UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

EARLY LIFE FACTORS ASSOCIATED WITH CHILDHOOD TRAJECTORIES OF VIOLENCE AMONG THE BIRTH TO TWENTY-PLUS COHORT IN SOWETO, SOUTH AFRICA.

By

MUCHAI, LILIAN NJERI

Student Number – 2606265

A Research Report Submitted to the faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements of Master of Science (MSc) in Epidemiology in the field of Epidemiology and Biostatistics.

Supervisor:

Prof. Juliana Kagura

Dr. Sara Naicker

January, 2024

Declaration

I, Lilian Muchai, declare that this research report is my original unaided work. This report is submitted in partial fulfilment of the requirements for the Master of Science in Epidemiology (Epidemiology & Biostatistics) degree at the University of the Witwatersrand, Parktown, Johannesburg, South Africa. This research report has not been submitted before for any degree or examination at University of the Witwatersrand, Johannesburg or at any other university.

(Candidate Signature)

I declare this on the 7th of January 2024.

Dedication

I dedicate this research work to my husband and children for their unwavering support, sacrifices and encouragement, and to my heavenly father for his sufficient grace and strength to accomplish this task.

Abstract

Introduction

Violence against children has devastating and long-term negative consequences on individuals' and society's health, social and economic well-being. There is limited research on the life course experience of violence especially in Africa. This study aimed to identify sub-groups of physical & sexual violence victimization patterns separately in childhood, and evaluate early life factors predicting these violence trajectories.

Methods

This study used data from age 5 to 18 years from the ongoing prospective Birth to Twenty Plus cohort (Bt20+). Children within the Bt20+ cohort with data on physical and sexual violence in at least 2-time points between 5 and 18 years were included in the analyses. Group-based trajectory modelling was employed to identify groups of children with similar patterns of violence over time. Descriptive statistics was used to summarize study variables by violence trajectory group membership, while multivariable logistic regression was used to identify early life factors measured between birth and 5 years, associated with violence trajectory group membership.

Results

Two trajectory groups were identified for both physical and sexual violence victimization. For physical violence victimization, the majority of participants fell into the adolescent limited group (65.1%) and just over a third (34.9%) of the children were in the chronic increasing group. For sexual violence victimization, most participants fell into the adolescent limited group (74.1%, with a quarter in the late increasing (25.9%) group. Early life factors associated with a higher risk of chronic increasing physical violence victimization trajectory group membership, after adjusting for

covariates, were being male (aOR 1.67, 95% CI 1.31; 2.10) and having a mother with at least secondary education compared to higher education (aOR 1.73, 95% CI 1.08; 2.76). In addition, residing in middle, compared to low, socioeconomic households (aOR 0.68, 95% CI 0.50; 0.92) was protective against membership in this group. Residing in high compared to low socioeconomic households, was the only early life factor with marginally significant (aOR 0.63, 95% CI 0.42; 0.95) association with membership in the late-increasing sexual violence victimization trajectory group, with those in better-off households less likely to experience sexual violence victimization with this pattern.

Conclusion

Children within the same community can follow different patterns of both physical and sexual violence victimization across childhood. Identification of early factors that predict membership to sub-groups of violence trajectories provides key violence prevention intervention points that can preempt or mitigate children's exposure or experience of violence. Future research should explore a larger variety of early life factors proximal to the child as well as those more distal at the community and school levels.

Keywords: Physical violence; sexual violence; trajectories; early life; longitudinal

Acknowledgements

A special appreciation to my supervisors Drs. Juliana Kagura and Sara Naicker for their immeasurable support, time, encouragement and dedication, throughout the research process. Their prompt feedback and guidance were paramount in the completion of this work.

Special assistance offered on trajectory modelling by Dr. Stephanie De Long was greatly appreciated.

My sincere gratitude to my families; Muchai & Manyara families for their prayers and encouragement throughout this Master's journey.

I am grateful to the DSI-NRF Centre of Excellence in Human Development for granting access to use the Birth to Twenty plus cohort data.

I would like to acknowledge the entire staff at the Epidemiology and Biostatistics Division in the School of Public Health, University of the Witwatersrand, Johannesburg for the knowledge and support provided to me during the course of this master's journey.

My appreciation goes to friends and classmates for making this journey memorable, enjoyable and bearable.

Finally, a special thanks to God for granting me perseverance, strength and grace to accomplish this research work.

Table of Contents

List of figures

List of tables

CHAPTER 1: INTRODUCTION

This chapter provides background into the burden and long-term impacts of violence victimization on a child's wellbeing, examines literature on early life factors, looking at both individual and family factors associated with violence victimization in childhood. The section further demonstrates the use of group-based trajectory modeling to identify groups of children following distinct violence patterns through childhood.

1.1 Background

The World Health Organization (WHO) describes violence against children (VAC) as any form of violence including physical, sexual, emotional violence and neglect that is either experienced or witnessed by children under the age of 18 years (1). Globally, more than half of the children between the ages of 2 and 17 years reported having experienced some type of violence in the previous year (2). Children can experience different forms of violence at different stages of their lives. Most children experience at least one of the six types of interpersonal violence namely child maltreatment; bullying; youth violence; intimate partner violence; non-partner sexual violence; emotional and psychological violence at different stages of childhood (3). A report by the United Nations Children Fund (UNICEF) indicated that globally about 3 in 4 children aged 2 to 4 years experienced violent discipline by caregivers regularly (4). Thirty two percent of students globally indicated having experienced bullying by peers at school on one or more days within the preceding month (5). Furthermore, almost 130 million students between ages 13 and 14 years experienced bullying and 9 million adolescent girls between 15 to 19 years were victims of forced sex within the past year (4).

1.1.1 Burden on VAC in Sub-Saharan Africa

Burden of VAC in Africa significantly contributes to the global burden of child violence exposure and experience. The highest proportion of school bullying incidents among students is reported in Sub-Saharan Africa with 48.2% of students reporting experiencing bullying (5). A systematic review of child maltreatment by gender estimated the prevalence of physical abuse in Africa at 60% and 51% for boys and girls respectively (6). Across 9 countries in East and Southern Africa, 12% of adolescent girls aged 15-19 years experienced physical violence within the previous 12 months (7). The prevalence of interpersonal violence across in-school children aged between 10 and 19 years across eight Sub-Saharan countries was 53.7%, with prevalence varying between the countries, and across age (8). Liberia had the highest prevalence of interpersonal violence (64.2%), while higher prevalence of interpersonal violence were recorded among adolescents 14 years and below (60.1%) compared to those above 14 years (49.3%) (8).

1.1.2 Burden of VAC in South Africa

Violence perpetration and victimization continues to be a serious problem in South Africa. The multiple definitions and forms (sexual, physical, emotional and neglect) of VAC, complicates the ability to quantify exposure, monitor incidence and analyze trends. A nationally representative survey among children 15–17 years of age reported that almost 20% of children had experienced some form of sexual abuse, 21.3% experienced neglect, over 30% and 16% experienced physical and emotional abuse respectively (9). Girls and women are at greater risk of experiencing sexual violence. Seedat et al. (10) reported that 39% of girls in South Africa experienced some form of sexual violence by the age of 18 years and 15% experienced neglect from one or both parents.

The school environment exposes children to different forms of violence. According to a 2012 national school violence study, 22.2% of learners were exposed or experienced violence at school

within the previous 12 months (11). South African children continue to experience corporal punishment despite the existence of legislation that prohibits the use of corporal punishment. In a study conducted among 3,743 grade 8 learners attending 24 public schools in Tshwane, 52% and 44.8% of the students indicated having experienced corporal punishment from teachers at school and parents at home in the preceding 6 months respectively (12).

Violence against children occurs in many forms and can be experienced (being a victim or perpetrator of violence), witnessed (exposure to violence), or both encountered concurrently during a child's life. Literature has demonstrated that the different forms of VAC are interrelated and experience of one form of violence predisposes children to different forms of violence (13). A study conducted among children followed up from birth to 22 years in Soweto, found that 36% of children were exposed to violence at home, in the community, at school, peer violence and were victims of interpersonal violence and sexual abuse (14). Data from a nationally representative survey of 5,635 children in South Africa indicated that 35.4% of these children experienced five or more different types of victimizations by the time they were 17 years old (15).

Prevalence estimates of VAC reported are an under-representation of actual prevalence. This is because many cases of VAC are perpetrated by persons known to the victims impeding reporting, with overburdened and weak reporting systems further exacerbating reporting of VAC (16,17). The method of data collection used to obtain information on VAC exposure or experience has significant implications on reported prevalence (4,6). A study among 4,095 school children in South Africa reported higher prevalence of sexual abuse when information was obtained using self-administered questionnaires compared to when the same information was obtained using interviewers (9). It is therefore important to take into account the methods applied in estimating prevalence of VAC when interpreting data.

1.1.3 Consequences of VAC

Violence against children has devastating and long-term effects on physical and mental health, social relations, academic achievement, and is linked to heightened engagement in health risky behaviour and violence perpetration. The nature and severity of the effects of violence can range from death, physical injury, and psychological impairment, which can have long-term negative impacts on child development. A report by UNICEF indicated that early and prolonged exposure to violence present the greatest risk to adverse and long-lived impacts on child development (7). For example, recent maternal emotional intimate partner violence was significantly associated with lower language, cognitive and motor scores among infants at 2 years of age in South Africa (18). Exposure to violence in childhood increases the probability of violence revictimization and perpetration in adulthood (19). A study conducted in Soweto, South Africa indicated that among women who reported sexual assault in childhood, 74.8% reported physical or sexual partner violence when adults (20). Child sexual violence was associated with revictimization and earlier age at onset of adult violence (20). The vicious intergenerational cycle of violence is further demonstrated in other studies. One study found a significant association between South African men who, as children, witnessed their mother's being abused and their own involvement in physical fights at work and in the community, physical conflicts against their partners and incarceration in adulthood (21). Due to the negative consequences of VAC, various national and international instruments have been put in place to ensure the protection of the rights and well-being of children in society. The 2030 Sustainable Development Goals, specifically target 16.2, aims to end exploitation, abuse, trafficking, torture and all forms of violence against children. Section 28 (1) of the South African constitution stipulates that every child should be protected from abuse, maltreatment and neglect.

1.1.4 Violence trajectories in childhood and risk factors for violence victimization

Trajectory groups of violence can be expressed as clusters of individuals that follow similar patterns of violence over time or age in a specified population (22). Previous studies have demonstrated heterogeneity in the number and forms of trajectories of physical and/ or sexual violence victimization, with two (23,24), three (23,25), four (26) and five (27) trajectory groups identified. In additions to the differential population exposure and experiences of violence, differences observed in the numbers and forms of trajectory groups between studies is also attributed to differences in the violence measurement indicators used and varying periods of observation between studies.

The majority of studies assess trajectories of violence victimization as predictors of subsequent physical and mental health outcomes in adulthood, rather than identifying risk factors for trajectory group membership. Those that do assess risk factors for violence trajectory group membership in childhood tend to focus on violence aggression or perpetration. However, significant overlap between victimization and perpetration experiences have been documented in research among South African children (28). This and other studies (29,30) have demonstrated that victims and perpetrators share similar contextual features that place them at increased risk for violence exposure and experience.

Several demographic and early life factors have been associated with violence trajectories. Being female and having parents with higher level of education were negatively associated with membership in the increasing physical violence victimization group, compared to the no physical victimization trajectory group, among American adolescents and adults between the age of 12 to 34 years (26). Maternal age, postpartum depression, presence of more than one child in the household and low socioeconomic status were some of the risk factors identified for membership in the high physical aggression group among Canadian children between the ages of 17 to 42 months (31). Low

maternal education and younger age at motherhood were significantly associated with membership in the high physical aggression group compared to low physical aggression group among Canadian school age children between the age of 6 to 15 years (32).

Associations between other early life factors and violence exposure or experience have also been documented in cross-section or retrospective studies. Infant and child growth has an effect on the risk of violence victimization. Low birthweight was associated with increased likelihood of inclusion into child physical, sexual, emotional abuse and neglect registries among children from the United Kingdom assessed from birth to 19 years (33). Relative weight and height gain during infancy is indirectly associated with violence experience through the effects on later overweight and obesity in childhood and adulthood (34). A study conducted in the same Bt20+ population demonstrated that children with a higher transient infant (0-1 years) catch-up weight gain had higher body mass index (BMI) at 18 years (35). Several studies have documented the association between overweight and obesity and increased bullying or teasing in childhood (35, 36). Paternal absence was associated with an increased risk of sexual violence among adolescent girls aged 15-17 years in a systematic review conducted across 13 sub-Saharan African countries (38). The current study therefore aims to identify early life factors that predispose children to follow specific violence trajectories. This is paramount towards identification of prevention strategies prior to the child's exposure or experience of violence.

1.2 Literature review

This section reviews evidence from literature on health, social and economic burden of violence. It introduces use of group-based trajectory modelling in the identification of groups of individuals following similar evolution of violence over age/time and provides literature on factors that predict membership into generated violence trajectory groups. This section further demonstrates how the

child's immediate microsystem, focusing on individual and family characteristics influence probability of child maltreatment.

1.2.1 Health, social and economic burden of VAC

Violence against children has long-term negative consequences on the health, social and economic well-being of individuals and the society. Early and repeated exposure to adverse childhood experiences (ACEs) – experiences of violence and household dysfunction, is associated with negative social, emotional and cognitive development. There is a significant dose-response relationship between number of ACEs and risk of diseases such as ischemic heart disease, cancer and emphysema, meaning that with increasing ACEs, risk for these conditions increases correspondingly (39). Impacts on brain development can affect a child's ability to develop emotional attachments and empathy which could lead to antisocial behaviour, violence victimization (31) and perpetration (10). Dual effects of low birthweight and child abuse were associated with higher delinquency rates and reduced quality of life in adulthood among children followed up from birth to 34 years in the United States (40). Literature has shown that engagement in risky sexual and health behaviors is a coping mechanism toward exposure and experiences of VAC. The odds of engagement in alcoholism, use of drugs and having greater sexual intercourse partners in adulthood increases with increasing number of ACEs (21,39). Conversely, alcohol and drug misuse are major factors underlying violence perpetration including rape, intimate partner violence and the abuse of children (10). Exposure to violence in childhood heightens engagement in these risky behaviours, which then predisposes individuals to negative psychological and health outcomes.

Violence against children increases the risk of HIV infection, sexually transmitted diseases and non-communicable diseases. Hsiao et al. (41) estimated that the prevention of sexual violence would result in an 8% reduction in sexually transmitted diseases, and a 5% reduction in HIV infection

among women in South Africa. In addition, reductions in physical violence was associated with a 22% reduction in HIV infection among women (41). Furthermore, prevention of sexual abuse would result in a 3% and a 7% reduction in interpersonal violence among men and women respectively(41).

Long term effects of VAC through impaired cognitive abilities limits individual potential to participate in the labour force in adulthood. This affects the population future productive economic growth and at the same time increases the health and social burden on the society. In 2015, the monetary value associated with physical, sexual, emotional violence and neglect in childhood in South Africa was US$6.7 billion, US$2.1 billion and US$3.6 billion respectively (41,42). In addition, US$2 billion and US$750 million were the estimated costs associated with reduced earning as a result of physical and emotional violence, respectively (41). Costs to the South African economy associated with child care and protection were estimated to be about US$ 124 million in 2015 (41). The intangible costs associated with alcohol-related harm at 2020 prices in South Africa was estimated at R13.3 billion (43). Given the role of VAC exposure on alcohol and drug abuse rates, prevention of VAC can be pivotal in reducing the costs associated with alcohol and drug abuse.

1.2.2 Trajectories of violence

Group-based trajectory modelling (GBTM) has been used over the years in clinical research to identify distinct groups (trajectory groups) of individuals that follow similar developmental courses of an outcome. This is because GBTM takes into account the individual-level changes of an outcome (violence victimization) over age or time (22). The majority of studies assessing risk factors for violence trajectories have a focus on violence offending or perpetration. However, research has shown that experiences of violence victimization and perpetration can occur within the same individual (28). A study conducted among children in Florida between the ages of 7 and 18 years

demonstrated specificity in the type of victimization-offending overlap. In this study, children who were physically and sexually abused had 1.55 and 3.58 greater odds of engaging in physical and sexual violence offending by the age of 18 years respectively (44). Therefore, taking this overlap into consideration, the behavioral & environmental risk factors predisposing children to violence victimization and perpetration should be similar. The number of violence trajectory groups generated is dependent on the violence experience of the population under study. Studies in populations with high rates of delinquents such as a sample of juvenile offenders have up to 5 trajectory groups while studies conducted on the general population have two to three trajectory groups (45). This is because the proportion of violent offenders in the general population is low, and therefore less patterns of violence offending are generated (45).

Individual factors such as gender play a role in the determination of trajectory group membership. A study assessing gender specific trajectories of conduct problems among children from the United Kingdom (UK) between the ages of 3 to 11 years, found that girls had fewer conduct problems than boys and majority of the girls belonged to the low conduct problem trajectory group compared to the early onset group (46). In addition, violence patterns can differ by gender when violence trajectories are generated separately for boys and girls. In a study among Canadian children between the ages of 1.5 to 13 years, 5 group and 3 group models provided the best description of physical aggression patterns for boys and girls respectively (47). A study among adolescent girls residing in Mpumalanga demonstrated that baseline reports of having anal or vaginal sex, older age and borrowing money in the previous 12 months were associated with an increased odds of being in the high-risk compared to low-risk physical intimate partner violence trajectory group (48).

Family structure also influences membership in violence trajectory groups. Among UK children assessed between 3 and 11 years of age, there was a significant association between single

parenthood at 9 months and boys belonging to early onset desisting and persistent conduct problem groups compared to membership in the low conduct group (46). However, this association between single parenthood and early onset trajectory group membership was not significant among girls (46), suggesting that, for boys, father presence was especially important for preventing or mitigating violence perpetration. Parent education, number of siblings at birth, and household income were some of the factors found to distinguish between high and low physical aggression trajectory groups generated for girls followed up from 18 months to 13 years (47). Boys in the chronic physical trajectory group had parents with lower education and socio-economic status, higher depression and maternal age at first childbirth (47). When assessing the development course of conduct problems from 7 to 26 years, 4 distinct conduct problem trajectory groups were identified (49). Parental conviction, socio-economic status and experience of child maltreatment were some of the risk factors for membership in the life course persistent (LCP) trajectory group, characterized by early onset of conduct problems in childhood (7 years) that persist through adulthood (26 years) (49). Prevalence for these risk factors differed significantly between the LCP group and the other three group namely; adolescent onset, child-limited and low conduct problem trajectory groups (49). Racial discrimination and socio-economic status were some of the factors that influenced membership into 4 violence delinquency trajectory groups through adolescence among African American males (50). Males from high socio-economic households had a higher likelihood of membership in the late starter delinquency group compared to the negligible delinquency group (50).

Dysfunctional households characterized by frequent violence are associated with different trajectories of violence in adulthood. In an IPV prevention intervention study among men in Rwanda, witnessing a mother being beaten was significantly associated with membership in high start trajectories (either beginning with high and rapid decrease or beginning low and rapid increase) compared to low-flat (consistently low exposure) trajectories of IPV perpetration in adulthood (51).

Overall childhood trauma was associated with membership in high start trajectories compared with low-flat trajectories of IPV perpetration among Rwandese and South African men (51).

1.2.3 Risk factors for VAC

1.2.3.1 Individual factors

Violence against children differs according to age as the child's environment evolves from predominantly being exposed to home environment during infancy and early childhood, to school and community environment exposure in later childhood and adolescence. Neglect, infanticide and abandonment are common among children between the ages of 0-4 years; bullying and corporal punishment are common among children aged 5-12 years (52). Violence in the community and homicide are common among boys above 15 years while teenage girls are more prone to intimate partner violence (52).

