Health Risk Behavior among adolescents and its socio-neuro-biological determinants in the context of HIV at the coast of Kenya

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Health Risk Behavior among adolescents and its socio-neuro-biological determinants in the context of HIV at the coast of Kenya

Gezondheidsrisicogedrag van adolescenten die opgroeien aan de kust van Kenia in relatie tot sociale, neurologische en biologische determinanten en HIV
(met een samenvatting in het Nederlands)

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List of Abbreviations and Acronyms

ACASI: Audio Computer Assisted Self Interview
AHOS: Adolescent Health Outcomes Study
AIC: Akaike information criterion
AIDS: Acquired Immunodeficiency Syndrome
ASRH: Adolescent Sexual and Reproductive Health
ALHIV/ALWHIV: Adolescents Living with HIV
AMP: Adolescent Master Protocol
ANOVA: Analysis of Variance
ART: Antiretroviral Therapy
ATOD: Alcohol, Tobacco and Other Drugs
AUDIT: Alcohol Use Disorder Identification Test
BIC: Bayesian Information Criterion
CAPI: Computer Assisted Personal Interview
CASAH: Child and Adolescent Self-Awareness and Health Study
CBO: Community Based Organization
CDC: Centers for Disease Control and Prevention
CGMRC: Centre for Geographic Medical Research
CI: Confidence Interval
CNS: Central Nervous System
CRAFT: Car, Relax, Alone, Forget, Friends, Trouble
CTMT: Comprehensive Trail Making Test
DALYS: Disability Adjusted Life Years
DSM-IV-MR-J: Diagnostic and Statistical Manual for Mental disorder-IV-Multiple Response-Juvenile
EF: Executive Functioning
FGDs: Focus Group Discussions
GSHS: Global School –Based Student Health Survey
HAART: Highly Active Antiretroviral Therapy
HBSC: Health Behavior in School-aged Children
HIV: Human Immunodeficiency Virus
HRB: Health Risk Behavior
HRG: High Risk Group
HRSU: Highest Risk Substance Users
HUU: HIV unexposed uninfected
IPAQ: International physical activity questionnaire
IQR: Interquartile Range
KHDSS: Kilifi Health and Demographic Surveillance System

KI: Key Informant
KRIBE-Q: Kilifi Health Risk Behavior Questionnaire
KWTRP: Kenya Medical Research Institute-Wellcome Trust Program
LCA: Latent Class Analysis
LMIC: Low and Middle Income Countries
LNS: Letter-Number Sequencing
LRG: Low Risk Group
MRG: Moderate Risk group
NCD: Non-Communicable Disease
NR: Not reported
PHEU: Perinatally HIV Exposed Unexposed
PHIV: Perinatally HIV infected
PICOS: Participants, Intervention, Comparison, Outcome and Study design
PMTCT: Prevention of Mother-To-Child Transmission of HIV
SCWT: Stroop color and word Test
SD: Standard Deviation
SMASH: Swiss Multi-centric Adolescent Survey on Health
SSA: sub-Saharan Africa
SRB: Sexual Risk Behaviors
STI: Sexually Transmitted Infection
USA: United States of America
YRBSS: Youth Risk Behavior Surveillance System

Chapter 1

Introduction

Introduction

State of Adolescent health in Sub-Saharan Africa

Sub-Saharan Africa (SSA) accounts for 18.5% (221 million) of the global adolescent population (UNICEF, 2016). In comparison to any other region, adolescents in SSA make up the greatest proportion (25%) of the general population (UNICEF, 2016). SSA is also home to 82% of the 1.2 million adolescents living with HIV globally (Idele et al., 2014). The region represents some of worst adolescent health outcomes globally. An estimated 45% of the 1.2 million adolescent deaths recorded in 2015 occurred in SSA (WHO, 2017) and 21% of the global burden of disability-adjusted-life years (DALYs) lost for all age groups was among young people (10-24 years) in this region (Gore et al., 2011). Most causes of mortality and morbidity among adolescents in SSA are preventable and many can be linked to health risk behavior (HRB) such as poor hygiene and sanitation (diarrheal diseases); behavior resulting to unintentional injury (road injuries, falls, drowning); violence; and self-injury (Kassebaum et al., 2017).

Besides the rapid developmental changes (cognitive, physical, social, emotional and sexual), increased need for self-agency and complex changing environments, adolescents' vulnerability to HRB is heightened by HIV/AIDS and social or economic deprivation- which are all common problems in SSA (WHO, 2017, Idele et al., 2014). Remarkably, research on HRB, its antecedents and consequences among adolescents in SSA, remains scarce, especially on vulnerable adolescent sub-populations like adolescents living with HIV (WHO, 2017). Consequently, the needs of adolescents are still not adequately reflected in policy and intervention programs in SSA.

Some significant challenges for adolescent HRB research and interventions within SSA include: i) a scarcity of adolescent age-specific studies (Idele et al., 2014); ii) a lack of contextually relevant and standardized measures for HRB (Conner and Norman, 2017); iii) a tendency to focus on specific forms of HRB in an isolated manner (Conner and Norman, 2017); iv) a dearth of studies investigating the role of neuro-cognitive functions like executive functions on health risk taking (Ezeamama et al., 2016); v) a scarcity of studies on HRB of perinatally HIV infected and HIV exposed uninfected adolescents that use adequate sample size and appropriate comparison groups (Lowenthal et al., 2014); and vi) currently few studies in SSA utilize sound theoretical frameworks (such as ecological models) to capture proximal, intermediate and distal factors influencing adolescent behavior (Atilola, 2017).

The current PhD research project aims to address some of these existing knowledge gaps, through adapting measures for HRB, describing and quantifying the burden of HRB and its underlying determinants among a cohort of perinatally HIV infected (PHIV), perinatally HIV exposed unexposed (PHEU) and HIV unexposed uninfected (HUU) adolescents from a low resource setting in SSA.

Background

Health risk behavior in adolescence

Health risk behaviors are detrimental forms of behavior that increase the odds of ill health or disease on the basis of epidemiological or social data (DiClemente et al., 2013). HRB are often initiated or consolidated during adolescence (10-19 years) (WHO, 2017, Steinberg, 2008). Within a psychosocial perspective, the definition of HRB comprises any form of behavior that can compromise psychosocial aspects of successful adolescent development, for instance achievement of expected social roles, sense of adequacy and competence, accomplishment of normal developmental tasks and transition into young adulthood (Jessor, 1991). These forms of behavior contribute to the top causes of morbidity and mortality among young people and thus have been prioritized for surveillance and monitoring in some societies. As an example, the Centers for Disease Control and Prevention (CDC) in the United States of America (USA) prioritize six categories of adolescent HRB namely: i) alcohol and other drug use; ii) sexual behaviors that contribute to unintended pregnancy and sexually transmitted diseases; iii) behaviors that contribute to unintentional injuries and violence; iv) unhealthy dietary behaviors; v) inadequate physical activity; and vi) tobacco use (CDC, 2018). Nonetheless, depending on context and research interest, some additional behavioral risk factors among adolescents include poor hygiene (WHO, 2013), poor sleep habits (Yilmaz et al., 2011), and gambling behavior (McComb and Sabiston, 2010). It is also conceptualized that there is a tendency of covariation among HRB during adolescence which subsequently results into behavioral clustering or a risk behavior syndrome (Jessor, 1991). Behavior clustering (also known as behavior co-occurrence) explains the existence of organized patterns of adolescent HRB and also elucidates the notion of 'unhealthy lifestyle'(Jessor, 1991).

Burden of HRB among adolescents in SSA

Six percent (6%) of the global burden of disease and injury arises during adolescence (WHO, 2017). Various forms of HRB contribute to this burden but the most notable ones include behavior resulting in unintentional injury especially road traffic injuries and drowning; self-harm, poor hygiene practices (culminating to a high burden of diarrheal diseases and intestinal infections); and sexual risk indirectly reflected by the high burden of pregnancy related complications like hemorrhage and hypertensive disorders among older adolescent girls (Kassebaum et al., 2017). Disability and mortality attributable to HRB among adolescents is greatest in SSA. As an example, deaths among young adolescents (10-14 years) from low and middle-income countries of Africa are almost 13 times higher compared to those in high-income countries, and deaths in older adolescents (15-19 years) in SSA are over 7 times higher than those in high-income countries (WHO, 2016). The disability-adjusted-life years (DALYs) rate for road injuries for example is about 10 times higher in boys and 9 times higher in girls from SSA when compared to that from high-income Asia Pacific (Haagsma et al., 2016). SSA also has the highest birth rate among adolescent girls (115 per 1000 girls aged 15-19 years) which is double the global average (49 per 1000 girls), and the highest rates of unsafe abortion (26 per 1000 girls) globally (WHO, 2015, WHO, 2016). Sexual risk behavior and related vulnerabilities also largely explicate the highest rate (430, 000 per year) of new HIV infections among young people (15-24 years) in East and Southern Africa (WHO, 2015). It is also estimated that close to 25% of adolescents (15-19 years) in SSA have their first sexual debut prior to 15 years (Doyle et al., 2012). The occurrence of multiple forms of HRB among adolescents from SSA has also been demonstrated by findings of a multi-site study with nationally representative data from four SSA countries. This study found that 7% of the adolescents (12-19 years) had been drunk or intoxicated in the previous 12 months preceding the study, 18% had a history of physical abuse during their childhood, and 15% of those that were sexually active (4%) reported coerced sexual intercourse during their first sexual debut (Kabiru et al., 2010). Other research findings also indicate that between 2005 and 2010 about 12% to 18% of adolescents (aged 13-15 years) in Eastern Africa consumed tobacco products (Marquez and Farrington, 2013).

Besides mortality and morbidity, the co-occurrence of HRB during adolescence is linked to poor educational achievement (Busch et al., 2015, So and Park, 2016), high economic costs (Bouchery et al., 2011), and judicial or policy related implications (Skeem et al., 2014). From a life-course perspective,

engagement in HRB during adolescence is a risk factor for poor quality of life and occurrence of various chronic conditions during adulthood, for example coronary heart disease, type II diabetes, and hemorrhagic stroke (Lynch and Smith, 2005). Therefore, adolescents, and more urgently those who are most vulnerable, should be targeted with research and evidence-based interventions to address the current burden posed by HRB.

Why are adolescents high risk takers?

Adolescents (mainly from mid-adolescence) generally experience heightened vulnerability to risky behavior when compared to other age-groups (Steinberg, 2008). This vulnerability is commonly linked to adolescents' coping challenges arising from their rapid cognitive, physical, social, emotional and sexual developmental changes. It is further compounded by adolescents' increased need for self-agency in their complex and changing environments (WHO, 2017). To understand how and why HRB occurs during adolescence, various perspectives are commonly examined (Steinberg, 2008). The contextual perspective focuses on an interplay of interpersonal and community level factors underlying behavior, a psychological perspective examines emotional and thought processes influencing behavior, and a biological perspective focuses on underlying aspects like genetics, neuro-biology and endocrinology. Nevertheless, there is much overlap and cross information amongst these perspectives (Steinberg, 2008).

Steinberg's social-neuroscience perspective on adolescent risk taking is one of the most fundamental models that explains the phenomenon of increase in risk-taking between childhood and adolescence and its subsequent decline during adulthood (Steinberg, 2008). He explains that the period of heightened vulnerability to risk taking during adolescence is largely attributable to a temporal gap between the arousal of the socio-emotional system and the full maturation of the cognitive control system. He refers to these two competing systems as the 'dual brain system' (Steinberg, 2008, Steinberg, 2010). The onset of puberty (between 9-14 years) coincides with the early and relatively abrupt development of a socio-emotional system which increases reward-seeking especially in the presence of peers. The reward salience and sensitivity is thought to result from remodeling of the dopaminergic pathway (i.e. synaptic pruning within the amygdala, orbitofrontal cortex, and medial prefrontal cortex) which often peaks by the age of 15 years after which it starts to decline. Remodeling causes an imbalance of dopamine neuro-receptors which results in diminished inhibitory control of dopamine circulation in the prefrontal

cortex; explaining the heightened reward salience. Synaptic remodeling at puberty is also linked to an increase in gonadal hormones like oxytocin that play an important role in social information and social bonding (Steinberg, 2008). Gonadal hormones influence emotional and behavioral responses that arise from social stimuli (e.g. self-consciousness and peer influence), and this potentially explains why most forms of HRB in adolescence are more likely to occur within peer group dynamics (Steinberg, 2008). Risk-taking however declines towards adulthood due to the gradual development (until mid-20s) of the cognitive control system and this improves individuals' capacity for self-regulation. This gradual development involves myelination of nerve fibers to insulate neural circuity (shown by increase in brain white matter), and this is associated with improvement in higher-order functions sub-served by the prefrontal cortex such as planning, response inhibition, attention and multi-tasking (Steinberg, 2008). Maturation of the cognitive control system also involves the improvement in connectivity between and within the cortical areas and subcortical regions (mostly prefrontal, limbic and paralimbic regions). The improved connectivity enhances coordination of affect and cognition, thus improving emotional regulation over the course of adolescence (Steinberg, 2008).

Furthermore, Blum and colleagues in their Ecological Model of Adolescent Behavior (Blum et al., 2001) which borrows from Bronfenbrenner's ecological systems of human development theory (Bronfenbrenner, 1977), explain that adolescents' risky behavior is influenced by complex mechanisms that occur within and beyond the immediate environment of the adolescent. These complex mechanisms involve interactions across six domains, namely: individual, family, peers, school, social environment and macro environment. Each domain comprises risk and protective factors which overall explain occurrence and variation in HRB during adolescence (Blum et al., 2001). Peer, family and school level factors fall into a broader social environment which also in turn fits within a much broader macro environment. In addition, there is bi-directionality of effects between the risk factors and behavioral outcomes. The protective factors moderate or mitigate the influences of risk factors on adolescent behavior (Blum et al., 2001). Blum and colleagues' model has been corroborated by findings from various representative studies on HRB in adolescent populations that reported on: i) individual level factors like age, self-esteem, religiosity, and risk perception (Resnick et al., 1997, Oyewole et al., 2018); ii) family level factors like parent-family connectedness (e.g. presence of parents at key times, parental expectations and shared activities),

family history of mental illness, substance use by close family members (Resnick et al., 1997, Kilpatrick et al., 2000); iii) school level factors like school connectedness and level of educational achievement (Resnick et al., 1997, Doyle et al., 2012); iv) peer influence (Oyewole et al., 2018); v) social and community level factors like neighborhood characteristics; and vi) macro level factors like legal framework (Cubbin et al., 2005, Shope and Bingham, 2008).

De Ridder and De Wit (2006) explored an important behavioral conundrum of why a majority of people who have good intentions for a healthy lifestyle succumb to obstacles and temptations of engaging in risky forms of behavior. They explain that self-regulation; a systematic process that involves conscious effort to influence thoughts, feelings and behavior- plays a key role in elucidating this phenomenon. They point out that goal setting, goal striving and managing emotional responses are integral aspects of self-regulation and they link these three aspects to cognitive processes. From this background, they stress the need to understand how people manage or cope with trade-offs and choices while faced with immediate urges that conflict with distal goals (De Ridder and De Wit, 2006). However, they note that adolescents' social goals are often more salient than their health goals which explains their behavioral willingness to adapt to social situations.

Adolescent health risk behavior in an HIV context in SSA

Perinatally HIV infected (PHIV) adolescents

Globally, 1.2 million adolescents are living with HIV, mainly acquired perinatally or vertically, and the majority (82%) resides in SSA (Idele et al., 2014). Prior to availability of antiretroviral therapy (ART), HIV-infected infants in SSA had a 50% probability of survival beyond the age of 2 years (Lowenthal et al., 2014). However survival has enormously improved following the inception of ART in resource-poor settings like SSA in 2004, and its subsequent accessibility by 20-80% of treatment eligible children from such settings (UNAIDS, 2012). The improvements in treatment access resulting in survival or longevity largely explain the emerging population of adolescents living with HIV.

