal of Studies on Alcohol and Drugs*, 70(2), 269–278.
- Smith, A. A. H., & Vedaste, B. (2016). 'In principle, yes, in application, no': Rwandan nurses' support for integration of mental health services. *Africa Journal of Nursing and Midwifery*, 18(1), 170–182.
- Stanton, B. (2019). Exploring craving among individuals with co-occurring trauma and substance use disorders (doctoral dissertation). Azusa Pacific University.
- Thege, B. K., Horwood, L., Slater, L., Tan, M. C., Hodgins, D. C., & Wild, T. C. (2017). Relationship between interpersonal trauma exposure and addictive behaviors: a systematic review. *BMC Psychiatry*, 17(1), 164.
- Townsend, L., Flisher, A. J., Gilreath, T., & King, G. (2006). A systematic literature review of tobacco use among adults 15 years and older in sub-Saharan Africa. *Drug and Alcohol Dependence*, 84(1), 14–27.
- Van de Mortel, T. F. (2008). Faking it: social desirability response bias in self-report research. *Australian Journal of Advanced Nursing*, 25(4), 40.
- Veeranki, S. P., John, R. M., Ibrahim, A., Pillendla, D., Thrasher, J. F., Owusu, D., Ouma, A. E. O., & Mamudu, H. M. (2017). Age of smoking initiation among adolescents in Africa. *International Journal of Public Health*, 62(1), 63–72.
- Verran, J. A., & Ferketich, S. L. (1987). Testing linear model assumptions: residual analysis. *Nursing Research*, 36(2), 127–130. doi: <https://doi.org/10.1097/00006199-198703000-00014>.
- Wittchen, H. U., Behrendt, S., Höfler, M., Perkonig, A., Lieb, R., Bühringer, G., & Beesdo, K. (2008). What are the high-risk periods for incident substance use and transitions to abuse and dependence? Implications for early intervention and prevention. *International Journal of Methods in Psychiatric Research*, 17(S1), S16–S29.
- World Bank. Fragile and conflict-affected situations. World Bank Group; 2019. Retrieved from: <https://data.worldbank.org/region/fragile-and-conflict-affected-situations>.
- World Health Organization, 2014. Global status report on alcohol and health, 2014: World Health Organization. Geneva: WHO Press.