Boys and girls are subject to varying experiences of violence. Among South African adolescents, being a girl is a significant predictor of violence non-involvement or victimization only. Boys are at greater odds of being violence perpetrators or victim and perpetrators of violence (28,53,54). Being a girl was one of the factors associated with increased sexual violence in a review conducted across low and middle income countries (55). However, the odds of engagement in physical violence perpetration were double for boys compared to girls between the ages of 13-20 years in England (56).

Divergent associations have been reported between birthweight and child maltreatment. Low birthweight British children followed up from birth to 6 years were twice as likely as standard birthweight children to be maltreated (57). Conversely, other studies did not find a relationship between birthweight and child abuse or neglect (58). Birthweight can indirectly influence child violence victimization through its effect on weight gain in childhood. Both low (35) and high (59,60)

birthweight have been associated with overweight and obesity in childhood. In addition, an association between infancy (0-2 years) catch-up growth (weight or length) is documented to predict future overweight and obesity (34,61), which are risk factors for child violence victimization. Findings from a meta-analysis conducted across 26 different studies, showed that overweight children and adolescents had 24% greater odds of bullying, while obese children had 46% greater odds of bullying compared to their normal-weight peers (62).

1.2.3.2 Family/ relationship factors

Family structure has key effects on experience and exposure to violence. There is contradictory evidence on the role of household socio-economic status on VAC (63). Many studies associate poverty with increased risk of child abuse and maltreatment (14,28,64). An analyses of Violence Against Children Survey (VACS) data from four countries (Cambodia, Kenya, Tanzania & Swaziland) showed that odds of violence victimization were higher among richer households at 90% confidence level (65). Analysis from Multiple cluster Indicator survey across 26 low and middle income countries demonstrated that household crowding was associated with violent disciplining grouped into physical punishment, severe physical punishment and psychological aggression(66). Parental age has been associated with childhood exposure and experience of violence (67). A 5-year follow-up study post-birth among residents of townships in Cape Town, South Africa reported that pregnancy above 35 years were associated with a child's internalizing and externalizing behavioural problems (68). In terms of use of corporal punishment at home, fewer younger parents in South Africa reported smacking their children compared to older parents (69).

A review of 15 studies conducted across different sub-Saharan African countries demonstrated that orphaned children (absence of one or both parents) are vulnerable to physical and sexual abuse, neglect, child labour and other forms of VAC(70). Family size contributes to VAC and has been

shown to be moderately associated with child neglect (19,67). This can be as a result of effect on quality of parental-child relationship which has been documented as a risk factor for neglect and physical abuse (67). Maternal involvement and well-being plays a key protective role against VAC. Sui et al. (28) reported that children from households where the mother was present and involved were less likely to be involved in violence victimization and perpetration.

The educational level attained by the mother or primary caregiver of a child affects the child's exposure or experience of violence. Lower education attainment of mother is associated with higher level of child violence (55). The odds of physical fighting among children followed up from the age of 13 to 20 years, were greater among children whose parents had lower educational level achievements compared to parents who attained university degrees or higher (56). Paternal presence in the household plays a protective role against violence victimization especially among females. Non-residence with biological father was associated with physical, sexual and emotional violence experience among females below the age of 18 years (63).

Mother's prior history of intimate partner violence experience was one of the factors associated with a child's behavioural problem and child maltreatment (67,68,71). Conversely, a systematic review across 94 studies from low and middle income countries did not find an association between mother's prior IPV experience and physical violence victimization among children below the age of 18 years (55). Violence within the household is not only associated with increased likelihood of VAC perpetration by parents, but it is also associated with propagating an intergenerational cycle of violence victimization or perpetration (21). Presence of family conflict or domestic violence, inconsistent disciplining and caregiver disability were associated with increased risk of physical and emotional abuse among vulnerable children in South Africa (64). Presence of birth complications or

a difficult pregnancy can have an effect in parent-newborn attachment relationship and as a consequence act as a risk factor for child maltreatment (19).

1.3 Conceptual Framework

Figure 1 below illustrates the complex interplay of risk factors acting at different levels to influence children's experience of and exposure to violence. As outlined under section 1.2.3 above, individual level factors directly influence violence victimization. These factors are heavily influenced by the immediate family factors. For example, a child's weight status at birth and rate of infant weight gain is determined by household socioeconomic status, maternal age and birth order (33,35). Moreover, family factors are determined by systems or structures in the society that further influence one's exposure and experience of violence. Households and schools are microcosms of the community where they are located. According to a 2012 national school survey in South Africa, 63.8% of learners who experienced school violence reported witnessing fights within their neighbourhood (11). High levels of poverty and inequality in South Africa are associated with decreased status, respect and loss of societal masculinity ideal among males, a factor contributing to violence victimization and perpetration (10). This study aims to identify individual and family level factors associated with physical and sexual violence victimization trajectories.

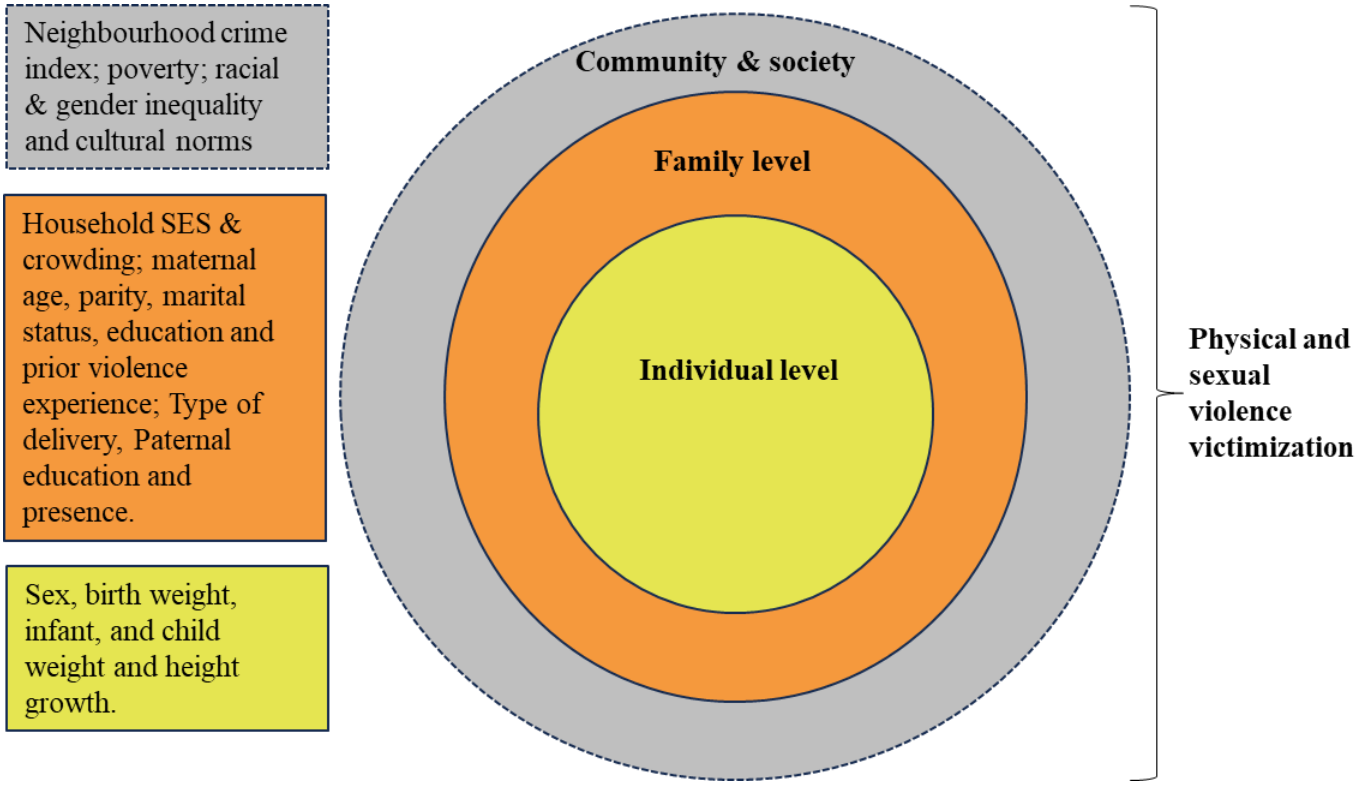


Figure 1: Conceptual framework showing the risk factors for physical & sexual violence victimization among the birth to 18-year cohort of children residing in Soweto, South Africa.

(Adapted from the modified Bronfenbrenner's ecological model (72))

1.4 Problem statement

In South Africa, approximately 20–34% of children below the age of 18 experience some form of contact violence (73). Richter et al. (14) reported that 99% of children followed up from birth to 22 years in Soweto, indicated having experienced some form of violence at a point in their life. Exposure and experience to VAC increases the probability of violence revictimization or perpetration in adulthood (19,20). A study assessing the economic burden of VAC in South Africa in 2015, estimated that a total of 2.3 million disability-adjusted life years (DALYs) lost as a result of health outcomes and health risky behaviour, were attributable to neglect, physical, emotional and

sexual violence (42). Reduced earnings due to lost productivity, and medical and child welfare costs accounted for almost 5% of the country's GDP in 2015 (41). The literature demonstrates that later years' onset of criminal behaviour has routes emanating from early childhood exposure to violence. It is therefore important to understand early life factors that are associated with patterns of violence victimization during a child's life.

1.5 Justification

Despite mounting evidence of determinants and burden of VAC, few studies have demonstrated the effect of life course exposure to multiple forms of violence and how these predict different clusters of violence patterns over time. Most research examines violent behaviours at a specific time point and associates this with violence victimization or perpetration in later years. This limits the ability to assess the developmental course of violence and the heterogeneity of violence trajectories documented in research. In addition, most studies on trajectories of violence tend to focus on risk factors for trajectories of violence perpetration and not on risk factors for patterns of violence victimization. There is a dearth of studies conducted in Africa assessing factors associated with childhood trajectory of violence due to a lack of longitudinal data on violence. This study aims to identify quantitative differences in the violence victimization trajectories and assess how factors early in life can predict patterns of violence victimization in later years. Understanding this association provides potential targets to inform policies and knowledge on violence prevention interventions before the exposure, victimization and onset of violent behaviour.

1.6 Research question

What are the early life factors associated with physical and sexual violence victimization trajectory group membership from 5 to 18 years among children residing in Soweto, Johannesburg in South Africa?

1.6.1 Aim

To investigate early life factors associated with childhood trajectories of physical and sexual violence victimization between 5 and 18-year cohort of children residing in Soweto, Johannesburg in South Africa.

1.6.2 Objectives

1. To generate and describe physical & sexual violence victimization trajectories from 5 to 18 years among the study population.
2. To investigate the association between early life factors and membership into trajectory groups of physical & sexual violence victimization from 5 to 18 years among the study population.

References

1. World Health Organization. Global status report on preventing violence against children 2020 [Internet]. Geneva: World Health Organization; 2020 [cited 2022 Jun 27]. Available from: https://apps.who.int/iris/handle/10665/332394

2. Hillis S, Mercy J, Amobi A, Kress H. Global Prevalence of Past-year Violence Against Children: A Systematic Review and Minimum Estimates. Pediatrics. 2016 Mar 1;137(3): e20154079.

3. World Health Organization. INSPIRE Technical Package [Internet]. [cited 2023 Mar 6]. Available from: https://www.who.int/teams/social-determinants-of-health/violence-prevention/inspire-technical-package

4. United Nations Children's Fund (UNICEF). UNICEF DATA. 2017 [cited 2022 Oct 13]. A Familiar Face: Violence in the lives of children and adolescents. Available from: https://data.unicef.org/resources/a-familiar-face/

5. United Nations Educational, Scientific and Cultural Organization (UNESCO). Behind the numbers: ending school violence and bullying - UNESCO Digital Library [Internet]. [cited 2023 Mar 2]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000366483

6. Moody G, Cannings-John R, Hood K, Kemp A, Robling M. Establishing the international prevalence of self-reported child maltreatment: a systematic review by maltreatment type and gender. BMC Public Health. 2018 Dec;18(1):1164.

7. United Nations Children's Fund (UNICEF). Hidden in plain sight: A statistical analysis of violence against children [Internet]. [cited 2022 Oct 13]. Available from:

https://www.unicef.org/documents/hidden-plain-sight-statistical-analysis-violence-against-children

8. Aboagye RG, Seidu AA, Adu C, Cadri A, Mireku DO, Ahinkorah BO. Interpersonal violence among in-school adolescents in sub-Saharan Africa: Assessing the prevalence and predictors from the Global School-based health survey. SSM - Popul Health. 2021 Oct 1; 16:100929.

9. Burton P, Ward CL, Artz L, Leoschut L. Scribd. [cited 2022 Aug 15]. The Optimus Study on Child Abuse, Violence and Neglect in South Africa (2015) | PDF | Child Neglect | Child Abuse. Available from: https://www.scribd.com/document/314489410/First-ever-national-study-of-child-maltreatment

10. Seedat M, Van Niekerk A, Jewkes R, Suffla S, Ratele K. Violence and injuries in South Africa: prioritizing an agenda for prevention. Lancet Lond Engl. 2009 Sep 19;374(9694):1011–22.

11. Burton P, Leoschut L. School Violence in South Africa: Results of the 2012 National School Violence Study (2013) | Children's Institute [Internet]. Centre for Justice and Crime Prevention; 2013 [cited 2022 Aug 17]. Available from: http://www.ci.uct.ac.za/violence-schools/monographs/school-violence-in-SA-results-of-the-2012-national-school-violence-study

12. Mahlangu P, Chirwa E, Machisa M, Sikweyiya Y, Shai N, Jewkes R. Prevalence and factors associated with experience of corporal punishment in public schools in South Africa. PLOS ONE. 2021 Aug 12;16(8): e0254503.

13. Ward CL, Artz L, Leoschut L, Kassanjee R, Burton P. Sexual violence against children in South Africa: a nationally representative cross-sectional study of prevalence and correlates. Lancet Glob Health. 2018 Apr;6(4): e460–8.

14. Richter LM, Mathews S, Kagura J, Nonterah E. A longitudinal perspective on violence in the lives of South African children from the Birth to Twenty Plus cohort study in Johannesburg-Soweto. S Afr Med J. 2018 Feb 27;108(3):181.

15. Leoschut L, Kafaar Z. The frequency and predictors of poly-victimisation of South African children and the role of schools in its prevention. Psychol Health Med. 2017 Mar;22(sup1):81–93.

16. Pfeiffer L, Salvagni EP. Current view of sexual abuse in childhood and adolescence. J Pediatr (Rio J). 2005 Dec 7;81(8):197–204.

17. Chetty R. A country with a broken psyche: violence against children in South Africa [Internet]. [cited 2022 Aug 15]. Available from: https://0-journals-co-za.innopac.wits.ac.za/doi/epdf/10.10520/EJC-1613d88266

18. Barnett W, Halligan SL, Wedderburn C, MacGinty R, Hoffman N, Zar HJ, et al. Maternal emotional and physical intimate partner violence and early child development: investigating mediators in a cross-sectional study in a South African birth cohort. BMJ Open. 2021 Oct 28;11(10):e046829.

19. World Health Organization. Preventing child maltreatment: a guide to taking action and generating evidence [Internet]. 2006 [cited 2022 Aug 16]. Available from: https://www.who.int/publications-detail-redirect/preventing-child-maltreatment-a-guide-to-taking-action-and-generating-evidence

20. Dunkle KL, Jewkes RK, Brown HC, Yoshihama M, Gray GE, McIntyre JA, et al. Prevalence and patterns of gender-based violence and revictimization among women attending antenatal clinics in Soweto, South Africa. Am J Epidemiol. 2004 Aug 1;160(3):230–9.

21. Abrahams N, Jewkes R. Effects of South African Men's Having Witnessed Abuse of Their Mothers During Childhood on Their Levels of Violence in Adulthood. Am J Public Health. 2005 Oct;95(10):1811–6.

22. Nagin DS, Odgers CL. Group-Based Trajectory Modeling in Clinical Research. Annu Rev Clin Psychol. 2010 Mar 1;6(1):109–38.

23. Sumter SR, Baumgartner SE, Valkenburg PM, Peter J. Developmental Trajectories of Peer Victimization: Off-line and Online Experiences During Adolescence. J Adolesc Health. 2012 Jun 1;50(6):607–13.

24. Jones DJ, Runyan DK, Lewis T, Litrownik AJ, Black MM, Wiley T, et al. Trajectories of childhood sexual abuse and early adolescent HIV/AIDS risk behaviors: the role of other maltreatment, witnessed violence, and child gender. J Clin Child Adolesc Psychol Off J Soc Clin Child Adolesc Psychol Am Psychol Assoc Div 53. 2010;39(5):667–80.

25. Pahl K, Williams SZ, Lee JY, Joseph A, Blau C. Trajectories of Violent Victimization Predicting PTSD and Comorbidities among Urban Ethnic/Racial Minorities. J Consult Clin Psychol. 2020 Jan;88(1):39–47.

26. Semenza DC, Testa A, Turanovic JJ. Trajectories of violent victimization over the life course: Implications for mental and physical health. Adv Life Course Res. 2021 Dec 1; 50:100436.

27. Tracy M, Salo M, Slopen N, Udo T, Appleton AA. Trajectories of childhood adversity and the risk of depression in young adulthood: Results from the Avon Longitudinal Study of Parents and Children. Depress Anxiety. 2019 Jul;36(7):596–606.

28. Sui X, Massar K, Ruiter RAC, Reddy PS. Violence typologies and sociodemographic correlates in South African adolescents: a three-wave cross-sectional study. BMC Public Health. 2020 Dec;20(1):221.

29. Maldonado-Molina MM, Jennings WG, Tobler AL, Piquero AR, Canino G. Assessing the victim-offender overlap among Puerto Rican youth. J Crim Justice. 2010;38(6):1191–201.

30. Jennings WG, Piquero AR, Reingle JM. On the overlap between victimization and offending: A review of the literature. Aggress Violent Behav. 2012 Jan 1;17(1):16–26.

31. Tremblay RE, Nagin DS, Séguin JR, Zoccolillo M, Zelazo PD, Boivin M, et al. Physical Aggression During Early Childhood: Trajectories and Predictors. Pediatrics. 2004 Jul 1;114(1): e43–50.

32. Nagin DS, Tremblay RE. Parental and Early Childhood Predictors of Persistent Physical Aggression in Boys from Kindergarten to High School. Arch Gen Psychiatry. 2001 Apr 1;58(4):389–94.

33. Spencer N, Wallace A, Sundrum R, Bacchus C, Logan S. Child abuse registration, fetal growth, and preterm birth: a population based study. J Epidemiol Community Health. 2006 Apr;60(4):337–40.

34. Ong KK, Ahmed ML, Emmett PM, Preece MA, Dunger DB. Association between postnatal catch-up growth and obesity in childhood: prospective cohort study. BMJ. 2000 Apr 8;320(7240):967–71.

35. Salgin B, Norris SA, Prentice P, Pettifor JohnM, Richter LM, Ong KK, et al. Even transient rapid infancy weight gain is associated with higher BMI in young adults and earlier menarche. Int J Obes 2005. 2015 Jun;39(6):939–44.

36. Janssen I, Craig WM, Boyce WF, Pickett W. Associations between overweight and obesity with bullying behaviors in school-aged children. Pediatrics. 2004 May;113(5):1187–94.

37. Feeg VD, Candelaria LM, Krenitsky-Korn S, Vessey JA. The relationship of obesity and weight gain to childhood teasing. J Pediatr Nurs. 2014;29(6):511–20.

38. Kidman R, Palermo T. The relationship between parental presence and child sexual violence: Evidence from thirteen countries in sub-Saharan Africa. Child Abuse Negl. 2016 Jan; 51:172–80.

39. Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, Edwards V, et al. Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults: The Adverse Childhood Experiences (ACE) Study. Am J Prev Med. 1998 May 1;14(4):245–58.