This emerging cohort of perinatally HIV infected (PHIV) adolescents in SSA presents various unique needs and challenges which warrant concerted research and intervention. These unique challenges include: (i) Due to their

later access to ART and changes in treatment guidelines (Gilks et al., 2006, NASCOP, 2018), PHIV adolescents in SSA comprise patients with varying treatment outcomes and related consequences. Some were initiated to ART soon after infection, others were initiated to ART after considerable insults (like HIV associated neurodevelopmental disability), and a few with slow HIV progression (Ferrand et al., 2009) or diagnosed late, may have only recently or actually not yet initiated ART (Laughton et al., 2013). (ii) A high risk for infectious and malignant conditions like cryptococcosis, tuberculosis, Kaposi' sarcoma, herpes zoster, warts, chronic lung disease and cardiac conditions is reported among PHIV adolescents in SSA (Lowenthal et al., 2014). These conditions further complicate treatment outcomes. (iii) Poor accessibility to ART by PHIV adolescents in SSA is confounded by the fact that the burden of poor adherence to ART and virologic failure (i.e. the failure of ART to suppress and sustain viral load to less than 1000 copies/ml) of adolescents, exceeds that of children and adult HIV patients (Lowenthal et al., 2014). As an example, one study conducted among 232 HIV-infected participants on ART from Kilifi County hospital in Kenya found a higher prevalence of virologic failure and acquired drug resistance among the HIV infected youth (15-24 years) compared to the older HIV infected participants and unsatisfactory adherence was a strong correlate of both outcomes (Hassan et al., 2014). Sub-optimal ART adherence can result in drug resistance which dramatically increases costs of treatment by second-line therapy, accelerated disease progression, psychosocial disease related complications, co-morbidity and mortality (Chesney, 2000, WHO, 2003). (iv) A majority of PHIV adolescents in SSA experiences a constellation of recurrent and cumulative psychological stressors arising from coping with their HIV infection, traumatic life experiences, responsibility of taking care of siblings and ill family members, stigma and discrimination, absenteeism from school, inconsistent guardianship among others (Lowenthal et al., 2014). Indeed, studies among PHIV adolescents from Kilifi County show that PHIV are more likely to experience greater psychosocial disadvantage when compared to the health community controls from the same setting (Abubakar et al., 2017). Amongst the cumulative risk factors orphanhood, care giver depression and low socio-economic status were the most significant and collectively explained the disproportionately greater burden of depression among PHIV adolescents compared to their healthy peers. Stigma, challenges associated with HIV disclosure, and lack of a responsive education system were also faced by PHIV in rural coastal Kenya (Abubakar et al., 2016). (v) The other unique challenge is the scarcity of research focused on PHIV adolescents in SSA. Even for existing research, most studies are largely cross-sectional, have

small samples, lack appropriate controls, consist of variations in assessment tools and procedures, and do not report about other various vital outcomes like HRB and neurodevelopmental outcomes (Lowenthal et al., 2014).

Overall, these unique challenges stress the urgent need to tailor research and intervention for adolescents living with HIV according to their mode of HIV transmission. This concern has also been highlighted by more recent research findings from South Africa showing that the behavioral, clinical, and psychological experiences of PHIV adolescents differ from those who acquire HIV infection behaviorally (Sherr et al., 2018). The authors of this study also cautioned that aggregating research findings from PHIV and behaviorally infected adolescent groups may blur their unique outcomes.

Perinatally HIV exposed uninfected (PHEU) adolescents

Owing to the roll-out of ART, improving access to highly active antiretroviral therapy (HAART) coupled with a better understanding of risk factors for transmission of HIV at birth and during breast feeding, more HIV free children are born to HIV infected mothers than previously (Filteau, 2009). It is estimated that in some parts of SSA, up to 30% of all births may comprise perinatally HIV exposed uninfected (PHEU) infants (Shapiro and Lockman, 2010). The significant improvements in prevention of mother-to-child transmission of HIV (PMTCT) have thus given dramatic rise to a sub-population of PHEU children and adolescents in SSA. This emerging PHEU adolescent sub-population however, has received very scanty research attention especially in SSA, thus longer-term public health implications of perinatal HIV exposure on adolescent health are poorly understood (Filteau, 2009). The PHEU adolescents require more research and programmatic interventions for a number of reasons. *First*, with exception of HIV infection, PHEU children/adolescents share a constellation of biological and psychosocial risks like those documented among their PHIV peers (Abubakar et al., 2017, Filteau, 2009). For instance, African PHEU children considerably face immune abnormalities linked to exposure to HIV and maternal placental responses, increased exposure to infections like tuberculosis and herpes, face traumatic experiences like loss of parents or immediate family, perinatal exposure to ART (in utero, breastmilk or PMTCT regimens), and poor home environment (Afran et al., 2014, Filteau, 2009). *Second*, amidst the constellation of many risk factors, PHEU children are often difficult to identify and monitor because they are not followed up in the HIV specialized clinics (with exception of a few studies). This lack of monitoring disrupts the identification and management of health

concerns like behavioral and mental health needs of these PHEU children and their immediate families (Abubakar et al., 2017, Mellins et al., 2011).

Burden of health risk behavior among PHIV and PHEU adolescents

There is mounting concern about a high occurrence of HRB like substance use and sexual risk behavior among PHIV and PHEU adolescents, although the majority of the evidence currently stems from high income settings like North America (Mellins et al., 2011, Wiener et al., 2007, Bauermeister et al., 2009, Bakeera-Kitaka et al., 2008, Test et al., 2012). In a Ugandan study (low income setting), however, among PHIV adolescents (15-19), it was found that a third was sexually active and contrary to the desires of their healthcare workers (mostly advised them to refrain or postpone sexual activity), very few (37%) reported condom use during their first sexual intercourse, half of them inconsistently used condoms and just a third of those in a romantic relationship had disclosed their HIV status to their partners (Birungi et al., 2009). Elsewhere in the United States of America (USA), findings from 349 PHIV and PHEU adolescents revealed that substance use, especially alcohol and marijuana, is highly prevalent (18% for PHIV and 14% for PHEU) (Mellins et al., 2011). In this study (Mellins et al., 2011), although only 16% reported being sexually active, the occurrence of unprotected vaginal and anal sex was high (65% for PHIV and 50% for PHEU), and so was the occurrence of early sexual debut (13-14 years). This study also found a trend of HRB co-occurrence in both PHIV and PHEU adolescents (Mellins et al., 2011). Another study found that overall sexually active PHIV adolescents in USA report an earlier age of sexual onset (11.9 years) compared to their PHEU colleagues (13.4 years) however, they there were no significant differences in the prevalence of sexual behavior between PHEU and PHIV (Bauermeister et al., 2009).

Sub-optimal treatment outcomes among PHIV adolescent have been linked to co-occurrence of HRB. One study for instance found that the presence of detectable HIV viral load was significantly associated with the occurrence of multiple behavioral risk factors among PHIV adolescents aged 10 -16 years (Mellins et al., 2011). Another cross sectional study found that adolescents with greater than 90% ART adherence were more likely to engage in health promoting behaviors (physical activity, fruit and vegetable consumption, having adequate sleep) compared to those with poorer adherence (LaGrange et al., 2012). Although still scanty, the existing evidence points to a potentially high burden of HRB and associated adverse consequences among PHIV and

PHEU adolescents. Paradoxically while the majority (83%) of PHIV live in SSA, very few studies on HRB involving this sub-population have been conducted in SSA (Lowenthal et al., 2014). Even then, only a few of these studies include appropriate comparison groups such as PHEU adolescents (Lowenthal et al., 2014).

Underlying factors for HRB in PHIV and PHEU adolescents

The evidence surrounding the high occurrence of risk behavior among PHIV and PHEU adolescents is still unclear especially in SSA. There is however general consensus that that most PHIV and PHEU adolescents dwell in vulnerable backgrounds characterized by various familial, environmental, genetic and biomedical factors that are linked to sub-optimal health and behavioral outcomes (Mellins and Malee, 2013). It is plausible that various underlying factors for HRB are generalizable to adolescent development (as described in earlier sections) and in addition, some are unique factors which result from HIV exposure. These two sets of underlying factors are however complex to disentangle (Mellins et al., 2011). Some of the HIV related underlying factors for HRB of PHIV and PHEU adolescents include: caregiver factors for example, chronic illness, being non-biological caregivers, mental illness and substance use by care givers (Mellins et al., 2011, Mellins et al., 2003); health system factors such as, conflicting health messages from health practitioners, poor transition to adult HIV care (Birungi et al., 2009); stigma and discrimination (Mellins et al., 2011, Musindo et al., 2018); cultural and social expectations (Birungi et al., 2009); and social deprivation resulting from orphanhood and household poverty (Mellins et al., 2011). More specific intrapersonal factors include adolescents' experience of traumatic life events like loss of close family members and violence (Mellins et al., 2011); poor HIV care behavior like sub-optimal ART adherence and HIV non-disclosure (Lowenthal et al., 2014); and mental illness (Mellins et al., 2011).

Early brain insult due to HIV's direct or indirect effects on the central nervous system (CNS) may elucidate risk taking among PHEU and PHIV adolescents. HIV infection, especially when treatment is sub-optimal, causes neuropathy (arising from toxic elements released by macrophages) within the frontal and pre-frontal regions of the brain (McArthur et al., 2005). Indeed some studies have found 16-18% thinning of the prefrontal cortex in adults living with HIV (Thompson et al., 2005, Ketzler et al., 1990). Some adverse effects of ART's toxicity on the CNS have also been reported (Shah et al., 2016). Thus, perinatal and/or prolonged exposure to ART (in utero, through breast milk

or treatment) among PHIV and PHEU may have some undesirable effects on the prefrontal cortex of the brain. Neuropathy results to neuronal loss with in the prefrontal cortex regions which hampers important brain maturation processes (e.g. synaptic pruning and myelination) during adolescence (Hoare et al., 2011). The neuropathy may result to sub-optimal development of subtle neuro-cognitive abilities (like executive functions) thus predisposing PHIV and PHEU adolescents to risk-taking behavior (Laughton et al., 2013). Substance use (Vik et al., 2004) and some earlier discussed factors aggravated by HIV/AIDS like poor infant feeding, poor maternal health, experience of traumatic experiences and chronic poverty have also been linked to poor neuro-cognitive outcomes (Filteau, 2009, Laughton et al., 2013, Llorente et al., 2014). Beyond probable behavioral implications, HIV associated neurodevelopmental problems pose significant burden for individuals and their families plus health and education systems (Laughton et al., 2013). In **Figure 1.1**, we present plausible mechanisms that underlie HRB in PHIV and PHEU adolescents.

Executive functioning and HRB

The need to investigate the impact of HIV associated neurocognitive outcomes on HRB of PHIV and PHEU adolescents is highlighted by extensive evidence linking perinatal HIV infection and neurocognitive impairments (Boivin et al., 2018, Laughton et al., 2013). Such poor neuro-cognitive outcomes relate to functions like processing speed, working memory, planning, attention, recall, reasoning, cognitive flexibility, inhibition, and problem solving (Boivin et al., 2018, Laughton et al., 2013, Nichols et al., 2016); which belong to a domain known as executive functions (EF). EF are a set of higher order cognitive abilities particularly sub-served by the frontal and prefrontal regions of the human brain and they govern complex self-regulatory activities commonly categorized into three components of cognitive flexibility, inhibitory control and working memory (Best and Miller, 2010, Diamond, 2013). There is evidence that some subtle deficits in EF may still persist among HIV patients exhibiting optimal ART adherence and those with cognitive scores within normal range (Laughton et al., 2013).

Significant EF problems are traceable among PHIV and PHEU children very early in life, as shown in a study on EF of children of ages 6-35 months in rural coastal Kenya (Abubakar et al., 2013). A multi-centre study (Uganda, South Africa, Malawi, and Zimbabwe) also found that PHIV children (5-11 years) performed poorer than PHEU and HUU children in areas of planning, learning, sequential processing and recall (Boivin et al., 2018). Although severe forms

of HIV-associated neurologic deficits were reduced by continued ART, some behavioral and neurocognitive problems still persisted among children who attained good viral suppression at an early age (Boivin et al., 2018). Another study among adolescents (13-15 years) from the USA did not find significant differences in performance on domains of cognitive flexibility, inhibition and problem solving between PHIV and PHEU with the exception of the PHIV adolescents who had a history of compromised immune system and performed much poorer (Nichols et al., 2016). PHIV children and adolescents (9-19 years) with HIV associated neurocognitive impairment are also highly susceptible to more severe deficits in memory for future intentions (prospective memory) (Harris et al., 2017). A notable challenge however is that most of the research on neurodevelopment among PHIV group comprises younger-age groups, small samples and tends to be reported from mainly high income settings (Laughton et al., 2013).

Important daily functions such as, goal-directed behavior, self-efficacy, complex thought, problem solving, long-term planning, regulation and inhibition mechanisms are directly linked to EF (Miller and Cohen, 2001). EF plays an important role in behavior regulation and this has been noted in numerous behavioral theories such as Health Belief model, Social Cognitive Theory, and Theory of Planned Behavior (Bartholomew et al., 2011). Correspondingly, a study among young South African female adults (18-25 years) found that those whose scores ranged within the lower quintile for cognitive flexibility (trail-making task) were 60% more likely to report concurrent sexual partnerships and 70% more likely to report transactional sex compared to those who had better task scores (Rosenberg et al., 2018). Likewise, the women who had poor outcomes in planning and working memory were more likely to report concurrent sexual partnerships (Rosenberg et al., 2018). In another study, initiation of alcohol use and binge drinking among young Dutch adolescents (12-15 years) was predicted by poorer working memory and inhibitory control; these deficits preceded the initiation of the alcohol related behavior (Peeters et al., 2015). Aspects of EF and behavioral impulsivity like disinhibition and risk taking propensity are shown to predict heavy alcohol consumption among British adolescents (Fernie et al., 2013).

This noted, there is still growing demand for evidence on implications of executive dysfunction (especially HIV associated neuro-cognitive impairment) for health behavior so as to improve the effectiveness of risk reduction interventions (Anand et al., 2010). On the contrary, the existing evidence on

impacts of HIV associated neuro-cognitive impairment is still scarce and has mainly focused on outcomes like daily functions and ART adherence (Woods et al., 2017, Gorman et al., 2009) but rarely on HRB. Moreover, most of this research (on EF and HRB) is still concentrated among smaller samples of older age groups from outside SSA.

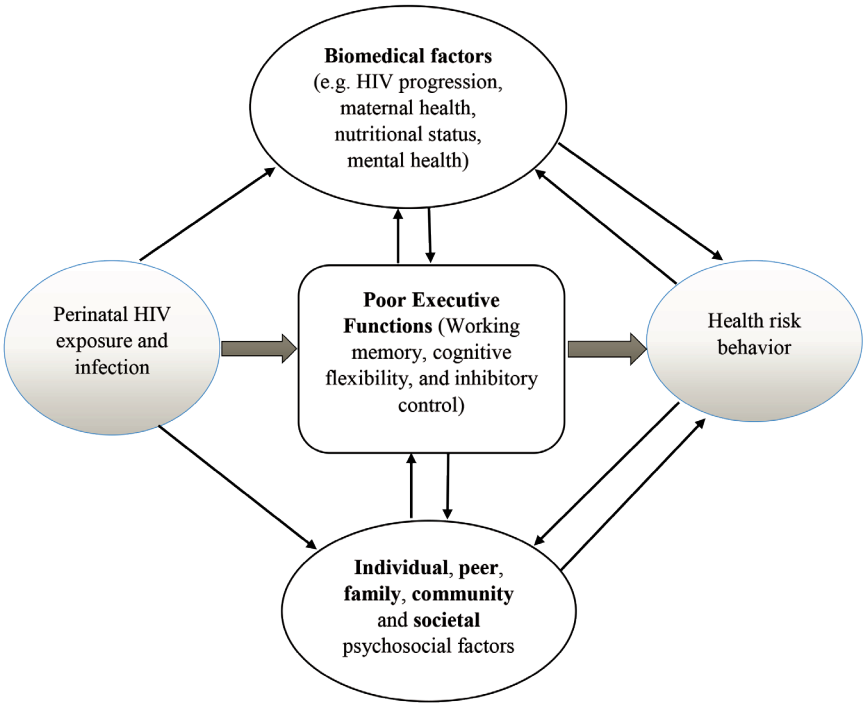

Figure 1.1. A conceptualization of the relationship between perinatal HIV exposure and infection and health risk behavior**.**

Assessment tools for HRB in SSA

Inadequate research in adolescent health in settings like SSA has had glaring implications such as the lack of comprehensiveness in several social and health policies and programs (WHO, 2017). HRB of adolescents is a key field that is still inadequately researched within SSA and yet is fundamental for adolescent wellbeing and has far-reaching outcomes for future adult life and future generations (Kleinert and Horton, 2016). A shortage of appropriately standardized and validated measures/tools presents a considerable bottle neck for adolescent HRB research in SSA. Many prominent and comprehensive measures for adolescent HRB such as Youth Risk Behavior Surveillance

System [YRBSS] (CDC, 2015), International Physical Activity Questionnaire [IPAQ—Short] (Craig et al., 2003), and Health Behavior in School-aged Children [HBSC] (Currie et al., 2009) were been developed and are mainly utilized in high income countries. There are numerous research implications due to a shortage of appropriately standardized and validated measures of HRB. These include: i) the considerable financial and technical requirements for tool adaptation, which potentially constrains research in contexts where locally appropriate tools are lacking; ii) some researchers may choose to use existing HRB tools or borrow their items with minimal or no tool adaptation in diverse cultural settings which may result in assessment bias. Assessment bias may arise from unfamiliar content of the test, translational challenges, and unfamiliar administration modalities (Abubakar and Van De Vijver, 2017); iii) some researchers may develop new items and administer them without thoroughly ascertaining their cultural appropriateness and content validity; iv) there is a risk of an oversight of priority forms of behaviors within settings where HRB tools are scarce or there may be a focus on isolated forms of behavior due to a lack of comprehensive tools. Such oversight and focus on isolated forms of HRB potentially hinders the effectiveness of public health and behavioral interventions (Spring et al., 2012).

