Childhood Trauma and Post-traumatic Stress Disorder (PTSD) among Adolescent girls and young women aged between 18-28 years in Mpumalanga, South Africa: A Cross-sectional Study

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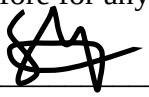
A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Master of Epidemiology in the field of Epidemiology and Biostatistics.

Johannesburg, 2024

DECLARATION

I Siyanda Alex Madala declare that this Research Report is my own, unaided work. It is being submitted for the Degree of Master of Science in Epidemiology in the Field of Epidemiology and Biostatistics at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



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(Signature of candidate)

22nd day of October 2024 in Johannesburg

Dedication

First and foremost, I would like to dedicate this piece of work to my Lord and Savior Jesus Christ who has been a constant and relentless helper in the good, the bad, and the ugly times. I owe every fiber of my being to him for the Grace he has bestowed upon me.

After God, I must dedicate this piece of work to my lovely and beautiful wife Sandisiwe Madala. God made you for me baby. I love you very much and you have been a wonderful spouse, friend, and confidant. I wish that this work could be an inspiration to our kids Yayama Madala and Yonwaba Madala. Guys, the thought of contributing positively to the world has been significantly influenced by you.

I can't forget my mother Nosipho Madala, my mothers-in-Law Lindelwa Matshoba and Zukiswa Gxabela. Your support to our family will always be appreciated.

Thank you very much my family. I am truly grateful and blessed to be numbered among you.

Abstract

Introduction

Background: Post traumatic stress disorder (PTSD), is a mental disorder which has been found to be associated with comorbid mental and physical disorders, as well as reduced quality of life. Children who have experienced traumatic events (TEs) before the age of 18 are at risk of physical disorders, mental disorders, and substance abuse later in life but more evidence is needed regarding their risk of PTSD.

Main objective: To examine the association between PTSD and childhood TEs among adolescent girls and young women (AGYW) aged between 18 and 28 years in Agincourt, South Africa, in 2015-2017 utilising Complete Case Analysis (CCA). We also examined the effect of using Multiple Imputation (MI) or Inverse Probability Weighting (IPW) given the large proportion of missing values, on the estimated measure of association.

Methods

This study was a secondary analysis of cross-sectional data from a Randomised Controlled Trial (RCT). PTSD and childhood TEs data were collected between 2015 and 2017 from AGYW. Participants who had at least one childhood TE were included in the secondary analysis. Univariable and multivariable logistic regression models were used for the analyses. In addition to carrying out a CCA, MI, and IPW were utilised as methods for handling missing data.

Results

There were 1175 participants who met the inclusion criteria. The mean age of the study participants was 20.1 years with a standard deviation of 1.3 years. In the CCA multivariable model, PTSD was found to be associated with childhood TEs (aOR=1.69, 95% CI 1.01-2.47). This association remained after accounting for missing data in the MI multivariable model (aOR= 2.06, 95% CI 1.35-3.15), and the IPW multivariable model (aOR= 1.49, 95% CI 1.01-2.21).

Conclusion

We found that PTSD was associated with childhood TEs with the odds of experiencing PTSD increasing with increasing childhood TEs. The data were not MCAR, and CCA was biased as an analysis method. MI and IPW improved the analysis. Future analyses could use simulated data to examine which method performs better between MI and IPW.

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Ndibamba ngazo zozibini (thank you in isiXhosa).

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Chapter 1

1. Introduction

1.1.Background

Post-Traumatic Stress Disorder (PTSD) is a mental disorder dependent on a previous traumatic event (TE) (1). PTSD diagnosis consists of two stages: 1, the risk of exposure to a TE and 2, the risk of the onset of PTSD based on that TE (2). Examples of TEs, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), include witnessing an actual death, either experiencing or witnessing threatened death, a serious injury, and/or sexual violence. These exposures can be experienced in different ways. TEs can be directly experienced, personally witnessed when happening to others, learning of a TE happening or that happened to a close family member, and/or repeated exposure to extreme TEs (3). When individuals experience TEs, they can be at risk of PTSD symptoms yet not everyone who experiences TEs will develop PTSD (4).

The symptoms associated with PTSD are arousal (fast heartbeat), intrusive manifestations (nightmares), and/or avoidance of people or places that act as triggers and remind one of the TEs (4). When these symptoms persist for at least a month, one can be diagnosed with PTSD (4). PTSD, apart from being a mental disorder, is also associated with physical disorders such as cardiovascular disease and has been shown to reduce quality of life (5).

1.2.Epidemiology of PTSD and childhood TE

Data suggests that PTSD is globally prevalent. The lifetime prevalence of PTSD in Europe is estimated between 1-2%, 6-9% in North America, and greater than 10% in regions experiencing protracted violence (6). PTSD prevalence in South Africa is also documented. South Africa's long history of segregation, apartheid, and violence suggests a traumatised society that has experienced police and institutional violence (7). In 2016, the lifetime prevalence of PTSD in South Africa was estimated to be around 2.3% (6). In their study, Swain *et al*. found that PTSD was reported by 6% of their study participants. This was a cross sectional study on traumatic stress among a sample of adolescents (n=324) and their maternal caregivers (n=324) in KwaZulu-Natal (6). Peltzer found that among 67% of children (from a study in rural South Africa) exposed to violence, 8.4%

subsequently had PTSD diagnoses (8). According to Mathew *et al*., among adolescents, PTSD is associated with poor health outcomes, substance abuse, suicide, poor social support, and academic problems (9).

It is important to take into account the age at which a TE occurs in relation to the risk of a psychopathology. Around two-thirds of youth who have experienced TEs as children, when they are at a critical stage of brain development, develop PTSD as adolescents or adults (10). According to Maercker *et al*., the age of TEs is one of the predictors of the onset of PTSD (10). Biologically this is plausible as early childhood TE may lead to structural changes in the thalamus: a region of the brain related to sensation, cognition, and fear processing (11). This rationale illustrated above is corroborated by the American Psychiatric Association who reported that childhood TEs at this stage of development are associated with an increased risk of suicidal thoughts and actual suicidal plans and attempts (4).

According to the Centers for Disease Control and Prevention (CDC), childhood TEs have devastating effects on children's brain development, immune system, educational opportunities, and sexual-and-reproductive health. Children growing up with prolonged stress may struggle with relationships, work history, finances, and depression throughout their lives. Furthermore, exposure may lead to chronic diseases, mental disorders, and substance abuse during adulthood (12). A comprehensive study of United States of America (USA) veterans who fought in the Vietnam War suggested that a number of experiences during childhood were associated with PTSD. These included an adverse environment during childhood and previous trauma history (13).

1.3.Measuring PTSD and childhood TE

There are a number of different scales that are used to measure PTSD both in clinical and epidemiological settings as evidenced by a number of studies that are cited below. In section 1.1 of this report above we defined PTSD, explained its symptoms and its diagnostic criteria based on the DSM-IV and we now move to the measurement of PTSD using different scales. PTSD among children can also be measured using the *Child PTSD Symptom Scale* (CPTSDSS). This is a self-reported tool with a maximum score of 80. Participants scoring ≥ 31 are classified as having

significant PTSD symptoms. This scale has been reported to have internal reliability and validity with a Cronbach's α=0.92 (14).

The *Child PTSD checklist* is a 28-item scale on a 4-point Likert scale that measures PTSD among children between the ages of 8 to 18 years, and it is based on the DSM-IV criteria: symptoms such as nightmares and avoidance of thoughts and feelings. Possible scores range from 0 to 84 (15).

The *Trauma Checklist* is a scale that measures symptoms of TEs such as robbery, physical hurt, and rape; it is based on the DSM-IV criteria (15). The *Harvard Trauma Questionnaire* is a 30-item scale that measures PTSD. People scoring ≥ 60 are categorised as being positive for PTSD, and it has a Cronbach's α= 0.96. The *Trauma Screening Questionnaire* is a short screening tool with 10 items designed for screening PTSD symptoms. It is based on the DSM-IV diagnostic criteria. Questions 1-5 cover PTSD symptoms and 6-10 cover arousal symptoms. A cutoff score of 6 classifies a participant as being positive for PTSD. It has a sensitivity of 94%, and a 76% specificity (9). Lastly, the *Davidson Trauma scale* (DTS) is a 17-item scale that measures the severity and frequency of PTSD symptoms. The DTS scores range from 0 to 136, and a cutoff score of 40 or more is used to categorise significant levels of PTSD symptoms while scores less than 40 categorise participants who had PTSD symptoms that were not significant (16).

There are also multiple scales that are used to measure childhood TEs as evidenced by a number of studies that are cited below. The *Adverse Childhood Experiences International Questionnaire* by the World Health Organization (ACE-IQ) is a tool covering childhood TEs before the age of 18 years in all countries. The ACE-IQ covers childhood TEs of neglect, household dysfunction, and abuse. It has binary questions and leads to an overall total score of between 0 and 13. According to Cheong *et al*., the ACE-IQ is a valid and reliable tool (17,18) .

The *Childhood Trauma Questionnaire* (CTQ) is an inventory of 70 questions on a 7-point Likert scale (1=Not at all traumatic to 7=Extremely traumatic), while the revised CTQ includes 28 of the questions. These scales seek to measure childhood TEs at or before the age of 12 years. The CTQ covers childhood TEs such as sexual abuse, emotional neglect, physical neglect, and emotional TEs (19). The 28 item CHQ uses scores of ≥ 35 to categorise significant levels of childhood TEs and has a reliability that has been shown to be > 80% (20,21) . The *Composite International Diagnostic Interview* (CIDI) is an extensive diagnostic tool used by trained interviewers to measure multiple psychological disorders such as childhood TEs and PTSD. It takes about 2 hours

to complete the assessment, however, according to studies carried out by McLaughlin *et al*. it is possible to use only a subset of questions, namely the sections that cover childhood TEs, and omit other sections (22,23). *The University of California Los Angeles Traumatic Stress Disorder Reaction Index* for children and adolescents (UCLA-RI) is a tool used to measure TEs among children and adolescents. This scale has 11 binary questions assessing interpersonal TEs (beaten up, threatened, and badly hurt), as well as non-interpersonal TEs (disasters of different kinds) (14).

1.4.Literature Review

The search strategy for this literature review is presented in Appendix 4. The psychometric properties of the scales for measuring PTSD and childhood TEs cited in this section are found in section 1.1.3. The section will briefly review international literature, and then focus on literature in the South African context.

1.4.1. PTSD and childhood TE in the international context

International literature provides diverse findings on the association between PTSD and childhood TEs compared to South African literature as seen in the following studies. A study was carried out by Maercker *et al*. that examined the association between PTSD or major depression disorder (MDD) and age of TEs among women between 18 and 24 years. The study was part of a larger epidemiological study of mental disorders among women in Dresden Germany. The mean age of the participants (n= 1966) was 21.8 years (sd= 1.8 years). No other demographic variables were reported. PTSD and childhood TEs were measured using the DSM-IV diagnostic criteria. Childhood TEs were split into TEs at/before the age of 12 years and childhood TEs at/after the age of 13 years. The authors found that PTSD alone was not associated with childhood TEs at/before the age of 12 years (OR= 0.91, 95% CI 0.48-1.69). PTSD alone was also not associated with childhood TEs that happened at/after the age of 13 years (OR= 1.10, 95% CI 0.59-2.06). The authors did find that PTSD or MDD combined were associated with childhood TEs at/before the age of 12 years (OR= 2.85, 95% CI 1.05-7.71) and the association remained for childhood TEs at/after the age of 13 years (OR= 0.35, 95% CI 0.13-0.95). According to these findings, childhood TEs at/after the age of 13 years are protective against PTSD, while childhood TEs at/before the

age of 12 years increase the odds of PTSD 2.85 times. (24). These findings do suggest that other mental disorders including MDD may be associated with TEs though as stated above PTSD is the only mental disorder dependent on TEs.

According to Pumariega *et al*., TEs disproportionately affect minority adolescents and youth in the USA compared to other demographic groups (white and European). In their paper, the authors reviewed literature that examined trauma among minority children and youth. The authors stated that the disproportionality in TEs in the minority children and youth increased the risk of mental disorders including PTSD. The authors reviewed childhood TEs related to child abuse and family violence, immigration TEs, Natural disasters TEs, terrorism TEs, community violence, and historical TEs (25).