40. Nomura Y, Chemtob CM. Conjoined Effects of Low Birth Weight and Childhood Abuse on Adaptation and Well-being in Adolescence and Adulthood. Arch Pediatr Adolesc Med. 2007 Feb 1;161(2):186.

41. Hsiao C, Fry D, Ward CL, Ganz G, Casey T, Zheng X, et al. Violence against children in South Africa: the cost of inaction to society and the economy. BMJ Glob Health. 2018 Jan;3(1): e000573.

42. Fang X, Zheng X, Fry DA, Ganz G, Casey T, Hsiao C, et al. The Economic Burden of Violence against Children in South Africa. Int J Environ Res Public Health. 2017 Nov 22;14(11):E1431.

43. Murray M, Barr GDI. The cost of harmful alcohol use in South Africa: A commentary. S Afr Med J. 2022 Mar 1;112(3):187–8.

44. Miley LN, Fox B, Muniz CN, Perkins R, DeLisi M. Does childhood victimization predict specific adolescent offending? An analysis of generality versus specificity in the victim-offender overlap. Child Abuse Negl. 2020 Mar 1; 101:104328.

45. Tzoumakis S, Lussier P, Blanc ML, Davies G. Onset, Offending Trajectories, and Crime Specialization in Violence. Youth Violence Juv Justice. 2013 Apr;11(2):143–64.

46. Gutman LM, Joshi H, Parsonage M, Schoon I. Gender-Specific Trajectories of Conduct Problems from Ages 3 to 11. J Abnorm Child Psychol. 2018;46(7):1467–80.

47. Teymoori A, Côté SM, Jones BL, Nagin DS, Boivin M, Vitaro F, et al. Risk Factors Associated with Boys' and Girls' Developmental Trajectories of Physical Aggression From Early Childhood Through Early Adolescence. JAMA Netw Open. 2018 Dec 28;1(8): e186364.

48. DeLong SM, Powers KA, Pence BW, Maman S, Dunkle KL, Selin A, et al. Longitudinal Trajectories of Physical Intimate Partner Violence Among Adolescent Girls in Rural South Africa: Findings from HPTN 068. J Adolesc Health. 2020 Jul;67(1):69–75.

49. Odgers CL, Caspi A, Broadbent JM, Dickson N, Hancox RJ, Harrington H, et al. Prediction of differential adult health burden by conduct problem subtypes in males. Arch Gen Psychiatry. 2007 Apr;64(4):476–84.

50. Evans SZ, Simons LG, Simons RL. Factors that Influence Trajectories of Delinquency Throughout Adolescence. J Youth Adolesc. 2016 Jan;45(1):156–71.

51. Gibbs A, Dunkle K, Mhlongo S, Chirwa E, Hatcher A, Christofides NJ, et al. Which men change in intimate partner violence prevention interventions? A trajectory analysis in Rwanda and South Africa. BMJ Glob Health. 2020 May;5(5): e002199.

52. Mathews S. Violence against children in South Africa: Developing a prevention agenda [Internet]. [cited 2022 Aug 5]. Available from: http://www.ci.uct.ac.za/overview-violence/academic-papers/VAC-in-SA-developing-a-prevention-agenda

53. Burton P. Results of the national youth victimisation study: easy prey. SA Crime Q. 2006 Jun;2006(16):1–6.

54. Seedat M, van Niekerk A, Suffla S, Ratele K. Psychological research and South Africa's violence prevention responses. South Afr J Psychol. 2014 Jun 1;44(2):136–44.

55. Cerna-Turoff I, Fang Z, Meierkord A, Wu Z, Yanguela J, Bangirana CA, et al. Factors Associated with Violence Against Children in Low- and Middle-Income Countries: A Systematic Review and Meta-Regression of Nationally Representative Data. Trauma Violence Abuse. 2021 Apr;22(2):219–32.

56. Salo M, Appleton AA, Tracy M. Childhood Adversity Trajectories and Violent Behaviors in Adolescence and Early Adulthood. J Interpers Violence. 2022 Aug;37(15–16):NP13978–4007.

57. Sidebotham P, Heron J. Child maltreatment in the “children of the nineties:” the role of the child. Child Abuse Negl. 2003 Mar 1;27(3):337–52.

58. Starbuck GW, Krantzler N, Forbes K, Barnes V. Child abuse and neglect on Oahu, Hawaii: description and analysis of four purported risk factors. J Dev Behav Pediatr. 1984 Apr 1;5(2):55–9.

59. Evensen E, Emaus N, Kokkvoll A, Wilsgaard T, Furberg AS, Skeie G. The relation between birthweight, childhood body mass index, and overweight and obesity in late adolescence: a longitudinal cohort study from Norway, The Tromsø Study, Fit Futures. BMJ Open. 2017 Jun 22;7(6): e015576.

60. Kapral N, Miller SE, Scharf RJ, Gurka MJ, DeBoer MD. Associations between birthweight and overweight and obesity in school-age children. Pediatr Obes. 2018 Jun;13(6):333–41.

61. Zheng M, Lamb KE, Grimes C, Laws R, Bolton K, Ong KK, et al. Rapid weight gain during infancy and subsequent adiposity: a systematic review and meta-analysis of evidence. Obes Rev Off J Int Assoc Study Obes. 2018 Mar;19(3):321–32.

62. Cheng S, Kaminga AC, Liu Q, Wu F, Wang Z, Wang X, et al. Association between weight status and bullying experiences among children and adolescents in schools: An updated meta-analysis. Child Abuse Negl. 2022 Dec 1; 134:105833.

63. Palermo T, Pereira A, Neijhoft N, Bello G, Buluma R, Diem P, et al. Risk factors for childhood violence and polyvictimization: A cross-country analysis from three regions. Child Abuse Negl. 2019 Feb 1; 88:348–61.

64. Meinck F, Cluver LD, Boyes ME, Ndhlovu LD. Risk and Protective Factors for Physical and Emotional Abuse Victimization amongst Vulnerable Children in South Africa: Physical and Emotional Child Abuse in South Africa. Child Abuse Rev. 2015 May;24(3):182–97.

65. Ravi S, Ahluwalia R. What explains childhood violence? Micro correlates from VACS surveys. Psychol Health Med. 2017 Mar 6;22(sup1):17–30.

66. Gao Y, Mi X, Wang Y, Zou S, Zhou H. Association between Household Crowding and Violent Discipline and Neglect of Children: Analysis of Multiple Indicator Cluster Surveys in 26 Low- and Middle-Income Countries. Int J Environ Res Public Health. 2021 Feb;18(4):1685.

67. Stith SM, Liu T, Davies LC, Boykin EL, Alder MC, Harris JM, et al. Risk factors in child maltreatment: A meta-analytic review of the literature. Aggress Violent Behav. 2009 Jan;14(1):13–29.

68. Hayati Rezvan P, Tomlinson M, Christodoulou J, Almirol E, Stewart J, Gordon S, et al. Intimate Partner Violence and Food Insecurity Predict Early Behavior Problems Among South African Children over 5-years post-birth. Child Psychiatry Hum Dev. 2021 Jun;52(3):409–19.

69. Dawes A, Kropiwnicki Z, Kafaar Z, Richter L. Corporal punishment of children: A South African national survey. 2005 Jul 1;

70. Morantz G, Cole D, Vreeman R, Ayaya S, Ayuku D, Braitstein P. Child abuse and neglect among orphaned children and youth living in extended families in sub-Saharan Africa: What have we learned from qualitative inquiry? Vulnerable Child Youth Stud. 2013 Dec;8(4):338–52.

71. Bordin IA, Duarte CS, Peres CA, Nascimento R, Curto BM, Paula CS. Severe physical punishment: risk of mental health problems for poor urban children in Brazil. Bull World Health Organ. 2009 May;87(5):336–44.

72. Flynn K, Mathias B. "How Am I Supposed to Act?": Adapting Bronfenbrenner's Ecological Systems Theory to Understand the Developmental Impacts of Multiple Forms of Violence. J Adolesc Res. 2023 Mar 15;07435584231159674.

73. Jamieson L, Sambu W, Mathews S. Out of Harms Way? Tracking Child Abuse Cases Through the Child Protection System at Five Selected Sites in South Africa (2017) | Children's Institute [Internet]. [cited 2022 Oct 17]. Available from: http://www.ci.uct.ac.za/overview-violence/reports/out-of-harms-way-tracking-child-abuse-cases-through-the-child-protection-system

CHAPTER 2: MANUSCRIPT

This chapter presents the completed draft manuscript for the submissible research report submission. Manuscript drafted based on PLOS ONE guidelines: https://journals.plos.org/plosone/s/submission-guidelines. This chapter includes an introduction of the research topic, the objectives of the study, a detailed description of the materials and methods, results, discussion of findings and finally conclusions drawn.

Full title: Early life factors associated with childhood trajectories of violence among the Birth to Twenty-Plus Cohort in Soweto, South Africa.

Short title: Early life factors associated with childhood trajectories of violence.

Lilian Muchai[1¶], Sara Naicker [2¶], Juliana Kagura[1¶]

[1] School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa

[2] DSI-NRF Centre of Excellence in Human Development, University of the Witwatersrand, Johannesburg, Gauteng, South Africa

*Corresponding author

Email: muchailily@gmail.com (LM)

Abstract

Violence against children (VAC) has devastating and long-term negative consequences on individuals' and society's health, social and economic well-being. There is limited research on the life course experience of VAC, especially in Africa. This study aimed to identify sub-groups of physical & sexual violence victimization patterns separately in childhood, and evaluate early life factors predicting violence trajectories. This study used data from ages 5 to 18 years from the ongoing prospective Birth to Twenty Plus cohort (Bt20+). Children with data on physical and sexual violence in at least 2-time points between 5 and 18 years were included in the analyses. Group-based

trajectory modelling was employed to identify groups of children with similar patterns of violence over time, while multivariable logistic regression was used to identify early life factors associated with violence trajectory group membership. Separately, two trajectory groups of physical violence (adolescent limited (65.1%) and chronic increasing (34.9%)) and sexual violence (adolescent limited (74.1%) and late increasing (25.9%)) victimization were identified. Early life factors associated with a higher risk of chronic increasing trajectory group membership, after adjusting for covariates, were being male (aOR 1.67, 95% CI 1.31; 2.10) and having a mother with at least secondary education compared to higher education (aOR 1.73, 95% CI 1.08; 2.76). In addition, residing in middle, compared to low, socioeconomic households (aOR 0.68, 95% CI 0.50; 0.92) was protective against membership in this group. Residing in high compared to low socioeconomic households, was the only early life factor with marginally significant (aOR 0.63, 95% CI 0.42; 0.95) association with membership in the late-increasing sexual violence victimization trajectory group. In conclusion, children follow different violence victimization trajectories over childhood. Identifying early life factors predicting violence trajectories provides key prevention intervention areas that can mitigate children's violence experience.

Keywords: Physical violence; sexual violence; trajectories; early life;

Introduction

Globally, more than half of children between the ages of 2 and 17 years reported having experienced some type of violence each year, in a systematic review on the global prevalence of childhood violence, which included reports published between the years 2000 and 2013 [1]. Africa bears the biggest brunt of violence against children (VAC), with the prevalence of physical violence at 60% and 51% for girls and boys respectively [2]. Violence is endemic to South Africa, particularly associated with structural and systemic violence originating from the Apartheid period. A nationally representative survey among children 15–17 years of age reported that almost 20% of children had experienced some form of sexual abuse, 21.3% experienced neglect, and over 30% and 16% experienced physical and emotional abuse respectively [3]. Children are likely to experience different forms of violence at different stages of their lives, as their environments and interactions change [4]. This ranges from violent discipline during early childhood by caregivers, bullying by peers at school, sexual violence victimization and intimate partner violence during the adolescent period – although the boundaries of these timeframes are porous [5,6]. A study conducted among children followed up from birth to 22 years in Soweto, found that 36% of children were exposed to violence at home, in the community, at school, peer violence and were victims of interpersonal violence [7].

Despite mounting evidence of determinants and the burden of VAC, few studies have demonstrated the effects of life course exposure to multiple forms of violence, and even fewer studies have identified the different clusters of violence patterns (trajectories) over time. Previous studies, carried out in developed countries have demonstrated heterogeneity in the number and shapes of trajectories of physical and/ or sexual violence victimization, with two [8,9] three [8,10], four [11] and five [12] trajectory groups identified. The majority of these studies assess trajectories of violence victimization as predictors of subsequent physical and mental health outcomes in adulthood, rather

than the identification of risk factors for trajectory group membership. Most studies assessing risk factors for violence trajectory group membership in childhood tend to focus on violence aggression or perpetration. However, a significant overlap between victimization and perpetration experiences documented in research [13–16], show that victims and perpetrators share similar contextual features that place them at an increased risk for violence victimization and perpetration.

Several demographic and early life factors have been associated with violence trajectories. Being male, residing in households with low socioeconomic status, early motherhood, having more than one child in the household, single parenthood and low parental education were some of the risk factors identified for membership in high or life course persistent physical violence victimization or aggression trajectory groups [11,17–19]. From cross-sectional analyses conducted in both developing and developed countries, early life factors predicting violence victimization include, household crowding [20], paternal absence [21] and mother's prior history of violence [22,23]. Both low [24] and high birth weight [25,26], and catch-up growth (weight and length) in infancy (0-2 years) are documented to predict future overweight and obesity [27,28], which are risk factors for violence victimization [29–31].

There is a dearth of studies conducted in Africa assessing factors associated with childhood trajectories of violence due to a lack of longitudinal data on violence. This limits the ability to assess the developmental course of violence and the heterogeneity of violence trajectories in populations outside of the Global North. This is paramount towards the identification, development and implementation of context-specific prevention strategies prior to the child's exposure or experience of violence. The current study aims to generate physical and sexual violence victimization trajectories across childhood and assess how factors in early life predict membership into specific violence trajectories.

Materials and methods

Study setting and site

The primary study (Birth to Twenty plus study, Bt20+) is an ongoing prospective birth cohort study that follows singleton children born between April 23 to June 8, 1990 in public health facilities in Soweto, South Africa. Soweto is a densely populated suburb located within the Johannesburg metropolitan municipality in Gauteng province in South Africa. This primary study included pregnant women attending public antenatal clinics with expected delivery dates within the above-mentioned dates, and later continued residence of the mother and the baby within the study area during the child's first six months of life. Data collected in the Bt20+ study is multidisciplinary, tracking infant, child, adolescent and now adult physical, social and psychosocial well-being [32]. Of 3,273 children enrolled at the beginning of the study, follow-up has been conducted bi-annually through home, study sites or through school surveys. Full descriptions of the Bt20+ cohort, its attrition and methods have been published elsewhere [32,33].

Study design

This study involved secondary data analysis of the prospective Bt20+ cohort study. Only data from birth until 18 years covering (1990 – 2018) from the primary study was included in this secondary study.

Study population and sample

The study population included all children from birth to 18 years from the primary ongoing prospective Bt20+ cohort study. This cohort of children is almost representative of the South African population, with a higher percentage of black Africans. However, there was a slight under-representation of white families [32].

From the 19 waves of data collection between birth to 18 years, there were only four time points, year 5, 11, 15 and 18, that had sufficient data on physical and sexual violence victimization. Data from data collection waves where physical and sexual violence data was combined were excluded from the analyses since trajectories were generated separately for physical & sexual violence victimization. Children in the study population with data on physical and sexual violence in at least 2 of the 4-time points were included in this study.

Study variables

Outcome variable. Two outcome variables namely; physical and sexual violence victimization were considered for this study. For the early years, from age 5 to 10 years, the primary caregiver reported on the experiences of the participant, from age 11 onwards, experiences were self-reported.

Physical violence victimization was coded as a binary variable (yes/no) generated from questions on any experience of physical violence in the previous 12 months based on the following 4 categories: at home, at school, in the neighbourhood and at work (only year 18). The questions separately assessed for each of the four categories above included: have you been (a) physically hurt; (b) hit ;(c) kicked; (d) badly beaten up; (e) attacked with a knife or sharp object. Responses to each of these questions were never, once or twice, few times and many times. The responses were recoded to a dichotomous variable with responses no, coded '0' (never) and yes, coded '1' (once or twice, few times and many times combined). A positive yes to any of the 5 questions for each of the 4 categories mentioned above was coded as having been a victim of physical violence (yes) for that specific time point of data collection (Appendix 2).

Sexual violence victimization similar to the first outcome above was coded as a binary outcome of sexual violence experience in the preceding 12 months based on the categories (at home, at school, in the neighbourhood and at work) for question a and b below. Questions c to g where not based on the

specified categories. Sexual violence in the primary study was defined as unwanted sexual experiences. Questions included: have you been (a) sexually assaulted/ attacked (b) sexually harassed (c) wanted to engage in oral sex (d) wanted to have oral sex last month (e) wanted to have sex (f)wanted to have sex last month (g)wanted to engage in heavy petting or foreplay. Responses to questions a and b were never, once or twice, a few times or many times. These were recoded to no, coded '0' (never) and yes, coded '1' (once or twice, a few times and many times). Yes or no responses were recorded for questions c, d, e, f and g. Questions c to g were limited to children who had engaged in sex. Based on the definition of sexual violence as unwanted sexual experiences, a no response to questions c to g meant that study participants did not want to engage in sexual acts and was recoded (yes, coded '1') to having experienced sexual violence. A yes response to question c, d, e, f and g was recoded no, coded '0', to mean that the child did not experience sexual violence. A positive yes to any of the questions above was coded as having been a victim of sexual violence (yes) (Appendix 2).

For details on the proportions of physical and sexual violence across the given time points please refer to supplementary table 1

Risk factors of interest: Early life factors measured between birth and 5 years associated with violence experience were selected based on aprior knowledge and literature, as well as data availability. These were selected as correlates for physical and sexual violence victimization trajectories and grouped into individual and family level factors.

Individual / Child- level factors: Birthweight was obtained from birth notifications and categorized as low birthweight (less than 2,500 grams) or normal birthweight (2,500 grams or higher). Relative weight gain and relative height gain were derived as standardized residuals computed from sex-

specific linear regression of these growth changes measured between infancy (0-2) and early childhood (2-5 years).

Family level factors: Household socioeconomic status was based on total household asset scores, grouped into tertiles of low (coded '1'), middle (coded '2') and high (coded '3') socioeconomic status. Examples of some of the household assets included possession of a television, refrigerator, washing machine and a car. Household crowding was recorded as a ratio of persons per sleeping room, this was recoded to yes ('1') and no ('0'). Household crowding was defined as households whose ratio was equal to or above the total sample household crowding ratio mean. Maternal age was recorded at birth and grouped for analysis - 24 years and below (coded '0'), between 25 and 34 years (coded '1') and above 35 years (coded '2') at the time of birth. Parity was coded as only child from mother (coded '0') or mother had more than one child (coded '1'). Maternal and paternal education was categorized as primary school and below (coded '0'), secondary school (coded '1'), and post-school training (diploma, bachelors, masters or doctoral degrees, coded '2'). Marital status was recorded as married, living together, widowed/ divorced or single. This was recoded to married (married & living together, coded '1') and single (widowed/divorced and single, coded '0'). Father's presence in the household was coded as yes ('1') or no ('0'). Maternal prior violence experience was derived using data from 2 variables. Any positive (yes) response on either mother's prior violence in childhood or intimate partner violence during pregnancy was coded as mother having experienced violence (yes, coded '1'). Finally, mode of delivery obtained from birth notifications was recoded to normal vaginal delivery ('0') or assisted (caesarian section/ use of forceps or vacuum) delivery ('1') (Appendix 3).

Data management and analysis

Electronic data received from the Birth to Twenty Plus study database was imported into Stata 17 for cleaning and analysis. Only data on early life factors between the antenatal period to 5 years of age and data on physical and sexual violence victimization between ages 5 to 18 years were extracted from the primary Bt20+ database. The data was checked for missing and duplicate values, followed by recoding and generation of new variables. No duplicates were identified and the final study dataset was stored in a password-protected file for analyses.