Increasingly, standard practices on ensuring cultural appropriateness and validity of research tools in low resource settings have been documented (Abubakar and Van De Vijver, 2017, Harachi et al., 2006). Conversely, so far studies on HRB tool development in settings even as SSA are currently scanty. In general, the evidence recommends for either tool adaptation (systematically evaluating aspects of an existing instrument and modifying them to suit context) or tool assembly (either developing a tool informed by local context or borrowing and modifying items from various standardized measures) in preference to tool adoption (translating a tool and using it in another context without modifications) (Abubakar and Van De Vijver, 2017). So as to attain better reliability, generalizability and comparability of HRB research, it is crucial that proper development of culturally appropriate tools and their administration procedures is done especially for settings like SSA where most of these are currently lacking.

Current study

Five important research questions emerge from the summarized literature in the preceding sections of this thesis. The current PhD project sets out to fill these important knowledge gaps with a key focus on HRB of adolescents

within an HIV context from a rural coastal Kenyan setting. These five research questions are summarized below:

(i) To what extent has research explicitly focused on HRB of perinatally HIV infected (PHIV) and perinatally HIV exposed uninfected (PHEU) adolescents in SSA?
(ii) Which steps should be taken to avail valid, contextually appropriate and comprehensive HRB tools that can be utilized for assessment of HRB of adolescents in SSA settings such as rural coastal Kenya?
(iii) Which are the most important forms of HRB and their prevailing risk and protective factors among adolescents in rural coastal Kenya?
(iv) Which profiles of HRB exist among perinatally HIV infected (PHIV), perinatally HIV exposed uninfected (PHEU) and HIV unexposed uninfected (HUU) adolescents in rural coastal Kenya?
(v) Does EF explain how HRB profiles among of PHIV, PHEU and HUU adolescents in rural coastal Kenya?

This thesis address the above five research questions by focusing on three specific research objectives below:

1. To describe the forms, burden and underlying factors for HRB among PHIV, PHEU and HUU adolescents in SSA and specifically in Kilifi, Kenya.
2. To adapt and validate measures of HRB of adolescents for use within the Kilifi setting
3. To investigate associations between HRB profiles and adolescents' EF among PHIV, PHEU and HUU adolescents in Kilifi.

The findings generated from the various studies undertaken in this project to address the research questions and specific objectives are arranged into four broad sections described below:

A. Systematic reviews of evidence on HRB of adolescents in the context of HIV

This section consists of two chapters. These chapters summarize the current state of evidence on HRB of adolescents living with HIV (ALHIV) in SSA and the PHEU adolescent sub-population generated by reviewing existing empirical studies on this subject. Precisely, these chapters are: A systematic review and meta-analysis on HRB of adolescents living with HIV in SSA (chapter 2); and a systematic review on HRB among PHEU adolescents (chapter 3).

B. Focus on HRB of the general adolescent population in Kilifi County

In this section of the thesis, we report a series of empirical studies conducted among adolescents and stakeholders in our study setting (Kilifi) to describe the forms, burden and potential underlying factors for HRB among adolescents living in Kilifi County. The three qualitative cross sectional studies describe forms and underlying factors for sexual risk (chapter 4), diet and physical activity (chapter 5), and alcohol, and tobacco and other drug use (chapter 6).

C. Developing tools for HRB assessment among adolescents

This section comprises a systematic review on commonly utilized tools for HRB assessment among chronically ill adolescents (chapter 7) and an empirical study utilizing a four-step mixed methods process to assemble and validate a comprehensive HRB tool that is contextually relevant for use among adolescents in Kilifi (chapter 8).

D. Behavioral clusters and underlying factors for HRB of adolescents in an HIV context

In this section of the thesis, we generate HRB clusters and identify their underlying biomedical, neuro-cognitive (specifically EF) and psychosocial factors among the three groups of PHIV, PHEU and HUU adolescents in Kilifi (chapter 9).

We present a conclusive chapter (chapter 10) of this thesis which summarizes the findings generated from this PhD project. Additionally, the implications of our findings for research, policy and practice are discussed.

Study setting

Geographical context

The studies were conducted in SSA, specifically in Kilifi County on the coast of Kenya (See Figure 1.2). Kenya is an East African country bordered by Uganda to the west, South Sudan to the North West, Ethiopia to the North, and Somalia to the north east, Tanzania to the south and the Indian Ocean to the south east. The population of Kenya was estimated at 49.6 million people in 2017 (Olver and Morara, 2018) up from 38.6 million people in 2009 (KNBS, 2010). Kilifi County covers 12,600 square kilometers (km^2) and together with 5 other counties form the Kenyan Coast region. The county has 7 sub-counties of Kilifi

South, Kilifi North, Malindi, Ganze, Kaloleni, Rabai and Magarini (NCPD, 2017). By 2016, there were 1,359,506 residents in Kilifi County the majority of whom are rural dwellers (61%) and 22% are aged 10-20 years (NACC, 2015). Specifically, the data for this PhD research project were largely collected within the area covered by the Kilifi Health and Demographic Surveillance System (KHDSS) (Scott et al., 2012) which is nested in the Centre for Geographic Medical Research, (CGMRC). The KHDSS covers 891 km^2 and had 270,000 residents in 2011, 49% of whom were below 15 years of age (Scott et al., 2012).

Social and economic situation

The majority (45%) of the population in KHDSS belong to the Giriama sub-group of Mijikenda ethnicity (Scott et al., 2012). The Mijikenda language (commonly Giriama) and Swahili (national language) are most commonly spoken in Kilifi. Close to 58% of Kilifi County residents live below the poverty line and a third (36%) have not attained any formal education (KNBS and SID, 2013). The total dependency ratio i.e., the age-population ratio of those typically not in the labor force and those typically in the labor force (0-14 years and 65+ per 15-64 years) of 101.3 in Kilifi (NCPD, 2017) is much higher than the Kenyan national average dependency ratio of 87.3 (KNBS and SID, 2013). Subsistence farming and local home businesses are the main source of livelihood. Recently however, the transport industry especially motorcycle taxi (boda-boda) and tuk-tuk have become significant sources of livelihood for many unemployed youths in Kilifi County (NACC, 2015). Educational achievement in Kilifi County is still poor and characterized by high school drop-out rate, low transition across educational stages, and suboptimal school net enrollment (83.9% for primary and 26% for secondary school) (NCPD, 2017). Abject poverty, detrimental cultural practices, a high burden of gender-based violence (ranked highest nation-wide in 2015) and challenges with accessibility of quality health services are cited sources of vulnerability for youths in Kilifi (NACC, 2015).

Health situation

Kenya is among six countries (South Africa, Nigeria, India, Mozambique and Tanzania) that account for nearly a half of the HIV infected sub-population (UNICEF, 2015). About 16% of the 1.5 million people living with HIV in Kenya are adolescents and young people (15-24 years) (NASCOP, 2016). Kilifi is a medium HIV county (HIV prevalence of 45 per 1000) with 6,000 (19%) of persons living with HIV being adolescents and youth (15-24) (NASCOP, 2016). However, HIV testing and counseling in this county is low, due to HIV related

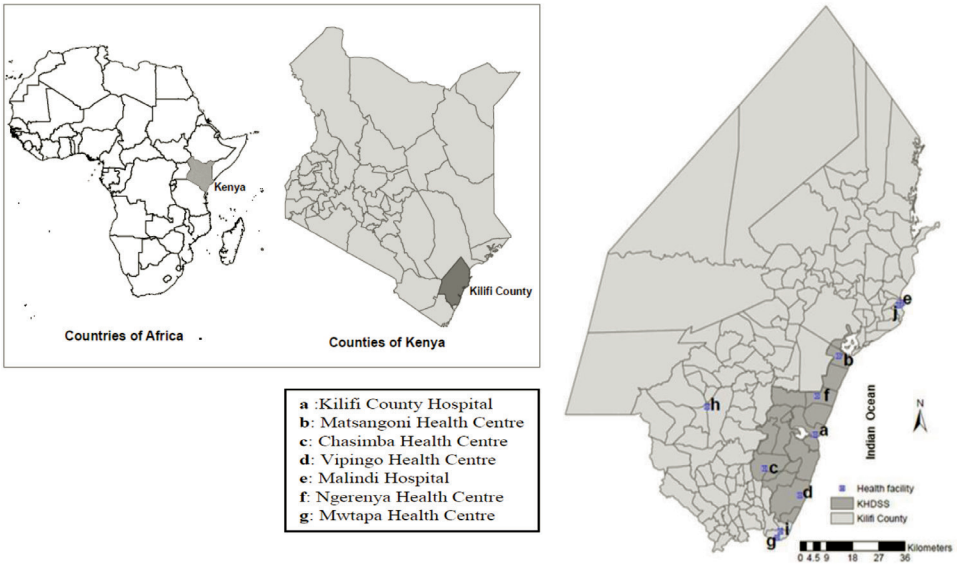

Figure 1.2. A map of Kilifi County demarcating the KDHSS and HIV clinics where participant recruitment was conducted

stigma and imbalanced distribution of healthcare services (NACC, 2015). Although ART coverage is high (71%) among the adult population, it is much lower (42%) among infants and children in Kilifi County (NACC, 2015). It is also reported that 55% of individuals in Kilifi have their first sexual debut before the age of 15 years (NACC, 2015). To this end, the teenage pregnancy rate is highest (21%) at the Kenyan coast, and the unmet need for family planning among married adolescent girls (15–19 years) in the coastal region is 59% compared to the national prevalence of 23% (KNBS and ICF, 2014). Kilifi County has five 'level four' public hospitals, 13 'level three' public health centres, 197 'level two' public dispensaries, two faith based hospitals and two private hospitals (NACC, 2015). This stated, the service provider to patient ratios are still poor and reported at 1: 26,000 (for doctors) and 1: 30,194 (for clinical officers). Kilifi County hospital (KCH) is the primary care centre and is also the only referral facility within the KDHSS (Scott et al., 2012). In **figure 1.2**, we present a map of Kilifi County demarcating the area covered by the KDHSS, as well as the HIV clinics involved in our research project.

Study population

This project was sub-divided into two study phases and each of this phases comprised a range of study participants with different sample sizes. The participants of the first study phase were a mix of adolescents, young adults and adult stakeholders who were all residents of the KDHSS. See **table 1.1** for a breakdown of these participants. The first phase of the project involved empirical studies to describe forms of HRB and their underlying factors, and a process to assemble and validate HRB tools within Kilifi.

During the second phase of the project, we involved PHIV, PHEU and HUU adolescents together with their caretakers in the cross sectional study. See **table 1.2** for a description of participants who took part in the second phase of this project.

Table 1.1. A description of the characteristics of study phase one's participants

Participants (N)	Sample description
Primary school adolescents (n=30)	-Upper primary school attending adolescents. -50% were males and the age range was 10-16 years. -Participants were chosen from both peri-urban and rural school settings.
Secondary school adolescents (n=32)	53% males and the age range was 15-18 years. Participants were chosen from both peri-urban and rural school settings.
Adolescents living with HIV (n=9)	-55% males and the median age was 13.5 years. -Were members of a youth support group of an HIV specialized clinic. -Were both primary or secondary school students
School drop-out adolescents (n=7)	71% were males and median age was 14 years.
Stakeholders (n=10)	-Adults who extensively work with adolescents (4 employees of Community based organizations (CBOs), 2 County hospital staff, 3 teachers responsible for guidance and counseling affairs, and 1 County government staff.
Young adult community representatives (n=7)	-43% males and the median age was 25 years. -Members of an existing community engagement platform within Kilifi
Primary and secondary school adolescents (n=164)	School attending adolescents randomly selected from 4 peri-urban and rural primary and secondary schools. 49% males and age range of 10-19 years

Table 1.2. A description of the characteristics of study phase two's participants

Participants (N)	**Sample description**
PHIV adolescents (n=202)	-PHIV adolescents on ART treatment and with disclosed HIV status, recruited from 6 specialized HIV treatment clinics at health facilities in Kilifi. -48% were males and their mean age was 13.7 years
PHEU adolescents (n=158)	PHEU adolescents who had been disclosed to about their HIV exposure status. Recruited with support from HIV care and treatment staff in various health facilities and communities in Kilifi. 44% were males and the mean age was 13.3 years
HUU adolescents (n=200)	-HUU adolescents randomly recruited from the KDHSS. -48.0% were males and the mean age was 14.1 years
Caretakers of PHIV, PHEU and HUU (n=486)	Legal caretakers or parents who accompanied adolescents for assessments during their appointment date. They also completed various parental level measures/items such as parental reports on adolescent behavior and household socio-economic status

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Part A:

Systematic reviews of evidence on HRB of adolescents in the context of HIV

Chapter 2

Health Risk Behaviour among Adolescents Living with HIV in Sub-Saharan Africa: A Systematic Review and Meta-Analysis.

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Abstract

The burden of health risk behaviour (HRB) among adolescents living with HIV (ALWHIV) in sub-Saharan Africa (SSA) is currently unknown. A systematic search for publications on HRB among ALWHIV in SSA was conducted in PubMed, Embase, PsycINFO and Applied Social Sciences Index & Abstracts databases. Results were summarized following PRISMA guidelines for systematic reviews and meta-analyses. Heterogeneity was assessed by the DerSimonian and Laird method and the pooled estimates were computed. Prevalence of current condom non-use behaviour was 59.8% (95% CI: 47.9-71.3%), risky sexual partnerships at 32.9% (95% CI: 15.4-53.2%), transactional sex at 20.1% (95% CI: 9.2-33.8%) and the experience of sexual violence at 21.4% (95% CI: 16.3-27.0%) among ALWHIV. From this meta-analysis, we did not find statistically significant differences in pooled estimates of HRB prevalence between ALWHIV and HIV uninfected adolescents. However, there was mixed evidence on the occurrence of alcohol and drug use behaviour among the two HIV groups. Overall, we found that research on HRB among ALWHIV tends to focus on behaviour specific to sexual risk. With such a high burden of HRB for the individuals as well as society, these findings highlight an unmet need for age-appropriate interventions to address the behavioural needs of these adolescents.

Introduction

Health risk behaviour (HRB) is a major concern in the prevention and management of HIV (Crepaz et al., 2006). Such behaviour is often initiated or reinforced during adolescence (UNAIDS, 2014). The main forms of HRB include: sexual behaviour contributing to unintended pregnancy and sexually transmitted diseases, alcohol, tobacco and drug use, unhealthy dietary habits, inadequate physical activity, and behaviour that contributes to unintentional injury or violence (CDC, 2015, Currie et al., 2009). Increased propensity for risk taking is a common phenomenon during adolescence (Steinberg, 2008); adolescents living with HIV are vulnerable (Bakeera-Kitaka et al., 2008, Nöstlinger et al., 2006). They encounter various adverse impacts following their engagement in HRBs.

A number of studies conducted among sexually active adolescents living with HIV report that about a half have early sexual debut and unprotected sexual intercourse (Murphy et al., 2001, Bakeera-Kitaka et al., 2008, Tassiopoulos et al., 2013, Mellins et al., 2009). Other studies have reported that adolescents living with HIV (ALWHIV) engage in various HRBs such as transactional sex, that is, sexual intercourse in exchange for material benefit or status (Gavin et al., 2006, Jaspan et al., 2006), alcohol abuse and drug use (Jewkes et al., 2006a, Test et al., 2012, Murphy et al., 2001, Hein et al., 1995). This is problematic for persons living with HIV, because such behaviour underlies sub-optimal health outcomes such as: poor adherence to anti-retroviral treatment (Chesney, 2000, Chander et al., 2006, LaGrange et al., 2012), HIV co-infection (Kalichman et al., 2011, Danta et al., 2007), injury and mortality (Helleberg et al., 2012). Furthermore, this behaviour adversely impacts the socio-economic welfare of affected families (Masanjala, 2007).