A study was carried out by Lewis *et al*. that examined PTSD and TEs among young people in England and Wales. PTSD and childhood TEs were measured using the DSM-IV diagnostic criteria when the participants were 18 years old. The median age of index trauma was 15 years (IQR 13-17). Index traumas included network trauma (TEs in the participant's network), direct interpersonal assault or threat, and direct accident or illness. The authors found that PTSD was associated with childhood TEs (index trauma) in the univariable (OR= 7.19, 95% CI 4.68-11.06) and multivariable (aOR= 6.22, 95% CI 3.96-9.75) logistic regression models. The authors also found that females exposed to childhood TEs had 97% and 51% increased odds of PTSD compared to males in the univariable and multivariable logistic regression models respectively (26). It is noted that international literature shows that PTSD is diagnosed by psychiatrists as evidenced by the studies above, and that PTSD is largely not diagnosed in South Africa as evidenced by the following studies. South African literature largely uses scales to measure PTSD symptoms. The strength in international literature (middle-and-high income countries) is that PTSD is medically diagnosed.

1.4.2. PTSD and childhood TE in South Africa

Literature of both adult and adolescent samples suggests that PTSD is associated with childhood TEs in South Africa as evidenced by the following studies. Choi *et al*. conducted a study that examined coping mechanisms that mediate the relationship between PTSD and childhood TEs among pregnant women in Cape Town, South Africa (n=82). The women were recruited from peri-urban antenatal clinics. Demographic variables included age, relationship status, education level, employment, and HIV status, and the participants' ages ranged from less than 18 to 36 years (the study did not specify a minimum age). PTSD was measured using the *Davidson Trauma Scale* (DTS). Childhood TEs were measured using the 28-item *Trauma Screening Questionnaire* (TSQ-SF) which covers childhood sexual abuse, physical abuse, emotional abuse, emotional neglect, and physical neglect as subscales. The researchers found that overall, PTSD and childhood TEs had a correlation of 0.40 ($p< 0.0001$). Furthermore, the researchers found that PTSD was associated with childhood TEs of sexual abuse, emotional abuse, and physical abuse at the 5% level. However, PTSD was not associated with emotional neglect or physical neglect (27). On the other hand, Nöthling *et al.* found that community violence, abuse, and neglect was associated with PTSD, while sexual abuse was not associated with PTSD (28). Similar findings were reported by Schwartz *et al.* (29) and Martin *et al.* (30). There is evidence that different samples experience different weightings of TEs in relation to PTSD.

A study was carried out by Suliman *et al*. examining the association between PTSD and TEs, as well as anxiety and depression among adolescents in Cape Town, South Africa (n=1140). The participants were recruited from 7 public schools and 2 private schools in the Cape Town metropolitan area (urban and peri-urban). Demographic variables such as sex, ethnicity, age, and socio-economic status were collected; the participants' ages ranged between 14 and 18 years. PTSD was measured using the *Trauma Checklist* which highlighted traumas of being robbed, physically hurt, and rape, and childhood PTSD was measured using The *Child PTSD Checklist*. Childhood TEs were measured using the 28-item *Childhood Trauma Questionnaire* (CTQ). The researchers found that PTSD was correlated with childhood TEs (0.37). Although the correlation was low, they did find that it was statistically significant (15).

Machisa *et al*. found that PTSD was associated with childhood TEs of child abuse: measured using the *Childhood Trauma Questionnaire* (CTQ). A unit increase in child abuse score was found to

increase PTSD score by 0.35 units (95% CI 0.27 – 0.44, p<0.0001). The study was among 511 women (ages 18 – 34) in Gauteng Province, South Africa. The authors did not specify which areas in Gauteng they sampled from, but they did state that Gauteng province, their research site, was mostly urban. Their project was on Mental Illness, including PTSD, and Intimate Partner Violence (IPV); IPV had a physical violence component, a sexual violence, an emotional violence, and an economic violence component. PTSD was measured using the 30-item *Harvard Trauma Questionnaire* (HTQ). Child abuse was a covariate, but an association with PTSD was investigated. Missing Data in this study were dealt with by Complete Case Analysis (31). In a later study, the researchers corroborated their results. This latter study was on suicidal thoughts, PTSD, depression, alcohol use, and IPV among women in TVET Colleges and Universities in South Africa (n= 1293). The participants were recruited from historically disadvantaged public universities (in rural South Africa) and Technical and Vocational Education and Training (TVET) colleges (across five provinces). PTSD was measured using the HTQ and childhood TEs were measured using the CTQ. The researchers found that PTSD was associated with childhood TEs. A unit increase in childhood TEs score increased PTSD score by 1.44 units (95% CI 1.27 – 1.66, p-value <0.0001). There were two age groups among the women in the study: 18-24 and 25 – 30 years. Missing data were described, but there was no mention of how they were dealt with (32).

1.4.3. PTSD in adolescent Girls and Young Women

Women and girls who have experienced childhood TEs are seen to be disproportionately affected by PTSD compared to males who have experienced childhood TEs in South Africa as illustrated by several studies cited below. A descriptive study was carried out on treatment utilisation and trauma among 737 children and adolescents aged between 2 to 18 years, and with PTSD in Cape Town, South Africa. The study retrospectively reviewed charts of adolescent girls and boys (n= 737) who were patients with documented PTSD diagnoses in the psychiatric unit of Tygerberg Hospital. Tygerberg is a tertiary hospital situated in the Tygerberg area. PTSD was measured using the DSM-IV diagnostic criteria, however, the authors did not specify any further details. The authors highlighted childhood TEs such as rape, violence, bereavement, sexual abuse, and physical abuse, but they did not mention how these TEs were measured. The study was carried out between 1994 and 1998; Eighty-five percent of children and adolescents exposed to TEs and with

significant PTSD symptoms were female, and 14.5% were male. Furthermore, the researchers found that female TEs were primarily and disproportionately sexual abuse and rape. For males, the childhood TEs were disproportionately physical abuse. The authors stated that the disproportionality may be as a result of referral bias rather than a true difference. The authors did not compare the prevalence(s) of PTSD using analytical methods between males and females (33).

Another study by Hiscox *et al*. compared the prevalence of PTSD between males and females exposed to adversity in Khayelitsha, Cape Town (n=735). Khayelitsha is a peri-urban township situated in the Cape Flats. Participants were randomly selected from High schools in quintile 1 (poor) to quintile 5(wealthy). The mean age of the participants in the study was 15.4 years. PTSD was measured using the *Child PTSD Symptom Scale – Self Report* for DSM-IV (CPSS-RS-5). Childhood TEs were measured using the UCLA *Traumatic Stress Disorder Reaction Index* for children and adolescents (UCLA-RI). The researchers found that females were 71% more likely to meet PTSD criteria compared to males (RR= 1.71, 95% CI 1.33 – 2.20). In this study there were some missing data but only a Complete Case Analysis was carried out as an analysis method (14).

1.4.4. Indirect Approach: Childhood Trauma and PTSD

All the literature reviewed thus far has used a direct approach. The following paragraph considers literature on indirect approach(s). The Direct approach examines the relationship between an exposure and an outcome of interest without considering any variables in between this relationship: it does not consider the effect of intermediaries. An example of a direct approach is the direct relationship between PTSD and childhood TE. Indirect approaches on the other hand consider intermediaries. An example of an indirect pathway is examining the relationship between PTSD and childhood TE through intimate partner violence.

There is some evidence that both PTSD and childhood TEs play an intermediary role in other social health related problems. Machisa *et al*., in their study on mental illness and IPV (the findings are presented in this section), found that PTSD mediates the relationship between Intimate Partner violence (IPV) and childhood TEs (childhood TEs → PTSD → IPV). The researchers used Structural Equation Modelling to model these structural pathways. The indirect effect of this relationship is, childhood TE → PTSD (Coefficient= 0.35) and PTSD to IPV (Coefficient= 0.18),

therefore the total indirect effect is 0.35 × 0.18= 0.063. However, no confidence intervals were reported (31).

1.4.5. Missing Data

In addition to examining the association between PTSD and childhood TEs, the current study will examine statistical methods for handling missing data. The terms "Missing data" and "missing values" are used interchangeably in the current study. A number of techniques for identifying missing data mechanisms and handling missing data are presented in the following paragraphs. Missing data is an issue of concern in data analysis (34). Missing data can bias one's estimates and cause the study to lose power (35,36) . The nature of missing data is classified in the literature under mechanisms of missingness. Data can either be Missing Completely At Random (MCAR), Missing At Random (MAR), or Missing Not At Random (MNAR) (37). Suppose we have a variable Y where data were collected for 10 study participants. Let us assume that seven participants of the 10 provided information for the variable Y, and 3 participants did not provide information for the variable Y. In this example, we have 7 observed values and 3 missing values. We can create a dummy variable M that takes the value M=1 if Y is missing and M=0 if Y is not missing. Data are MCAR when there is no systematic difference between both the missing and the observed values: missingness does not depend on either the observed or the missing values (38). In our example, M=1 does not depend on Y, missing or observed. Data are MAR when missingness depends only on observed values and not on the missing values (38). In our example, M=1 depends on the values of Y that are observed: depends on the seven observed values, and not on the 3 missing values. Lastly, data are MNAR if the missingness depends on the missing values (38) . In our example, M=1 depends on the values of Y that are missing. Knowing which mechanism of missingness characterises the missing data helps the analyst choose the appropriate method(s) for handling missing data (37).

Complete Case Analysis (CCA) is not biased as a result of missing data when the data are MCAR (37). In CCA, only observations with no missing data are included in the analysis, and CCA is the default method of analysis in most statistical packages.

Multiple Imputation (MI) is not biased as a result of imputing missing data when the data are MAR provided that it is carried out correctly. However, there are MI methods that are designed to work

with data that are MNAR (39,40). MI is a statistical method for handling missing values by replacing the missing values with imputed values (38). This is achieved by creating multiple datasets that account for the missing values and averaging the results of a regression model over the multiple-imputed datasets (39).

Inverse Probability Weighting (IPW) approaches work well with any mechanism and patterns of missingness (41). IPW is a statistical method for handling missing values where weighted copies of the observed data are created in order to account for selection bias that may be a result of the missing values (41).

There are statistical tests available to assess the mechanism of missingness that characterise the missing data. Little's test is designed to test MCAR. The null hypothesis that the data are MCAR is tested against the alternate hypothesis that the data are not MCAR. The test uses the *Univariate Mean Difference Method* (42). The *Univariate Mean Difference* method for testing MCAR generates a binary missingness indicator variable and a two sample ttest is used to compare mean differences in any fully observed continuous variable between the groups defined by the missingness indicator (43). Ridout's logistic regression method is one of the methods that are used to test for MAR. Fairclough's logistic regression method is primarily used to test for MCAR and MAR, an example of how this method works is extracted from Fielding *et al*. who investigated missing data mechanisms in quality of life (QoL) outcomes (34). In this method, a missingness indicator variable is generated, and covariates that are associated with the missingness indicator variable are identified. After these covariates are identified, they are included in a multivariable logistic regression model. To differentiate between MCAR and MAR, an association between the missingness indicator and QoL scores is carried out. If the QoL scores are significant in the multivariable logistic regression, the authors state that there is evidence of MAR (42). According to Enders, the only reliably testable mechanism of missing data is the MCAR; MAR and MNAR as rely on unstable assumptions (43).

1.5.Conceptual Framework

The literature reviewed above leads to the conceptual framework on the relationship between PTSD and childhood TEs is adapted from Morris' theoretical framework on the psychobiology of PTSD and acute trauma (44).