Identification of trajectory groups: Group based trajectory modelling (GBTM) was used to identify clusters of children with similar violence victimization trajectories from age 5 to 18 years. GBTM is a semiparametric group strategy that applies finite mixture models to identify clusters of persons (trajectory groups) with similar developmental course of an outcome over time [34,35]. This technique assumes that the population is composed of distinct groups defined by their outcome progression over time and makes no assumptions about the population distribution of the trajectories [34]. Determination of the number of trajectory groups that best fit the data was based on the most parsimonious model determined by lowest Bayesian Information Criterion (BIC) and high entropy after comparison of two and three group models. Linear, quadratic and cubic polynomial orders were tested to identify the polynomial order that best characterized the evolution of violence victimization over time. The logit function reflecting the Bernoulli distribution of the outcome was specified in all the models tested. The final model was selected based on theoretical plausibility, average posterior probabilities of trajectory group membership greater than the set threshold of 0.70, highest entropy and group membership greater than 10% [34]. All trajectory analyses were conducted using the stata plug-in Traj [36].

Early life factor correlates for trajectory membership: Descriptive analyses were conducted for the individual and family level early life factors disaggregated by sex. Once each of the children

were assigned to trajectory groups to which each had maximum probability of group membership, a two steps process was used to identify early life factors associated with childhood trajectories of physical and sexual violence victimization. First, the independent association of each correlate to trajectory group membership was assessed using univariable logistic regression analysis. Odds ratios, 95% confidence intervals and p-values were reported. P-values <0.05 were considered statistically significant. Secondly, selection of exposure variables for the multivariable model was based on documented evidence from existing literature of the associations between each of the correlates and violence victimization. Individual level factors were first added into the model, followed by family level factors. All correlates supported by literature and those with sufficient data were included in the final multivariable logistic regression model. Adjusted odds ratios (aOR), confidence intervals and p-values were reported following the multivariable analyses, with p-values <0.05 regarded as statistically significant. Post regression analyses conducted included a test for collinearity to assess if the explanatory variables in the model were inter-related. In addition, the Hosmer -Lemeshow goodness of fit test was conducted to test the final model fitness.

Ethical considerations

Ethical approval for the primary Bt20+ study was obtained from the Human Ethics and Research Committee (HREC-Medical) of the University of the Witwatersrand, Johannesburg prior to the start of the study (certificate number M111182 – Appendix 4). Written informed consent was initially obtained from the primary caregivers of the participants and at the appropriate age both children and the caregivers then provided written informed consent. For this secondary data analyses, permission to use the data was granted by Development Pathways for Health Research Unit (DPHRU) responsible for the primary study (Appendix 5) and a memorandum of agreement signed (Appendix 6). Ethical clearance for the current study was granted by HREC-Medical at the University of the

Witwatersrand, Johannesburg (certificate number M230218 – Appendix 7). Confidentiality of data was maintained throughout the research period by use of anonymized data which was password protected and backed up for safety.

Results

Study characteristics

A total of 3,273 children were enrolled at birth, of these 2,057(62.9%) and 2,051(62.7%) children had data on physical & sexual violence victimization in at least 2 of the 4 time points of data collection, respectively. Experience of physical violence ranged from 14.0% at age 5, with a peak of 71.8% at age 15, that declined to 38.6% at 18 years of age. Sexual violence experiences ranged from 0.8% at 5 years to a peak of 28.9% at the age of 18 years (Supplementary table 1). For both physical and sexual violence victimization, there were no significant differences between included and excluded samples with reference to sex, maternal age at birth, father's presence and birth weight. Compared to children excluded in this study, a greater proportion of children included in the study resided in households with middle level socioeconomic status, lived in single parent households, with the Bt20+ child being an only child. In contrast, the included sample had a lower proportion of parents (both mothers and fathers) with post-school training compared to children in the excluded sample (Supplementary table 2 & 3). Covariates for physical and sexual violence victimization trajectories that were significantly different between included and excluded samples, were adjusted for in the multivariable analyses.

Similar proportions of children stratified by gender were reported among children included in the physical violence victimization and sexual violence victimization trajectory analyses (Table 1). Among the 2057 children included in the physical violence and 2051 children included in the sexual

violence victimization trajectory analyses, there was a higher proportion of girls (52.5% physical violence; 52.4% sexual violence) than boys. More girls (12.7%) than boys (9.7%) were born with low birth weight. In both analyses, there was a decline in infant weight and height during infancy (0-2 years) for both girls and boys. During early childhood (2-5 years), a slight increase in weight was observed among boys, with no reported change in height for both boys and girls. Overall, a higher proportion of children were born in households with low socioeconomic status (65.0% physical violence; 64.8% sexual violence) and less than half of the children resided in crowded households (41.8% physical violence; 42.0% sexual violence). In both analyses, only 10.4% of the children were born to a mother above the age of 35 years, a higher proportion of these children had siblings (61.9% physical violence; 61.8% sexual violence) and approximately 62.0% were living in single parent households at birth. A higher proportion of fathers (18.8% physical violence; 18.7% sexual violence) than mothers (8.6%) had attained higher schooling after completion of secondary school and only 15.2% of the children indicated that the father was at home. For both analyses, less than a fifth of the mother's indicated having previously experienced violence (18.4%) and most children were born through normal vaginal delivery (88.2%).

266 Table 1. Description of study sample characteristics stratified by sex

	Physical violence victimization			Sexual violence victimization		
Variables	**Total N (%)**	**Female n (%)**	**Male n (%)**	**Total N (%)**	**Female n (%)**	**Male n (%)**
Total sample	2057	1080 (52.5)	977 (47.5)	2051	1074 (52.4)	977 (47.6)
Outcome variables						
Violence trajectories						
Adolescent limited	1340 (65.1)	770 (71.3)	570 (53.8)	1519 (74.6)	801 (74.6)	718 (73.5)
Increasing (chronic /late)	717 (34.9)	310 (28.7)	407 (41.7)	532 (25.9)	273 (25.4)	259 (26.5)
Exposure variables						
Individual level factors						
Birth weight						
Low birth weight (<2500 grams)	231 (11.3)	137 (12.7)	94 (9.7)	230 (11.2)	136 (12.7)	94 (9.7)
Normal birth weight (≥ 2500 grams)	1822 (88.8)	942 (87.3)	880 (90.4)	1817 (88.8)	937 (87.3)	880 (90.4)
Infant and child growth						
Relative weight gain 0-2 years [a]	1401	-0.01 (1.00)	-0.05 (1.00)	1398	-0.01 (1.00)	-0.05 (0.99)
Relative weight gain 2-5 years [a]	1292	-0.03 (1.03)	0.02 (1.03)	1291	-0.03 (1.03)	0.02 (1.03)
Relative height gain 0-2 years [a]	1402	-0.03 (0.99)	-0.06 (0.98)	1399	-0.03 (0.99)	-0.06 (0.98)
Relative height gain 2-5 years [a]	1292	0.00 (0.97)	0.00 (1.03)	1291	0.00 (0.97)	0.00 (1.03)
Family level factors						
Household socioeconomic status						
Low	1217 (65.0)	630 (64.3)	587 (65.8)	1212 (64.8)	626 (64.1)	586 (65.6)
Middle	392 (20.9)	200 (20.4)	192 (21.5)	392 (21.0)	199 (20.4)	193 (21.6)
High	263 (14.1)	150 (15.3)	113 (12.7)	266 (14.2)	152 (15.6)	114 (12.8)
Household crowding						
Yes	744 (41.8)	378 (40.3)	366 (43.5)	745 (42.0)	376 (40.3)	369 (43.8)
No	1034 (58.2)	559 (59.7)	475 (56.5)	1030 (58.0)	556 (59.7)	474 (56.2)
Maternal age at the time of birth						
≤ 24 years	962 (46.8)	504 (46.8)	458 (46.9)	961 (46.9)	502 (46.8)	459 (47.0)
25–34 years	879 (42.8)	466 (43.2)	413 (42.3)	875 (42.7)	463 (43.2)	412 (42.2)

267

	Physical violence victimization			Sexual violence victimization		
Variables	**Total N (%)**	**Female n (%)**	**Male n (%)**	**Total N (%)**	**Female n (%)**	**Male n (%)**
≥ 35 years	214 (10.4)	108 (10.0)	106 (10.9)	213 (10.4)	107 (10.0)	106 (10.9)
Maternal parity						
1 child	783 (38.1)	423 (39.2)	360 (36.9)	784 (38.2)	423 (39.4)	361 (37.0)
>1 child	1274 (61.9)	657 (60.8)	617 (63.2)	1267 (61.8)	651 (60.6)	616 (63.1)
Marital status						
Married	773 (37.8)	394 (36.7)	379 (39.1)	773 (37.9)	392 (36.7)	381 (39.2)
Single	1270 (62.2)	679 (63.3)	591 (60.9)	1266 (62.1)	676 (63.3)	590 (60.8)
Maternal education status						
Primary & below	232 (12.3)	124 (12.5)	108 (12.1)	233 (12.4)	125 (12.6)	108 (12.1)
Secondary	1491 (79.1)	786 (79.3)	705 (78.9)	1490 (79.1)	785 (79.4)	705 (78.8)
Post school training	162 (8.6)	81 (8.2)	81 (9.1)	161 (8.6)	79 (8.0)	82 (9.2)
Paternal education status						
Primary & below	121 (8.3)	67 (8.8)	54 (7.8)	120 (8.3)	66 (8.7)	54 (7.8)
Secondary	1061 (72.9)	543 (71.4)	518 (74.6)	1060 (73.0)	542 (71.6)	518 (74.5)
Post-school training	273 (18.8)	151 (19.8)	122 (17.6)	272 (18.7)	149 (19.7)	123 (17.7)
Father present						
Yes	1568 (84.9)	825 (85.0)	743 (84.7)	1564 (84.8)	822 (84.9)	742 (84.7)
No	280 (15.2)	146 (15.0)	134 (15.3)	280 (15.2)	146 (15.1)	134 (15.3)
Maternal prior violence experience						
Yes	184 (18.4)	91 (17.3)	93 (19.5)	185 (18.4)	92 (17.5)	93 (19.5)
No	818 (81.6)	435 (82.7)	383 (80.5)	819 (81.6)	434 (82.5)	385 (80.5)
Mode of delivery						
Vaginal delivery	1012 (88.2)	525 (88.8)	487 (87.6)	1006 (88.2)	521 (88.8)	485 (87.6)
Assisted delivery	135 (11.8)	66 (11.2)	69 (12.4)	135 (11.8)	66 (11.2)	69 (12.5)

268 [a] Values are means (standard deviation)

Trajectories of physical & sexual violence victimization

After the examination of different trajectory group numbers and polynomial functions, a two-group model provided the most parsimonious model that best described patterns for both physical & sexual violence victimization between 5 and 18 years of age. However, the shape or patterns of violence victimization differed between physical and sexual violence victimization trajectories.

The two group trajectories of physical violence victimization had an early onset of violence victimization. These groups were (a) adolescent limited (65.1%) characterized by gradual increase in violence victimization from age 5 to 15 years, after which there was a decrease in violence victimization beginning at age 15, (b) the chronic increasing group (34.9%) was characterized by a persistently increasing pattern of violence victimization at all time points (Figure 2). The two-group model selected had the lowest BIC value, with average posterior probabilities for group membership greater than 0.70 for the adolescent limited group (0.93) and the chronic increasing group (0.73). This model had medium entropy of 0.56 reported (Supplementary table 4).

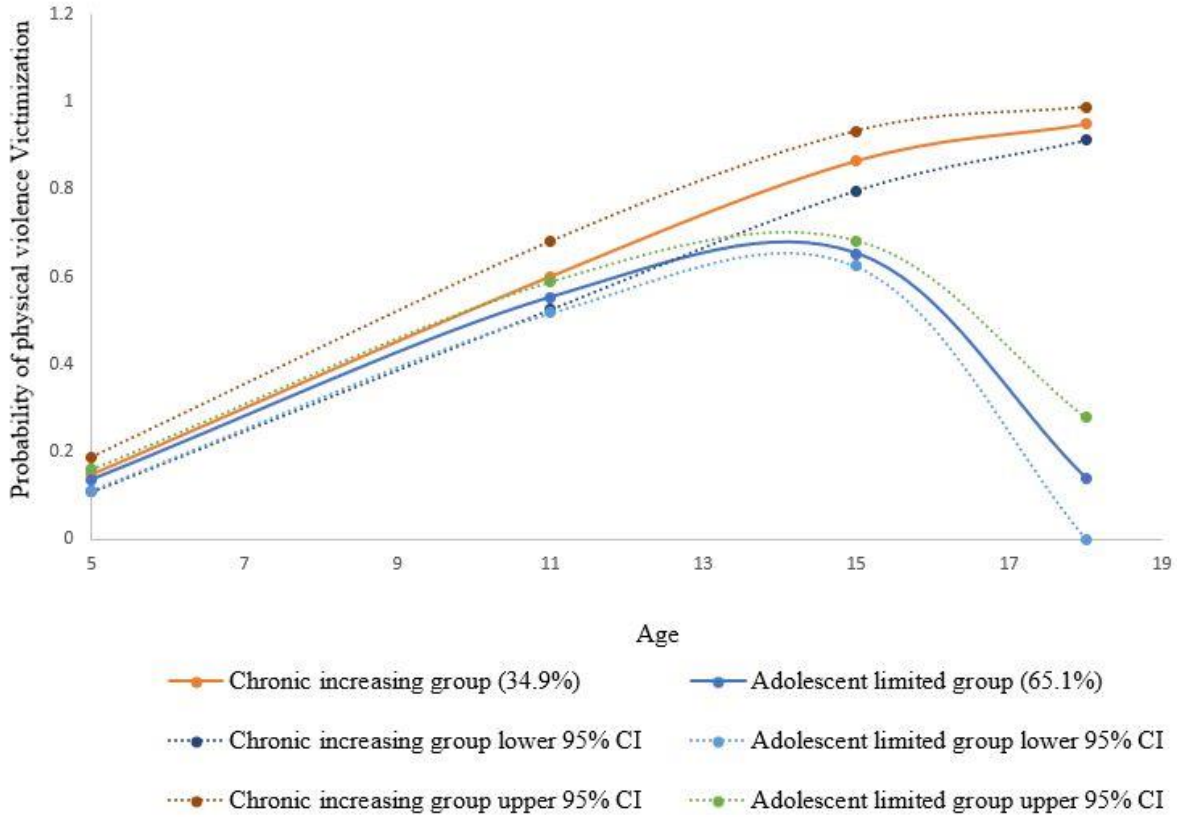


Figure 2. Physical violence victimization trajectories among children between 5 and 18 years of age. Note; lines show estimated trajectories, points at each age represent the observed proportion of children between the age of 5 to 18 years reporting physical violence victimization according to the assigned physical violence trajectory group.

Figure 3 below shows the two-group trajectories of sexual violence victimization that were characterized by a late onset of sexual violence victimization. These groups were the (a) adolescent limited (74.1%) and (b) late increasing (25.9%) trajectory groups of sexual violence victimization. The adolescent limited group was characterized by low sexual violence victimization at the age of 5 years, whose onset was at age 11 with a peak at age 15. This was followed by a decrease in experience of sexual violence from age 15. Onset for the late increasing trajectory group was also at age 11, followed by a persistent increase in sexual violence victimization at the age of 15 continuing

to 18 years. The model with a quadratic (2) and cubic (3) term provided the best description of sexual violence victimization trajectories. Although the 2-group model with quadratic terms had a slightly lower BIC compared to the model selected, the significantly lower entropy (0.44) for this model made it less desirable for describing sexual violence victimization patterns. The final model selected had average posterior probabilities of 0.85 and 1.00 for the adolescent limited and late increasing group, respectively, with an entropy of 0.57 (Supplementary table 4).

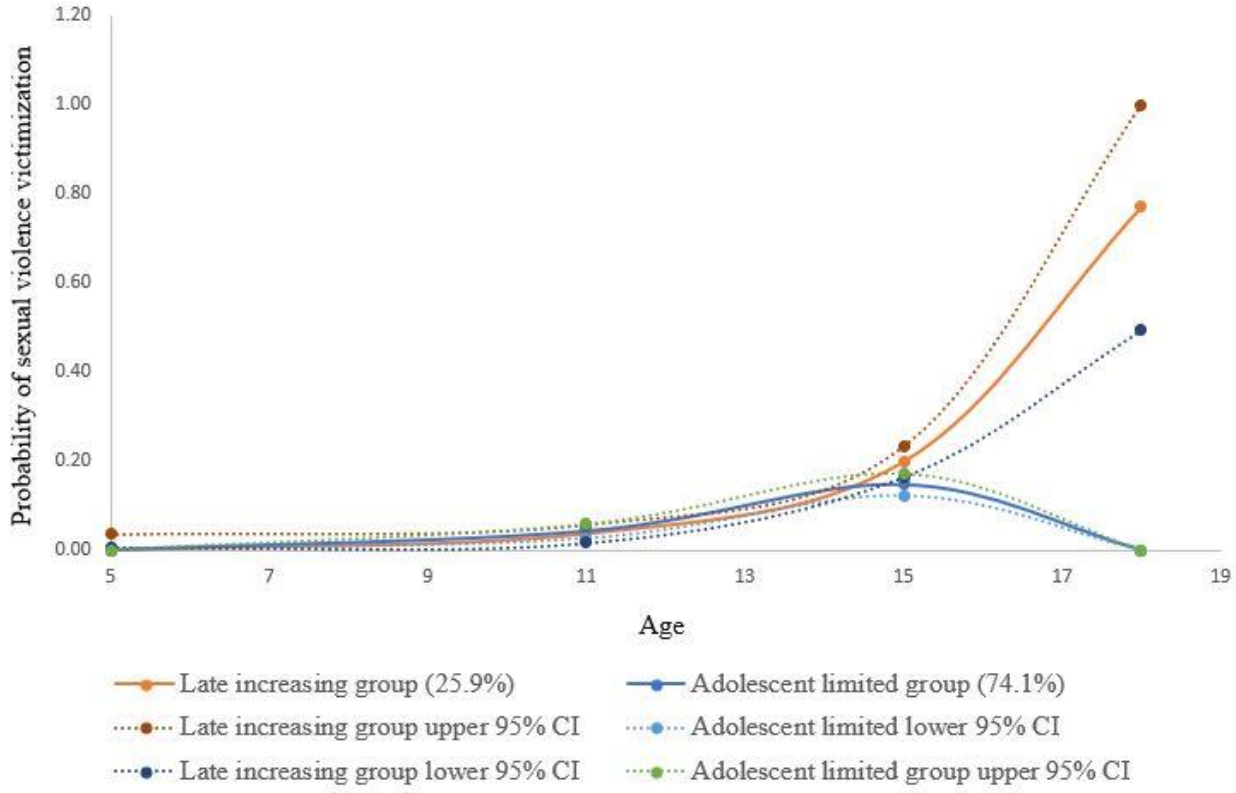


Figure 3. Sexual violence victimization trajectories among children between 5 and 18 years of age. Note; lines show estimated trajectories, points at each age represent the observed proportion of children between the age of 5 to 18 years reporting physical violence victimization according to the assigned physical violence trajectory group.

Early life factors associated with physical & sexual violence victimization trajectories

Table 2 and 3 show results of the independent and adjusted associations between the early life factors and physical and sexual violence victimization trajectory group membership, respectively. For physical violence victimization trajectories, individual and family level factors were significantly associated with trajectory group membership, both independently and after adjusting for other variables in the multivariable model. However, only family level factors significantly predicted sexual violence victimization trajectory group membership in the univariable, but not in the multivariable regression analyses.