The occurrence of HRB among ALWHIV is of major public health significance in sub-Saharan Africa (SSA) where there was an estimated 1.2 million ALWHIV between 15–19 years and 3.2 million HIV infected children below 15 years in 2014 (UNAIDS, 2014). The vulnerability to HRB and its consequences among the ALWHIV in SSA is exacerbated by the social environmental factors surrounding the HIV epidemic in this region. Amongst such factors are: household poverty, orphanhood, gender inequality, stigma, cultural practices and poor accessibility to social or health services (Birdthistle et al., 2008, Swendeman et al., 2006, Clark, 2004, Nakigozi et al., 2013, Foster and Williamson, 2000). Besides these factors, growing evidence suggests that underlying physiological

conditions such as HIV associated neurodevelopmental deficits (Anand et al., 2010), anxiety, and depression (Murphy et al., 2001, Mellins et al., 2009) increase susceptibility to risk taking among young people living with HIV.

In response to the enormous burden of HIV in SSA, some research and intervention programs have been conducted over the past few decades. Unfortunately such efforts have not addressed the needs of adolescents (UNICEF., 2011) particularly in Africa which is home to 19% of the global youth population (UN, 2015). Key amongst the research gaps is the scarcity of literature on HRB among adolescents living with HIV in SSA. Specifically, there is a dearth of knowledge regarding which forms of HRB have so far been assessed, characteristics of the ALWHIV (e.g. routes of HIV transmission), where such studies have been conducted in SSA and the general burden of HRB among the ALWHIV. The lack of such research is further compounded by combining the adolescent age-group with other age categories (Sawyer et al., 2007) and the assessment of HRBs in isolation (Zweig et al., 2001). Upon this backdrop, this systematic review and meta-analysis aims at ascertaining the amount of research on HRB and documenting the general burden of HRB among adolescents living with HIV in SSA. The specific objectives are as follows:

(i) To identify and summarize characteristics of studies that quantify HRB among ALWHIV in SSA
(ii) To summarize the major forms of HRB assessed among ALWHIV in SSA
(iii) To compare the burden of HRB among ALWHIV and HIV uninfected adolescents among the eligible studies from SSA.

Methods

Search strategy

Guidelines for preferred reporting items for systematic reviews and meta-analyses (http://www.prisma-statement.org/) were utilized (Moher et al., 2009). Four databases (PubMed, Embase, PsycINFO and Applied Social Sciences Index & Abstracts) were searched for publications from 1980 until 30th April 2016. We utilized the following key terms: (Adolescent* OR Teen* OR Youth*) AND (Risk Taking OR Risk Behavior OR Risk Behaviour OR Life Style OR Health Behavior OR Health Behaviour) AND (HIV OR HIV/AIDS

OR AIDS) AND (sub-Saharan Africa OR Africa). Additionally, a snowballing technique was applied by searching through reference lists of identified articles to access more articles which had not been identified from the database search.

We choose studies based upon the PICOS approach (participants, intervention, comparison, outcome and study design) (Moher et al., 2009). Studies were eligible if they: (*i*) were empirical studies published in a peer reviewed journal and conducted within SSA; (*ii*) involved ALWHIV whose age range, mean or median age fell within 10 – 19 years; and (*iii*) quantified any form of HRB among the ALWHIV. We excluded studies that: (*i*) were published in languages other than English; and (*ii*) those that did not aggregate HRB by HIV status of the participants.

Two authors (DS and PNM) independently screened the titles, abstracts and full articles for eligibility and reached consensus.

Data extraction

We used one data extraction sheet to extract general study characteristics of the eligible studies. These characteristics included: (*i*) author and year of publication; (*ii*) country where the study was done; (*iii*) year the study was done; (*iv*) study design; *v*) population description; (*vi*) number of ALWHIV and HIV uninfected adolescents; (*vii*) route of HIV transmission; and (*viii*) form of HRB quantified.

Then, using two separate data extraction forms, we extracted the: (*i*) author and year of publication; and (*ii*) data on each specific HRB. From each study HRB data for ALWHIV was extracted. However for the HIV uninfected adolescents this data was only extracted if it had been assessed as well among the ALWHIV. One form was used to extract data used in meta-analysis and the other for data that was to be narratively summarized. Data abstraction was conducted by two authors (D.S. and P.N.M.) independently who then compared their results and reached consensus.

Our main outcome of interest for this systematic review and meta-analysis was the prevalence of specific HRBs among ALWHIV and HIV uninfected adolescents. For studies that were exclusively conducted among ALWHIV, we computed or extracted the reported percentages of those that engaged in a specific HRB. For those that mixed HIV infection groups and/or had additional age categories besides 10 -19 years, we computed percentages of those that took

part in a specified HRB for each HIV group within the 10-19 years age group. For those studies where it was impossible to compute these percentages, the occurrence of HRB was reported in its original effect measure, for example, odds ratio, median or mean.

For each of the eligible studies, an assessment of the risk of bias across the studies was aided by the quality assessment tool for systematic reviews of observational studies (QATSO) (Wong et al., 2008). The QATSO was designed for studies related to HIV prevalence or risky behaviour among men who have sex with men. It utilizes 5 parameters to obtain a total score that rates the overall quality of an observational study as either bad (0-33%), satisfactory (33-66%) or good (67-100%). These parameters include: representativeness of sampling method used, objectivity of HIV measurement, report of participant response rate, control for confounding factors (in case of prediction or association studies) and privacy/sensitivity considerations. Each parameter is scored "1" if the condition was fulfilled and "0" if it was not.

Statistical analysis

Data was synthesized both quantitatively and narratively. We assessed the variation in effect size attributable to heterogeneity using the I^2 statistic of the DerSimonian and Laird method. Using random effects model (Riley et al., 2011), the pooled estimate was computed after Freeman-Tukey Double Arcsine transformation (Nyaga et al., 2014). We compared the confidence intervals of the pooled estimates of the forms of HRB for the ALWHIV and HIV uninfected adolescents to determine if there were statistically significant differences. The statistical analyses were performed using STATA software (Stata Corporation, College Station, TX, 2005). We report the pooled estimates for four specific forms of HRB. These include the following:

(i) Current condom non-use behaviour (including any reported episode of sexual intercourse without a condom for any duration that includes the current period, e.g., last 3 months or last 6 months)
(ii) Risky sexual partnerships (including reports of having 2 or more sexual partners currently or in past 12 months, or any form of multiple sexual partnerships)
(iii) Sexual violence (including any reported episode (experienced or perpetrated) of forced sex, nonconsensual sex or rape)
(iv) Transactional sex (including any reported exchange of gifts or money for sex).

We summarized the results that could not be quantitatively pooled (e.g., poor hygiene behaviour, alcohol and drug use behaviour) by describing the effect estimates such as percentages, odds ratios, mean with their standard deviations, and median with their interquartile ranges whatever reported in the study.

Results

We identified 1,691 published study citations from the 4 databases and an additional 2 articles (Konde-Lule et al., 1997, Auvert et al., 2001) through snowballing. Of these, 220 were duplicates. We therefore screened 1,473 abstracts for initial eligibility, out of which 269 articles were identified. Full articles were obtained for these citations, of which 14 satisfied the eligibility criteria (**Figure 2.1**).

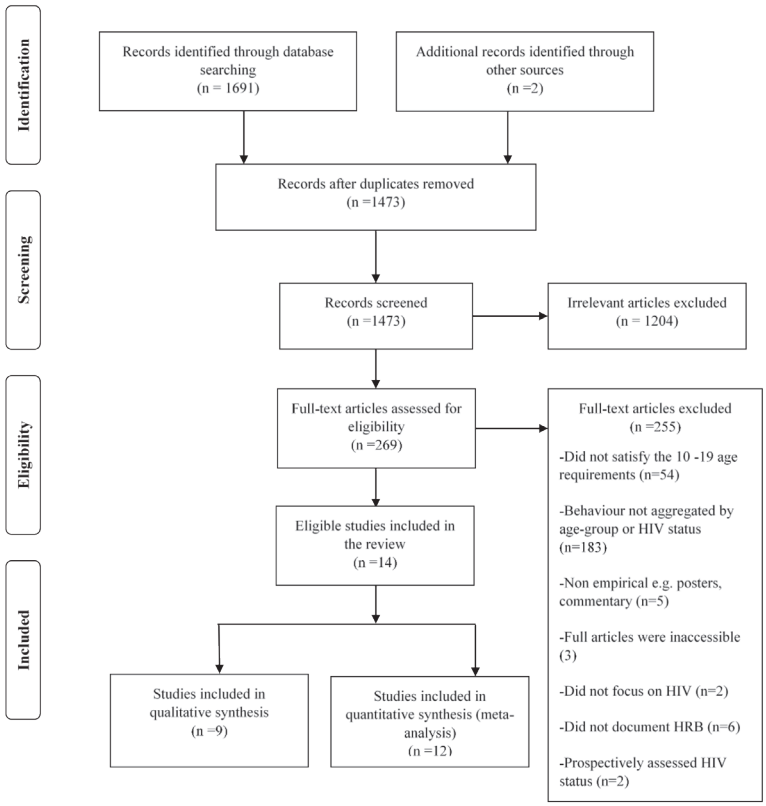

Figure 2.1. A Flow diagram for the literature review

The eligible studies were conducted between 1990 and 2012 among 6 sub-Saharan African countries of Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zimbabwe. The majority of the studies emanated from South Africa (n= 6) and Uganda (n=4) of a total of 14. Most studies had a cross-sectional design, in addition two that utilized baseline data from a randomized control trial (Jewkes et al., 2006a, Jewkes et al., 2006b) and another that used baseline data from a cohort study (Konde-Lule et al., 1997). Samples of the ALWHIV per study ranged from 26 to 3,992 while those for HIV uninfected adolescents were from 296 to 6,600. Four studies (Bakeera-Kitaka et al., 2008, Birungi et al., 2009, Mhalu et al., 2013, Test et al., 2012) had ALWHIV recruited from a clinical setting while the rest had their ALWHIV recruited from a general population setting through household surveys and community samples. Only three studies (Bakeera-Kitaka et al., 2008, Birungi et al., 2009, Test et al., 2012) described the route of HIV transmission among their participants. In these studies the majority (61 – 100%) had been perinatally infected (**Table 2.1**).

All the 14 eligible studies quantified sexual risk behaviour whereas alcohol use was quantified by 42.9%, sexual violence by 50.0%, and drug use by 21.4%. One study (Auvert et al., 2001) assessed genital hygiene practices among male adolescents (**Table 2.1**). Among these 5 forms of HRB, sexual risky behaviour was the most variously assessed with specific examples like: condom non-use, transactional sex, sexual violence, dry sex practices (i.e., reducing vaginal lubrication to cause more friction during intercourse), early sexual debut, and multiple sexual partnerships. Details on specific HRB are summarized in **Table 2.2(a)** and **2.2(b)**.

Table 2.1: Description of studies included in the systematic review and meta-analysis

First author	Country	Year of study	Population description	ALWHIV	HIV uninfected adolescent participants	Route of HIV transmission	Form of HRB	Quality Assessment (QATSO score)
Aboki et al., 2014	Nigeria	2007, 2012	Adolescent participants in a national survey	1,980 (in 2007) 3,992 (in 2012)	N.A	N.R	-Sexual risk behaviour	80% (Good)
Auvert et al., 2001	South Africa	1999	Sexually active youths living in a small mining town	325	857	N.R	-Alcohol use behaviour -Sexual risk behaviour -Sexual violence -Hygiene practices	100% (Good)
Bakeera-Kitaka et al., 2008	Uganda	2006	ALWHIV from a pediatrics clinic	75	N.A	86% (perinatal) 2.6% (blood transfusion) 1.3% (Heterosexual) 9.3% (unknown)	-Sexual risk behaviour	50% (Satisfactory)
Birungi et al., 2009	Uganda	2007	ALWHIV from various HIV/ AIDS treatment programs	732	N.A	Perinatal	-Sexual risk behaviour -Sexual violence	75% (Good)
Bunnell et al., 2008	Uganda	2004 – 2005	Adolescent participants from a household survey	43	N.A	N.R	-Sexual risk behaviour	100% (Good)
Gavin et al., 2006	Zimbabwe	2001 – 2002	Adolescent females from a household survey	192	1,615	N.R	-Sexual risk behaviour -Alcohol use behaviour -Sexual violence	100% (Good)
Jaspan et al., 2006	South Africa	2004 – 2005	Adolescents participants from a house hold survey	35	296	N.R	-Sexual risk behaviour -Sexual violence	80% (Good)

Jewkes et al., 2006a	South Africa	2002 - 2003	Males from a rural setting	26	1,252	N.R	-Sexual risk behaviour -Alcohol use behaviour -Drug use behaviour -Sexual violence	60% (Satisfactory)
Jewkes et al., 2006b	South Africa	2002 – 2003	Females from a rural setting	160	1,135	N.R	-Alcohol use behaviour -Drug use behaviour -Sexual risk behaviour -Sexual violence	60% (Satisfactory)
Lane et al., 2006	South Africa	2003	Males who engage in heterosexual anal sex (data from household survey)	N.R	N.R	N.R	-Sexual risk behaviour -Alcohol use behaviour -Drug use behaviour	60% (Satisfactory)
Mhalu et al., 2013	Tanzania	2010	ALWHIV receiving care	110	N.A	N.R	-Sexual risk behaviour	80% (Good)
Steffenson et al., 2011	South Africa	2003	Adolescent participants from a household survey	1,092	6,600	N.R	-Sexual risk behaviour	100% (Good)
Test et al., 2012	Rwanda	2010	Adolescents receiving medication from an ART clinic	68	N.A	61% (perinatal) 33% (Sexually) 5% (others)	-Sexual risk behaviour -Alcohol use behaviour -Sexual violence	80% (Good)
Konde-Lule et al., 1997	Uganda	1990	Adolescents from a household survey	70	499	N.R	-Sexual risk behaviour	100% (Good)

ALWHIV were adolescents (10 -19 years) that were living with HIV in each of the eligible study; N.R refers to “not reported”; N.A refers to “not applicable”

Sexual risk behaviour

Condom use behaviour was reported in 11 studies. We pooled results on current condom non-use behaviour among ALWHIV from 9 studies and for HIV uninfected adolescents from 5 studies.

The pooled prevalence of condom non-use behaviour among ALWHIV was estimated at 59.8% (95% CI: 47.9-71.3%) while among their HIV uninfected counterparts it was 70.3% (95% CI: 55.5-83.2%) (**Figure 2.2**). In contrast, findings from an additional study that was not part of the meta-analysis (Auvert et al., 2001) reported a higher prevalence of condom non-use at first sex among ALWHIV as compared to HIV uninfected adolescents (**Table 2.2(b)**).

Additionally, the pooled prevalence of engagement in any form of risky sexual partnerships among ALWHIV was 32.9% (95% CI: 15.4-53.2%) whereas among HIV uninfected adolescents it was 30.4% (95% CI: 8.4-58.8%) (**Figure 2.3**).