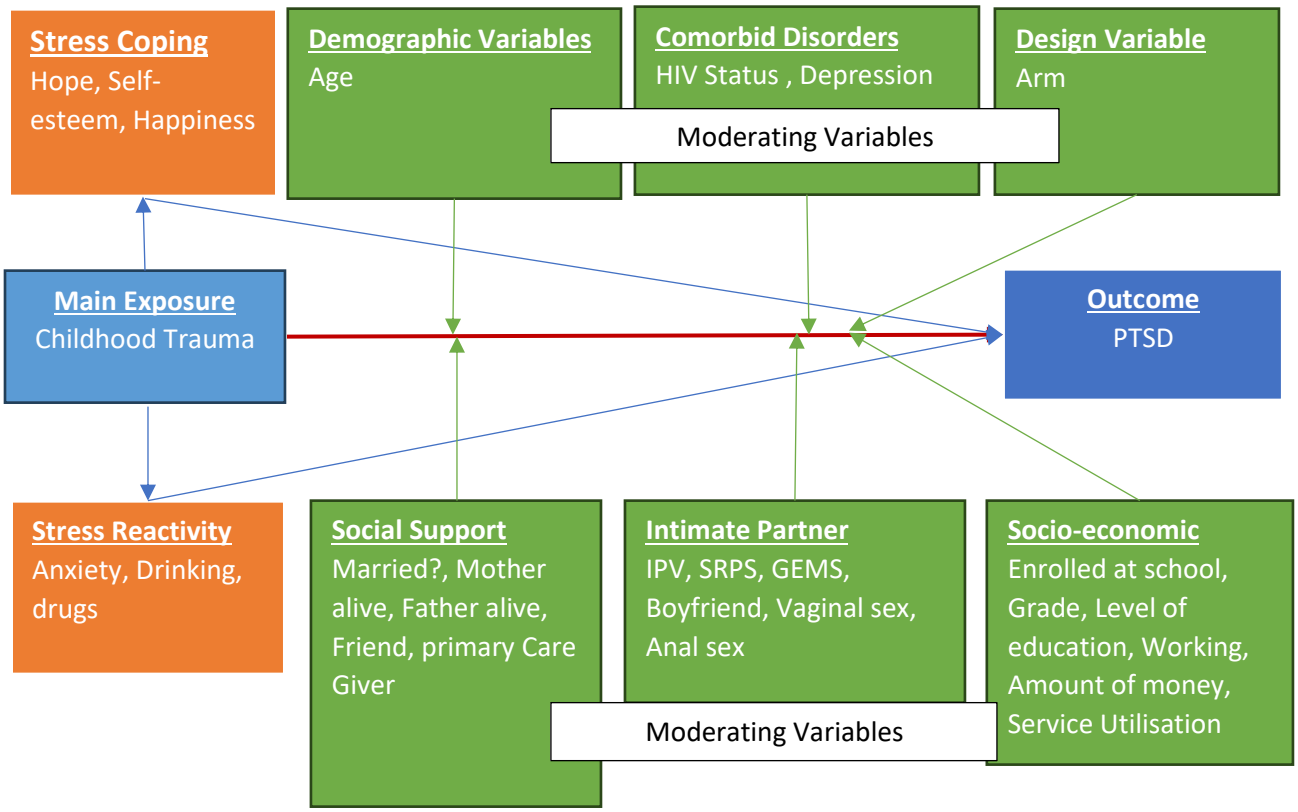

Figure 1. : Conceptual Framework on the association between PTSD and childhood TEs (where IPV= Intimate partner violence; srps= sexual relationship power scale; gems= gender equitable power scale; Arm= control or the intervention arm in the primary study).

1.6.Problem Statement

There is a need to study the association between PTSD and childhood TEs. This is especially needed among adolescent and young females in rural settings. Many of the studies that have been done in the South African context as per the above citations (16,31,32) have been in non-rural areas, and a considerable number of these studies have only carried out univariable analyses i.e. have not taken into account potential confounders. We know that childhood TEs influence human development (45). Women report more mental health problems compared to men (46). PTSD across the lifetime has been seen to be more prevalent in females compared to males, and females are reported to experience PTSD over a longer period compared to males (4).

Strategies for handling missing data in mental health literature are limited, despite the fact that most studies will have some missing data. Studies of childhood TEs in particular have suggested inconsistency between follow up periods where adult participants are asked to report TEs at different time points. In general, it is not clear whether any method has been used to deal with missing data, and if a method has been used, the methods are not clearly described (47). Missing data methodology is of importance in data analysis because it has been established that missing data can bias one's estimates and cause the study to lose power. There is a need to clearly define methods used to account for missing data.

1.7.Justification

The current research seeks to add to the limited literature on the relationship between PTSD and childhood TEs in the rural setting. Furthermore, a focus on females is important as females are more likely to report mental illness compared to males where females are more likely to be affected by IPV (46). Studying the relationship between PTSD and childhood TEs among young women is important. Females exposed to childhood TEs are disproportionately affected by PTSD compared to males exposed to childhood TT. PTSD has devastating effects on a person's functioning academically, in relationships, and in health (48).

Missing data is a major concern in epidemiological research and data analysis. There are a number of strategies for handling missing data and in order to apply these strategies, the mechanisms that lead to the missing data need to be examined. If we use CCA the estimated effects will only be

unbiased if the data are MCAR. In this study we will first use CCA and then compare the results to those found using MI as well as IPW as methods for handling missing data.

1.8.Research Question

Is there an association between PTSD and childhood TEs among adolescent girls and young women (AGYW) aged between 18 and 28 years in Mpumalanga, South Africa, 2015-2017, and what effect does using MI or IPW for handling missing data have on the estimated measures of association?

1.9.Aim

To examine the association between PTSD and childhood TEs among AGYW aged between 18-28 years in Mpumalanga, South Africa, 2015-2017, and to examine the effect of using MI or IPW for handling missing data on the estimated measures of association.

1.10. Objectives

1.10.1. Objective 1

To describe the demographic and exposure characteristics of AGYW aged between 18 and 28 years in Mpumalanga, South Africa, 2015-2017.

1.10.2. Objective 2

To examine the association between PTSD and childhood TE among AGYW aged between 18 and 28 years in Mpumalanga, South Africa, 2015-2017, utilising CCA.

1.10.3. Objective 3

To examine the effect of using MI or IPW for handling missing data on the measures of the association between PTSD and childhood TEs among AGYW aged between 18 and 28 years in Mpumalanga, South Africa, 2015-2017.

Chapter 2

2. Methods

This section will first summarise the primary study methods, and then proceed to outline the methods that were utilised in the current study. The current study was an analysis of secondary data.

2.1.Primary Study

Study Design: A Phase 3 individually randomised control trial (RCT) (49).

Study title: "The effects of conditional cash transfer on HIV incidence in young women in rural South Africa (HPTN 068): a phase 3, randomised controlled trial."

Structure of Intervention: Conditional Cash Transfer (CCT). Participants in the intervention arm received monthly cash stipends of R300 on condition that they remain in school (as measured by at least 80% school attendance). The control arm received no cash transfers (49).

Primary outcome: HIV incidence: established at each visit (50).

Primary Objective/Aim: To determine if AGYW who were randomised into receiving cash transfers on condition that they remain in school had a lower incidence of HIV compared to the control group who are also adolescent girls and young women who were randomised not to receive the conditional cash transfers (49).

Study Setting: The study was conducted in Agincourt, a rural sub-district of Bushbuckridge Municipality, Mpumalanga. The Medical Research Council and the University of the Witwatersrand (MRC/Wits) run the Agincourt Health and Demographic Surveillance System (AHDSS) in the area (49).

Study Population: AGYW aged between 13 and 20 years (n=2537) at the beginning of the study. The study took place between 2011 and 2015. Participants were at school in Grade 8 -11 at baseline. Pregnant or married adolescent girls and young women and those who had no parent at baseline were excluded (49).

Sampling: Data from the AHDSS were used to identify eligible participants. Household visits were carried out in order to recruit identified participants (49).

Randomisation and Follow up: Participants were randomized into the treatment or control arm, with site staff being blinded to the allocation. Participants were followed from 2011. They were followed from Grade 8,9,10, and 11 until high school graduation. HIV testing was done on every visit. Follow-up visits were carried out during which questionnaires were completed and blood samples were collected (49).

Having summarised the primary study, we proceed to address the current study methods.

2.2.Current Study: secondary analysis

2.2.1. Study Design

A cross-sectional study design was used for the current study. Data on PTSD and childhood TEs were collected on a single occasion between 2015 and 2017 for all study participants.

2.2.2. Study Site

The primary study was conducted in Agincourt, a rural sub-district of Bushbuckridge Municipality, Mpumalanga, South Africa. The area has 22 high schools. The MRC/Wits run the Agincourt Health and Demographic Surveillance System (AHDSS) in the area (49).

2.2.3. Study Population

AGYW aged between 18-28 years in Agincourt, Mpumalanga, South Africa, 2015-2017.

2.2.4. Sampling

Data on PTSD and childhood TEs were collected cross-sectionally, once between 2015 and 2017 for each participant in the primary study.

Inclusion Criteria: All participants who experienced at least one childhood TE or participants with missing childhood TEs were included in the secondary analysis. However, for the purposes of calculating statistical power, only participants who had experienced any childhood TEs were considered, which corresponds to the CCA. Since we can demonstrate statistical power in the CCA, we therefore demonstrate that subsequent analyses accounting for missing values were also sufficiently powered.

Exclusion Criteria: Participants who had a zero score for childhood TEs were excluded from the analysis given that PTSD can only be experienced by those who have at least one childhood TE and/or other TEs.

The most current prevalence estimate of lifetime PTSD in South Africa is 2.3% in 2016 (6). A total of 1174 adolescent girls and young women experienced any childhood TE. This information was obtained from one of the primary study data gate keepers for the purpose of estimating the current study's power.

For a power calculation based on the number of participants who experienced any childhood TE from the primary study, participants exposed to childhood TEs were n=1174. We assume that approximately 1/3 (n=400) of those who experience childhood TEs will experience a higher degree of childhood TEs, while 2/3 (n=774) will experience a lesser degree of childhood TEs (51). Since the 2.3% PTSD is the national prevalence estimate, we assume that the 2.3% prevalence is the unexposed group. Using the "power" command in Stata, we calculated that the current study had 87% power to detect as statistically significant, at the 5% level, an increase in the proportion experiencing PTSD from 2.3% to 6%.

2.2.5. Data Collection

Data from the primary study were obtained by means of a formal request to the data gate keepers of the primary study; they provided the data on receipt of ethics approval from the University of the Witwatersrand Human Research Ethics Committee Medical (HREC) for the current study.

2.2.5.1.Variables

The main exposure variable, the outcome variable, and demographic variables were chosen *a priori*. Exposure variables were chosen based on their importance in the literature and the conceptual framework by Morris et al. (44), which was adapted to produce the conceptual framework for the current study in chapter 1.

Main Exposure: Childhood TEs. Childhood TEs were measured using the Adverse Childhood Experience International Questionnaire (ACE-IQ). The ACE-IQ measures childhood TEs in all countries (52). The questionnaire has a total of 8 sections which are categorised into 13 questions. The ACE-IQ is a tool covering childhood TEs before the age of 18 in all countries and it is

recommended to be administered to persons 18 years and older. The ACE-IQ covers traumas of emotional abuse, physical abuse, sexual abuse, violence against household members who are mentally ill or suicidal, living with household members who are/were imprisoned, having only one or no parent(s), parental separation or divorce, emotional neglect, bullying, community violence, and collective violence . The binary version of the score was utilised with a possible score between a minimum of 0 and a maximum of 13 (53,54). The actual ACE-IQ score was utilised in its quantitative form. ACEs has previously been used in South Africa (55,56).

Outcome: PTSD was measured using the Trauma Screening Questionnaire (TSQ). The TSQ is a 10-item (binary questions) tool designed to measure PTSD. The score is designed such that Scores ≥ 8 indicate significant PTSD symptoms and scores that are < 8 indicate PTSD symptoms that are not significant. The TSQ is 94% sensitive, and with a specificity of 76% (9).

Demographic Variables: Age in years.

Design variable: Study arm. This is a binary variable where participants were randomised into the intervention arm or the control arm. It is important to include study arm in secondary analysis of data from a RTC as it is common practice (57–59).

Potential Confounders and Effect Measure Modifiers

Education. The education variables include a binary question on whether the participants were at school or not. If they were in school, they reported which grade they were in.