Of the individual level factors, sex, relative infant weight gain and childhood height gain were independently associated with membership in the chronic increasing physical violence victimization trajectory group (table 2). From the univariable analysis, an increase in infant weight was associated with 14% greater odds of membership in the chronic increasing trajectory group (OR 1.14, 95% CI 1.02; 1.27). The results show that height gain during childhood was protective against membership in the chronic increasing trajectory group. An increase in relative height was associated with 22% lower odds of membership in the chronic increasing trajectory group (OR 0.88, 95% CI 0.79; 0.99). Relative growth variables during infancy and childhood could not be included in the multivariable model due to the high proportion of missing data. After adjusting for other variables in the multivariable model, sex was the only individual level factor that was significantly associated with membership in the chronic increasing trajectory group. Boys had 67% higher odds of membership in the chronic increasing trajectory group compared to girls (aOR 1.67, 95% CI 1.31; 2.10).

Household socioeconomic status was the only family level factor significantly associated with membership in the chronic increasing physical violence victimization trajectory group, in the unadjusted analysis. In addition, maternal education (p=0.061), household crowding (p=0.079) and

mode of delivery (p=0.082) were marginally associated with chronic increasing trajectory group membership prior to adjusting for other factors. From the multivariable model, lower household socioeconomic status and lower maternal education were the only family level early life factors that predicted membership in the chronic increasing trajectory group, after adjusting for other variables in the model. Children from households within the middle socioeconomic status level had 32% lower odds of membership in the chronic increasing trajectory group compared to children residing in the low household socioeconomic status level (aOR 0.68, 95% CI 0.50; 0.92). Furthermore, children whose mothers had received at least some secondary education had 73% greater odds of chronic increasing trajectory group membership compared to mothers with post-school training (aOR 1.73, 95% CI 1.08; 2.76). Mother's prior experience of violence and mode of delivery were not included in the multivariable analysis because of the high proportion of missing data for these two variables.

Table 2. Univariable and multivariable logistic regression model showing early life factors associated with physical violence victimization trajectory group membership

Variables	**OR (95% CI)**	**P-values**	**aOR (95% CI)**	**P-values**
Individual level factors				
Sex		<0.001		<0.001
Female (ref)	1.00		1.00	
Male	1.77 (1.48; 2.13)		1.67 (1.31; 2.10)	
Birth weight		0.416		0.479
Normal (ref)	1		1	
Low birth-weight	1.12 (0.85; 1.49)		1.15 (0.78; 1.68)	
Infants and child growth				
Relative weight gain 0-2 years	1.14 (1.02; 1.27)	0.023		
Relative weight gain 2-5 years	0.98 (0.87; 1,09)	0.664		
Relative height gain 0-2 years	0.96 (0.86; 1.07)	0.486		
Relative height gain 2-5 years	0.88 (0.79; 0.99)	0.035		
Family level factors				
Household socioeconomic status		0.006		0.034
Low (ref)	1.00		1.00	
Middle	0.71 (0.55; 0.90)		0.68 (0.50; 0.92)	
High	0.73 (0.55; 0.98)		0.77 (0.54; 1.11)	

Variables	OR (95% CI)	P-values	aOR (95% CI)	P-values
Household crowding		0.079		0.909
Yes (ref)	1.00		1.00	
No	0.84 (0.69; 1.02)		0.99 (0.77; 1.26)	
Maternal age				
≤ 24 years (ref)	1.00	0.975	1.00	0.465
25 – 34 years	0.99 (0.82; 1.20)		1.18 (0.87; 1.60)	
≥ 35 years	1.03 (0.75; 1.40)		1.29 (0.80; 2.08)	
Parity		0.395		0.601
One child (ref)	1.00		1.00	
more than one child	1.08 (0.90; 1.31)		0.92 (0.68; 1.25)	
Marital Status		0.096		0.238
Married (ref)	1.00		1.00	
Single	1.17 (0.97; 1.42)		1.18 (0.89; 1.57)	
Maternal education status		0.061		0.041
Primary & below	1.63 (1.05; 2.53)		1.34 (0.74; 2.43)	
Secondary	1.52 (1.06; 2.19)		1.73 (1.08; 2.76)	
Post-school training (ref)	1.00		1.00	
Paternal education status		0.192		0.869
Primary & below	1.26 (0.80; 1.99)		1.15 (0.66; 1.98)	
Secondary	1.31 (0.98; 1.74)		1.08 (0.77; 1.51)	
Post-school training (ref)	1.00		1.00	
Father present		0.473		0.624
Yes (ref)	1.00		1.00	
No	1.10 (0.85; 1.43)		1.10 (0.76; 1.59)	
Maternal prior violence experience		0.816		
Yes (ref)	1.00			
No	1.04 (0.74; 1.46)			
Mode of delivery		0.082		
Vaginal (ref)	1.00			
Assisted	0.70 (0.48; 1.04)			

OR: odds Ratio. aOR: adjusted Odds Ratio. Ref: reference group. Adolescent limited violence trajectory group acts as the outcome reference group. Goodness of fit of the model; p=0.262

Results from table 3 demonstrate that only family level factors significantly predicted membership in the late increasing sexual violence victimization trajectory group, in the univariable regression analyses($p<0.05$). Children from households with high socioeconomic status and no crowding had

42% (OR 0.58, 95% CI 0.41; 0.81) and 26% (OR 0.74, 95% CI 0.60; 0.92) lower odds of membership in the late increasing trajectory group compared to children from lower socioeconomic households and children from crowded households, respectively. Independently, the odds of membership in the late increasing trajectory group were greater with decreasing maternal (primary & below OR 2.56, 95% CI 1.55; 4.23, secondary OR 1.83, 95% CI 1.18; 2.83) and paternal (primary & below OR 1.70 95% CI 1.02; 2.83, secondary OR 1.60, 95% CI 1.19; 2.34) education compared to children from parents with post-school training. None of these factors remained statistically significant after adjusting for all other variables in the multivariable model. However, household socioeconomic status showed marginally significant (p=0.07) association with membership in the late increasing trajectory group in the multivariable analyses. Children residing in high socioeconomic households had 37% lower odds of membership in the late increasing trajectory group compared to children residing in households with low socioeconomic status (aOR 0.63, 95% CI 0.42; 0.95), after adjusting for covariates in the model. Due to the high proportion of missing data for growth variables, maternal prior violence experience and mode of delivery, these variables could not be included in the multivariable model.

Table 3. Univariable and multivariable logistic regression model showing early life factors associated with sexual violence victimization trajectory group membership

Variables	**OR (95% CI)**	**P-values**	**aOR (95% CI)**	**P-values**
Individual level factors				
Sex		0.574		0.519
Female (ref)	1.00		1.00	
Male	1.06 (0.87; 1.29)		0.92 (0.71; 1.19)	
Birthweight		0.312		0.848
Normal (ref)	1.00		1.00	
Low birth-weight	1.17 (0.86; 1.59)		1.04 (0.69; 1.57)	
Infant and child growth				
Relative weight gain 0-2 years	1.02 (0.90; 1.15)	0.736		
Relative weight gain 2-5 years	0.99 (0.88; 1.12)	0.915		

Variables	OR (95% CI)	P-values	aOR (95% CI)	P-values
Relative height gain 0-2 years	0.95 (0.84; 1.07)	0.393		
Relative height gain 2-5 years	0.91 (0.80; 1.03)	0.128		
Family level factors				
Household socioeconomic status		<0.003		0.0671
Low (ref)	1.00		1.00	
Middle	0.81 (0.62; 1.05)		0.82 (0.59; 1.13)	
High	0.58 (0.41; 0.81)		0.63 (0.42; 0.95)	
Household crowding		0.007		0.300
Yes (ref)	1.00		1.00	
No	0.74 (0.60; 0.92)		0.87 (0.66; 1.13)	
Maternal age		0.248		0.862
≤ 24 years (ref)	1.00		1.00	
25 – 34 years	0.91 (0.74; 1.13)		0.93 (0.67; 1.29)	
≥ 35 years	1.20 (0.87; 1.67)		1.02 (0.61; 1.72)	
Parity		0.332		0.721
One child (ref)	1.00		1.00	
more than one child	1.11 (0.90; 1.36)		1.06 (0.76; 1.47)	
Marital Status		0.761		0.768
Married (ref)	1.00		1.00	
Single	1.03 (0.84; 1.27)		1.05 (0.77; 1.42)	
Maternal education status		0.001		0.327
Primary & below	2.56 (1.55; 4.23)		1.63 (0.85; 3.13)	
Secondary	1.83 (1.18; 2.83)		1.31 (0.77; 2.23)	
Post-school training (ref)	1.00		1.00	
Paternal education status		0.012		0.337
Primary & below	1.70 (1.02; 2.83)		1.13 (0.62; 2.06)	
Secondary	1.67 (1.19; 2.34)		1.32 (0.89; 1.94)	
Post-school training (ref)	1.00		1.00	
Father present		0.741		0.225
Yes (ref)	1.00		1.00	
No	0.95 (0.71; 1.27)		0.77 (0.50; 1.18)	
Maternal prior violence experience		0.432		
Yes (ref)	1.00			
No	1.17 (0.80; 1.71)			
Mode of delivery		0.482		
Vaginal (ref)	1.00			
Assisted	0.86 (0.56; 1.31)			

OR: Odds Ratio. aOR: adjusted Odds Ratio. Ref: reference group. Adolescent limited violence trajectory group acts as the outcome reference group. Goodness of fit of the model; p=0.520

Results for the post regression goodness of fit analysis conducted after selection of final models for both physical (p=0.262) and sexual (p=0.520) violence victimization trajectories, did not provide evidence of a lack of model fitness. Low variance inflation factor (VIF) scores for both physical (mean VIF 1.2) and sexual (mean VIF 1.18) violence victimization, from the multivariable analyses indicate that there was no multicollinearity among covariates included in each of the multivariable models.

Discussion

The present study sought to examine the number and shapes of physical and sexual violence victimization trajectories between the ages of 5 and 18 years, as well as identify factors in early life associated with trajectory group membership. The results from the group-based trajectory modelling identified two trajectories of physical and two trajectories of sexual violence victimization, for the best description of physical violence victimization and sexual violence victimization patterns between the ages of 5 and 18 years. Divergence in these identified violence trajectory groups occurred at different ages for physical and sexual violence victimization. For physical violence victimization, patterns of violence victimization began to differ between the two groups at the age of 11 years, while differences in violence victimization occurred at 15 years between the two generated groups of sexual violence victimization. Overall, both the individual level (sex) and family level (household socioeconomic status and maternal education) factors were identified as important determinants of physical violence victimization trajectory group membership. However, vulnerability to increasing sexual violence victimization was largely determined by the family level factors (household socioeconomic status).

These findings show that less than a fifth of all the children in the sample experienced physical violence during early childhood. However, cases of physical violence victimization increased with age, as children engage with more environments outside the home. By mid-adolescence (15 years), almost three quarters of all the children were victims of physical violence. Physical violence victimization then begins to decline at 18 years. These findings are consistent with previous literature indicating that physical violence victimization is concentrated during childhood and early adolescent years and decreases with increasing age after mid-adolescence [37–39].

In accordance with literature, the majority of the children in the present study exhibited an increasing pattern of physical violence victimization as they grew older, with incidences of physical violence victimization primarily occurring between early childhood and mid-adolescence. However, for a third of the children, their experience of physical violence did not decrease in mid-adolescence, and gradually increased as they reached adulthood. Evidence of the presence of an adolescent limited and increasing physical violence trajectory group was reported by Semenza et al. [11], among individuals assessed across 4 data collection points between 12 and 34 years of age (wave 1 - 12-19 years, wave 2-13-20 years, wave 3 - 18-26 years and wave 4 - 24-34 years). Similar to our findings, the adolescent limited trajectory group was characterized by elevated levels of violence victimization in early adolescence that decreased rapidly as respondents transitioned to adulthood. In contrast, the increasing physical violence trajectory group was characterized by low experience of physical violence in adolescence which increased into adulthood. Two other trajectory groups, little to no victimization and high decreasing trajectory groups were identified by these authors [11].

Our results show that parent - reported cases of sexual violence victimization were less than 1% for children at 5 years. In general, incidence of sexual violence steadily increased with age during adolescence, and by the age of 18, nearly 1 in 3 children in the sample experienced sexual violence.

412 The few to no parent-reported cases of sexual violence in early childhood may be a result of under-
413 reporting or lack of knowledge of their child sexual experiences by parents or caregivers [40]. Other
414 studies have documented a higher likelihood of sexual violence victimization among adolescent and
415 adult samples compared to younger child samples [38,41]. A study among South African children
416 between the ages of 10 and 17 years reported that, almost a quarter of child abuse perpetrators were
417 intimate partners, a reason that can account for higher sexual abuse cases as children grow older and
418 engage in intimate partner relationships [38].

419 For three quarters of the children, low sexual violence experiences were reported at 11 years, with
420 incidences of sexual violence decreasing from 15 years of age. In contrast, a quarter of the children
421 experience of sexual violence increased exponentially as they approached adulthood. Similar to our
422 results, Jones et al. [9] generated two trajectory groups of sexual violence victimization assessed
423 between the ages of 2 to 12 years. The two groups were; (a) no sexual violence victimization (b) a
424 curvilinear pattern of sexual violence victimization characterized by low violence allegations at
425 younger and older ages and a peak in sexual violence victimization between ages 4 to 8 years. The
426 study recruited high risk children with data on alleged or substantiated allegations of child
427 maltreatment or witnessing violence from child protective services records, a plausible reason for
428 high sexual victimization experiences at younger ages [9].

429 Our findings show that individual level factors predicted membership in the chronic physical
430 violence but not the late increasing sexual violence victimization trajectory group. For physical
431 violence victimization, independent of other factors, boys were almost twice as likely as girls to be in
432 the chronic increasing trajectory group. Similar findings have been demonstrated in other studies
433 [2,11,37,42,43], and a possible reason for this is the fact that boys experience more conduct problems
434 and exhibit greater externalizing behaviour compared to girls that places them at a heightened risk

for both physical violence victimization and perpetration [18,44]. Although boys had a lower likelihood of membership in the late increasing sexual violence victimization group, this association was not significant. Contrary to this, many studies report significantly higher prevalence of sexual violence among girls than boys [38,41,45]. The lack of a significant difference in trajectory group membership between boys and girls may be explained by the use of self-completed questionnaires from the age of 11 years, that has been documented to contribute to higher disclosure on sexual violence experiences especially among boys [46].

From the univariable analyses increase in infant weight was a risk factor for chronic increasing physical violence trajectory group membership. In addition, being taller had a protective effect against membership in the persistently increasing physical violence victimization group. Rapid infant weight gain during infancy [24,28] and lower conditional height/ stunting during mid-childhood have been associated with overweight/ obesity in later childhood or adulthood [47,48], a risk factor for bullying and teasing in childhood [29,30]. None of the infant and child growth factors were associated with late increase sexual violence victimization group membership. Richter et al. [49] found conflicting results with stunted boys having a higher likelihood of sexual violence experience compared to boys with normal height for their age. Child growth factors could not be assessed further in adjusted analyses due to limited responses for these variables. Similar to findings from Startbuck et al. [50], birthweight was not significantly associated with physical and sexual violence victimization.

Family level factors independently, and when adjusted for other confounding variables, predicted membership in the increasing trajectory group for both physical (household socioeconomic status and maternal education) and sexual violence (household socioeconomic status only) victimization. Adjusting for other factors, higher household socioeconomic status was associated with lower risk of

membership in the chronic increasing physical violence victimization trajectory group. This corresponds with evidence from other studies showing that physical violence experiences are higher among poorer households [43,51]. Higher socioeconomic status appeared to be protective against inclusion in the late increasing sexual violence victimization group. However, this association was not significant after other factors were taken into account. Richter et al. [49] found similar findings, with household socioeconomic status being only significantly associated with sexual abuse among boys prior to adjusting for other covariates.

Maternal education seems to be protective against chronic physical violence victimization trajectory group membership. Further evidence of this was reported by Semenza et al. [11], who found that higher parental education was associated with a lower probability of membership in the increasing physical violence victimization compared to no victimization trajectory group. However, in our study higher maternal rather than paternal education was negatively associated with chronic physical violence victimization trajectory group membership. This could be explained by the study results by Sui et al. [13], which demonstrated that maternal presence in the household was associated with non-involvement in both violence victimization and perpetration.

From the independent analyses lower maternal and paternal education and household crowding were associated with a greater likelihood of membership in the late increasing sexual violence victimization trajectory group. This association, however, was not found to be significant after adjusting for other covariates in the model. Consistent with our findings, Ward et al. [46], found a marginal significant association in the univariable and not multivariable analyses between sharing a bedroom with more than one person and sexual abuse. Similar to our findings, marital status, maternal education and father's presence were not found to be significantly associated with sexual abuse among boys in South Africa [49].

Interpretation of study findings should take into consideration the following limitations. First, presence of large gaps between data collection points when data on physical or sexual violence victimization could be captured separately, may have affected the ability to discern more heterogeneity in violence victimization trajectories. Additional time points with violence victimization data in future research will provide a better characterization of violence patterns during childhood. Furthermore, the study only used a single test for model adequacy (average posterior probability) to assess final model fitness. The use of average posterior probability as the only measure for model fitness following group-based trajectory modelling could incorporate spurious results. Future studies should consider more than one measure for model adequacy, for example, the odds of correct classification to assess model adequacy. High proportion of missing data limited the inclusion of growth variables into the multivariable model. Further research on the effect of infant catch-up and early childhood growth on violence victimization should be explored. The population under study represents an urban population, with a majority black population, and therefore results of this study should not be generalizable to the South African population. Finally, use of caregiver reports and self-reporting on sensitive issues such as sexual violence victimization may be subject to under-reporting or introduce social desirability bias. The large sample size and repeated collection of measures at different waves can reduce the magnitude of this bias.

Irrespective of the limitation mentioned above, several strengths of this study are worth mentioning. Studies identifying risk factors for violence victimization are based largely on cross-sectional or retrospective studies on lifetime childhood violence experiences. Results from these studies are subject to recall bias. This current study is based on a prospective study design with smaller recall period of 12 months limiting the magnitude of recall bias. In addition, longitudinal nature of data collection allows for the characterization of violence victimization patterns. These violence patterns

generated can further be assessed as predictors of later human capital outcomes in adulthood. Assessment of early life risk factors at the first years of life that predict violence trajectory group membership allow for the possibility of temporal association to be assessed.

In summary, this study demonstrates that children within the same environment or neighborhoods can follow different patterns of physical and sexual violence victimization from childhood to adolescence. The identification of early life factors associated with membership in these violence victimization groups, provides potential early target prevention areas that impede the risk of increasing violence victimization and also provides information on factors that can be encouraged to mitigate a child's exposure and experience of violence. This study only identified individual and family early life factors associated with violence experience. Both these factors are heavily influenced by the community factors and structures set up in the society. There is a need for future research to include community and societal exposure factors when assessing risk factors for violence victimization trajectories. Lastly, literature has shown that experiences of violence differ by sex and therefore future research should consider the generation of sex-specific violence trajectories and assess whether any differences in risk factors by gender exists, for the identification of more targeted interventions specific for girls and boys.

Acknowledgements

The authors would like to thank the Birth to Twenty-Plus participants for their role in providing data for this work and also appreciate DSI-NRF Centre of Excellence in Human Development for granting access to use the Birth to Twenty-Plus Cohort data. We are grateful to the University of the Witwatersrand, Johannesburg HREC for provision of ethical clearance.