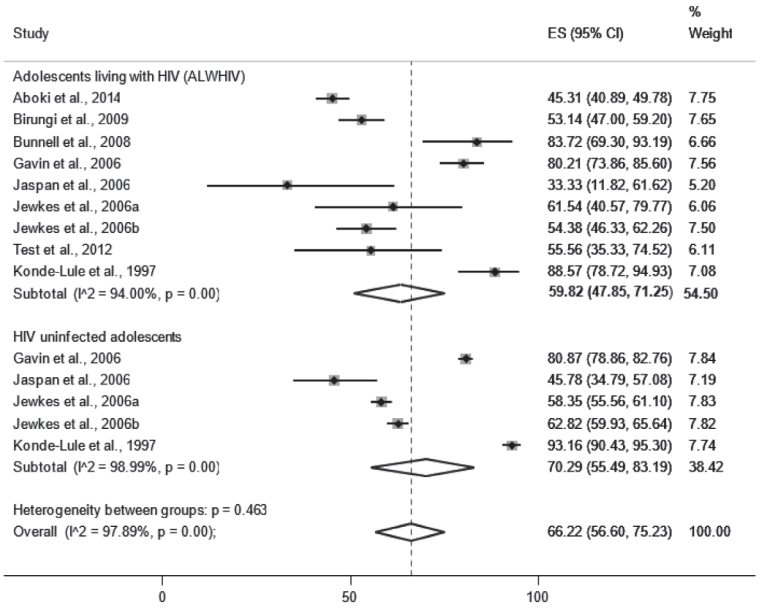

Figure 2.2. Prevalence of current condom non-use behaviour among ALWHIV and HIV uninfected adolescents

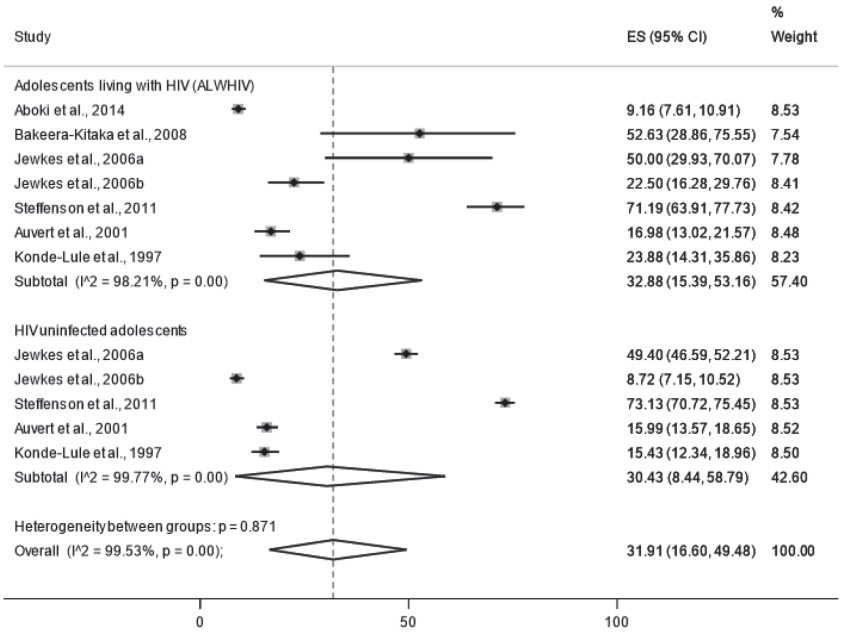

Figure 2.3. Prevalence of risky sexual partnerships among ALWHIV and HIV uninfected adolescents

Besides, there were four more studies capturing risky sexual partnerships that were not meta-analyzed (Gavin et al., 2006, Jaspan et al., 2006, Lane et al., 2006, Mhalu et al., 2013) (**Table 2.2(b)**). One of them explored the association between HIV status and engagement in multiple sexual partnerships while comparing adolescents to young adults (aged 20-24 years), and found no statistically significant differences (Mhalu et al., 2013). The second found no significant association between HIV status and having 6 or more sex partners in the past year among males who engaged in heterosexual anal sex (Lane et al., 2006). The remaining 2 studies documented lifetime sexual partners among the adolescents of which one found that 4.7% of the ALWHIV compared to 1.4% of the HIV uninfected had more than 3 lifetime sexual partners (Gavin et al., 2006) and the other reported a mean of 1.8 lifetime sexual partners among the ALWHIV compared to 0.7 among their HIV uninfected counterparts (Jaspan et al., 2006).

Transactional sex was prevalent among 20.1% (95% CI: 9.2-33.8%) of the ALWHIV and 12.7% (95% CI: 4.2-24.7%) of the HIV uninfected ones (**Figure 2.4**).

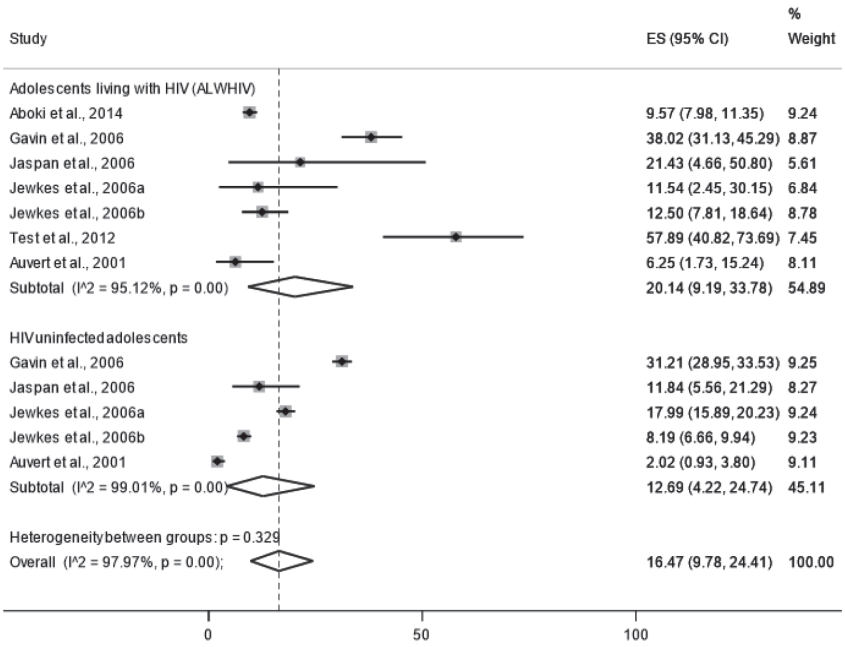

Figure 2.4. Prevalence of transactional sex among ALWHIV and HIV uninfected adolescents

Another study (Lane et al., 2006) not included in this pooled estimate found no significant association between HIV status and purchasing sex among adolescents that reported heterosexual anal intercourse.

Early sexual debut among the ALWHIV was reported in 5 studies (**Table 2.2(b)**). Two of these studies reported that 25.5% (Auvert et al., 2001) and 42.1% (Bakeera-Kitaka et al., 2008) of the ALWHIV initiated their first sex at the age of 15 years or less. Furthermore, a study from South Africa (Jewkes et al., 2006a) and another from Rwanda (Test et al., 2012) reported the median age at first sexual encounter as 14.7 (IQR: 12.9 – 16.2) and 17 (IQR: 15 – 18) years, respectively. A study among female ALWHIV reported a mean age of 16.4 (S.D: 0.1) years among the ALWHIV and 16.2 (S.D: 0.1) years among HIV uninfected adolescents at first sexual intercourse (Gavin et al., 2006).

Two studies reported a 6.2% prevalence of dry sex practices (i.e., reducing vaginal lubrication to cause more friction during intercourse) among female ALWHIV. In both studies, the prevalence of dry sex practices was lower among the HIV uninfected adolescents (Jewkes et al., 2006b, Auvert et al., 2001)

(**Table 2.2(b)**). Another study (Birungi et al., 2009) reported high prevalence of non-contraceptive use at either first sex (63%) or during current or previous relationships (48%) among ALWHIV (**Table 2.2(b)**).

Alcohol and drug use

Six studies quantified alcohol and drug use behaviour (**Table 2.2(b)**). All of the 6 studies reported alcohol drinking behaviour of which 3 compared ALWHIV and uninfected adolescents. Among the 3 studies with results for both HIV groups (Gavin et al., 2006, Jewkes et al., 2006a, Jewkes et al., 2006b) the ALWHIV recorded higher occurrence of alcohol drinking behaviour (**Table 2.2(b)**). Another study reported that 61% of ALWHIV receiving medication from a clinic, had drunk alcohol within 6 hours prior to having sex (Test et al., 2012). In another study among males who engaged in heterosexual anal sex, HIV status was not significantly associated with having anal sex under the influence of alcohol (Lane et al., 2006).

Drug use behaviour was reported by 3 studies. One reported its occurrence among 53.8% of the male ALWHIV compared to 38.1% of their HIV uninfected male counterparts (Jewkes et al., 2006a). The same authors in another study (Jewkes et al., 2006b) reported the occurrence of drug use among 5.0% of the female ALWHIV compared to 6.3% of the HIV uninfected ones. The third study reported drug use among males who had heterosexual anal sex and showed that there was not a significant association between HIV status and heterosexual anal sex under the influence of drugs (Lane et al., 2006).

Sexual violence

Seven studies captured reports of various forms of sexual violence such as forced sex, tricked sex, non-consensual sex and rape. Six of these studies (Gavin et al., 2006, Jaspan et al., 2006, Test et al., 2012, Auvert et al., 2001, Birungi et al., 2009, Jewkes et al., 2006b) specifically reported victims' experience of sexual violence while only one study (Jewkes et al., 2006a) conducted among rural South African males reported perpetrators' experience of sexual violence. The pooled prevalence of any form of sexual violence (i.e., either as a victim or perpetrator) was 21.4% (95% CI: 16.3-27.0%) among ALWHIV, while that among HIV uninfected adolescents was 15.3% (95% CI: 8.7-23.3%) (**Figure 2.5**).

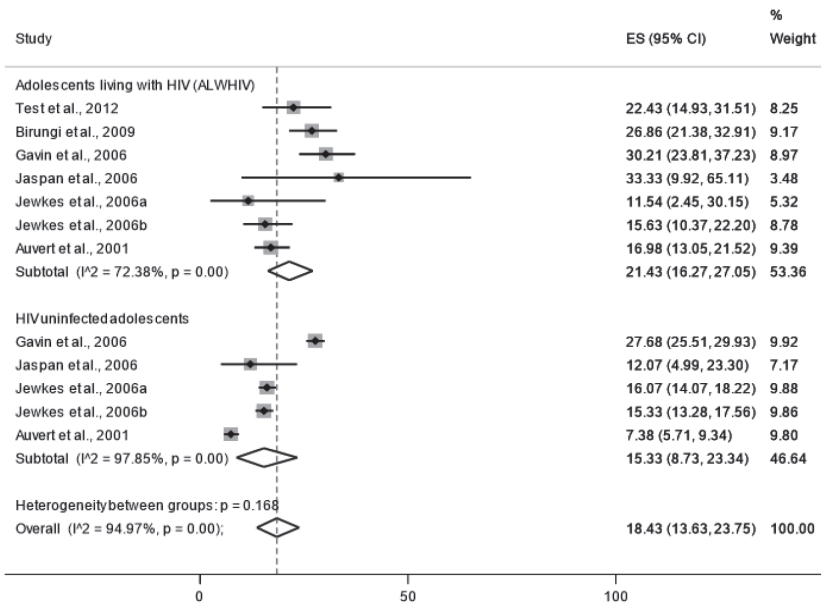

Figure 2.5. Prevalence of sexual violence behaviour among ALWHIV and HIV uninfected adolescents

Table 2.2 a). Description of health risk behaviour of ALWHIV and HIV uninfected adolescents among studies included in the meta-analysis

First author	Condom non use % (total respondents)	Transactional sex % (total respondents)	Risky sexual partnerships % (total respondents)	Sexual violence % (total respondents)
Aboki et al., 2014	44.7 (501) of ALWHIV did not use a condom with a non-marital partner at last sex from data collected in 2012	9.5 (1,223) of ALWHIV engaged in transaction sex from data collected in 2012	9.2 (1,234) of ALWHIV had multiple non-marital partners from data collected in 2012	N.A
Auvert et al., 2001		6.3 (64) of male ALWHIV had ever given money in exchange for sex	16.9 (318) of ALWHIV had 2 or more current sexual relationships	16.9 (324) of ALWHIV ever had sex against his/her will
		1.9 (446) of HIV uninfected adolescent males had ever given money in exchange for sex	15.9 (838) of HIV uninfected adolescents had 2 or more current sexual relationships	7.4 (854) of HIV uninfected adolescents ever had sex against his/her will
Bakeera-Kitaka et al., 2008	N.A	N.A	52.8 (19) of ALWHIV had more than 2 sexual partners	N.A
Birungi et al., 2009	53 (271) of ALWHIV who ever had sex were currently not using condoms	N.A	N.A	27 (242) of ALWHIV ever had sex against his/her will
Bunnell et al., 2008	83.7 (43) of ALWHIV did not always use a condom with all most recent partners in the last 12 months	N.A	N.A	N.A
Gavin et al., 2006	80.3 (192) of ALWHIV did not use a condom at last sex	37.9 (192) ALWHIV exchanged goods for sex with last partner	N.A	29.9 (192) of ALWHIV were ever forced to have sex
	80.9 (1,615) of HIV uninfected adolescents did not use a condom at last sex	31.2 (1,615) of HIV uninfected adolescents exchanged goods for sex with last partner		27.7 (1,615) of HIV uninfected adolescents were ever forced to have sex
Jaspan et al., 2006	33.3 (15) of sexually active ALWHIV had never used a condom 45.8 (83) of HIV uninfected sexually active adolescents had never used a condom	21.4 (14) of ALWHIV ever received a gift in exchange for sex 12 (76) of HIV uninfected adolescents ever received a gift in exchange for sex	N.A	33 (12) of female ALWHIV reported forced sex from their boyfriends 12 (58) of HIV uninfected females reported forced sex from their boyfriends

Jewkes et al., 2006a	61.5 (26) of ALWHIV did not correctly use a condom during last sex 58.4 (1,251) of HIV uninfected adolescents did not correctly use a condom during last sex	11.5 (26) of ALWHIV had transactional sex with a casual partner 18.0 (1,251) of HIV uninfected adolescents had transactional sex with a casual partner	50 (26) of ALWHIV had 3 or more consenting partners in the last year 49.4 (1,251) of HIV uninfected adolescents had transactional sex with a casual partner	11.5 (26) of male ALWHIV reported having raped a non-partner 16.1 (1,251) of male HIV uninfected adolescents males reported having raped a non-partner
Jewkes et al., 2006b	54.4 (160) of ALWHIV did not correctly use a condom during last sex 62.8 (1,135) of HIV uninfected adolescents did not correctly use a condom during last sex	12.7 (160) of ALWHIV had transactional sex with a casual partner 8.2 (1,135) of HIV uninfected adolescents had transactional sex with a casual partner	22.5 (160) of ALWHIV had 3 or more consenting partners in the last year 8.7 (1,135) of HIV uninfected adolescents had 3 or more consenting partners in the last year	15.6 (160) of female ALWHIV reported having been forced or tricked in to first sex 15.3 (1,135) of HIV uninfected adolescent females reported having been forced or tricked in to first sex
Steffenson et al., 2011	N.A	N.A	71.2 (177) of ALWHIV had at least one concurrent sexual partnership in the past 12 months 73.1 (1,392) HIV uninfected adolescents had at least one concurrent sexual partnership in the past 12 months	N.A
Test et al., 2012	55.6 (27) of ALWHIV reported inconsistent condom use in past 6 months	57.9 (38) of ALWHIV had exchanged sex for money		22.4 (107) of ALWHIV had experienced forced sex
Konde-Lule et al., 1997	88.6 (70) of ALWHIV report that they do not use condoms 93.2 (453) HIV uninfected adolescents report that they do not never use condoms	N.A	23.9 (67) ALWHIV had 2 or more partners in the past year 15.4 (486) HIV uninfected adolescents had 2 or more partners in the past year	N.A

N.A refers to “not applicable” Total respondents refers to number of adolescents (10-19) that responded to a particular item assessing HRB.

Table 2.2 b): Description of health risk behaviour of ALWHIV and HIV uninfected adolescents among studies included in the narrative review

First author	Condom non-use	Transactional sex	Risky sexual partnerships	Alcohol & Drug use	Early sex debut	Others
Auvert et al., 2001	82.5 (325) of ALWHIV reported condom non-use at first sex 75.9 (854) HIV uninfected adolescents reported condom non-use at first sex	N.A	N.A	28.9% of 325 ALWHIV drank alcohol at least once a month	25.5% of 325 ALWHIV had first sex at 15 or less years	6.2% of 258 female ALWHIV engaged in dry sex practices 22.5% of 62 male ALWHIV did not wash their penis at least once a day 3.9% of 359 HIV uninfected female adolescents engaged in dry sex practices 11.4% of 491 HIV uninfected males did not wash their penis at least once a day
Bakeera-Kitaka et al., 2008	N.A	N.A	N.A	N.A	42.1% of 19 ALWHIV initiated sex at below 15 years	N.A
Birungi et al., 2009						63% of 87 ALWHIV did not use a method to prevent infection or reinfection at first sex 48% of the ALWHIV did not use any form of contraception in current or previous relationship
Gavin et al., 2006	N.A	N.A	4.7% of 192 ALWHIV reported more than 3 lifetime sexual partners 1.4% of 1,615 HIV uninfected adolescents reported more than 3 lifetime sexual partners	5.6% of 192 ALWHIV drank alcohol in past month 4.5% of 1,615 HIV uninfected adolescents drank alcohol in past month	Mean age at sex initiation was 16.4 years (SD: 0.14) among ALWHIV Mean age at sex initiation was 16.2 years (SD: 0.10) among HIV uninfected adolescents	N.A

Jaspan et al., 2006	N.A	N.A	Mean number of 1.8 life partners among the ALWHIV Mean number of 0.7 life partners among the HIV uninfected adolescents	N.A	N.A	N.A
Jewkes et al., 2006a	N.A	N.A	N.A	30.8% of 26 ALWHIV reported problem alcohol drinking 53.8% of 26 ALWHIV reported ever using drugs 25.8% of 1,251 HIV uninfected adolescents reported problem alcohol drinking 38.1% of 1,251 HIV uninfected reported ever using drugs	Median age sex initiation was 14.7 years (IQR: 12.9-16.2) among ALWHIV -Median age sex initiation was 14.7 years (IQR: 12.9-16.2) among HIV uninfected adolescents	N.A
Jewkes et al., 2006b	N.A	N.A	N.A	3.8% of 160 ALWHIV reported problem alcohol drinking 5% of 160 ALWHIV reported ever using drugs 3.5% of 1,135 HIV uninfected adolescents reported problem alcohol drinking 6.3% of 1135 HIV uninfected adolescents reported ever using drugs	N.A	6.2% of 160 female ALWHIV engaged in dry sex practices 4.1% of 1,135 female HIV uninfected adolescents engaged in dry sex practices

Lane et al., 2006	N.A	aOR=0.8* for HIV infection among male sex purchasers	aOR=0.3* for HIV infection among males with 6 or more partners in past year	aOR=1.2* for HIV infection among males that had sex under influence of alcohol aOR=1.3* for HIV infection among males that had sex under influence of drugs	N.A	N.A
Mhalu et al., 2013	aOR=2.7** for having unprotected sex at last sexual contact among ALWHIV of 15-19 vs 20-24 years	N.A	aOR=1.2* for engaging in multiple sexual partnerships among ALWHIV of 15-19 vs 20-24 years	N.A	N.A	N.A
Test et al., 2012	N.A	N.A	N.A	61% of 18 ALWHIV drank alcohol within 6 hours prior to sex	Median age sex initiation was 17 years (IQR: 15 -18)	N.A

N.A refers to "not applicable" aOR: Adjusted Odds ratio
**Statistically significant *Not statistically significant
IQR: Interquartile range SD: standard deviation

Poor hygiene behaviour

Was documented in one study from a small mining town in South Africa which reported that 22.5% of the male ALWHIV compared to 11.4% of HIV uninfected males did not wash their genitals at least once a day (Auvert et al., 2001).