Alcohol use. This was a binary variable: yes or no.

Drug use. This was binary variable: yes or no.

Partner grid. These categorical variables included the participants' relationship status, and whether the participants were exposed to vaginal or anal sex.

Intimate Partner Violence Scale (IPVS). The IPVS is a 10-item scale on a 4-point Likert scale (1=many times to 4=never) that measures intimate partner violence. Scores ranged between a minimum of 10 and a maximum of 40. The scale is reverse coded: lower IPV scores indicate greater levels of IPV, while higher IPV scores indicate lower levels of IPV.

Sexual relationship power scale (SRPS). The SRPS is a 12-item scale on a 3-point Likert scale (1=agree a lot to 3=do not agree at all) that measures romantic relationship power dynamics: relationship power and decision dominance. It has a minimum of 12 and a maximum of 36. The scale is reverse coded: lower SRPS scores indicate greater levels of SRPS, while higher SRPS scores indicate lower levels of SRPS. (60).

Gender Equitable Men's Scale (GEMS). The GEMS is a 33-item scale on a 3-point Likert scale (1=agree a lot to 3= do not agree at all) that measures gender equitable beliefs between men and women in general. It has a violence, sexual relationships, reproductive health and disease prevention, and domestic chores and daily life domains. Possible scores range between 33 and 99. The scale is reverse coded: lower GEMS scores indicate greater levels of GEMS, while higher GEMS scores indicate lower levels of GEMS. (61).

Center for Epidemiological Studies Depression Scale (CESDS). The CESDS has 20-items on a 4-point Likert scale (1=rarely to 4= all the time) that measures depression symptoms. Scores range from 20 to 80. Higher CESDS scores denoted greater depression symptoms while lower CEDS scores denoted lesser depression symptoms (62).

Revised Children's Manifest Anxiety Scale (RCMAS). The RCMAS has 14 binary questions, and it is used to measure anxiety among adolescents aged between 6 and 19 years. Scores range between 0 and 14 (63).

Hope Scale. The hope scale had 6 items on a 4-point Likert scale (1=I totally disagree to 4= I totally agree) that was used to measure hope. Possible scores ranged from 6 to 24. Higher hope scores denoted higher hope and lower hope score denoted lesser hope.

Happiness Scale. The happiness scale has 7-items with ratings from 1-7 on each of the 7 items. Higher happiness scores denoted greater happiness, while lower happiness scores denoted lesser happiness.

Rosenburg Self-esteem Scale (RSES). The RSES is a global scale used to measure self-esteem. It has 10 items on a 4-point Likert scale (1= I totally disagree to 4= I totally agree). Possible scores ranged from a minimum of 10 to a maximum of 40. Higher RSES scores corresponded to greater self-esteem, while lower RSES scores corresponded to lesser self-esteem (64).

Service Utilisation. The levels of this categorical variable include private, public, or other forms of health care services.

Friend gender. The friend is either male or female.

Marital Status. The levels of this categorical variable include married, divorced, widowed, and never married.

Primary Caregiver. The levels of this categorical variable include mother, father, older brother or sister, aunts or uncles, grandparents, boyfriend or husband, and no primary caregiver.

Father Alive. The levels of this categorical variable include yes, no, and I don't know.

Mother Alive. The levels of this categorical variable include yes, no, and I don't know.

2.6.Data Management

The data were imported into Stata 17 (StataCorp). PTSD was dichotomised into a binary variable using a cut-off score of eight or higher to denote the presence of PTSD. String data were encoded. String dates were converted into Stata friendly formats. Duplicates were investigated and none were found. The data were stored in a personal password protected cloud, computer, and removeable storage under lock and key. The removable storage was password-protected. The childhood TE scale was further scaled to reflect a 3-point increase instead of a unit increase in order to sensibly interpret the models. The SRPS was scaled to reflect a 10-point increase. The GEMS, anxiety scale, hope scale, depression scale, self-esteem scale, and the IPV scale were scaled to reflect a 5-point increase.

2.7.Data Analysis

The data analysis plan is given below for each research objective. Stata version 17 was used to carry out the analysis.

2.7.1. Analysis Plan: Objective 1

Categorical data, such as demographic information, were described using frequencies (actual numbers) and percentages. The data were presented using a table. The table is in the guidelines of the *International Journal of Epidemiology* and *the Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE) which discourages the use of p-values in descriptive tables (65,66) . Bar charts, pie charts, graphs, and other descriptive methods for categorical data were utilised where it was appropriate.

Quantitative data, such as age (in years), were described using means and standard deviations when the data were approximately normally distributed, and medians and interquartile ranges when the data were not normally distributed. Graphical methods were utilised to examine normality. The description was in the form of a table using the *International Journal of Epidemiology* and *the Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE) guidelines that discourage the use of p-values in descriptive tables (65,66). Histograms, scatter plots, and other methods for describing quantitative data were utilised where it was appropriate. The mechanism of missingness was described in text and inserted into the table that summarises the analysis of objective 1. Details of the methods for testing mechanisms of missingness are listed under the 3rd objective's analysis plan. Reliability tests were carried out for all scales utilising Cronbach's alpha, and the results were presented in a table.

2.7.2. Analysis Plan: Objective 2

The analyses for objective 2 were carried out by fitting univariable and multivariable logistic regression models. The analysis utilised the CCA method, which is the default analysis in Stata. The CCA method analysed observations with complete values for all variables. Observations with missing values were excluded from the analysis.

A univariable analysis (also known as an unadjusted analysis or crude analysis) was carried out by fitting a simple logistic regression model to investigate the association between each exposure variable and the outcome variable (67). The significance level for the univariable analysis was initially set at 25% (p= 0.25) as recommended by Bendel and Afifi and Mickey and Greenland for initial screening criterion . The authors report that using the traditional 5% significance level (p=0.05) leads to failure in identifying known important variables (68).

Variables that satisfied the initial screening criteria were included for further investigation in the multivariable logistic regression analysis. Variable selection for the multivariable logistic regression model was carried out through *Change In Estimate* (CIE) as outlined by Greenland *et al*. CIE is of the form:

$$\Delta MSE = (\beta\_reduced - \beta\_current)^2 - (SE\_current^2 - SE\_reduced^2)$$

Where ΔMSE is the change in the mean square error, β_reduced is the main exposure coefficient in the reduced model, β_current is the main exposure coefficient in the current model, SE_current is the standard error of the main exposure coefficient in the current model, and SE_reduced is the standard error of the main exposure coefficient in the reduced model. Below are the steps for variable selection as proposed by Greenland et al. (69):

Step 1. The variables were grouped into three classes: Main exposure, forced variables, and non-forced variables. Childhood TE is the main exposure. Age in years and study arm are the forced variable, and the rest of the variables are non-forced variables. All the non-forced variables were candidates for deletion.

Step 2. A multivariable logistic regression model was fitted without interaction terms. All variables were included in the fitted model: main exposure, forced variables, and non-forced variables.

Step 3. A reduction loop was carried out in order to eliminate non-forced variables that were not important. The CIE formula was utilised in order to carry out the reduction loop:

$\Delta MSE = (\beta\_reduced - \beta\_current)^2 - (SE\_current^2 - SE\_reduced^2)$.

The reduction loop started with the model in step two as the current model. Non-forced variables were removed individually and/or by groups; the information from the current and reduced models were computed into the formula and solved for. ΔMSE that were less than zero meant that the reduced model was better than the current model and thus, the non-forced variable(s) were removed. When the ΔMSE was equal to or greater than zero, the current model was better than the reduced model and thus, the non-forced variable(s) were kept in the model.

Step 4. When no non-forced variables remained for which ΔMSE was negative, we proceeded to investigate interaction terms. The significance of the interaction terms followed the same reduction loop entered into in step three.

Post estimation diagnostics, or goodness of fit tests in the case of logistic regression, were performed in order to assess if the fitted values of the multivariable logistic regression accurately depicted the true experience of the observed values (67). Summary measures for goodness of fit tests utilised for diagnostics are the Hosmer-Lemeshow test (with ten groupings) and/or the Area Under the Receiver Operator Curve (ROC). Individual measures utilised for goodness fit tests included three plots: Leverage vs estimated probability, change in Pearson's Chi-square vs estimated probability, and change in deviance vs estimated probability (67).

2.7.3. Analysis Plan: Objective 3

Multiple Imputation (MI) and Inverse Probability Weighting (IPW) were utilised to carry out the analysis of objective 3. Missing data and missing data mechanisms were described in this section.

Multiple Imputation

MI is a statistical method for handling missing values by replacing the missing values with imputed values across multiply imputed datasets (38) . This is achieved by creating multiple datasets that account for the missing values and averaging the results of a regression model over the multiple-imputed datasets (39).

Multiple Imputation by Chained Equations (MICE) was used for the analysis. An important advantage of MICE is that it has the ability to fit predictive imputation models for different variable types and that it does not assume multivariate normality (40). Continuous, nominal categorical variables, and binary variables were imputed using variable-distribution appropriate imputation models.

All variables with missing values were included in the MICE including covariates. We assumed that the data were MAR; Enders state that MACR is the only testable assumptions (43). Literature shows that missing values can be multiply imputed up to 78% of missingness (70). Childhood TE and the TSQ (discrete PTSD scale) were imputed using predictive mean matching (PMM) in a linear regression imputation model. Since both the TSQ and childhood TE were discrete scales, they were not normally distributed in the original dataset. In order to preserve their distribution in the imputation models, PMM was used (40). Primary care giver (3 level nominal categorical variable) was imputed using a multinomial regression imputation model. The binary PTSD variable, exposure to vaginal sex, and exposure to anal sex were imputed using a logistic regression imputation model.

As seen in the previous paragraph, imputation models for PTSD included both the discrete scale (TSQ) and the binary version of PTSD. This was carried out in order to compare the estimated measure of effect as a result of using either of these variables. The imputed TSQ (PTSD) scale was categorised in the imputed datasets using the same TSQ cut-of score of ≥ 8 that was used in the original dataset. The new PTSD variable that was generated from the imputed TSQ scale was used in the final dataset after a sensitivity analysis was carried out against the imputed binary version

of PTSD. It is argued that participants with imputed outcome variables should be excluded from the analysis of a multiply imputed dataset due to the noise they may cause (40). However, White et al., demonstrated that coefficients including individuals with missing outcome variables are similar to analyses that exclude them. Furthermore, missingness in the current study was in the outcome variable.

To assess the performance of the imputation models, a plot of the variable distribution of the imputation models versus the variable distribution of the original dataset was generated using the discrete TSQ (PTSD) score and childhood TE. To assess the performance of the imputation models, the distribution of the imputed variables (TSQ and childhood TEs) needed to be similar to that of the original dataset (40).

There are available techniques to determine the number of imputations that are needed to reduce simulation error as the result of MI. The Monte Carlo error, defined as the standard deviation of results of a repeated analysis, is one of the techniques that is used to determine the number of imputations that are needed. To determine the number of imputations needed, the Monte Carlor error is multiplied by the Fraction of Missing Information (FMI). However, the FMI is hard to estimate. Thus, the Bodner's approximation was used to determine the required number of imputations that were required in order to achieve the same results when the same data are analysed repeatedly. The Bodner's approximation asserts that the number of imputations should be equal to the proportion of the missing values in the outcome variable: m=proportion of missing values expressed in percent form: the percentage is equal to the number of imputations (40).

The final model from objective 2 (CCA) was run over the multiply imputed dataset, and Stata uses Rubin's rule for adding/averaging the estimated parameters across the multiply imputed datasets.

Inverse Probability Weighting

IPW is a statistical method for dealing with missing values where weighted copies of the observed data are created in order to account for selection bias that may be a result of the missing values (41). IPW is particularly useful when missingness is in the outcome variable. The steps followed in carrying out IPW are given below:

1. A dummy variable taking the values 1 if participants had observed PTSD values and 0 if PTSD was missing was created.
2. A multiple logistic regression model was fitted to find predictions of PTSD being observed: the dummy variable fitted in the previous step was used as the outcome variable.
3. A new variable was generated that is in the form 1/(probability of being observed).
4. The final model from objective one was fit and weighted by 1/(probability of being observed). The option [pw=1/(probability of being present)] was utilised for the weighting in Stata.