References

1. Hillis S, Mercy J, Amobi A, Kress H. Global Prevalence of Past-year Violence Against Children: A Systematic Review and Minimum Estimates. Pediatrics. 2016;137: e20154079. doi:10.1542/peds.2015-4079

2. Moody G, Cannings-John R, Hood K, Kemp A, Robling M. Establishing the international prevalence of self-reported child maltreatment: a systematic review by maltreatment type and gender. BMC Public Health. 2018;18: 1164. doi:10.1186/s12889-018-6044-y

3. Burton P, Ward CL, Artz L, Leoschut L. The Optimus Study on Child Abuse, Violence and Neglect in South Africa (2015) | PDF | Child Neglect | Child Abuse. Available from: https://www.scribd.com/document/314489410/First-ever-national-study-of-child-maltreatment

4. World Health Organization. INSPIRE Technical Package. [cited 6 Mar 2023]. Available from: https://www.who.int/teams/social-determinants-of-health/violence-prevention/inspire-technical-package

5. United Nations Children's Fund (UNICEF). A Familiar Face: Violence in the lives of children and adolescents. In: UNICEF DATA. 1 Nov 2017 [cited 13 Oct 2022]. Available from: https://data.unicef.org/resources/a-familiar-face/

6. United Nations Educational, Scientific and Cultural Organization (UNESCO). Behind the numbers: ending school violence and bullying - UNESCO Digital Library. [cited 2 Mar 2023]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000366483

7. Richter LM, Mathews S, Kagura J, Nonterah E. A longitudinal perspective on violence in the lives of South African children from the Birth to Twenty Plus cohort study in Johannesburg-Soweto. S Afr Med J. 2018;108: 181. doi:10.7196/SAMJ. 2018.v108i3.12661

8. Sumter SR, Baumgartner SE, Valkenburg PM, Peter J. Developmental Trajectories of Peer Victimization: Off-line and Online Experiences During Adolescence. J Adolesc Health. 2012;50: 607–613. doi: 10.1016/j.jadohealth.2011.10.251

9. Jones DJ, Runyan DK, Lewis T, Litrownik AJ, Black MM, Wiley T, et al. Trajectories of childhood sexual abuse and early adolescent HIV/AIDS risk behaviors: the role of other maltreatment, witnessed violence, and child gender. J Clin Child Adolesc Psychol Off J Soc Clin Child Adolesc Psychol Am Psychol Assoc Div 53. 2010;39: 667–680. doi:10.1080/15374416.2010.501286

10. Pahl K, Williams SZ, Lee JY, Joseph A, Blau C. Trajectories of Violent Victimization Predicting PTSD and Comorbidities among Urban Ethnic/Racial Minorities. J Consult Clin Psychol. 2020;88: 39–47. doi:10.1037/ccp0000449

11. Semenza DC, Testa A, Turanovic JJ. Trajectories of violent victimization over the life course: Implications for mental and physical health. Adv Life Course Res. 2021;50: 100436. doi: 10.1016/j.alcr.2021.100436

12. Tracy M, Salo M, Slopen N, Udo T, Appleton AA. Trajectories of childhood adversity and the risk of depression in young adulthood: Results from the Avon Longitudinal Study of Parents and Children. Depress Anxiety. 2019;36: 596–606. doi:10.1002/da.22887

13. Sui X, Massar K, Ruiter RAC, Reddy PS. Violence typologies and sociodemographic correlates in South African adolescents: a three-wave cross-sectional study. BMC Public Health. 2020;20: 221. doi:10.1186/s12889-020-8332-6

14. Maldonado-Molina MM, Jennings WG, Tobler AL, Piquero AR, Canino G. Assessing the victim-offender overlap among Puerto Rican youth. J Crim Justice. 2010;38: 1191–1201.

15. Jennings WG, Piquero AR, Reingle JM. On the overlap between victimization and offending: A review of the literature. Aggress Violent Behav. 2012;17: 16–26. doi: 10.1016/j.avb.2011.09.003

16. Miley LN, Fox B, Muniz CN, Perkins R, DeLisi M. Does childhood victimization predict specific adolescent offending? An analysis of generality versus specificity in the victim-offender overlap. Child Abuse Negl. 2020;101: 104328. doi: 10.1016/j.chiabu.2019.104328

17. Tremblay RE, Nagin DS, Séguin JR, Zoccolillo M, Zelazo PD, Boivin M, et al. Physical Aggression During Early Childhood: Trajectories and Predictors. Pediatrics. 2004;114: e43–e50. doi:10.1542/peds.114.1.e43

18. Gutman LM, Joshi H, Parsonage M, Schoon I. Gender-Specific Trajectories of Conduct Problems from Ages 3 to 11. J Abnorm Child Psychol. 2018;46: 1467–1480. doi:10.1007/s10802-017-0379-1

19. Nagin DS, Tremblay RE. Parental and Early Childhood Predictors of Persistent Physical Aggression in Boys from Kindergarten to High School. Arch Gen Psychiatry. 2001;58: 389–394. doi:10.1001/archpsyc.58.4.389

20. Gao Y, Mi X, Wang Y, Zou S, Zhou H. Association between Household Crowding and Violent Discipline and Neglect of Children: Analysis of Multiple Indicator Cluster Surveys in 26 Low-

and Middle-Income Countries. Int J Environ Res Public Health. 2021;18: 1685. doi:10.3390/ijerph18041685

21. Palermo T, Pereira A, Neijhoft N, Bello G, Buluma R, Diem P, et al. Risk factors for childhood violence and polyvictimization: A cross-country analysis from three regions. Child Abuse Negl. 2019;88: 348–361. doi: 10.1016/j.chiabu.2018.10.012

22. Stith SM, Liu T, Davies LC, Boykin EL, Alder MC, Harris JM, et al. Risk factors in child maltreatment: A meta-analytic review of the literature. Aggress Violent Behav. 2009;14: 13–29. doi: 10.1016/j.avb.2006.03.006

23. Hayati Rezvan P, Tomlinson M, Christodoulou J, Almirol E, Stewart J, Gordon S, et al. Intimate Partner Violence and Food Insecurity Predict Early Behavior Problems Among South African Children over 5-years post-birth. Child Psychiatry Hum Dev. 2021;52: 409–419. doi:10.1007/s10578-020-01025-1

24. Salgin B, Norris SA, Prentice P, Pettifor JohnM, Richter LM, Ong KK, et al. Even transient rapid infancy weight gain is associated with higher BMI in young adults and earlier menarche. Int J Obes 2005. 2015;39: 939–944. doi:10.1038/ijo.2015.25

25. Evensen E, Emaus N, Kokkvoll A, Wilsgaard T, Furberg A-S, Skeie G. The relation between birthweight, childhood body mass index, and overweight and obesity in late adolescence: a longitudinal cohort study from Norway, The Tromsø Study, Fit Futures. BMJ Open. 2017;7: e015576. doi:10.1136/bmjopen-2016-015576

26. Kapral N, Miller SE, Scharf RJ, Gurka MJ, DeBoer MD. Associations between birthweight and overweight and obesity in school-age children. Pediatr Obes. 2018;13: 333–341. doi:10.1111/ijpo.12227

27. Ong KK, Ahmed ML, Emmett PM, Preece MA, Dunger DB. Association between postnatal catch-up growth and obesity in childhood: prospective cohort study. BMJ. 2000;320: 967–971. doi:10.1136/bmj.320.7240.967

28. Zheng M, Lamb KE, Grimes C, Laws R, Bolton K, Ong KK, et al. Rapid weight gain during infancy and subsequent adiposity: a systematic review and meta-analysis of evidence. Obes Rev Off J Int Assoc Study Obes. 2018;19: 321–332. doi:10.1111/obr.12632

29. Van Geel M, Vedder P, Tanilon J. Are overweight and obese youths more often bullied by their peers? A meta-analysis on the relation between weight status and bullying. Int J Obes. 2014;38: 1263–1267. doi:10.1038/ijo.2014.117

30. Haegele JA, Aigner C, Healy S. Impact of weight and disability status on bullying victimisation and perpetration among youth. J Paediatr Child Health. 2021;57: 383–387. doi:10.1111/jpc.15230

31. Janssen I, Craig WM, Boyce WF, Pickett W. Associations between overweight and obesity with bullying behaviors in school-aged children. Pediatrics. 2004;113: 1187–1194. doi:10.1542/peds.113.5.1187

32. Richter L, Norris S, Pettifor J, Yach D, Cameron N. Cohort Profile: Mandela's children: The 1990 birth to twenty study in South Africa. Int J Epidemiol. 2007;36: 504–511. doi:10.1093/ije/dym016

625 33. Norris SA, Richter LM, Fleetwood SA. Panel studies in developing countries: case analysis of
626 sample attrition over the past 16 years within the birth to twenty cohort in Johannesburg, South
627 Africa. J Int Dev. 2007;19: 1143–1150. doi:10.1002/jid.1390

628 34. Nagin DS, Odgers CL. Group-Based Trajectory Modeling in Clinical Research. Annu Rev Clin
629 Psychol. 2010;6: 109–138. doi: 10.1146/annurev.clinpsy.121208.131413

630 35. Nagin DS. Group-Based Trajectory Modeling: An Overview. Ann Nutr Metab. 2014;65: 205–
631 210. doi:10.1159/000360229

632 36. traj: group-based modeling of longitudinal data. [cited 7 Aug 2023]. Available from:
633 https://www.andrew.cmu.edu/user/bjones/

634 37. Macmillan R. Violence and the Life Course: The Consequences of Victimization for Personal
635 and Social Development. Annu Rev Sociol. 2001;27: 1–22. doi: 10.1146/annurev.soc.27.1.1

636 38. Meinck F, Cluver LD, Boyes ME, Loening-Voysey H. Physical, emotional and sexual adolescent
637 abuse victimisation in South Africa: prevalence, incidence, perpetrators and locations. J
638 Epidemiol Community Health. 2016;70: 910–916. doi:10.1136/jech-2015-205860

639 39. Aboagye RG, Seidu A-A, Adu C, Cadri A, Mireku DO, Ahinkorah BO. Interpersonal violence
640 among in-school adolescents in sub-Saharan Africa: Assessing the prevalence and predictors
641 from the Global School-based health survey. SSM - Popul Health. 2021;16: 100929. doi:
642 10.1016/j.ssmph.2021.100929

643 40. Pfeiffer L, Salvagni EP. Current view of sexual abuse in childhood and adolescence. J Pediatr
644 (Rio J). 2005;81: 197–204. doi:10.2223/JPED.1408

41. Stoltenborgh M, van Ijzendoorn MH, Euser EM, Bakermans-Kranenburg MJ. A global perspective on child sexual abuse: meta-analysis of prevalence around the world. Child Maltreat. 2011;16: 79–101. doi:10.1177/1077559511403920

42. United Nations Children's Fund (UNICEF). Hidden in plain sight: A statistical analysis of violence against children. [cited 13 Oct 2022]. Available from: https://www.unicef.org/documents/hidden-plain-sight-statistical-analysis-violence-against-children

43. Mahlangu P, Chirwa E, Machisa M, Sikweyiya Y, Shai N, Jewkes R. Prevalence and factors associated with experience of corporal punishment in public schools in South Africa. PLOS ONE. 2021;16: e0254503. doi: 10.1371/journal.pone.0254503

44. Richter LM, Ahun MN, Besharati S, Naicker SN, Orri M. Adolescent Mental Health Problems and Adult Human Capital: Findings from the South African Birth to Twenty Plus Cohort at 28 Years of Age. J Adolesc Health. 2021;69: 782–789. doi: 10.1016/j.jadohealth.2021.04.017

45. Cerna-Turoff I, Fang Z, Meierkord A, Wu Z, Yanguela J, Bangirana CA, et al. Factors Associated with violence against children in Low- and Middle-Income Countries: A Systematic Review and Meta-Regression of Nationally Representative Data. Trauma Violence Abuse. 2021;22: 219–232. doi:10.1177/1524838020985532

46. Ward CL, Artz L, Leoschut L, Kassanjee R, Burton P. Sexual violence against children in South Africa: a nationally representative cross-sectional study of prevalence and correlates. Lancet Glob Health. 2018;6: e460–e468. doi:10.1016/S2214-109X(18)30060-3

665 47. Bove I, Miranda T, Campoy C, Uauy R, Napol M. Stunting, overweight and child development
666 impairment go hand in hand as key problems of early infancy: Uruguayan case. Early Hum Dev.
667 2012;88: 747–751. doi: 10.1016/j.earlhumdev.2012.04.002

668 48. Adair LS, Fall CHD, Osmond C, Stein AD, Martorell R, Ramirez-Zea M, et al. Associations of
669 linear growth and relative weight gain during early life with adult health and human capital in
670 countries of low and middle income: findings from five birth cohort studies. Lancet Lond Engl.
671 2013;382: 525–534. doi:10.1016/S0140-6736(13)60103-8

672 49. Richter LM, Mathews S, Nonterah E, Masilela L. A longitudinal perspective on boys as victims
673 of childhood sexual abuse in South Africa: Consequences for adult mental health. Child Abuse
674 Negl. 2018;84: 1–10. doi: 10.1016/j.chiabu.2018.07.016

675 50. Starbuck GW, Krantzler N, Forbes K, Barnes V. Child abuse and neglect on Oahu, Hawaii:
676 description and analysis of four purported risk factors. J Dev Behav Pediatr. 1984;5: 55–59.

677 51. Meinck F, Cluver LD, Boyes ME, Ndhlovu LD. Risk and Protective Factors for Physical and
678 Emotional Abuse Victimization amongst Vulnerable Children in South Africa: Physical and
679 Emotional Child Abuse in South Africa. Child Abuse Rev. 2015;24: 182–197.
680 doi:10.1002/car.2283

Supporting information

Supplementary table 1. Proportion of physical and sexual violence per age disaggregated by sex

			Prevalence of violence		
	Age (years)	**Total (N)**	**total sample n (%)**	**Male n (%)**	**Female n (%)**
Physical violence victimization					
	5	1404	197 (14.0)	105 (15.0)	92 (12.6)
	11	1361	772 (56.7)	366 (57.8)	406 (55.7)
	15	1950	1400 (71.8)	711 (75.9)	689 (68.0)
	18	1859	717 (38.6)	407 (46.6)	310 (31.5)
Sexual violence victimization					
	5	1394	11 (0.8)	5 (0.7)	6 (0.8)
	11	1216	49 (4.0)	26 (4.7)	23 (3.5)
	15	1949	325 (16.7)	184 (19.5)	141 (14.0)
	18	1830	528 (28.9)	256 (29.6)	272 (28.2)

Supplementary Table 2. Characteristics of excluded and included sample for physical violence victimization trajectory analyses.

Variables	Total N (%)	Included n (%)	Excluded n (%)	P-values
	3269	2057 (62.9)	1212 (37.1)	
Individual factors				
Sex				0.073
Male	1592 (48.7)	977 (47.5)	615 (50.7)	
Female	1677 (51.3)	1080 (52.5)	597 (49.3)	
Birthweight				0.206
Low birth weight (<2500 grams)	350 (10.7)	231 (11.2)	119 (9.8)	
Normal birthweight (≥ 2500 grams)	2913 (89.2)	1822 (88.8)	1091 (90.2)	
Infant and child growth factors				
Relative weight gain 0-2 years [a]	1785	-0.03 (0.99)	0.11 (1.02)	0.01
Relative weight gain 2-5 years [a]	1552	0.00 (1.03)	0.02 (0.81)	0.741
Relative height gain 0-2 years [a]	1786	-0.04 (0.98)	0.15 (1.04)	0.001
Relative height gain 2-5 years [b]	1552	-0.02 (-0.62; 0.62)	-0.10(-0.55; 0.49)	0.671
Family level factors				
Household socioeconomic status				<0.001
Low	996 (34.9)	606 (32.4)	390 (39.6)	
Middle	1401 (49.1)	1003 (53.6)	398 (40.5)	
High	459 (16.1)	263 (14.1)	196 (19.9)	
Household crowding				<0.001
Yes	1020 (38.6)	777 (43.7)	243 (28.0)	
No	1626 (61.5)	1001 (56.3)	625 (72.0)	
Maternal age				0.141
≤ 24 years	1493 (45.7)	962 (46.8)	531 (43.8)	
25 – 34 years	1440 (44.1)	879 (42.7)	561 (46.3)	
≥ 35 years	336 (10.3)	216 (10.5)	120 (9.9)	
Maternal Parity				0.025
1 child	1197 (36.6)	783 (38.1)	414 (34.2)	
>1 child	2072 (63.4)	1274 (61.9)	798 (65.8)	
Marital status				<0.001
Married	1413 (43.5)	773 (37.8)	640 (53.2)	
Single	1834 (56.5)	1270 (62.2)	564 (46.8)	
Maternal education status				<0.001
Primary & below	454 (15.5)	232 (12.3)	222 (21.3)	
Secondary	2148 (73.4)	1491 (79.1)	657 (63.0)	
Post school training	326 (11.1)	162 (8.6)	164 (15.7)	

Variables	Total N (%)	Included n (%)	Excluded n (%)	P-values
Paternal education status				<0.001
Primary & below	220 (9.9)	121 (8.3)	99 (13.0)	
Secondary	1520 (68.6)	1061 (72.9)	459 (60.2)	
Post-school training	477 (21.5)	273 (18.8)	204 (26.8)	
Father present				0.226
Yes	1966 (85.3)	1568 (84.9)	398 (87.1)	
No	339 (14.7)	280 (15.2)	59 (12.9)	
Maternal prior violence experience				0.469
Yes	302 (18.9)	184 (18.4)	118 (19.8)	
No	1295 (81.1)	818 (81.6)	477 (80.2)	
Mode of delivery				0.986
Vaginal delivery	1468 (88.2)	1012 (88.2)	456 (88.2)	
Assisted delivery	196 (11.8)	135 (11.8)	61 (11.8)	

[a] Reported as means (standard deviation), [b] reported as medians (interquartile range)

Supplementary table 3. Characteristics of included and excluded sample for sexual violence victimization trajectory analyses.

Variables	Total N (%)	Included n (%)	Excluded n (%)	P-values
	3269	2051 (62.7)	1218 (37.3)	
Individual level factors				
Sex				0.114
Male	1592 (48.7)	977 (47.5)	615 (50.5)	
Female	1677 (51.3)	1074 (52.5)	603 (49.5)	
Birthweight				0.222
Low birth weight (<2500 grams)	350 (10.7)	230 (11.2)	120 (9.9)	
Normal birthweight (≥ 2500 grams)	2913 (89.2)	1817 (88.8)	1096 (90.1)	
Infant and child growth factors				
Relative weight gain 0-2 years [a]	1785	-0.03 (0.99)	0.11 (1.02)	0.011
Relative weight gain 2-5 years [a]	1552	-0.01 (1.03)	0.03 (0.81)	0.519
Relative height gain 0-2 years [a]	1786	-0.04 (0.98)	0.14 (1.04)	0.001
Relative height gain 2-5 years [b]	1552	-0.02 (-0.62; 0.62)	-0.12 (-0.55; 0.51)	0.723
Family level factors				
Household socioeconomic status				<0.001
Low	996 (34.9)	602 (32.2)	394 (40.0)	
Middle	1401 (49.1)	1002 (53.6)	399 (40.5)	
High	459 (16.1)	266 (14.2)	193 (19.6)	
Household crowding				<0.001
Yes	1020 (38.6)	778 (43.8)	242 (27.8)	
No	1626 (61.5)	997 (56.2)	629 (72.2)	
Maternal age				0.115
≤ 24 years	1493 (45.7)	961 (46.9)	532 (43.7)	
25 – 34 years	1440 (44.1)	875 (42.7)	565 (46.4)	
≥ 35 years	336 (10.3)	215 (10.5)	121 (9.9)	
Maternal Parity				0.013
1 child	1197 (36.6)	784 (38.2)	413 (33.9)	
>1 child	2072 (63.4)	1267 (61.8)	805 (66.1)	
Marital status				<0.001
Married	1413 (43.5)	773 (37.9)	640 (53.0)	
Single	1834 (56.5)	1266 (62.1)	568 (47.0)	
Maternal education status				<0.001
Primary & below	454 (15.5)	233 (12.4)	221 (21.2)	
Secondary	2148 (73.4)	1490 (79.1)	658 (63.0)	
Post school training	326 (11.1)	161 (8.6)	165 (15.8)	

Variables	Total N (%)	Included n (%)	Excluded n (%)	P-values
Paternal education status				<0.001
Primary & below	220 (9.9)	120 (8.3)	100 (13.1)	
Secondary	1520 (68.6)	1060 (73.0)	460 (60.1)	
Post-school training	477 (21.5)	272 (18.7)	205 (26.8)	
Father prese				0.196
Yes	1966 (85.3)	1564 (84.8)	402 (87.2)	
No	339 (14.7)	280 (15.2)	59 (12.8)	
Maternal prior violence experience				0.520
Yes	302 (18.9)	185 (18.4)	117 (19.7)	
No	1295 (81.1)	819 (81.6)	476 (80.3)	
Mode of deliver				0.921
Vaginal delivery	1468 (88.2)	1006 (88.2)	462 (88.3)	
Assisted delivery	196 (11.8)	135 (11.8)	61 (11.7)	

[a] Reported as means (standard deviation), [b] reported as medians (interquartile range)

Supplementary table 4. Physical and sexual violence victimization trajectory model selection and adequacy.