Quality of the studies

Overall, the studies were of good quality with 10 of them rating as good and the remaining 4 (Bakeera-Kitaka et al., 2008, Jewkes et al., 2006a, Jewkes et al., 2006b, Lane et al., 2006) as satisfactory. Only 2 of the studies utilized non-probability sampling (Birungi et al., 2009, Bakeera-Kitaka et al., 2008), 6 did not report the participant response rate (Bakeera-Kitaka et al., 2008, Jaspan et al., 2006, Lane et al., 2006, Mhalu et al., 2013, Jewkes et al., 2006a, Jewkes et al., 2006b), and 3 did not mention how privacy or sensitivity of HIV was considered in the study (Jewkes et al., 2006a, Jewkes et al., 2006b, Lane et al., 2006).

Discussion

This review indicates that research on HRB among adolescents living with HIV in SSA is still scanty. Moreover, within SSA, this research emanates from a few countries in eastern and southern Africa. The within region variation possibly represents disparities in HIV burden such that most of this research has so far focused on parts of SSA with higher HIV prevalence, for example, southern Africa. However, since SSA globally accounts for the largest population of ALWHIV (UNAIDS, 2014), there is an urgent need for more research on HRB of this population.

Furthermore, even among the few existing studies, important details such as the route of transmission and the adolescents' awareness of their HIV status are scanty and yet these are potential determinants of behavioural decision making (Marks et al., 2005). The participants are also mainly drawn from the general population or clinical setting. However, it is likely that adolescents from certain settings, for example dwellers of fishing communities and busy transport corridors, would report a disproportionately higher burden of HRB, since such settings are associated with high HIV socio-behavioural risk (Seeley et al., 2012, Morris and Ferguson, 2007).

Owing to the over-lapping confidence intervals of effect estimates, our findings indicate that there is no statistically significant difference in the prevalence of documented forms of HRB across the ALWHIV and HIV uninfected adolescent groups in SSA. This stated, the prevalence of these HRB is high among both groups which stresses a major and so far unmet need for intervention among adolescents. The consequences of HRB in terms of psychosocial burden, injury, morbidity and mortality are enormous (WHO, 2014). Moreover, for ALWHIV, these may be exacerbated by their compromised health condition coupled with their increased need for optimizing care and treatment outcomes (Kalichman et al., 2011, Danta et al., 2007, Chander et al., 2006).

The high occurrence of unprotected sex at both current and first sexual intercourse among these adolescents is a serious concern. This is moreover compounded by concurrent sexual partnerships, transactional sex and sexual related violence in the form of non-consensual sex, intimate partner violence and rape which are comparably high among both the ALWHIV and HIV uninfected adolescents. Similar to results from this review, some cross sectional studies from the USA have documented a high prevalence of unprotected sex of 65% (Mellins et al., 2009) and 62% (Tassiopoulos et al., 2013) among adolescents living with HIV. Another systematic review of studies from SSA also indicates that transactional sex is a significant risk factor for HIV infection especially among young women (Wamoyi et al., 2016). Our findings on prevalence of sexual violence are within the ranges reported among adolescent girls from SSA (Moore et al., 2007). This burden is similar for both ALWHIV and their uninfected counterparts, but most importantly is that this is an unacceptably high burden for both groups. We suggest that high occurrence of risky sexual behaviour, sexual violence and other forms of potentially high risk sexual practices such as transactional sex among ALWHIV, may partly result from their vulnerable background that often is characterized by stigma, psychological vulnerability, family stressors, poverty, and orphanhood (Cluver et al., 2011, Birdthistle et al., 2008). Additionally, some underlying physiological pathways such as neurodevelopmental deficits, mental health and HIV comorbidities possibly elucidate some behavioural trends.

Furthermore, our findings reveal that the use of alcohol and drugs is largely problematic especially among male adolescents in SSA. Similar to our findings, a number of studies from other regions have reported a similar problem of alcohol and drug use including amongst male adolescents living with HIV (Mellins et al., 2009, Tanney et al., 2010). The use of alcohol and drugs among

people living with HIV is linked to numerous problems like poor adherence outcomes (Chesney, 2000), psychiatric comorbidity (Bing et al., 2001), and HIV infection (Fritz et al., 2010). More so, drug and alcohol use may form a niche for impulsivity and aggravated risk taking such as intimate partner violence, rape, unprotected sex among others (Leonard, 2005, Slaughter, 2000).

Our results highlight much needed efforts of increasing research on HRB among ALWHIV in SSA, broadening the scope of HRBs currently being explored and including adolescents from most-at risk settings among such studies. Additionally, it is necessary to target ALWHIV with pragmatic interventions that address their specific needs so as to prevent or reduce their engagement in HRBs. These interventions also need to foster safe and healthy environments in which adolescents do not fall victim to HRBs and forms of sexual injustices such as sexual violence and transactional sex.

One of the limitations of our review is that HRB is self-reported among all the eligible studies and this may have involved some degree of social desirability bias. This form of bias generally arises when respondents answer questions in a way that favours their impression management (Fisher, 1993). However, assessment of HRB is predominantly conducted through self-reports. Additionally, our research focus was limited to studies conducted in SSA and thus generalizability of our results to the entire African and other geographical contexts should only be done with caution.

Conclusion

Research on HRB among adolescents living with HIV in SSA is still limited and currently focuses on a few forms of HRB especially behaviour specific to sexual risk. Nonetheless, the existing research from this region reveals an appalling burden; especially of sexual violence (where in most cases the adolescents are victims), sexual risk behaviour and substance or drug use. While HRB is noted to compromise health outcomes, the studies do not report a number of factors such as route of HIV transmission and awareness of HIV status which could enhance our understanding of the context of HRB in this group. Furthermore, the assessment of HRB is not uniform pointing to the need for utilization of standardized assessment tools that would ensure better comparability of findings across studies. Nonetheless, the current review provides important insights for future research in the field of HRB and highlights the urgent need for age-appropriate interventions that will effectively address the behavioural

and health needs of adolescents living with HIV in SSA. The ALWHIV themselves do not engage less in HRB than HIV uninfected adolescents. We suggest that further research is needed to explore in depth the forms of HRB and their predisposing and protective factors among ALWHIV and HIV uninfected adolescents within the SSA context. Such research may be crucial in guiding intervention planning for HRB and ensuring that the interventions are responsive to special needs and challenges faced by specific adolescent groups like ALWHIV, for example stigma, depression, and orphanhood (Chesney, 2000, Chander et al., 2006, Birdthistle et al., 2008, Swendeman et al., 2006).

Competing Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Acknowledgements of authors' contributions

D.S designed the study, conducted the database search and abstraction, statistical analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript. P.N.M conducted database search and abstraction, and approved the final manuscript. A.vB revised the manuscript and approved the final manuscript. C.R.N advised on the study methodology, was involved in the protocol development, revised the manuscript and approved the final manuscript. A.A advised on the study methodology, revised the manuscript and approved the final manuscript.

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Chapter 3

Health Risk Behavior among Perinatally HIV exposed uninfected Adolescents: A systematic review.

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Abstract

Background: Perinatally HIV exposed uninfected (PHEU) adolescents are an increasing sub-population especially in high HIV epidemic settings. HIV exposure may have some lasting implications for adolescents' development, however, longer term health outcomes such as health risk behavior (HRB) are so far not well understood in this adolescent sub-population.

Methods: In this systematic review, we identify the prevalent forms, burden, and underlying risk factors for HRB of PHEU adolescents. We searched in PubMed, PsycINFO and Applied Social Sciences Index & Abstracts for peer reviewed empirical studies published between 1980 and August 2018 on HRB among PHEU adolescents aged 10 – 19 years.

Results: Eleven eligible studies, all conducted in North America were identified and they showed that sexual risk behavior such as lifetime unprotected sex increased drastically especially in mid-adolescence. PHEU adolescents' substance use (especially alcohol and marijuana) was high and increased over time. In a significant minority (10-18%) substance use disorder was screened. Some intra and interpersonal risk factors such as caregiver and PHEU adolescents' mental health problems, age and HIV status were shared across the two forms of HRB. However, other risk factors such as, race, gender and experience of traumatic life events were behavior specific.

Conclusion: Overall, there is need to conduct similar research in other settings especially those with high HIV burden where the PHEU adolescent sub-population is rising. Future research in this area could benefit from examining more forms of HRB and exploring the clustering of HRB among PHEU adolescents.

Introduction

A high propensity for risk taking among adolescents is extensively documented (Rivers et al., 2008, Steinberg, 2008). In the past, most of the research on health risk behavior (HRB) among adolescents focused on the general population (Shrier et al., 2001, Brener et al., 2003) however, emerging evidence indicates that HRB such as aggressive behavior, multiple sexual partnerships, and early sexual debut, are common among HIV affected adolescents (Foster & Williamson, 2000, Thurman et al., 2006, Birdthistle et al., 2008, Tu et al., 2009). HRB are specific forms of behavior that are known to increase susceptibility to disease or ill health on the basis of social or epidemiological data (DiClemente et al., 2013). The Centres for Disease Control and Prevention (CDC) and World Health Organization (WHO) prioritize alcohol, tobacco and drug use, unhealthy dietary habits, sexual behaviors contributing to unintended pregnancy and sexually transmitted diseases, behavior that contributes to unintentional injury or violence, poor hygiene, and inadequate physical activity as major forms of HRB (CDC, 2015, Currie et al., 2009).

For most of the studies, the "HIV affected adolescents" comprise a diverse assortment of HIV infected, HIV orphaned, perinatally HIV exposed uninfected (PHEU) and uninfected adolescents living with an HIV infected household member or caregiver (Williams et al., 2010, Tu et al., 2009). One shortcoming of combining HIV status groups into one (i.e., HIV affected) is the potential variation in the magnitude and associated risk factors for HRB across HIV status sub-groups. For instance, some studies have found different levels of cumulative psychosocial risk and burden of HRB between perinatally and behaviorally HIV infected adolescents, which highlights the potential challenge of consolidating research outcomes of different HIV groups (Sherr et al., 2018).

Of specific interest in this review is the burden of HRB among PHEU adolescents. This sub-population is steadily growing as a result of better access to the prevention of mother-to-child transmission of HIV (PMTCT) services (Stringer et al., 2008). Although numerous health indicators such as morbidity, immunity and mortality are sub-optimal among PHEU adolescents especially during early childhood (Afran et al., 2014, Filteau, 2009), presently not much is documented on PHEU adolescents' long-term health outcomes. HRB is an example of longer-term health outcomes that warrant more research in the PHEU group since potentially predisposing factors like the poor EF and

cumulative psychosocial risk are commonly documented in this group (Sherr et al., 2014, McNally et al., 2006). This stated, most of the time PHEU children and adolescents are not actively monitored through healthcare systems that attend to their siblings or caregivers and thus rarely screened for HRB or attended to for the various psychosocial risks they face (Mellins et al., 2011). Besides, HRB is a significant public health threat that could compromise health and other quality of life of outcomes of PHEU adolescents.

The current systematic review aims to document the burden of HRB among PHEU adolescents. Specifically, we set out to: (i) identify and summarize characteristics of studies quantifying HRB among PHEU adolescents globally; (ii) summarize the major forms of HRB assessed among PHEU adolescents; (iii) identify commonly documented risk factors for HRB among PHEU; and (iv) document the burden of HRB among this adolescent sub-population. We anticipate that the results from this study will highlight some of the relevant behavioral specific needs of PHEU adolescents and consequently inform research and intervention programs in this field.

Methods

Search strategy

This study utilized Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). A comprehensive data base search in PubMed, PsycINFO and Applied Social Sciences Index & Abstracts was conducted for peer reviewed articles published from January 1980 up to 31st August 2018. We utilized a stepwise approach to implement a database search criterion with search terms comprising of subject headings and Boolean operators in titles, abstracts, topics and keywords as follows: (HIV exposed uninfected OR HIV exposed-uninfected OR HIV exposed OR HIV affected) AND (Adolescent* OR Peer* OR Youth* OR Teen*) AND (Risk Taking OR Risk Behavior OR Risk Behaviour OR Life Style OR Health Behavior OR Health Behaviour).

The eligibility criteria of the studies was guided by the participants, intervention, comparison, outcome and study design (PICOS) criteria. Studies were eligible if: (i) they were empirical studies; (ii) were conducted among adolescents aged 10 -19 years who were perinatally exposed to HIV but were not infected; (iii) they assessed and reported any form of HRB among the PHEU adolescents; and (iv) they were published in English language.

In this review, we considered HRB that have been considered as priority based on epidemiological and social data according to CDC and WHO for example behavior that results to injury or violence; any form of risky sexual behavior; alcohol, tobacco and drug use; unhealthy dietary habits; and inadequate physical activity (CDC, 2015, Currie et al., 2009). We excluded all studies: (i) that did not verify the perinatal HIV exposure status of the adolescent; (ii) were non empirical; (iii) whose participants' age range, mean or median did not fall within 10 – 19 years (WHO, 2014); (iv) were published in languages other than English; and (v) did not assess or document HRB of the PHEU adolescents. In order to identify other potentially eligible articles that had not been retrieved in the database search, we further searched the reference lists of identified articles and also searched in google scholar using the following search terms: 'perinatally HIV exposed uninfected' OR 'seroreverters' AND 'risk behavior'. Three authors (D.S., P.N.M, M.K.N.) independently screened the titles, abstracts and full articles for eligibility and reached consensus on the data extracted.

Data Extraction

From all the eligible studies data on: the author and date of publication; country where the study was conducted; year the study was conducted; study characteristics (including sample size); participant characteristics; and forms of HRB assessed were extracted into a Microsoft Excel data sheet (Table 3.1). Details of each form of HRB and associated risk factors were then extracted into a separate Excel data sheet. The detailed summary is presented in the results section. Data extraction was independently conducted by two authors (D.S. and P.N.M.) who thereafter compared their results and reached consensus.

Statistical Analysis

We synthesized the findings from all the eligible studies in this review. We report the various forms of HRB and furthermore, specific details in terms of percentages (prevalence), means, frequencies and dates that were used to summarize the findings and to draw interpretations of the data. We utilized a Socio-Ecological model (McLeroy et al., 1988) to scrutinize the underlying risk factors for HRB. This model posits that there are five levels of interaction which determine human behavior. These are: intrapersonal factors that comprise personal history and biological factors; interpersonal factors which involves support systems such as, family, and friendships, and formal or informal social networks; institutional factors such as social institutions with organizational characteristics; community factors for example relationships among informal

networks, organization, and institutions; and public policy factors which entails local, state and national laws or policies. We reported risk factors that were statistically significant (P≤0.05).

We also assessed the methodological quality of eligible studies using the New Castle-Ottawa Quality Assessment Scale (Wells et al., 2000). This tool is developed to assess the quality of non-randomized studies and utilizes a star rating system for which a study is judged based on three broad areas: the selection of study groups; the comparability of these groups; and the ascertainment of exposure or outcome of interest (Wells et al., 2000). We considered a study to be of satisfactory methodological quality if six or more stars were scored out of a maximum of eight.

Results

We identified 11 eligible studies from the 2,111 retrieved citations (see figure 3.1).