The final MI and IPW models were compared to the final CCA model to see how addressing the missing data affected the calculated measures of association.

Chapter 3

3. Results

3.1.Demographic and exposure characteristics

Out of the 13124 study participants in the primary study, 1286 participants had at least one childhood TE. Thirty-nine participants under the age of 18 were excluded due to age. Seventy-two participants who had study id's recorded but no other data since the beginning of the trial were dropped. Our final sample size was n= 1175.

Table 1.1 below describes and summarises the demographic characteristics of the study participants. Overall, the mean age of the study participants was 20.2 years with a standard deviation (sd) of 1.3 years. The mean age among participants who did not meet the criteria for risk of PTSD by symptoms (hereafter PTSD negative) was 19.8 years (sd= 1.2), and the mean age among participants who met the criteria for risk of PTSD by symptoms (hereafter PTSD positive) was 20 years(sd= 1.4).

Overall, 567(48.3%) participants indicated that they were not in school, and 608(51.7%) indicated that they were in school. Among the PTSD negative group, 199(42.5%) were not in school, while 269(57.5%) were in school. Among those who were PTSD positive, 33(41.8%) were not in school, while 46(58.2%) were in school. Overall, 7(0.6%) of the participants were in grade 10, 81(6.9%) were in grade 11, 199(16.9%) were in grade 12, and 321(27.3%) were in university.

Overall, 1134 (96.5%) participants were never married, 40(3.4%) were married, and 1(0.1%) was a widow. Among participants who were PTSD negative, 454(97.0%) were never married, 13(2.8%) were married, and 1(0.2%) was a widow. Among participants who were PTSD positive, 75(94.9%) were never married, 4(5.1%) were married, and there were no widows in this group.

Overall, 832(70.8%) participants had their mother as a primary care giver, 96(8.2%) had their father, 68(5.5%) had their older brother or sister, 36(3.1%) had their aunts or uncles, 132(11.2%) had their grandparents, 9(0.8%) had their boyfriend or husband, and 1(0.1%) participant had no primary caregiver. The one participant with no primary caregiver was in the PTSD negative group. Eight hundred and thirteen (69.2%) of the participants had fathers who were alive, for 350(29.8%) participants their fathers were deceased, and 12(1.0%) did not know whether their fathers were

alive or deceased, while 983(83.7%) had mothers who were alive, 191(16.3) had mothers who were deceased, and 1(0.1%) did not know whether her mother was alive or deceased.

Table 1.1: Demographic Characteristics of the AGYW (n=1175)

VARIABLE	LEVEL	PTSD NO (n= 468)	PTSD YES (n=79)	PTSD MISSING (n=628)	ALL (n= 1175)
AGE (IN YEARS)		468	79	628	1175
	Mean(sd)	19.8(1.2)	20.0(1.4)	20.5(1.4)	20.2(1.3)
	Missing n(%)	0(0)	0(0)	72(10.3)	72(5.8)
FATHER ALIVE? n(%)	Yes	332(70.9)	55(69.6)	426(67.8)	813(69.2)
	No	133(28.4)	23(29.1)	194(30.9)	350(29.8)
	I don't know	3(0.3)	1(1.3)	8(1.3)	12(1.0)
	Missing	0(0)	0(0)	0(0.0)	0(0.0)
MOTHER ALIVE n(%)	Yes	391(83.6)	57(72.2)	535(85.2)	983(83.7)
	No	76(16.2)	22(27.9)	93(14.8)	191(16.3)
	I don't know	1(0.2)	0(0.00)	0(0.0)	1(0.1)
	Missing	0(0.0)	0(0.00)	0(0.0)	0(0.0)
PRIMARY CAREGIVER n(%)	Mother	328(70.1)	46(58.2)	458(72.9)	832(70.8)
	Father	36(7.7)	10(12.7)	50(8.0)	96(8.2)
	Older brother/sister	25(5.3)	9(11.4)	34(5.4)	68(5.5)
	Aunts/uncles	21(4.5)	3(3.8)	12(1.9)	36(3.1)
	Grandparents	51(10.9)	11(13.9)	70(11.2)	132(11.2)
	Boyfriend/husband	6(1.3)	0(0.0)	3(0.5)	9(0.8)
	No primary caregiver	1(0.2)	0(0.0)	0(0.0)	1(0.1)
	Missing	0(0.0)	0(0.0)	1(0.2)	1(0.1)
CURRENTLY AT SCHOOL n(%)	No	199(42.5)	33(41.8)	335(53.3)	567(48.3)
	yes	269(57.5)	46(58.2)	293(46.7)	608(51.7)
	Missing	0(0.0)	0(0.0)	0(0.0)	0(0.0))
GRADE n(%)	Grade 10	6(1.3)	0(0.0)	1(0.1)	7(0.6)
	Grade 11	45(9.6)	11(13.9)	25(4.0)	81(6.9)
	Grade 12	105(22.4)	17(21.5)	77(12.3)	199(16.9)
	University	113(24.2)	18(22.8)	190(30.3)	321(27.3)
	Missing	199(42.5)	33(411.8)	335(53.3)	567(48.3)
MARITAL STATUS n(%)	Never Married	454(97.0)	75(94.9)	605(96.3)	1134(96.5)
	Married	13(2.8)	4(5.1)	23(3.7)	40(3.4)
	Widow	1(0.2)	0(0.0)	0(0.0)	1(0.1)
	Missing	0(0.0)	0(0.0)	0(0.0)	0(0.0)

Table 1.2 describes and summarises the exposure characteristics of the study participants. Overall, the median childhood TEs score was 2, with an interquartile range (IQR) between 1 and 4. The median childhood TEs score among participants who were PTSD negative (n=468) was 2(IQR 1-3). The median childhood TEs score among participants who were PTSD positive (n=79) was 4(IQR 2-6).

A total of 582(49.5%) participants were in the control arm in the primary study, and 593(50.5) were in the intervention arm. Among PTSD negative participants, 237(50.6%) were in the control arm and 231(49.4%) were in the intervention arm. Among participants who were PTSD positive, 40(50.6%) were in the control arm and 39(49.4%) were in the intervention arm.

Overall, 355(30.2%) participants did not have a boyfriend, while 817(69.5%) had a boyfriend. Among participants who were PTSD negative, 162(34.6%) did not have a boyfriend, while 304(65.0%) had a boyfriend. Among the PTSD positive group, 15(19.0%) did not have a boyfriend, and 64(81.0%) had a boyfriend. Overall, 348(29.6%) of the participants were not exposed to vaginal sex, while 823(70.4%) were exposed to vaginal sex. Among the PTSD negative group, 164(35.0%) were not exposed to vaginal sex, while 304(65.0%) were exposed to vaginal sex. Overall, 1067(90.8%) of the participants were not exposed to anal sex, while 106(9.0%) were exposed to anal sex. Among the PTSD negative group, 441(94.2%) of the participants were not exposed to anal sex, while 27(5.8%) were exposed to anal sex. Overall, the median intimate partner violence (IPV) score was 32(IQR 28-32). Among PTSD negative participants, the median IPV scale was 32(IQR 30-32), while the IPV median scale among PTSD positive participants was 31(IQR 28-32).

Overall, 198(16.9%) of the participants were never exposed to alcohol, 38(3.2%) drank alcohol less than once a month, 9(0.8) drank alcohol once a month, and 9(0.8%) drank 2 to 3 times a month. Seventy-eight percent (n=921) of data was missing in the alcohol variable. One thousand one hundred-and-one (93.7%) of the participants were not exposed to drugs while 66(5.6%) were exposed to drugs. Among participants who were negative for PTSD, 447(95.5%) were not exposed to drugs, while 19(4.1) were exposed to drugs. Among the PTSD positive group, 73(92.4%) were not exposed to drugs, while 6(7.8%) were exposed to drugs.

Overall, the mean depression score was 34.5 (sd= 9.5). Among the PTSD negative group, the mean depression score was 34.1(sd= 8.9). Among the PTSD positive group, the mean depression score was 36.8 (sd= 12.9). The median anxiety score among the PTSD negative group was 1(IQR 0-4), while the median anxiety score was 5(IQR 2-11) in the PTSD positive group.

Table 1.2: Exposure Characteristics of the AGYW (n=1175)

VARIABLE	LEVEL	PTSD NO (n= 468)	PTSD YES (n=79)	PTSD MISSING (n=628)	ALL (n= 1175)
CHILDHOOD TRAUMA SCALE	n Median(IQR) Missing n(%) MM	464 2(1-3) 4(0.01) Not MCAR	78 4(2-6) 1(0.01) Not MCAR	595 2(1-5) 33(5.3) Not MCAR	1137 2(1-4) 38(3.2) Not MCAR
STUDY ARM n(%)	Control Intervention Missing	237(50.6) 231(49.4) 0(0.0)	40(50.6) 39(49.4) 0(0.0)	305(48.6) 323(51.4) 0(0.0)	582(49.5) 593(50.5) 0(0.0))
ADULT TRAUMA	n Median(IQR) Missing n(%)	26 4(2-5) 442(94.4)	2 3(1-5) 77(97.5)	102 2(1-5) 598(85.4)	130 2(1-5) 130(89.6)
SEXUAL/RELATIONSHIP POWER SCALE	n Median(IQR) Missing	468 28(0-33) 0(0.0)	79 28(19-32) 0(0.0)	628 27(0-32) 0(0.0)	1175 28(0-32) 0(0.0)
INTIMATE PARTNER VIOLENCE SCALE	n Median(IQR) Missing	468 32(30-32) 0(0.0)	79 31(28-32) 0(0.0)	628 31(28-32) 0(0.0)	1175 32(28-32) 0(0.0)
GENDER EQUITABLE MEN'S SCALE	n Mean(sd) Missing n(%)	468 74.5(12.3) 0(0.0)	79 69.1(15.1) 0(0.0)	628 65.4(27.0) 0(0.0)	1175 73.3(14.8) 0(0.0)
BOYFRIEND n(%)	No Yes Missing	162(34.6) 304(65.0) 2(0.4)	15(19.0) 64(81.0) 0(0.0)	178(28.3) 449(71.5) 1(0.2)	355(30.2) 817(69.5) 3(0.3)
VAGINAL SEX n(%)	No Yes Missing	164(35.0) 304(65.0) 0(0.0)	10(12.7) 69(87.3) 0(0.0)	174(27.7) 450(71.7) 4(0.6)	348(29.6) 823(70.4) 4(0.3)
ANAL SEX n(%)	No Yes Missing	441(94.2) 27(5.8) 0(0.0)	66(83.5) 13(16.5)) 0(0.0)	560(89.2) 66(10.5) 2(0.3)	1067(90.8) 106(9.0) 2(0.2)
ALCOHOL n(%)	Never < once a month Once a month 2-3 times a month Missing	75(16.0) 17(3.6) 5(1.1) 4(0.9) 367(78.4)	19(24.1) 4(5.1) 0(0.0) 2(2.5) 54(68.4)	104(16.6) 17(2.7) 4(0.6) 3(0.5) 500(79.6)	198(16.9) 38(3.2) 9(0.8) 9(0.8) 921(78.4)
DRUGS n(%)	No Yes Missing	447(95.5) 19(4.1) 2(0.4)	73(92.4) 6(7.8) 0(0.0)	581(92.5) 41(6.4) 6(1.0)	1101(93.7) 66(5.6) 8(0.7)
SPENDING	n Median(IQR) Missing n(%)	323 250(100-500) 145(40.0)	62 300(150-500) 17(21.5)	390 300(100-500) 238(37.9)	775 300(100-500) 400(34.0)