Number of groups	Polynomial order	BIC	Entropy	APP	Lowest assigned group membership (%)
Physical violence victimization trajectory models					
1	3	-3917.55	-	-	-
2	3 3	-3909.63	0.59	0.93; 0.70	20.47
3	3 3 3	-3930.31	0.57	0.84; 0.56; 0.60	8.46
2	**3 1**	**-3904.30**	**0.56**	**0.93; 0.75**	**34.86**
Sexual violence victimization trajectory models					
1	2	-2263.51	-	-	-
2	2 2	-2271.08	0.44	0.71; 0.89	25.94
3	2 2 2	-2282.35	0.66	0.71; 0.89; 0	0
2	2 3	-2275.49	0.57	0.84; 1.00	25.94

BIC - Bayesian information criterion, APP - Average posterior probabilities

CHAPTER 3: EXTENDED METHODOLOGY, RESULTS, DISCUSSION AND CONCLUSION

Extended Methodology

This chapter provides an extended description of the methodology not included in the manuscript. It outlines how the power of the study to detect a significant difference in trajectory group membership, based on the exposure variable of interest, was calculated. Finally, a description of bivariate analyses conducted to assess differences in covariate proportions based on trajectory group membership is explained in this section.

Power calculation

Of the total 3,273 children recruited at birth, 2,057 and 2051 children followed up from birth to 18 years had data on physical and sexual violence victimization in at least two of the four-time (5, 11, 15 and 18) points of data collection, respectively. Stata version 17 was used to calculate power based on two sample proportions at 95% confidence interval.

Exposure variable selected for power calculation was household socioeconomic status. This variable was re-categorized from three categories (lower, middle and higher) to a binary variable comprising of low and high (average and high combined) household socioeconomic status. However, only 1,872 and 1,870 children had responses on household socioeconomic status at birth for physical and sexual violence victimization trajectory analyses, respectively. These samples will be used to represent the minimum sample size used for power calculation using the proportions described below;

For physical violence victimization analyses, the proportion of children from low and high socioeconomic status households were 65.0% (1,217) and 35.0% (655) respectively. 37.1% of children from households with low socioeconomic status and 29.9% of children from households

with high socioeconomic status were assigned to the chronic increasing trajectory group (see supplementary table 5).

For sexual violence victimization, 64.8% (1,212) of children resided in households with low socioeconomic status, while 35.2% (658) of the children resided in high socioeconomic households. 28% of children from households with low socioeconomic status and 22% of children from households with high socioeconomic status belonged to the late increasing sexual violence victimization trajectory group (see supplementary table 5).

Using power two proportions command on stata and the above proportions, this study had 86.3% and 81.3% power to detect a statistically significant difference in physical and sexual violence trajectory group membership between children residing in households with low and high socioeconomic status, respectively.

Supplementary table 5. Proportions for sample power calculation.

	Physical violence victimization		**Sexual violence victimization**	
Children proportions	Total (n=1872)	Chronic increasing n (%)	Total (n=1870)	Late increasing n (%)
Low socioeconomic status	1217 (65.0)	454 (37.1)	1212 (64.8)	341 (28.1)
High socioeconomic status	655 (35.0)	196 (29.9)	658 (35.2)	143 (21.7)

Data analysis

Trajectory group identification; The final trajectory model selected was based on the lowest BIC, highest entropy and theoretical plausibility, which determined the number and shape of distinct trajectory groups of violence victimization among children in the samples (1). Entropy is a measure of the accuracy to which each individual is assigned to their most likely trajectory group (1). The closer the value is to one, the higher the accuracy of trajectory group classification. Model adequacy

was based on posterior probabilities; a measure of a child's probability of belonging to each identified trajectory group. Average posterior probabilities closer to 1.0 for each group based on group assignment indicate that children were assigned to trajectory groups that best described their patterns of violence through childhood (2).

Once each of the children were assigned to trajectory groups to which each had maximum probability of group membership, bivariate analyses were conducted to test differences in each correlate proportions or means stratified by trajectory group membership. Pearson's chi-square and two sample-independent t-test were used to test for these differences for categorical and continuous data respectively. Normality testing (p-norm test) was conducted for continuous variables prior to the conduct of the independent t-tests.

Extended results

Trajectories of physical and sexual violence victimization

For GBTM, only children with data in at least 2 of the 4-time points were included in the trajectory analysis as described in the methodology section. Children with violence data in all 4 points of data collection were 38.6% for physical violence and 34.1% for sexual violence victimization More than 2 in every 5 children had data on violence in 3 of the 4 data collection points for both physical (42.3%) and sexual (43.3%) violence victimization. Lastly, children with violence data in 2 time points of data collection was 19.1% and 22.6% for physical and sexual violence victimization, respectively.

Further description of trajectories and group membership has been provided in the manuscript.

Bivariate association between early life factors and violence victimization trajectory group members

Supplementary table 5 details the study characteristics by physical violence trajectory group. We see more children were assigned to the adolescent limited physical violence victimization trajectory group (65.1%). A higher proportion of boys (56.8%) than girls (43.2%) were assigned to the chronic increasing trajectory group ($p<0.001$). Mean infant weight gain ($p=0.02$) and childhood height gain ($p=0.03$) were the only other individual factors with significant differences in covariate proportions based on children's trajectory group membership. The results show that children in the chronic physical violence trajectory group were more likely to have an increase in relative weight gain during infancy, and those in the adolescent limited group were more likely to have a decrease in relative weight gain. A similar inverse relationship was noted in relative height gain between age 2 to 5 years. Children in the chronic trajectory group were more likely to be shorter for their age (-0.08) compared to children in the adolescent limited group. Household socioeconomic status was the only family level factor that differed significantly based on trajectory group membership ($p=0.006$). A higher proportion of children in the chronic trajectory group resided in low socioeconomic households (69.9%) compared to children assigned to the adolescent limited group (62.4%). However, marginally significant differences were observed in terms of household crowding ($p=0.08$), maternal education at birth ($p=0.06$) and mode of delivery ($p=0.08$) between children in the adolescent limited and chronic increasing trajectory groups. A higher proportion of children in the chronic increasing trajectory group were born through vaginal delivery (90.5%), they had mothers with lower education status (13.1%) and resided in crowded households (44.7%), compared to children in the adolescent limited group.

Supplementary table 6. Study characteristics by physical violence victimization trajectory group membership.

Variables	Total N (%)	Adolescent limited n (%)	Chronic increasing n (%)	P-values
Trajectory group membership	2057	1340 (65.1)	717 (34.9)	
Individual level factors				
Sex	2057			<0.001
Female	1080 (52.5)	770 (57.5)	310 (43.2)	
Male	977 (47.5)	570 (42.5)	407 (56.8)	
Birthweight	2053			0.416
Low birth weight (<2500 grams)	231 (11.3)	145 (10.8)	86 (12.0)	
Normal birthweight (≥ 2500 grams)	1822 (88.8)	1193 (89.2)	629 (88.0)	
Infant and child growth				
Relative weight gain 0-2 years [a]	-0.03 (0.99)	-0.07 (0.99)	0.05 (0.99)	0.023
Relative weight gain 2-5 years [a]	0.00	0.01 (1.03)	-0.02 (1.03)	0.665
Relative height gain 0-2 years [a]	-0.04	-0.03 (0.99)	-0.07 (0.98)	0.486
Relative height gain 2-5 years [a]	0.00	0.04 (0.99)	-0.08 (1.01)	0.035
Family level factors				
Household socioeconomic status	1872			0.006
Low	1217 (65.0)	763 (62.4)	454 (69.9)	
Middle	392 (20.9)	276 (22.6)	116 (17.9)	
High	263 (14.1)	183 (15.0)	80 (12.3)	
Household crowding	1778			0.079
Yes	744 (41.8)	468 (40.3)	276 (44.7)	
No	1034 (58.2)	692 (59.7)	342 (55.3)	
Maternal age	2055			0.975
≤ 24 years	962 (46.8)	626 (46.8)	336 (46.9)	
25 – 34 years	879 (42.8)	574 (42.9)	305 (42.5)	
≥ 35 years	214 (10.4)	138 (10.3)	76 (10.6)	
Maternal Parity	2057			0.395
1 child	783 (38.1)	519 (38.7)	264 (36.8)	
>1 child	1274 (61.9)	821 (61.3)	453 (63.2)	
Marital status	2043			0.096
Married	773 (37.8)	521 (39.1)	252 (35.4)	
Single	1270 (62.2)	810 (60.9)	460 (64.6)	
Maternal education	1885			0.058
Primary & below	232 (12.3)	146 (11.9)	86 (13.1)	
Secondary	1491 (79.1)	962 (78.4)	529 (80.4)	
Post school training	162 (8.6)	119 (9.7)	43 (6.5)	

Variables	Total N (%)	Adolescent limited n (%)	Chronic increasing n (%)	P-values
Paternal education status	1455			0.191
Primary & below	121 (8.3)	79 (8.3)	42 (8.4)	
Secondary	1061 (72.9)	684 (71.6)	377 (75.4)	
Post-school training	273 (18.8)	192 (20.1)	81 (16.2)	
Father's presence	1848			0.473
Yes	1568 (84.9)	1026 (85.3)	542 (84.0)	
No	280 (15.2)	177 (14.7)	103 (16.0)	
Maternal prior violence experience	1002			0.816
Yes	184 (18.4)	122 (18.6)	62 (18.0)	
No	818 (81.6)	535 (81.4)	283 (82.0)	
Mode of delivery	1147			0.08
Vaginal delivery	1012 (88.2)	642 (87.0)	370 (90.5)	
Assisted delivery	135 (11.8)	96 (13.0)	39 (9.5)	

[a] Values are means (standard deviation)

Of the total sample of 2,051 children included in the sexual violence victimization trajectories analyses, close to three quarters (74.1%) of the children were assigned to the adolescent limited trajectory group (supplementary table 6). None of the individual factors (sex, birth weight, relative infant and childhood weight and height gain) differed significantly based on trajectory group membership. However, covariate proportions of family level factors such as household socioeconomic status, household crowding, maternal and paternal education, differed significantly between children assigned to the adolescent limited and late increasing trajectory groups ($p<0.05$). A higher proportion of children in the late increasing group resided in households with low socioeconomic status (70.5% late increasing group; 62.8% adolescent limited group), with close to half of these children indicating that their household were crowded (47.4% late increasing group; 40.1% adolescent limited group). Only 5.3% and 13.4% of mothers and fathers of children in the late increasing trajectory group had attained further post-schooling training, respectively. This is significantly lower than the 9.7% of mothers and 20.9% of fathers who indicated having post-school training among children in the adolescent limited trajectory group.

Supplementary table 7. Study characteristics by sexual violence victimization trajectory group membership.

Variables	Total N (%)	Adolescent limited n (%)	Late increasing n (%)	P-values
Trajectory group membership	2051	1519 (74.1)	532 (25.9)	
Individual level factors				
Sex	2051			0.574
Female	1074 (52.4)	801 (52.7)	273 (51.3)	
Male	977 (47.6)	718 (47.3)	259 (48.7)	
Birthweight	2047			0.312
Low birth weight (<2500 grams)	230 (11.2)	164 (10.8)	66 (12.4)	
Normal birthweight (≥ 2500 grams)	1817 (88.8)	1352 (89.2)	465 (87.6)	
Infant and child growth factors				
Relative weight gain 0-2 years a	-0.03 (0.99)	-0.04 (0.99)	-0.02 (0.99)	0.736
Relative weight gain 2-5 years a	-0.01 (1.03)	-0.00 (1.04)	-0.01 (1.00)	0.915
Relative height gain 0-2 years a	-0.04 (0.98)	-0.03 (0.98)	-0.08 (0.98)	0.393
Relative height gain 2-5 years a	0.00 (1.0)	0.02 (0.98)	-0.07 (1.05)	0.127
Family level factors				
Household socioeconomic status	1870			0.003
Low	1212 (64.8)	871 (62.8)	341 (70.5)	
Middle	392 (21.0)	298 (21.5)	94 (19.4)	
High	266 (14.2)	217 (15.7)	49 (10.1)	
Household crowding	1775			0.006
Yes	745 (42.0)	528 (40.1)	217 (47.4)	
No	1030 (58.0)	789 (59.9)	241 (52.6)	
Maternal age	2049			0.247
≤ 24 years	961 (46.9)	708 (46.7)	253 (47.6)	
25 – 34 years	875 (42.7)	660 (43.5)	215 (40.4)	
≥ 35 years	213 (10.4)	149 (9.8)	64 (12.0)	
Maternal Parity	2051			0.332
1 child	784 (38.2)	590 (38.8)	194 (36.5)	
>1 child	1267 (61.8)	929 (61.2)	338 (63.5)	
Marital status	2039			0.761
Married	773 (37.9)	575 (38.1)	198 (37.4)	
Single	1266 (62.1)	934 (61.9)	332 (62.6)	
Maternal education	1884			0.001
Primary & below	233 (12.4)	156 (11.2)	77 (15.7)	
Secondary	1490 (79.1)	1102 (79.1)	388 (79.0)	
Post school training	161 (8.6)	135 (9.7)	26 (5.3)	

Variables	Total N (%)	Adolescent limited n (%)	Late increasing n (%)	P-values
Paternal education status	1452			0.011
Primary & below	120 (8.3)	88 (8.1)	32 (8.9)	
Secondary	1060 (73.0)	781 (71.5)	279 (77.7)	
Post-school training	272 (18.7)	224 (20.5)	48 (13.4)	
Father's presence	1844			0.741
Yes	1564 (84.8)	1147 (84.7)	417 (85.3)	
No	280 (15.2)	208 (15.4)	72 (14.7)	
Maternal prior violence experience	1004			0.432
Yes	185 (18.4)	144 (19.0)	41 (16.7)	
No	819 (81.6)	615 (81.0)	204 (83.3)	
Mode of delivery	1141			0.482
Vaginal delivery	1006 (88.2)	739 (87.8)	267 (89.3)	
Assisted delivery	135 (11.8)	103 (12.2)	32 (10.7)	

[a] Values are means (Standard deviation)

All other results have been sufficiently explained in the manuscript.

Extended discussion, conclusion and recommendation

This section provides further discussion of the findings and their consequences in relation to literature. Provides additional study limitations, conclusions and recommendations not included in the manuscript.

Extended discussion

The overall findings from the study were that children follow heterogenous patterns of physical and sexual violence victimization between 5 and 18 years of age. Experiences of physical violence increased with age as children's external environments change from predominant exposure to the home environment at the age of 5 years, to increased interactions with peers in the neighbourhood and at school in later years. Supported by literature, a downward trend of physical violence victimization is experienced starting at mid-adolescence as children approach adulthood (3). This

was the case for 65.1% of the children, where physical violence victimization decreased from 15 years of age. However, for over 3 out of every 10 children, violence victimization continued to increase through mid and late adolescence.

Less than 1% of cases of sexual violence were reported at the age of 5 years. Sexual abuse was limited to the mid-adolescence period for about three quarters of the children, while 25% experienced an increase in sexual violence experiences as they approached adulthood. A study conducted among adolescents in 2 provinces in South Africa found that only 11% of sexual abuse cases are perpetrated in the home, with 52.6% and 32.1 % of sexual abuse experiences taking place in the school and the community, respectively (4). In addition, some of the documented risk factors for sexual abuse such as substance abuse and engagement in high risk behaviours (5) are more common during adolescence than at younger ages. These are some of the plausible reasons for increase in sexual violence at later ages, once children are exposed to other environments outside the home. Although the low number of cases reported among younger children, may also be subject to under-reporting by parents at this age (6).

The study results show that family level factors either independently or after adjusting for other factors predict membership into the chronic physical violence and late sexual violence victimization trajectories. However, individual level factors were only significantly associated with physical violence victimization and not sexual violence victimization trajectory group membership. Residing in poorer households seemed to be the single most influential early life factor that either significantly or marginally significantly predicted physical and sexual violence victimization trajectory group membership. Poverty has been associated with increased family stress and a higher probability of living in a violent neighbourhood, both of which propagate physical violence victimization (7). In

contrast to our findings, presence of a flush toilet, an indicator of higher socioeconomic status was associated with increased risk of sexual abuse among South African adolescents (5).

There is inconsistent literature on the effect of gender on sexual violence victimization. Many studies report that girls are at an increased risk of sexual violence victimization than boys (7). However, a higher proportion of boys than girls reported sexual violence experiences among South African secondary school students from the Northern province (8). Greater disclosure especially among boys was provided as a reason for the higher proportion of sexual violence reported among boys. Ward et al.(5) found similar prevalence of life-time sexual violence experiences between South African boys and girls aged 15 to 17 years, using confidential self-reported questionnaires in schools. Use of self-completed questionnaires from the age of 11 years in the current study may have contributed to greater disclosure of sexual violence experiences especially among boys. This could possibly explain the lack of a significant difference in sexual violence victimization trajectory group membership between boys and girls.

Similar to other longitudinal studies, attrition was a problem in the study, with loss to follow up attributed to factors such as migration (9). However, the large sample size at the beginning of the study mitigated the effects of loss to follow up on the study's internal validity. In addition, questions probing experiences of physical and sexual violence changed over the years. Greater data on violence experiences was collected in later years and this may have impacted reports of violence experiences. Finally, the lack of data on community and societal factors included in the conceptual framework, limits the assessment of these factors as risk factors for physical and sexual violence victimization trajectories. These limitations should be taken into consideration when interpreting the results of this study.

Extended conclusion and recommendations

Children following the increasing physical violence victimization pattern through adolescence and adulthood, have been shown to experience more adverse health outcomes compared to children where violence victimization is limited to the adolescence period. Semenza et al. (10) demonstrated that children in the increasing physical violence victimization group into adulthood, were at greater risks of physical and mental health problem compared to the little or no violence victimization group in adolescence. In contrast, membership in the adolescent limited physical violence trajectory group was not associated with elevated risk of poor adult mental and physical health (10). The identification of children whose physical violence experience continues to increase after mid-adolescence is therefore important to mitigate the long-term impacts on later adult health and well-being.

Early life factors explored are dynamic and have a possibility of changing as years progress. Therefore, future research should explore if changes in any of the early life factors is protective or exacerbates the risk of continuous victimization. Finally, findings from this and previous studies on the lack of significant differences in sexual violence victimization by sex, supports the need for gender inclusive strategies and interventions for both physical and sexual violence victimization prevention.

References

1. Nagin DS, Odgers CL. Group-Based Trajectory Modeling in Clinical Research. Annu Rev Clin Psychol. 2010 Mar 1;6(1):109–38.