These studies were conducted between 2003 and 2010 (original recruitment), and they all took place in the United States of America (USA). All the 11 studies were from 2 longitudinal studies with majority (82%) from Child and Adolescent Self-Awareness and Health Study (CASAH) and the rest from the Adolescent Master Protocol (AMP).

CASAH is a multi-centre longitudinal study of perinatally HIV infected (PHIV) infected and PHEU adolescents designed to examine differences in mental health and behavioral health outcomes. Recruitment was conducted between 2003 and 2008 for adolescents aged 9 – 16 years from 4 primary and tertiary healthcare centres in New York. The first follow-up was conducted 18 months after the baseline and when additional funding was found, re-recruitment from the original cohort occurred and 3 more follow-ups (CASAH-2) conducted each a year apart. The first phase of this second follow-up (CASAH-2) was conducted 3 years after the first follow-up (Mutumba et al., 2016, Elkington et al., 2015).

AMP is an ongoing cohort study comprising PHIV infected and PHEU children and adolescents (with ages 7-15 years at inception) recruited from 15 medical centres (mainly based at academic medical centres in urban settings) across USA and Puerto Rico (Mellins et al., 2011).

The sample size of the PHEU adolescents among these studies included in our review ranged from 47 to 157. More details on study characteristics are presented in Table 1.

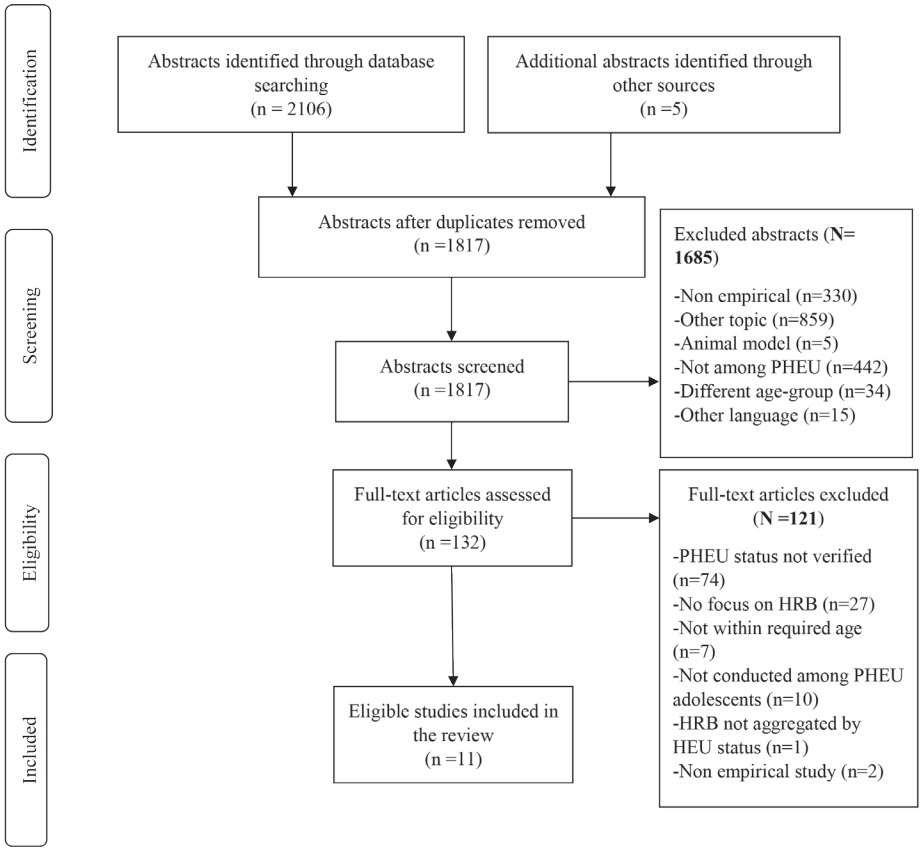

Figure 3.1: A flow diagram representing the article screening process of this review

Risky sexual behavior

Sexual risk behavior of PHEU adolescents was documented in 7 of the 11 eligible studies (see Table 1). The specific forms of sexual risk behavior documented were early sexual debut (Bauermeister et al., 2009, Mellins et al., 2011, Benson et al., 2018), lifetime unprotected sex (Mellins et al., 2009b, Elkington et al., 2009, Elkington et al., 2015), recent (past 3 months) unprotected sex (Benson et al., 2018, Dolezal et al., 2014), unprotected first time sex (Dolezal et al., 2014), and multiple sexual partnerships (Elkington et al., 2009).

In one study, the sexual debut of PHEU adolescents was 12 years and did not statistically differ from that of PHIV peers (Mellins et al., 2011). However another study found a significantly higher age (13.4 years) of sexual debut among PHEU than that (11.9 years) for PHIV adolescents (Bauermeister et al., 2009). Although Benson and colleagues did not report the age of sexual onset, they noted that substance use and behavioral disorders were associated with earlier onset of sexual behavior among PHEU adolescents (Benson et al., 2018).

Overall, prevalence of lifetime unprotected sex increased with time among PHEU adolescents and no significant differences were found across HIV groups (i.e. PHEU vs PHIV). For instance, in the CASAH cohort, occurrence of lifetime unprotected sex increased from 33% at baseline (participant mean age of 11.9 years) to 50% after 18 months (first follow-up) and to 62.5% during the second follow-up period when participants were on average 16.7 years old (Elkington et al., 2015). However, during the second follow-up, PHEU adolescent reported significantly higher occurrence of lifetime unprotected sex than their PHIV peers (62.5% compared to 48.8%) (Elkington et al., 2015). Results from a different cohort study of PHEU adolescents (AMP) reported a 50% lifetime prevalence of unprotected sex (vaginal or anal) among the sexually active PHEU adolescents (compared to 65% among PHIV) with a mean age of 12.7 years (Mellins et al., 2011).

Unlike lifetime unprotected sex, one study from CASAH cohort that reported the prevalence of recent (past 3 months) unprotected sex (both anal and vaginal sex) of PHEU at second and fourth follow-up periods found a reduction from 43.1% during the second follow-up to 29.2% at fourth follow-up (Benson et al., 2018). Although the trend of recent unprotected sex was different for the PHIV group (a rise from 22.7% to 31.5%), the authors did not find any statistical differences in prevalence of most recent unprotected sex by HIV group (Benson et al., 2018). A more robust measure of recent unprotected vaginal sex (combining both non-use and partial condom use) during the second follow-up period of CASAH cohort found a burden of 37% (compared to 23% if they only asked about non-use) among PHEU but didn't find statistically significant differences across HIV groups (Dolezal et al., 2014).

Multiple sexual partnership (having 2 or more sexual partners) was reported among 58.8% of sexually active PHEU adolescents and did not statistically differ from the occurrence among PHIV peers (Elkington et al., 2009).

Alcohol, tobacco and other drug use behavior

Alcohol, tobacco and other drug (ATOD) use was documented in 9 of the 11 eligible studies (see Table 1). ATOD use was reported in the form of substance use disorder or substance abuse (Benson et al., 2018, Mellins et al., 2009a), lifetime use of alcohol or marijuana or cigarettes (Alperen et al., 2014, Elkington et al., 2009, Mellins et al., 2009b, Mellins et al., 2011, Elkington et al., 2015) , use of marijuana or other substance use within the past year (Mutumba et al., 2016, Elkington et al., 2016) and recent (past 3 months) substance use (Mellins et al., 2011).

There was an increasing trend in the burden of substance use disorder over time among PHEU from 10% to 18% between second and fourth follow-up of the CASAH cohort (Benson et al., 2018). In this cohort, PHIV adolescents had a significantly higher burden of substance use disorder than PHEU (19% vs 10%) at second follow-up but there were no statistically significant differences found at fourth follow-up (Benson et al., 2018).

Lifetime use of alcohol and marijuana was high and increased steadily over time among PHEU. In the CASAH cohort for example alcohol use increased from 15.5% at baseline (participants' mean age was 11.9 years) (Mellins et al., 2009b, Elkington et al., 2009, Elkington et al., 2015) to 25.6% at first follow-up (18 months later), and thereafter almost doubled (48.9%) at the second follow-up period when participants were 16.7 years on average (Elkington et al., 2015). Although lesser prevalent than alcohol use, marijuana use of PHEU adolescents increased by almost four times from 7.8% at the baseline to 29.6% during the second follow-up period (Elkington et al., 2015).

Table 3.1: A summary of the characteristics of eligible studies

Author	Country	Study recruitment period	Study characteristics	Participant characteristics	HRBs assessed	Study quality assessment
Elkington et al., 2016	USA	2003 – 2008	Baseline, follow-up 1 & 2 of a cohort study (CASAH project)	-134 PHEU and 206 PHIV adolescents -Mean age 12.4 years and 16.7 at follow-up 2	Marijuana use	satisfactory
Mutumba et al., 2016	USA	2003 - 2008	Baseline, follow-up 1 & 2 of a cohort study (CASAH project)	-129 PHEU and 196 PHIV adolescents -Mean age for PHEU adolescents at baseline was 11.9 years and 16.7 at follow-up 2	Substance use (excluding nicotine)	satisfactory
Elkington et al., 2015	USA	2003 - 2008	Baseline, follow-up 1 & 2 of a cohort study (CASAH project)	-129 PHEU and 195 PHIV adolescents -Mean age for PHEU adolescents was 12.4 years at baseline and 16.7 at follow-up 2	Risky sexual behavior, Alcohol use, Marijuana use	satisfactory
Alperen et al., 2014	USA	2007 - 2009	Baseline of a cohort study (AMP)	-157 PHEU and 354 PHIV adolescents -Mean age for PHEU adolescents was 12.3 years	Alcohol use, Cigarette use, Marijuana use	satisfactory
Dolezal et al., 2014	USA	2009	Follow-up 2 of a cohort study (CASAH project)	-47 PHEU and 88 PHIV sexually active adolescents -Mean age for PHEU sexually active adolescents was 18.7 years	Risky sexual behavior	satisfactory
Mellins et al., 2011	USA	2007 - 2010	Baseline and follow-up1 of a cohort study (AMP)	-111 PHEU and 238 PHIV adolescents -Mean age for PHEU adolescents was 12.7 years	Risky sexual behavior, Alcohol use, Marijuana use	satisfactory
Bauermeister et al., 2009	USA	2003 - 2007	Baseline of a cohort study (CASAH project)	-127 PHEU and 195 PHIV adolescents -Mean age for PHEU adolescents was 11.9 years	Risky sexual behavior	satisfactory
Elkington et al., 2009	USA	2003 - 2008	Baseline of a cohort study (CASAH project)	-134 PHEU and 206 PHIV adolescents -Mean age for PHEU adolescents was 11.9 years	Risky sexual behavior, Alcohol use, Cigarette use, Marijuana use	satisfactory

Mellins et al., 2009a	USA	2003 - 2008	Baseline of a cohort study (CASAH project)	-134 PHEU and 206 PHIV adolescents -Mean age for PHEU adolescents was 11.9 years	Substance use (marijuana & alcohol)	satisfactory
Mellins et al., 2009b	USA	2003 - 2008	Baseline of a cohort study (CASAH project)	-127 PHEU and 193 PHIV adolescents -Mean age for PHEU adolescents was 11.9 years	Risky sexual behavior, Alcohol use, Cigarette use, Marijuana use	satisfactory
Benson (Benson et al., 2018)	USA	2003-2008	Follow-up 2 and follow-up 4 of a cohort study (CASAH project)	-105 PHEU and 178 PHIV adolescents -Mean age 17 years at follow-up 2 and 19 years at follow-up 4	Substance use (marijuana, alcohol and other drugs) Risky sexual behavior	satisfactory

AMP: Adolescent Master Protocol; CASAH: Child and Adolescent Self-Awareness and Healthy Study; PHEU- Perinatally HIV Exposed Uninfected; Mean age is for the PHEU; PHIV- Perinatally HIV infected

Overall, there were no significant differences by HIV group (i.e. PHEU and PHIV). Results from another cohort (AMP); whose participants' mean age (12.3 years) was slightly higher than the baseline mean age of CASAH participants, reported higher prevalence of lifetime use of alcohol (42%) and marijuana (19%) among PHEU adolescents (Alperen et al., 2014) although we could not ascertain if there was significant difference in prevalence of these two forms of behavior between the cohort two studies.

Tobacco use was reported by three studies that all documented lifetime cigarette use. Two of these originated from the baseline data of the CASAH cohort study, and reported the occurrence of this behavior as ranging between 6% and 7% among PHEU adolescent whose mean age was 11.9 years (Mellins et al., 2009b, Elkington et al., 2009). However, the results from the AMP cohort study reported a higher prevalence of 16% lifetime cigarette use among the PHEU adolescents who were 12.3 years on average (Alperen et al., 2014).

More recent use (past 3 months or past year) of alcohol or marijuana or cigarettes was much lower than lifetime substance use behavior among PHEU from both cohort studies. There were however general increasing trends in more recent use over time but without statistically significant differences across HIV groups.

The occurrence of substance use (excluding nicotine) within the past year was 6.9 % at baseline, 4.6% at first follow-up and 10.1% at second follow-up among PHEU adolescents from the CASAH cohort (Mutumba et al., 2016). A similar increasing trend in marijuana use by PHEU adolescents within the past year from 8.2% at baseline to 24.8% at second follow-up period of CASAH was reported (Elkington et al., 2016).

Co-occurrence of HRB

Only one study from AMP cohort explored the co-occurrence of HRB among PHEU adolescents (Mellins et al., 2011). In this study sexual, substance use and mental health behavioral risk factors were utilized to classify PHEU adolescents into behavioral categories corresponding to their engagement in 0, 1, 2 and all the 3 behavioral risk factors. The findings were that 11% of PHEU adolescents (16% for PHIV) reported engagement in 2 or more behavioral risk factors and there were no significant difference by HIV group (Mellins et al., 2011).

Table 3.2: A summary of risk factor for HRB among PHEU adolescents

Adolescent HRB	Intrapersonal level	Interpersonal level
Marijuana	-Severity of emotional and conduct problems (Alperen et al., 2014, Elkington et al., 2016) -Earlier onset of marijuana use (Elkington et al., 2016)	-Substance use by caregivers or close family members (Alperen et al., 2014)
Alcohol	-Severity of emotional and conduct problems (Alperen et al., 2014)	-Substance use by caregivers or close family members (Alperen et al., 2014) -Mental illness of caregiver (Alperen et al., 2014)
Substance use (combined)	-Older adolescent age (Elkington et al., 2009, Mutumba et al., 2016) -Experiencing negative life events (Mutumba et al., 2016) -HIV status (being PHEU) (Mutumba et al., 2016, Benson et al., 2018)	Mental illness of caregiver (Mellins et al., 2009b)
Sexual risk behavior	-HIV status (earlier onset of sexual debut in PHIV compared to PHEU (Bauermeister et al., 2009, Benson et al., 2018), PHIV were less likely to report unprotected sex at follow-up 2 (Elkington et al., 2015) -Gender (especially being male) (Dolezal et al., 2014) -Older adolescent age (Elkington et al., 2009, Elkington et al., 2015) -Having behavioral disorders (Benson et al., 2018) -Substance use (alcohol, marijuana, cigarettes) (Elkington et al., 2009, Elkington et al., 2015, Benson et al., 2018) -Race (being black) (Elkington et al., 2015)	-Mental illness of caregiver (Mellins et al., 2009b) -Having a caretakers who do not promote youth autonomy (Elkington et al., 2009) -Norms and beliefs (that peers engage in risky sexual practices, norms endorsing risky behavior) (Elkington et al., 2009)
Co-occurrence of substance use, sexual risk behavior and mental health problems	-Older adolescent age (Mellins et al., 2011)	-Type of caregiver (biological mother) (Mellins et al., 2011)

Risk factors

All reported risk factors underlying sexual risk behavior and alcohol, tobacco and other drug use (ATOD) were from an intrapersonal and interpersonal level (See Table 3.2). Some of the risk factors were cross cutting among different forms of HRB. From an intrapersonal risk factor level, underlying

poor emotional and conduct behavior of PHEU adolescents (for marijuana use, alcohol use and sexual risk behavior); having early age of onset or being an older PHEU (marijuana use, multiple substance use, sexual risk behavior and co-occurrence of substance use and sexual risk behavior); and HIV status (multiple substance use and sexual risk behavior) were shared risk factors. From an interpersonal risk factor level, caregiver conditions like substance use by caregivers or close family (marijuana and alcohol use) and mental illness of caregivers (alcohol use, substance use and sexual risk behavior) were cross cutting. There were also various behavior specific risk factors especially for sexual risk behavior and these are summarized in Table 3.2.

All the eligible studies were of satisfactory methodological rigor based on the New Castle-Ottawa Quality Assessment Scale (Wells et al., 2000). All these studies received a star ranking for each field/criteria with exception of one item under the aspect of outcome assessment since HRB is majorly self-reported.