TABLE 1.2 CONTINUED

VARIABLE	Level	PTSD No (n= 468)	PTSD Yes (n=79)	PTSD Missing (n=628)	All (n= 1175)
WORK FOR MONEY n(%)	No	382(81.6)	54(68.4)	473(75.3)	909(77.3)
	Yes	86(18.4)	24(30.4)	135(21.5)	245(20.9)
	Missing n(%)	0(0.0)	1(1.3)	20(3.2)	21(1.8)
FRIENDS n(%)	Male	0(0.0)	0(0.0)	65(10.4)	65(5.5)
	Female	0(0.0)	0(0.0)	447(71.2)	447(38.0)
	Missing	468(100)	79(100)	116(18.5)	663(56.4)
SERVICE UTILISATION TYPE n(%)	Government	172(36.8)	35(44.3)	225(35.8)	432(36.8)
	Private	44(9.4)	21(26.6)	80(12.7)	145(12.3)
	Other	7(1.5)	3(3.8)	2(0.3)	12(1.0)
	Missing	245(52.4)	20(25.3)	321(51.1)	586(49.9)
DEPRESSION SCALE	n	462	76	588	1126
	Mean(sd)	34.1(8.9)	36.8(12.9)	34.4(9.3)	34.5(9.5)
	Missing n(%)	6(1.3)	3(3.8)	40(6.4)	49(4.2)
HOPE SCALE	n	468	79	628	1175
	Mean(sd)	20.3(4.4)	18.2(5.2)	19.6(9.1)	21.0(5.9)
	Missing n(%)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
SELF-ESTEEM SCALE	n	463	77	595	1135
	Mean(sd)	25.1(5.6)	24.5(6.8)	24.9(6.1)	25.0(5.9)
	Missing n(%)	5(0.1)	2(2.5)	33(5.5)	40(3.4)
HAPPINESS SCALE	n	468	79	628	1175
	Mean(sd)	19.5(11.1)	24.3(11.8)	17.3(12.8)	19.7(11.7)
	Missing n(%)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
ANXIETY SCALE	n	468	79	628	1175
	Median(IQR)	1(0-4)	5(2-11)	1(0-5)	2(0-5)
	Missing n(%)	0(0.0)	0(0.0)	0(0.0)	0(0.0)

sd: standard deviation; n: frequency; MM (Mechanism of Missingness); IQR: interquartile range (25^{th}- 75^{th} percentile)

Table 2 summarises the results of the reliability tests for the scales that were administered to the study participants.

Table 2: Reliability of Scales

SCALE NAME	NUMBER OF ITEMS	CRONBACH'S ALPHA
PTSD (TRAUMA SCREENING QUESTIONNAIRE)	10	0.9264
CHILDHOOD TRAUMA (ACES-INT)	10	0.8411
ADULT TRAUMA	5	0.8949
SEXUAL RELATIONSHIP POWER SCALE	12	0.8563
GENDER EQUITABLE MEN'S SCALE	33	0.9144
INTIMATE PARTNER VIOLENCE SCALE	8	0.9066
CENTER OF EPIDEMIOLOGICAL STUDIES DEPRESSION SCALE	20	0.8432
HOPE SCALE	7	0.9580
SELF-ESTEEM SCALE	10	0.7933
HAPPINESS SCALE	7	0.8706
ANXIETY SCALE	14	0.9000

3.2. Factors associated with PTSD: Complete Case Analysis

Table 3 summarises the results of the univariable logistic regression investigating the association between PTSD and childhood TE. We found that PTSD was associated with childhood TEs (OR=2.26, 95% CI 1.72 -2.99). This indicated that a 3-point increase in the childhood TEs score increased the odds of PTSD 2.26 times. PTSD was associated with the IPV scale (OR=0.72, 95% CI 0.57-0.89). This indicated that a 5-point increase in the IPV (higher IPV scores denote less IPV) score decreased the odds of PTSD by 28%. PTSD was associated with the depression scale (OR= 1.13, 95% CI 1.01-1.28). This indicated that a 5-point increase in the depression score increased the odds of PTSD by 13%. PTSD was associated with the anxiety scale (OR=2.94, 95% CI 2.19-3.93). This indicated that a 5-point increase in the anxiety score increased the odds of PTSD 2.94 times.

The odds of PTSD were 2.27 times higher for participants who had a boyfriend compared to participants who did not have a boyfriend (OR=2.27, 95%CI 1.26 - 4.12). The odds of PTSD were 3.22 times higher for participants who were exposed to anal sex compared to participants who were not exposed to anal sex (OR=3.22, 95% CI 1.58-6.55), and the odds of PTSD were 3.72 times higher for participants who were exposed to vaginal sex compared to participants who were not exposed to vaginal sex (OR=3.72, 95% CI 1.87-7.42).

Service utilisation (n=222) and educational level (n=315) were excluded in subsequent analyses: in multivariable logistic regression variable selection algorithm (CIE); the variables were excluded because of the low number of observations in both variables. A sensitivity analysis was carried out excluding and including the two variables. The model was better without them: including them caused the model to be unstable.

Table 3: Univariable logistic regression model for PTSD (n=547)

VARIABLE	OBSERVATIONS	UN-ADJUSTED ODDS RATIO(95% CI)	P-VALUE
CHILDHOOD TRAUMA SCALE (PER 3-POINT INCREASE)	542	2.27(1.72-2.99)	<0.001
AGE (IN YEARS)	547	1.15(0.95-1.39)	0.157
STUDY ARM	547		
CONTROL		1 (reference)	
INTERVENTION		1.00(0.62-1.61)	0.999
PRIMARY CAREGIVER	547		
MOTHER		1 (reference)	
FATHER		1.98(0.92-4.26)	0.080
OLDER BROTHER/SISTER		2.57(1.13-5.84)	0.025
AUNTS/UNCLES		1.02(0.29-3.55)	0.977
GRANDPARENTS		1.54(0.75-3.16)	0.242
CURRENTLY AT SCHOOL	547		
NO		1 (reference)	
YES		1.03(0.64-1.67)	0.901
CURRENT EDUCATION LEVEL	315		
HIGH SCHOOL		1 (Reference)	
UNIVERSITY		0.89(0.47-1.68)	0.715
SEXUAL/RELATIONSHIP POWER SCALE (PER 10-POINT INCREASE)	547	1.22(1.02-1.45)	0.030
INTIMATE PARTNER VIOLENCE SCALE (PER 5-POINT INCREASE)	547	0.72(0.58-0.89)	0.004
GENDER EQUITABLE MEN'S SCALE (PER 5-POINT INCREASE)	547	0.86(0.78-0.92)	0.001
CURRENT BOYFRIEND	545		
NO		1 (Reference)	
YES		2.27(1.26-4.12)	0.007
VAGINAL SEX	547		
NO		1 (Reference)	
YES		3.72(1.87-7.42)	<0.001
ANAL SEX	547		
NO		1 (Reference)	
YES		3.22(1.58-6.55)	0.001

TABLE 3 CONTINUED

VARIABLE	Observations	Un-adjusted Odds Ratio(95% CI)	P-value
MARITAL STATUS	546		
NEVER MARRIED		1 (Reference)	
MARRIED		1.86(0.59-5.86)	0.288
DRUGS	545		
NO		1 (reference)	
YES		1.93(0.75-5.00)	0.174
WORK FOR MONEY	546		
NO		1 (Reference)	
YES		1.97(1.16-3.37)	0.013
SERVICE UTILISATION TYPE	222		
GOVERNMENT		1 (Reference)	
PRIVATE		2.35(1.24-4.42)	0.008
OTHER		2.11(0.52-8.54)	0.297
DEPRESSION SCALE (PER 5-POINT INCREASE)	538	1.14(1.01-1.28)	0.029
HOPE SCALE (5-POINT EFFECT)	547	0.65(0.52-0.82)	<0.001
HAPPINESS SCALE (5-POINT EFFECT)	547	1.19(1.08-1.32)	0.001
ANXIETY SCALE (5-POINT EFFECT)	547	2.94(2.11-3.93)	<0.001
SELF-ESTEEM SCALE (5-POINT EFFECT)	540	0.91(0.74-1.12)	0.394

Table 4 presents the results of fitting a multivariable logistic regression model to investigate the association between PTSD and childhood TEs adjusting for other variables using CCA. PTSD was associated with childhood TEs; a 3-point increase in the childhood TEs score increased the odds (adjusted Odds Ratio) of PTSD by 69% (aOR=1.69, 95% CI 1.16-2.47). PTSD was associated with the anxiety scale; a 5-point increase in the anxiety score increased the odds of PTSD 2.23 times (aOR= 2.23, 95% CI 1.61-3.09). PTSD was associated with the happiness scale; a 5-point increase in the happiness score increased the odds of PTSD by 15% (aOR=1.15, 95% CI 1.01-1.29).

The odds of PTSD were 11.06 times higher for participants who were exposed to vaginal sex compared to participants who were not exposed to vaginal sex (aOR=11.06, 95% CI 1.93-63.12). There was some evidence that the sexual relationship power scale was protective against PTSD (aOR=0.58, 95% CI 0.34-1.00).

Table 4: Multivariable logistic regression model for PTSD using CCA (n=541)

VARIABLE	ADJUSTED ODDS RATIO(95% CI)	P-VALUE
CHILDHOOD TRAUMA SCALE (PER 3-POINT INCREASE)	1.69(1.16-2.47)	0.007
AGE (IN YEARS)	1.09(0.87-1.36)	0.470
STUDY ARM		
CONTROL	1 (Reference)	
INTERVENTION	1.12(0.64-1.94)	0.695
PRIMARY CAREGIVER		
MOTHER	1 (Reference)	
FATHER	1.88(0.76-4.66)	0.171
OTHER	1.49(0.78-2.82)	0.224
CURRENTLY AT SCHOOL		
NO	1 (Reference)	
YES	1.40(0.78-2.53)	0.258
SEXUAL/RELATIONSHIP POWER SCALE (10-POINT EFFECT)	0.58(0.34-1.00)	0.050
INTIMATE PARTNER VIOLENCE SCALE (5-POINT EFFECT)	1.14(0.77-1.69)	0.511
VAGINAL SEX		
NO	1 (reference)	
YES	11.06(1.93-63.13)	0.007
ANAL SEX		
NO	1 (Reference)	
YES	2.07(0.87-4.91)	0.100
MARITAL STATUS		
NEVER MARRIED	1 (Reference)	
MARRIED	0.88(0.21-3.67)	0.865
HAPPINESS SCALE (PER 5POINT INCREASE)	1.15(1.01-1.29)	0.030
ANXIETY SCALE (5-POINT EFFECT)	2.23(1.61-3.09)	<0.001

Table 5 presents the results of the diagnostics tests carried out on the final model in table 4. The Hosmer and Lemeshow test indicated that there is not enough evidence against the null hypothesis: there is no evidence of lack of fit.

Table 5: Diagnostic tests for the multivariable logistic regression for PTSD using CCA (n=541)

TEST	PROPERTIES	P-VALUE
HOSMER-LEMESHOW TEST	Grouping=10	0.5294
LINK TEST	_hat	<0.001
	_hatsq	0.724
	Constant	0.976

Figure 2 presents the scatter plot between Pearson's standardised residuals and predicted probabilities of PTSD. There is not enough evidence to suggest that there were extreme outliers.

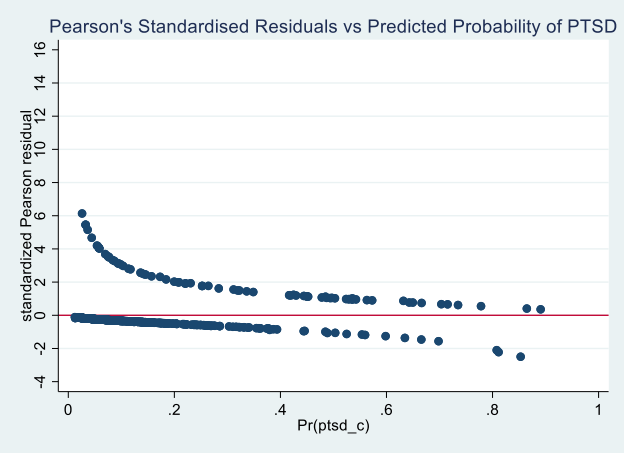

Figure 2. Pearson's Standardised Residuals vs Predicted Probabilities

The scatter plot between leverage values and predicted probabilities (Figure 3) indicated that there were some extreme leverage observations: above 0.15. A sensitivity analysis was carried out where the observations were removed. The analysis indicated that the model excluding the extreme leverage values did not differ much compared to the model including the extreme leverage values. Thus, the observations were included in the model.