2. Nagin DS. Group-Based Trajectory Modeling: An Overview. Ann Nutr Metab. 2014;65(2–3):205–10.

3. Macmillan R. Violence and the Life Course: The Consequences of Victimization for Personal and Social Development. Annu Rev Sociol. 2001;27(1):1–22.

4. Meinck F, Cluver LD, Boyes ME, Loening-Voysey H. Physical, emotional and sexual adolescent abuse victimisation in South Africa: prevalence, incidence, perpetrators and locations. J Epidemiol Community Health. 2016 Sep 1;70(9):910–6.

5. Ward CL, Artz L, Leoschut L, Kassanjee R, Burton P. Sexual violence against children in South Africa: a nationally representative cross-sectional study of prevalence and correlates. Lancet Glob Health. 2018 Apr;6(4):e460–8.

6. Pfeiffer L, Salvagni EP. Current view of sexual abuse in childhood and adolescence. J Pediatr (Rio J). 2005 Dec 7;81(8):197–204.

7. Meinck F, Cluver LD, Boyes ME, Mhlongo EL. Risk and Protective Factors for Physical and Sexual Abuse of Children and Adolescents in Africa. Trauma Violence Amp Abuse. 2014;16(1):81.

8. Madu SN, Peltzer K. Risk factors and child sexual abuse among secondary school students in the Northern Province (South Africa). Child Abuse Negl. 2000 Feb;24(2):259–68.

9. Richter L, Norris S, Pettifor J, Yach D, Cameron N. Cohort Profile: Mandela's children: The 1990 birth to twenty study in South Africa. Int J Epidemiol. 2007 Jun 1;36(3):504–11.

10. Semenza DC, Testa A, Turanovic JJ. Trajectories of violent victimization over the life course: Implications for mental and physical health. Adv Life Course Res. 2021 Dec 1; 50:100436.

APPENDICES

Appendix 1. Plagiarism report

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Lilian Muchai (Student number: 2606265) am a student registered for the degree of MSc. Epidemiology (Epidemiology & Biostatistics) in the academic year 2023.

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.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- 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.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: _____ Date: 16 September 2023

Appendix 2. Outcome variable of interest

	Primary dataset		Secondary dataset	
Physical violence victimization at each age	**Code**	**Categories**	**Code**	**Categories**
At home in the last 12 months. How often have you been?				
Physically hurt at home	1	Never	0	No
Hit by caregivers at home	2	Once or twice	1	Yes
Kicked at home	3	Few times		
Badly beaten up at home	4	Many times		
Attacked with a knife or sharp object				
At school. How often have you been?				
Hit by a student / staff at school	1	Never	0	No
Kicked by a student or staff at school	2	Once or twice	1	Yes
Badly beaten up at school	3	Few times		
Attacked with a knife or sharp weapon	4	Many times		
In the neighbourhood. How often have you been?				
Hit in the neighbourhood	1	Never	0	No
Kicked in the neighbourhood	2	Once or twice	1	Yes
Badly beaten up in neighbourhood	3	Few times		
Attacked with a knife or sharp object	4	Many times		
At work. How often have you been?				
Hit by a colleague or supervisor at work	1	Never	0	No
Kicked by a colleague or supervisor at work	2	Once or twice	1	Yes
Badly beaten up at work	3	Few times		
Attacked with a knife or sharp weapon	4	Many times		

	Primary dataset		Secondary dataset	
Sexual violence victimization at each age	**Code**	**Categories**	**Code**	**Categories**
At home in the last 12 months. How often have you been?				
Sexually harassed at home	1	Never	0	No
	2	Once or twice	1	Yes
Sexually attacked at home	3	Few times		
	4	Many times		
At school. How often have you been?				
Sexually harassed by student / staff at school	1	Never	0	No
	2	Once or twice	1	Yes
Sexually attacked at school	3	Few times		
	4	Many times		
In the neighbourhood. How often have you been?				
Sexually harassed in the neighbourhood	1	Never	0	No
	2	Once or twice	1	Yes
Sexually attacked	3	Few times		
	4	Many times		
In the last 12 months Have you?				
Wanted heavy petting or foreplay	1	Yes	0	No
Wanted oral sex				
Wanted oral sex last month				
Wanted sex	0	No	1	Yes
Wanted sex last month				

Appendix 3. Explanatory variables of interest extracted from Bt20+ Cohort database

	Primary dataset		**Secondary dataset**	
Variables	**Code**	**Categories**	**Code**	**Categories**
Sex	1	Male	1	Male
	2	Female	2	Female
Birthweight	1	Low birth weight	1	Low birth weight (<2500 grams)
		Normal birthweight		Normal birthweight ((≥ 2500 grams)
Relative infant weight / height		Continuous variable		Continuous variable
Relative child weight / height		Continuous variable		Continuous variable
Household socioeconomic status	Household score	Continuous variable	1	Lowest
			2	Middle
			3	Highest
Household crowding		Ratio of persons Per sleeping room	0	No (< sample ratio means, 3.4)
			1	Yes (≥ sample ratio means, 3.4)
Mothers age		Continuous variable	1	≤ 24 years
			2	25 - 34 years
			3	≥ 35 years
Maternal parity	1	Only child	1	Having one child
	2	More than 1 child	2	Having more than one child
Mother's marital status	1	Married	1	Yes (married or living together)
	2	Living together		
	3	Separated/ Divorced/Widowed	2	No (Separated/ Divorced/Widowed/ single)
	4	Single		
Maternal / paternal education	1	No formal education	1	Primary and below
	2	Less than grade 3		
	3	Primary education		
	4	First part secondary	2	Secondary education
	5	Last part secondary		
	6	Post school training	3	Post school training

	Primary dataset		Secondary dataset	
Father present	0	No	0	No
	1	Yes	1	Yes
Mother's prior experience of violence				
Mother's violence experience in childhood	1	Yes		No (No response to both questions)
	2	No	0	
Intimate partner violence experience during pregnancy	1	Yes		Yes (a yes to one or Both questions)
	2	No	1	
Mode of delivery	1	Normal vaginal	1	Vaginal
	2	Vacuum		
	3	Forceps		
	4	Caesarean section	2	Caesarean section

Appendix 4. Birth to Twenty Plus HREC certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Professor Shane Norris

CLEARANCE CERTIFICATE	M111182
PROJECT	Birth to Twenty Plus, Investigation into Young Adult Health
INVESTIGATORS	Professor Shane Norris
DEPARTMENT	Department of Paediatrics
DATE CONSIDERED	25/11/2011
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 25/03/2014 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof Shane Norris

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 5. Data access permission letter

linda.richter@wits.ac.za
www.wits.ac.za/coe-human/
011 717 2382 | 082 412 2589

Office 12, 2nd Floor MB House
641 Peter Mokaba Ridge, Durban 4001

Office 154, First Floor East Wing Wits
School of Public Health Education Campus
27 St Andrews Road, Parktown
Johannesburg 2193

To: Whom it may concern

Date: 15-12-2022

RE: AUTHORIZATION TO ACCESS Bt30 DATA

This letter is to confirm that the Scientific Committee of the Birth to Thirty Study has authorized Ms Lilian Muchai, student number: 2606265, access to the Bt30 data on Violence and Early life factors for the purposes of her MSc in Epidemiology and Biostatistics.

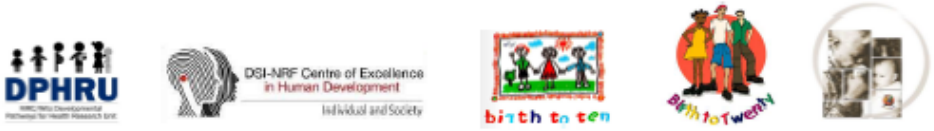
The data available for her use is detailed in a memorandum agreement (attached).

If you have any concerns or require additional information, feel free to contact the unit.

Yours sincerely

Linda M Richter (PhD)
Distinguished Professor, DSI-NRF Centre of Excellence in Human Development
University of the Witwatersrand
Email: linda.richter@wits.ac.za | Tel: +27 11 717 2382

Appendix 6. Bt30 Memorandum of Agreement



Memorandum of Agreement

Birth to Thirty

January 2022

Name: Lilian Muchai

Institution: University of the Witwatersrand

Email: 2606265@students.wits.ac.za

Title of project: Early life factors associated with childhood trajectories of violence among the Birth to Twenty Plus cohort in Soweto, South Africa.

Proposed research questions: What are the early life factors associated with membership in the different trajectory groups of violence from birth to 18 years among children residing in Soweto, Johannesburg in South Africa?

Bt20+ collaborator/s: Dr. Juliana Kagura & Sara Naicker

Potential for in-person meetings: Yes

Data shared [detailed list of variables]:

Socio-demographic factors

1. Age in years / Date of birth
2. Gender
3. Height
4. Weight
5. Socioeconomic status

Maternal & early life factors at 2 years

1. Mode of delivery
2. Birthweight
3. Maternal age
4. Marital status
5. Previous births / maternal parity

6. Maternal prior experience of violence
7. Mother's education
8. Mothers' socioeconomic status at birth

Violence exposure and experience

1. Observation of physical altercation in the home
2. Observation of fighting in school
3. Exposure to gun violence
4. Observe gang violence
5. Physical or verbal attack at home
6. Physical or verbal attack at school
7. Forced sexual intercourse
8. How often have you badly beaten up someone at school
9. How often have you verbally or emotionally abused someone at school
10. Outside of school, how often have you badly beaten up someone
11. Outside of school, how often have you verbally or emotionally abused someone

Data shared from the Birth to Thirty (Bt30) study is confidential, and has been provided by study participants on the understanding that the privacy of their identity and information will be respected. Please affirm your agreement on each point and sign at the bottom of this form to confirm your undertaking.

I will not try to identify study participants. ☒

I will not share the analytical dataset with anyone other than researchers working on this particular project, who have also signed a copy of this form. ☒

Prior to submission of any degree for examination or papers for publication based on Bt20+ data, I agree to notify the Bt30 Principal Investigators (Linda Richter and Shane Norris). ☒

When a manuscript is submitted for degree purposes or publication, I will submit the analytical dataset with any derived variables to the Birth to Thirty data team together with appropriate documentation. ☒

I undertake to store the Bt30 data in a secure manner on a computer or server with restricted access. ☒

I undertake to delete any Bt30 datasets from computers when my approved project ceases. ☒

I undertake to acknowledge all relevant sources of funding and support sources (available from the Bt30 team) in all publications. ☒

To the best of my ability, I undertake to publish results in open-access journals ☒

I understand that failure to abide by these undertakings will result in exclusion of myself and my institution from further access to Bt30 data and you will be subject to sanctions as applicable.

Signature: _____

Date: 14 December 2022

The Birth to Thirty Team

Appendix 7. HREC Ethics Clearance Certificate

M230218 MED22-12-041

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Mrs Lilian Muchai

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M230218 MED22-12-041

NAME: (Principal Investigator)	Mrs Lilian Muchai
DEPARTMENT:	Epidemiology & Biostatistics
PROJECT TITLE:	Early Life factors associated with childhood trajectories of violence among the Birth to Twenty-Plus Cohort in Soweto, South Africa
DATE CONSIDERED:	24/02/2023
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr J. Kagura and Miss S. Naicker
APPROVED BY:	Dr C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	03/04/2023 **EXPIRY DATE:** 03/04/2028

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 February and will therefore be due in the mo.
monnth of February each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Login to upload signed copy of this ethics clearance certificate prior to commencing with the study
https://www.witsethics.co.za/login.aspx

Principal Investigator Signature

21/04/2023
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 8. Turnitin report

Signed: Dr J Kagura 9/10/23

Signed: Dr S Naicker 11/10/23

Lilian_Muchai_Plaigarism_report.doc

ORIGINALITY REPORT

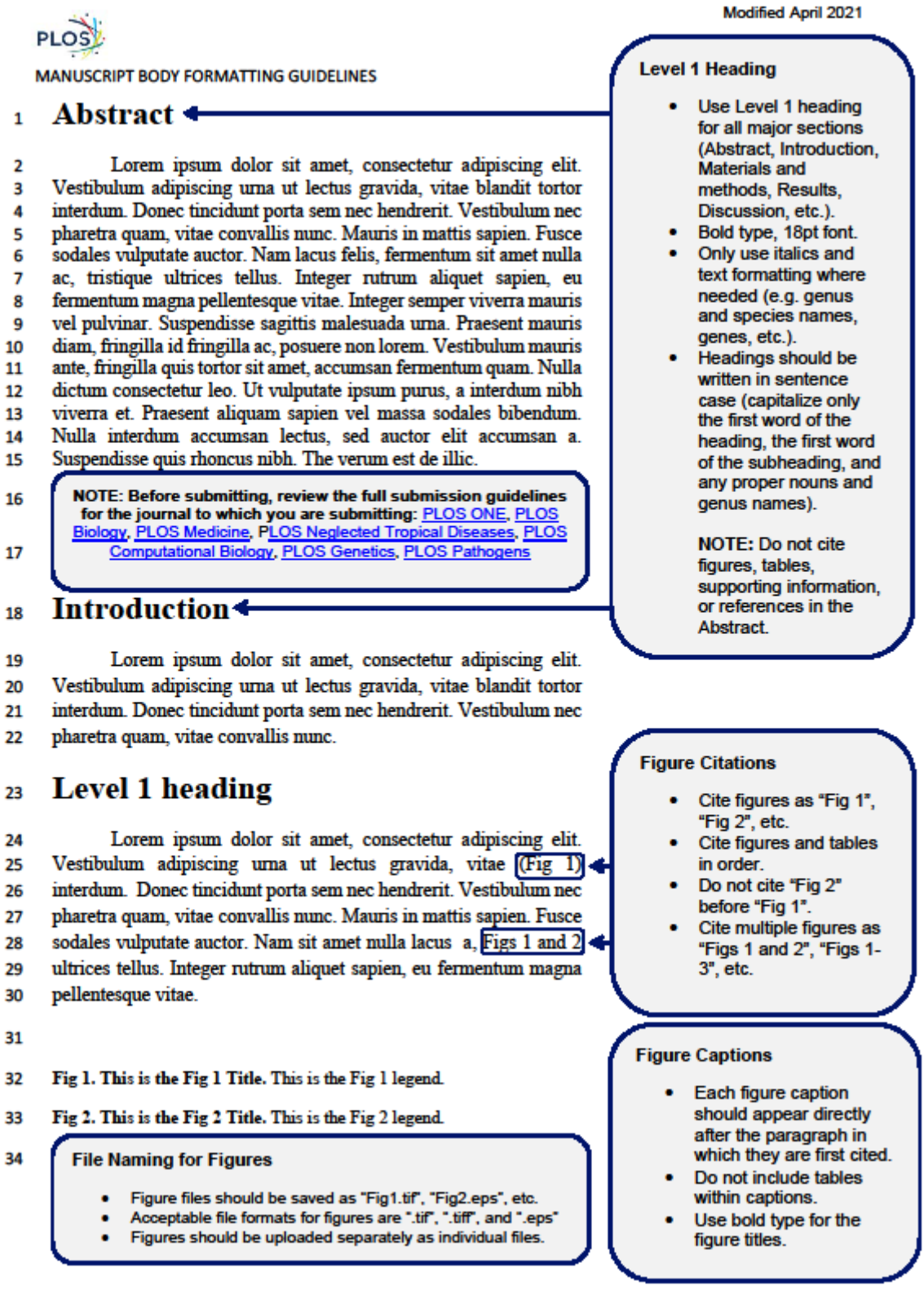
9%	6%	5%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Daniel C. Semenza, Alexander Testa, Jillian J. Turanovic. "Violent victimization trajectories from adolescence through young adulthood: Consequences for mental and physical health", Advances in Life Course Research, 2021 Publication	1%
2	www.medrxiv.org Internet Source	<1%
3	bmcwomenshealth.biomedcentral.com Internet Source	<1%
4	www.hst.org.za Internet Source	<1%
5	Ehrenreich, Samuel E., Kurt J. Beron, Dawn Y. Brinkley, and Marion K. Underwood. "Family predictors of continuity and change in social and physical aggression from ages 9 to 18 : Family Predictors of Aggression Trajectories", Aggressive Behavior, 2014. Publication	<1%

Appendix 9. PLOS ONE Journal guideline

Guidelines can be accessed through this link: https://journals.plos.org/plosone/s/submission-guidelines.



Appendix 10. Author contribution letter

To : The Examiners

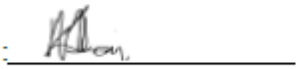
Date : 5th October 2023

Subject: Author Contributions – Lilian Muchai

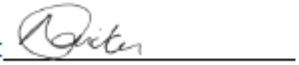
The following were the author's contributions made by Lilian Muchai to the manuscript entitled "**Early life factors associated with childhood trajectories of violence among the Birth to Twenty–Plus Cohort in Soweto, South Africa**": Study conceptualization and design, data cleaning, analysis, and interpretation of results, as well as drafting and revision of the manuscript.

Drs. Juliana Kagura and Sara Naicker were involved in the above-mentioned tasks including research conceptualization, supervision and guidance on appropriate revisions to the manuscript.

All Authors read and approved the final manuscript submitted to PLOS ONE.

Lilian Muchai : 

Dr Juliana Kagura: 

Dr Sara Naicker : 

Appendix 11. Proof of manuscript submission (PLOS ONE)

PLOS ONE

Early life factors associated with childhood trajectories of violence among the Birth to Twenty-Plus Cohort in Soweto, South Africa.

--Manuscript Draft--

Manuscript Number:	
Article Type:	Research Article
Full Title:	Early life factors associated with childhood trajectories of violence among the Birth to Twenty-Plus Cohort in Soweto, South Africa.
Short Title:	Early life factors associated with childhood trajectories of violence.
Corresponding Author:	Lilian Njeri Muchai, MSc University of the Witwatersrand Johannesburg School of Public Health Johannesburg, Gauteng SOUTH AFRICA
Keywords:	Physical violence; sexual violence; trajectories; early life factors
Abstract:	Violence against children (VAC) has devastating and long-term negative consequences on individuals' and society's health, social and economic well-being. There is limited research on the life course experience of VAC, especially in Africa. This study aimed to identify sub-groups of physical & sexual violence victimization patterns separately in childhood, and evaluate early life factors predicting violence trajectories. This study used data from ages 5 to 18 years from the ongoing prospective Birth to Twenty Plus cohort (Bt20+). Children with data on physical and sexual violence in at least 2-time points between 5 and 18 years were included in the analyses. Group-based trajectory modelling was employed to identify groups of children with similar patterns of violence over time, while multivariable logistic regression was used to identify early life factors associated with violence trajectory group membership. Separately, two trajectory groups of physical violence (adolescent limited (65.1%) and chronic increasing (34.9%)) and sexual violence (adolescent limited (74.1%) and late increasing (25.9%)) victimization were identified. Early life factors associated with a higher risk of chronic increasing trajectory group membership, after adjusting for covariates, were being male (aOR 1.67, 95% CI 1.31; 2.10) and having a mother with at least secondary education compared to higher education (aOR 1.73, 95% CI 1.08; 2.76). In addition, residing in middle, compared to low, socioeconomic households (aOR 0.68, 95% CI 0.50; 0.92) was protective against membership in this group. Residing in high compared to low socioeconomic households, was the only early life factor with marginally significant (aOR 0.63, 95% CI 0.42; 0.95) association with membership in the late-increasing sexual violence victimization trajectory group. In conclusion, children follow different violence victimization trajectories over childhood. Identifying early life factors predicting violence trajectories provides key prevention intervention areas that can mitigate children's violence experience.
Order of Authors:	Lilian Njeri Muchai, MSc
	Sara Naicker, PhD
	Juliana Kagura, PhD
Opposed Reviewers:	
Additional Information:	
Question	**Response**
Financial Disclosure Enter a financial disclosure statement that describes the sources of funding for the work included in this submission. Review the submission guidelines for detailed requirements. View published research	Yes

Powered by Editorial Manager® and ProduXion Manager® from Aries Systems Corporation