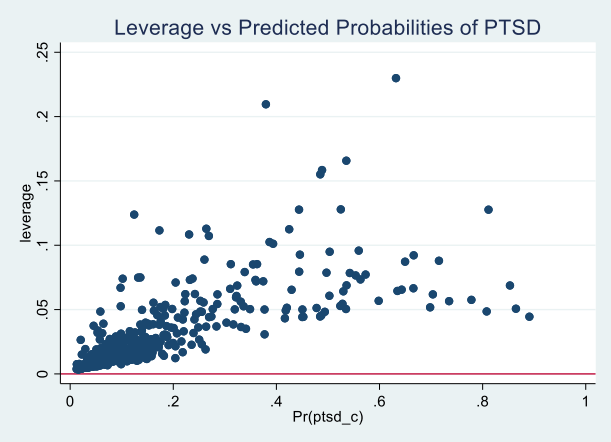

Figure 3. Leverage Values vs Predicted Probabilities

Figure 4 presents the deviance residuals versus the predicted probabilities of PTSD plot. We can conclude that there is not enough evidence that there are observations that were not a fit in the model.

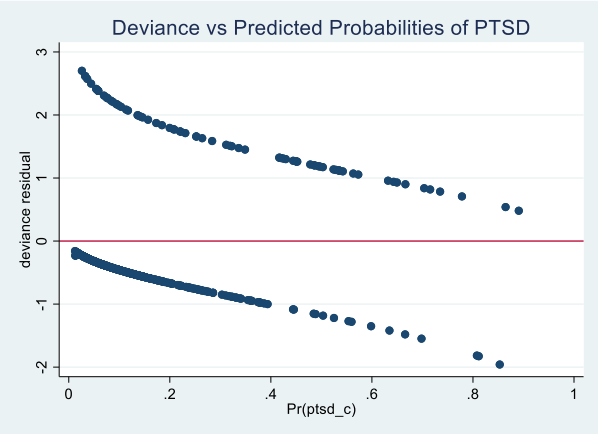

Figure 4. Deviance vs Predicted Probabilities

3.3.Factors associated with PTSD: Multiple Imputation by chained equations

Table 1.1 and table 1.2 summarises data related to missingness. PTSD had 628(53.4%) missing values in relation to the 1175 total number of observations in the sample. Participants who had missing PTSD data had a median childhood TEs score of 2 with an IQR that was between 1 and 5. The number of missing childhood TEs in the PTSD negative group was 4(0.01%), while 1(0.01%) was missing in the PTSD positive group. In total, childhood TEs had 38(3.2%) missing values. The result of the Univariate Mean Difference test for MCAR in PTSD indicated that there is enough evidence to conclude that PTSD data were not MCAR ($p<0.0001$). The results of the Univariate Mean Difference test for MCAR in childhood TEs indicated that there was enough evidence to conclude that childhood TEs data were not MCAR ($p<0.0001$). The depression scale had 40(6.4%) missing values for PTSD, and the self-esteem scale had 33(5.5%) missing values for PTSD.

Table 6 summarises the results of fitting a multivariable logistic regression model to investigate the association between PTSD and childhood TEs adjusting for other variables using MI by chained equations. The Bodner's approximation of the Monte Carlo error for determining the number of imputations that were needed asserts that the number of imputations should be equal to the proportion of the missing values in the outcome variable (40). We had 628 missing values for PTSD out the total sample of 1175. The number of imputations needed were 628/1175 *100= 53.4. We rounded the number of imputations needed upwards to the nearest 10, i.e. there were 60 multiply imputed datasets that produced 71675 observations/rows to inform the model.

PTSD was associated with childhood TEs; a 3-point increase in the childhood TEs score increased the odds of PTSD 2.06 times (aOR= 2.06, 95% CI 1.35 – 3.15). PTSD was associated with the Anxiety scale. A 5-point increase in the anxiety score increased the odds of PTSD by 54% (aOR= 1.54, 95% CI 1.19-1.99).

Table 6: Multivariable logistic regression model for PTSD using MI (Imputations= 60; n= 1175)

VARIABLE	ADJUSTED ODDS RATIO(95% CI)	P-VALUE
CHILDHOOD TRAUMA SCALE	2.06(1.35-3.15)	0.001
AGE (IN YEARS)	1.00(0.84-1.19)	0.993
STUDY ARM		
CONTROL	1 (Reference)	
INTERVENTION	1.01(0.66-1.55)	0.966
PRIMARY CAREGIVER	1.19(0.81-1.75)	0.376
MOTHER	1 (Reference)	--
FATHER	--	--
OTHER	--	
CURRENTLY AT SCHOOL		
NO	1 (Reference)	
YES	1.19(0.71-1.97)	0.509
SEXUAL/RELATIONSHIP POWER SCALE (10-POINT EFFECT)	0.86(0.55-1.1.32)	0.484
INTIMATE PARTNER VIOLENCE SCALE (5-POINT EFFECT)	1.10(0.83-1.47)	0.505
VAGINAL SEX		
NO	1 (reference)	
YES	2.82(0.68-11.62)	0.151
ANAL SEX		
NO	1 (Reference)	
YES	1.41(0.59-3.38)	0.441
MARITAL STATUS		
NEVER MARRIED	1 (Reference)	
MARRIED	1.09(0.31-3.85)	0.894
HAPPINESS SCALE (5-POINT EFFECT)	1.04(0.95-1.15)	0.399
ANXIETY SCALE (5-POINT EFFECT)	1.54(1.19-1.99)	0.001

Figure 5 presents the distribution of the TSQ in the original dataset versus the distribution of TSQ in the 60 imputation models. We see that the distribution of TSQ is preserved in most of the imputed datasets. This shows that the imputation models performed well.

Figure 5: Original distribution of TSQ (PTSD discrete scale) vs Imputation models

Figure 6 presents the distribution of the childhood TE scale in the original dataset versus the distribution of the childhood TE scale in the 60 imputation models. We see that the distribution of the childhood TEs scale is preserved in most of the imputed datasets. This shows that the imputation models performed well.

Figure 6: Original distribution of TSQ (PTSD discrete scale) vs Imputation models

3.4.Factors associated with PTSD: Inverse Probability Weighting

Table 7 summarises the results of fitting a multivariable logistic regression model to investigate the association between PTSD and childhood TEs adjusting for other variables using IPW. PTSD was associated with childhood TEs (aOR=1.49, 95% CI 1.01-2.21); a 3-point increase in the childhood TEs score increased the odds of PTSD by 49%.

PTSD was associated with the SRPS, vaginal sex, the happiness scale, and the anxiety scale. A 10-point increase in the SRPS score decreased the odds of PTSD by 48% (aOR=0.52, 95% CI 0.29-0.92). The odds of PTSD were 16.26 times higher for participants who were exposed to vaginal sex compared to participants who were not exposed to vaginal sex (aOR=16.26, 95% CI 2.78-94.94). A 5-point increase in the happiness score increased the odds of PTSD by 16% (aOR=1.16, 95 CI 1.01-1.33), and for every 5-point increase in the anxiety score, the odds of PTSD were increased by 92% times (aOR=1.92, 95% CI 1.31-2.80).

Table 7: Multivariable logistic regression for PTSD using IPW (N=541)

VARIABLE	ADJUSTED ODDS RATIO(95% CI)	P-VALUE
CHILDHOOD TRAUMA SCALE	1.49(1.01-2.21)	0.045
AGE (IN YEARS)	1.16(0.89-1.49)	0.276
STUDY ARM		
CONTROL	1 (Reference)	
INTERVENTION	1.05(0.58-1.92)	0.870
PRIMARY CAREGIVER		
MOTHER	1 (Reference)	
FATHER	2.02(0.75-5.45)	0.164
OTHER	1.12(0.58-2.16)	0.743
CURRENTLY AT SCHOOL		
NO	1 (Reference)	
YES	1.35(0.72-2.50)	0.347
SEXUAL/RELATIONSHIP POWER SCALE (10-POINT EFFECT)	0.52(0.29-0.92)	0.024
INTIMATE PARTNER VIOLENCE SCALE (5-POINT EFFECT)	1.09(0.76-1.58)	0.610
VAGINAL SEX		
NO	1 (reference)	
YES	16.26(2.78-94.94)	0.002
ANAL SEX		
NO	1 (Reference)	
YES	1.41(0.54-3.72)	0.483
MARITAL STATUS		
NEVER MARRIED	1 (Reference)	
MARRIED	1.65(0.41-6.57)	0.478
HAPPINESS SCALE (5-POINT EFFECT)	1.16(1.01-1.33)	0.030
ANXIETY SCALE (5-POINT EFFECT)	1.92(1.31-2.80)	0.001

Table 8 summarises the comparison between the CCA, MI, and IPW multivariable logistic regression models investigating factors associated with PTSD. PTSD was associated with childhood TEs in all the models. In the CCA model, a 3-point increase in the childhood TEs score increased the odds of PTSD by 69% (aOR= 1.69, 95% CI 1.16-2.47). In the MI model, a 3-point increase in the childhood TEs score increased the odds of PTSD 2.06 times (aOR= 2.06, 95% CI 1.35-3.15). In the IPW model, a 3-point increase in the childhood TEs score increased the odds of PTSD by 49% (aOR=1.49, 95% CI 1.01-2.21).

PTSD was associated with exposure to vaginal sex in the CCA and IPW models. PTSD was not associated with exposure to vaginal sex in the MI model. In the CCA model, the odds of PTSD were 11.06 times higher for participants who were exposed to vaginal sex compared to participants that were not exposed to vaginal sex (aOR= 11.06, 95% CI 1.93-63.13). In the IPW model, the odds of PTSD were 16.26 times higher for participants who were exposed to vaginal sex compared to participants that were not exposed to PTSD (aOR=16.26, 95% CI 2.78-94.94).

PTSD was associated with the happiness scale in the CCA and IPW models. In the CCA model, a 5-point increase in the happiness score increased the odds of PTSD by 15% (aOR= 1.15, 95% CI 1.01-1.29). In the IPW model, a 5-point increase in the happiness score increased the odds of PTSD by 16% (aOR= 1.16, 95% CI 1.01-1.33).

PTSD was associated with the anxiety scale in all the models. In the CCA model, a 5-point increase in the anxiety score increased the odds of PTSD 2.23 times (aOR= 2.23, 95% CI 1.61-3.09). In the MI model, a 5-point increase in the anxiety score increased the odds of PTSD by 54% (aOR= 1.54, 95% CI 1.19-1.99). in the IPW model, a 5-point increase in the anxiety score increased the odds of PTSD by 92% (aOR= 1.92, 95% CI 1.31-2.80).

Table 8: Comparison between the CCA, MI, and IPW multivariable logistic regression models for PTSD

VARIABLE	CCA MODEL OR (95% CI)	P-VALUE	MI MODEL OR (95% CI)	P-VALUE	IPW MODEL OR (95% CI)	P-VALUE
CHILDHOOD TRAUMA SCALE	1.69(1.16-2.47)	0.007	2.06(1.35-3.15)	0.001	1.49(1.01-2.21)	0.045
AGE (IN YEARS)	1.09(0.87-1.36)	0.470	1.00(0.84-1.19)	0.993	1.16(0.89-1.49)	0.276
STUDY ARM						
CONTROL	1 (Reference)		1 (Reference)		1 (Reference)	
INTERVENTION	1.12(0.64-1.94)	0.695	1.01(0.66-1.55)	0.966	1.05(0.58-1.92)	0.870
PRIMARY CAREGIVER			1.19(0.81-1.75)	0.376		
MOTHER	1 (Reference)		1 (Reference)	--	1 (Reference)	
FATHER	1.88(0.76-4.66)	0.171	--	--	2.02(0.75-5.45)	0.164
OTHER	1.49(0.78-2.82)	0.224	--		1.12(0.58-2.16)	0.743
CURRENTLY AT SCHOOL	1 (Reference)		1 (Reference)		1 (Reference)	
NO	1.40(0.78-2.53)	0.258	1.19(0.71-1.97)	0.509	1.35(0.72-2.50)	0.347
YES						
SEXUAL/RELATIONSHIP POWER SCALE (10-POINT EFFECT)	0.58(0.34-1.00)	0.050	0.86(0.55-1.32)	0.484	0.52(0.29-0.92)	0.024
INTIMATE PARTNER VIOLENCE SCALE (5-POINT EFFECT)	1.14(0.77-1.69)	0.511	1.10(0.83-1.47)	0.505	1.09(0.76-1.58)	0.610
VAGINAL SEX						
NO	1 (reference)		1 (reference)		1 (reference)	
YES	11.06(1.93-63.13)	0.007	2.82(0.68-11.62)	0.151	16.26(2.78-94.94)	0.002
ANAL SEX						
NO	1 (Reference)		1 (Reference)		1 (Reference)	
YES	2.07(0.87-4.91)	0.100	1.41(0.59-3.38)	0.441	1.41(0.54-3.72)	0.483
MARITAL STATUS						
NEVER MARRIED	1 (Reference)		1 (Reference)		1 (Reference)	
MARRIED	0.88(0.21-3.67)	0.865	1.09(0.31-3.85)	0.894	1.65(0.41-6.57)	0.478
HAPPINESS SCALE (5-POINT EFFECT)	1.15(1.01-1.29)	0.030	1.04(0.95-1.15)	0.399	1.16(1.01-1.33)	0.030
ANXIETY SCALE (5-POINT EFFECT)	2.23(1.61-3.09)	<0.001	1.54(1.19-1.99)	0.001	1.92(1.31-2.80)	0.001

Chapter 4

4. Discussion

The main objective of the current study was to examine the association between PTSD and childhood TEs. Additionally, given the large proportion of missing data, we examine the effect of using MI or IPW for handling missing data on the estimated measures of association. Of the 1175 study participants, 468(39.8%) were PTSD negative, and 79(6.7%) were PTSD positive. There were 628(53.4%) missing values for PTSD and 38(3.2%) missing values for childhood TEs.

Overall, PTSD was associated with childhood TEs in all the multivariable logistic regression models, as well as the univariable logistic regression model. In the CCA model, PTSD was found to be associated with childhood TEs (aOR=1.69, 95% CI 1.01-2.47). This association remained after accounting for missing data in the MI model (aOR= 2.06, 95% CI 1.35-3.15), and the IPW model (aOR= 1.49, 95% CI 1.01-2.21).

4.1.CCA Discussion

In the CCA model, we found that PTSD was associated with childhood TEs. A 3-point increase in the childhood TEs score increased the odds of PTSD by 69%. This finding is consistent with other studies on the association between PTSD and childhood TEs. Choi *et al*. found that PTSD was associated with childhood TEs in their study among pregnant women in Cape Town. In that study, PTSD and childhood TEs had a correlation coefficient of 0.40 ($p<0.0001$)(16). Similar findings were reported by Suliman *et al*. in their study on traumas among adolescents in Cape Town. The authors found that PTSD was associated with childhood TEs; they reported a correlation coefficient of 0.37 ($p<0.0001$) (15). Machisa *et al*., in two of their studies among women in Gauteng and women in TVET colleges in South Africa, corroborate these results. They found that PTSD was associated with childhood TEs (31,32).

The strength of the current study is that it was conducted among adolescent girls and young women in rural areas in South Africa. Many of the studies in the South African context have been in urban areas as seen in the previous paragraph. Furthermore, the CCA analysis in this study was carried out using multivariable methods. The majority of the literature reviewed in this study utilised univariable analyses. Thus, we were able to adjust for confounders. Another strength in the current

study is that we could combine important variables in the literature with known important variables in the theoretical framework found in chapter 1, which explains the association between PTSD and childhood TEs. These variables were not necessarily controlled for in the previous studies we reviewed. In all the studies that we reviewed, we found that PTSD was associated with childhood TEs.

We found that PTSD was associated with IPV in the univariable logistic regression for PTSD. PTSD was not associated with IPV in the CCA, MI, and IPW models. A study by Machisa *et al*. reviewed in this paper which examined the association between PTSD and childhood TEs, and controlled for IPV, found that IPV was associated with PTSD in their univariable and multivariable models. The authors made use of structural equation modelling (SEM), and they did not control for some of the variables we controlled for (31). We think that the combination of the SEM, where indirect pathways are controlled for, and the variables that were not controlled for which we controlled for in our study could have contributed to this divergence in IPV estimates in relation to PTSD .

The SRPS, the IPV scale, and the GEMS, were all reverse coded. This means that as the scale increases the participants are at disagreement with gender norms and abuses that are detrimental to women. Thus, we expected that as the scales increased, the odds of PTSD would decrease. We see that the SRPS conformed to these assumptions (42% decrease per 10-point increase), but the IPV scale did not. The higher the IPV score the odds of PTSD were increased. We expected a decrease in the odds of PTSD. This increment was 14% in the CCA model. We reiterate that PTSD was not associated with IPV in the CCA model, but this indicates that PTSD and IPV are potentially an area of focus in future studies.

There were some weaknesses that were observed in the study. One of the weaknesses of the study is that it did not split childhood TEs into its sub-scales. Choi *et al*. were able to split childhood TEs into the sexual abuse, emotional abuse, physical abuse, emotional neglect, and the physical neglect components. The authors found that PTSD was associated with sexual abuse, emotional abuse, physical abuse, while PTSD was not associated with physical neglect and emotional abuse (16).

One major weakness of CCA is that it is biased if data are not MCAR. We found that both results of the *Univariate Mean Difference* test for MCAR in PTSD and childhood TEs indicated that there was enough evidence to conclude that PTSD and childhood TEs were not MCAR ($p<0.0001$). We

have already noted that currently, we can reliably test whether the data are MCAR. If they are not MCAR, there is no reliable test to distinguish between the data being MAR or MNAR. We will examine how the estimated measures of effect change with the introduction of the MI and IPW models later in the discussion.

The theoretical framework indicated that genomic and personality data are important in studying the association between PTSD and childhood TEs. The primary study did not collect any genomic and personality data and thus, we could not adjust for them in our models. Because of the nature of genomic and personality data, and the availability of variables from the primary study, we could not carry out factor analyses to adjust for personality and genomic data.

4.2.MI Discussion

In our analysis, we handled missing data by MI using chained equations. In the MI model, we found that PTSD was associated with childhood TEs. A 3-point increase in the childhood TE score increased the odds of PTSD 2.06 times (aOR= 2.06, 95% CI 1.35-3.15). In the CCA model, had a 3-point increase in the childhood TEs score increased the odds of PTSD by 69% (aOR= 1.69, 95% CI 1.16-2.47). We see a 37% difference in the childhood TEs when we compare the CCA and the MI models with the MI model having a larger odds ratio compared to the CCA model. We have already established that if data are not MCAR, CCA analyses tend to be biased. Based on this, we can conclude that the CCA model in our study was biased towards the null hypothesis compared to the MI model.

PTSD was marginally associated with the SRPS in the CCA model (aOR=0.58, 95% CI 0.34-1.00, p= 0.050). PTSD was not associated with the SRPS in the MI model (aOR=0.86, 95% CI 0.55-1.32). We see that the MI model had a narrower confidence interval compared to the CCA model.

We notice some strengths that the MI had compared to the CCA. We notice that in the literature, some studies carried out their analyses utilising CCA. We are limited in our comparison as the previous studies did not report the magnitude of missingness in their studies by which we could examine if MI was appropriate. We know that in our study, missingness was predominantly in the PTSD variable: 53.4% missing (n=628). This proportion of missingness made it appropriate for us to use MI.

The best way of dealing with missing data is to prevent missing data by observing them, however we know that is not the case in many studies (71). MI is not perfect, but it is a reliable method for handling missing values.

4.3.IPW Discussion

In the IPW multivariable logistic regression model, PTSD was associated with childhood TEs. A 3-point increase in the childhood TEs score increased the odds of PTSD by 49% (aOR= 1.49, 95% CI 1.01-2.21). Compared to the CCA model (aOR=1.69, 95% CI 1.16-2.47) and the MI model (aOR= 2.06, 95% CI 1.35-3.15); The IPW odds ratio was the smallest of the three, and the confidence interval was the narrowest compared to the other two methods. This indicated that IPW, in the association between PTSD and childhood TEs, was more precise compared to the CCA and the MI models.

It is easier to compare point estimates and confidence intervals, but it is more difficult to conclude which method was better between the IPW and MI model. The main advantage of the MI method is sample size and precision. The main advantage of the IPW model is that it is flexible and has fewer assumptions compared to the MI method, and that it deals well with selection biases that may be as a result of missing outcome variable values. Future studies would be helpful to investigate this question. A simulation study that has complete data and then have the data removed, and then apply these two methods is one example that may help us answer this question.

4.4.Conclusion

We sought to examine the association between PTSD and childhood TEs using CCA, and to compare estimated measures of associations between two methods of handling missing data, namely MI, and IPW. In our study, we found that PTSD was associated with childhood TEs in all the multivariable logistic regression models. In the CCA model, a 3-point increase in the childhood TEs score increased the odds of PTSD by 69%. In the MI model, a 3-point increase in the childhood TEs score increased the odds of PTSD 2.06 times, and in the IPW model, a 3-point increase in the childhood TEs score increased the odds of PTSD by 49%.

Using the CCA, which we have established to be biased because the data were not MCAR would be in appropriate. While that has been established, it is difficult to conclude which method was better between the IPW and MI models. Future studies have the opportunity of comparing MI to IPW. Future studies may also follow-up participants prospectively to investigate the onset of PTSD.

4.5.Ethical Considerations

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Appendices

Appendix 1: Plagiarism declaration report

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Siyanda Ales Madala (Student number: 2500745) am a student registered for the degree of Master of Science in Epidemiology in the academic year 2024.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
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- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
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1

Appendix 2: Turn it in report

Supervisor signature: Sumaya Mall 

Supervisor signature: Jonathan Levin 

Siyanda_Research_Report_complete_draft_reduced.pdf

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Appendix 3: Ethics clearance certificate

M230775 MED23-05-237

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/48 Mr Siyanda Madala

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M230775 MED23-05-237

NAME: (Principal Investigator)	Mr Siyanda Madala
DEPARTMENT:	School of Public Health Epidemiology and Biostatistics
PROJECT TITLE:	Childhood Trauma and Post-Traumatic Stress Disorder (PSTD) among adolescent girls and young women aged between 18-28 years in Mpumalanga, South Africa: A Cross-sectional Study
DATE CONSIDERED:	11/08/2023
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Miss Sumaya Mall and Mr Jonathan Levin

APPROVED BY: Mrs M van Niekerk, Co-Chair, HREC (Medical)

DATE OF APPROVAL: 13/09/2023 **EXPIRY DATE:** 13/09/2028

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report** in January each year until study is closed. Failure to submit annual report will result in ethics clearance certificate suspension. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in July and will therefore be due in the month of July each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Email signed copy of this ethics clearance certificate prior to commencing with the study hrec-medical.researchoffice@wits.ac.za

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 4: Search Strategy

	Subheadings	Sources	Key Words
AIM	Post-Traumatic Stress Disorder. • Disorder • Prevalence • Globally • South Africa	• Pubmed • Proquest • Google scholar	Post-Traumatic Stress Disorder
Objective 1	To define PTSD	• Pubmed • Proquest Google scholar	Post-Traumatic Stress Disorder
AIM	Childhood Trauma	• Pubmed • Proquest • Google scholar	Childhood trauma Adverse life events
Objective 2	To Define Childhood trauma • What it is. • Its prevalence • Globally • South Africa	• Pubmed • Proquest • Google scholar	Childhood trauma Adverse life events
AIM	Childhood trauma and PTSD • Association • Relationship	• Pubmed • Proquest Google scholar	Childhood trauma AND PTSD. Adverse life Events AND PTSD
Objective 3	To look at the association between CHT and PTSD	• Pubmed • Proquest • Google scholar	Childhood trauma AND PTSD. Adverse life Events AND PTSD Filter: South Africa, English.