Discussion

Findings from this review reveal a dearth of research on HRB of PHEU adolescents and this can have multifaceted implications. First, the studies emanate from one geographical context (USA), and from only two cohort studies. This potentially limits generalizability of the current evidence on HRB of PHEU to other geographic settings like sub-Saharan Africa where socio-cultural and healthcare structures are different from those in the USA. Second, the studies only document sexual risk and ATOD use behavior which leaves an evidence gap on the occurrence and underlying risk factors for other forms of HRB such as, violence and injury related behavior, gambling, and dietary behavior of PHEU adolescents. Nonetheless, the longitudinal design and the between group comparison (PHEU vs PHIV) of HRB outcomes in the eligible studies provides important insights on the temporal trends and group specific needs both of which are vital for public health programs.

We found that overall, the reported occurrence of risky sexual behavior such as unprotected sex among the sexually active PHEU (baseline findings) was similar to the estimated national prevalence (37-40%) among the general adolescent population in the USA during the period between 2003 and 2011 (CDC, 2012). However, it is important to note that results from this review indicate that lifetime occurrence of unprotected sex among sexually active

PHEU adolescents increased rapidly during mid-adolescence periods (13-17 years) although the occurrence of more recent (past 3 months) unprotected sex reduced over the follow-up period. Since early sexual debut (12-13 years) was also reported among the PHEU adolescents, it is plausible that their first sexual encounters are often riskier especially when initiated at an earlier age compared to older age. This may explain the varying trends between lifetime and recent condom use behavior. Indeed, similar to this explanation, other findings from a general population in the USA found that adolescents who reported having had sex by 14 years or less were less likely to have used a contraceptive method at first sex as compared to those that initiated sex later on (Finer and Philbin, 2014). However, the estimated age of first sexual debut in the USA ranges between 17.8-18.1 years which is much higher than that reported for sexually active PHEU adolescents in our review (Finer and Philbin, 2014).

Findings on ATOD use of PHEU showed that although their substance use is not as high as that reported in the USA general adolescent population (CDC, 2012, Patrick and O'Malley, 2016), their trends of both lifetime and recent substance use especially alcohol and marijuana steeply raise and are compounded by an increasing burden of substance use disorder (Mellins et al., 2009a, Mellins et al., 2009b) across the adolescent period. Considering that more recent substance use is much less than lifetime substance use, we suggest that substance use may be recreational or irregular for many of the PHEU adolescents. However, amongst the substance users there is a minority with heighten vulnerability for problem substance use which is indicated by the 10-18% prevalence of substance use disorder among older PHEU adolescents. This finding highlights an urgent need for substance use intervention among PHEU adolescents and the need to identify (screen for) those at greater risk for substance use disorder so as to provide for more tailored intervention approaches.

Our findings also indicate that HRB clustering is a common phenomenon among PHEU as shown by the findings on co-occurrence of sexual risk and substance use among 11% of PHEU adolescents in one study (Mellins et al., 2011). This noted, only one of the 11 eligible studies investigated clustering of HRB which further highlights an increasingly documented problem of isolated analysis of HRB as opposed to use of more comprehensive approaches such as cluster analysis techniques (Lanza and Cooper, 2016).

The findings from the risk factors for sexual risk behavior and substance use of PHEU adolescents have various implications. First, there was a cross-cutting effect of certain inter- and intra-personal risk factors for both forms of HRB. This is suggestive of potential co-occurrence of HRB and further highlights the need for ecological (i.e., multi-system) and comprehensive analytical approaches in the HRB research. Second, being PHEU compounded by mental and behavioral problems was predictive of certain forms of HRB. This is important because in most settings PHEU children and adolescents are not often followed up and thus miss out on vital HIV related care and services (like counseling, routine screening and mental healthcare) because health systems tend to only focus on their infected siblings and caregivers (Mellins et al., 2011). This means that there is a missed opportunity (or a window of opportunity) for improving health outcomes of PHEU adolescents within the HIV service delivery. Third, we found that caregiver factors (like mental health and substance use, type of caretaker, parenting behavior) play an important cross-cutting role in predisposing PHEU to HRB which may indicate a need for family-based behavioral interventions in addressing HRB of adolescents. Fourth, some of the risk factors were behavior specific or intra-personal (e.g. gender and race) which highlights the need for tailored approaches in addressing HRB of PHEU adolescents.

Study strengths and weaknesses

The strengths of this review stem from the rigorous systematic approach we utilized to generate evidence on HRB and its underlying risk factors in an emerging adolescent sub-population, PHEU, whose longer-term health outcomes are not well understood. We also appraised the quality of the eligible studies which we found satisfactory. Nonetheless, the results from this review are limited by their origin from one geographical setting (USA) and that multiple studies are derived from same cohort studies. Although generalizability of the current findings is challenging, important findings from a temporal and within group comparison perspective are discussed thereby providing more explicit insight on HRB of PHEU adolescents.

Conclusion

Overall, research on HRB of PHEU is scanty, originates from a single geographic context and reports few forms of HRB majorly in isolation. A substantial evidence gap on HRB of PHEU in high HIV epidemic settings (such those in SSA) where the PHEU adolescent sub-population is steadily growing is eminent. The current evidence reveals that both substance use (especially

alcohol and marijuana) and sexual risk behavior (mainly early sexual debut and inconsistent condom use) are common among PHEU and their occurrence heightens especially during mid-adolescence. These forms of HRB tend to co-occur among a minority and many of their underlying inter- and intra-personal risk factors are cross-cutting. There is need for similar research in settings like SSA, and more comprehensive assessment of behavioral outcomes (i.e. more forms and co-occurrence of HRB). The findings also accentuate the need for monitoring health outcomes of PHEU children and adolescents; who in most of the circumstances miss out on opportunities from healthcare systems that prioritize only the immediate needs of their HIV infected siblings and caregivers.

Competing interests

No competing interests were disclosed

Acknowledgements of authors' contributions

D.S designed the study, conducted the database search and abstraction, synthesis of results, drafted the initial manuscript, revised the manuscript and approved the final manuscript. P.N.M conducted database search and abstraction, and approved the final manuscript. M.K.N conducted database search and abstraction, and approved the final manuscript. A.vB revised the manuscript and approved the final manuscript. C.R.N advised on the study methodology, was involved in protocol development, revised the manuscript and approved the final manuscript. A.A advised on the study methodology, revised the manuscript and approved the final manuscript.

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Part B:

Focus on HRB of the general adolescent population in Kilifi County.

Chapter 4

Young people's and stakeholders' perspectives of adolescent sexual risk behavior in Kilifi County, Kenya: a qualitative study.

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Abstract

A lack of research exists around the most common forms of sexual risk behaviors (SRB) among adolescents, including their underlying factors, in sub Saharan Africa. Using an Ecological Model of Adolescent Behavior, we explore the perceptions of 85 young people and 10 stakeholders on SRB of adolescents in Kilifi County on the coast of Kenya. Our findings show that transactional sex, early sexual debut, coerced sex and multiple sexual partnerships are prevalent. An urgent need exists to develop measures to counter SRBs. The results contribute to understanding the range of risk and protective factors in differing contexts, tackling underlying issues at individual, family, local institutional, wider socioeconomic and political levels.

Background

Sexual risk behavior (SRB) and forms of sexual exploitation faced by adolescents in sub-Saharan Africa (SSA) need to be addressed, since SRB, such as early sexual debut, multiple sexual partnerships, unprotected sex, intimate partner violence, and sexual exploitation through early marriage and transactional sex, have been extensively documented among adolescents within this region (Wamoyi et al., 2015, Bankole et al., 2007, Idele et al., 2014). Given this state, it is not surprising that SSA accounts for almost two-thirds of the 300,000 new HIV infections among adolescents between 15 and 19 years globally (Idele et al., 2014). Likewise, the adolescent birth rate in SSA was the highest globally (117 per 1,000 girls aged 15-19 years) for the period from 1991 to 2010 (UNFPA, 2013).

In SSA, Kenya is one of the eight countries that registered the highest rates of new HIV infections in 2015 and sexual intercourse remains the predominant route of HIV transmission (UNAIDS, 2016). Only 35% of sexually active Kenyan adolescents report having used any form of contraception (Obare et al., 2016); early sexual debut and cross-generational sex are prevalent (Nzioka, 2001; Luke, 2005); and 25% of the Kenyan adults report having experienced some form of sexual violence before the age of 18 years (UNICEF et al., 2012). Moreover, disparities exist such that adolescents living in the coastal region of Kenya face a disproportionately poorer state of adolescent sexual and reproductive health (ASRH) than those from most regions within the country (KNBS, 2014). Teenage pregnancy rate is highest (21%) at the Kenyan coast and the unmet need for family planning among married adolescent girls (15-19 years) is 59% which is twice more than the national prevalence of 23% (KNBS, 2014). Furthermore, other concerns of sexual violence, sexual tourism, early marriages and high school dropout rates are reported at the Kenyan coast (NACC, 2016; NCRC, 2014) which emphasize the urgent need for intervening around adolescent SRB in this context. Adolescent SRB has been linked to consequences such as high teenage pregnancy (currently at 18% in Kenya) (Obare et al., 2016), unsafe abortions, school dropout, mental ill health and sexually transmitted infections (Godia et al., 2014, Juma et al., 2014, UNICEF et al., 2012).

The assessment of different forms of SRB and their facilitating or contextual factors is a vital step towards designing effective strategies and interventions for SRB (Wight et al., 2016, Hanson et al., 2015). In Kenya only a few studies

have comprehensively explored underlying factors for adolescents' SRB. In western Kenya, socio-cultural factors such as funeral ceremonies, boy child preference, early marriage and widow inheritance are among reported factors for SRB (Juma et al., 2014; Njue et al., 2009). Studies from Central (Martson et al., 2013; Caroline & Orpinas, 2008), and Eastern (Nzokia, 2001) regions of Kenya describe peer pressure; low risk perception; lack of parental supervision; lack of school attendance; family dysfunction; alcohol and drug use; delinquent behavior; and gender norms as some predisposing factors for adolescent SRB. Nonetheless, it is not clear whether unique factors explain the disproportionately poor state of ASRH at the Kenyan coast since there is a paucity of literature on drivers of adolescent SRB associated with this specific setting. This presents challenges in guiding intervention and policy development (NACC, 2016). We therefore seek to engage adolescents and local community stakeholders to reflect on mechanisms by which SRB is generated and normalized within their context, as this avoids attributing SRB to merely broad and generic social norms (Hanson et al., 2015).

To contribute towards a clearer understanding of the prevalent adolescent SRB and their underlying factors, we conducted a qualitative study to understand young people's and stakeholders' perspectives on SRB among adolescents (10-19 years) in Kilifi County at the Kenyan coast. Specifically, we explored perceptions of (i) most common forms of SRB, (ii) predisposing or risk factors for SRB, and (iii) protective factors against SRB among adolescents. We draw on the perceptions of young people and a range of other community stakeholders to explore diversity and the convergence of viewpoints and factors underlying adolescent SRB behavior within this setting.

Theoretical framework

We utilize the Ecological Model of Adolescent Behavior by Blum et al. (2001), which provides a logical account of underlying factors responsible for the distribution and occurrence of adolescent risk behavior. This model draws on ecological systems theory which posits that understanding human development requires the examination of multi-person systems of interaction, and that this should take into consideration numerous aspects of the environment beyond an immediate situation concerning the subject (Bronfenbrenner, 1977). The model by Blum and colleagues postulates that there are intricate mechanisms that underlie risk behavior and these involve interactions of multiple explanatory domains (Blum et al., 2001). This model proposes six major explanatory domains or sources of behavioral variation and each of

these domains comprises risk factors and protective factors. These domains are as follows: (i) individual, (ii) family, (iii) peers, (iv) school, (v) social environment, and (vi) macro-environment (Blum et al., 2001). All the domains are presumed to have direct effects on adolescent risk behavior; however, there is interplay of factors within and across domains which explains the various forms of risk and protection. Moreover, various domains of risk can also have indirect effects on risk behavior. The model presumes a bi-directionality between the risk factors and behavioral outcomes, that is, engaging in a risk behavior can also affect the various domains of risk factors. The protective factors are considered to moderate or counter-balance and thus mitigate the impacts of risk on adolescent behavior (Blum et al., 2001). This model suggests that family, peer, and school influences on the adolescent fall within a broader social environment which also ultimately lies within a macro environment.

Methods

Study setting and participants

This qualitative study was conducted between August and November 2016 at the Kenya Medical Research Institute (KEMRI)-Wellcome Trust Research Programme (KWTRP), which has its main base within Kilifi County on the Kenyan coast. Data were collected within a well-defined health and demographic surveillance area, the Kilifi Health and Demographic Surveillance System (KHDSS). By 2011, the population of KDHSS was estimated at 270,000 residents and 49% were less than 15 years (Scott et al., 2012). The residents mainly belong to the Mijikenda ethnic group, which is a Bantu group comprising of nine sub-groups with a majority (45%) being Giriama. The main form of livelihood within this community is subsistence farming. Kilifi County is mainly served by one major hospital (KCH), a health center and 12 dispensaries (Scott et al., 2012).

This study involved the following two groups of study participants:

(i) Adolescents aged 10-19 years and young adults between 20 and 30 years who were Kilifi residents and serving as community representatives at KWTRP. The adolescents were sub-divided into three groups, including those who were school-going (both primary and secondary students), had 'dropped out' of school; and were living with HIV and attending an HIV Comprehensive Care Clinic at Kilifi County Hospital (KCH).

(ii) Key informants, who were female and male adults working extensively with adolescents within Kilifi, for example, teachers, employees of community based organizations (CBOs) addressing adolescent health challenges, community social workers, clinicians, and county government staff.

Recruitment and eligibility

Recruitment into this study was through a snowballing process. Initial contact was made with a small number of researchers at the KWTRP Kilifi whose work involved adolescents. They recommended additional key informants who should be contacted for interviews, based on experience of working with adolescents living with HIV. This process was repeated with all new interviewees to continue to identify participants sharing relevant perspectives for the study. In the school setting, head teachers suggested a contact teacher (who in most cases was a guidance & counseling teacher) who served as a key informant.

At KWTRP, we were able to draw on an existing network of community representatives to identify participants for this study (Kamuya et al., 2013). Using an existing data base of around 200 community representatives in the Community Engagement department at KWTRP, we purposively selected community members aiming to reflect diversity within a young adult population, taking account of residential area (peri-urban or rural settings), education status, sex and religion.

For school going adolescents, we purposively identified two primary and two secondary schools in the KHDSS area, as before aiming to explore diversity. Characteristics identified included the setting and type of schools, specifically, schools in peri-urban and rural settings, and day schools attended by both male and female students. For study purposes, we considered Kilifi town as a reference peri-urban setting and areas with limited social services and within 10 or more kilometers from Kilifi town as rural settings. In consultation with Kilifi County Education Office and researchers at the KWTRP with ongoing work within the school setting, we identified the four schools. Upper-primary school students (i.e. from class 5 to 8) and lower-secondary school students (i.e. from form 1 and 2) were purposively recruited from class records with a specific consideration of sex, religion, and age. School dropout adolescents were recruited with assistance from the County department of Public Health's community support staff. Recruitment of the school dropout adolescents was

done by purposively selecting them from two community health catchment units with consideration of age, sex and religious diversity. The adolescents living with HIV were recruited from the youth club at the comprehensive care and research clinic of KCH and some were recruited directly from the community through home visits to families of HIV infected adolescents by a worker from the KCH.

Ethical consideration

All recruitment processes involved obtaining prior written informed consent. Consent was directly sought from participants aged 18 years and over. For those aged under 18 years, parents or legal caretakers provided consent. In addition, for participants between 13 and 18 years, the adolescent's assent was also sought. Permission to involve schools in this study was obtained from the County director of education and head teachers at each school involved.

The ethical clearance for this study was granted by the Kenya Medical Research Institute Scientific and Ethics Review Unit (KEMRI/SERU/CGMR-C/0047/3263).

Data collection

We conducted in-depth interviews lasting on average 60-90 minutes with each of the key informants at a time of their convenience and at their preferred venue. We conducted focus group discussions (FGDs) comprising between seven and nine participants each lasting between 75 and 120 minutes with the young adult community representatives and adolescents. For school going adolescents, FGDs were conducted within the school and were sex disaggregated. Young adult community representatives, adolescents living with HIV and those who had dropped out of school were invited to participate in FGDs at the KWTRP, in a private and quiet setting. Participants (young adults) and caretakers of adolescents who were invited to CGMR-C were given 300 Kenyan shillings (about US$3) to compensate for time spent and transport expenses were reimbursed. All interviews and discussions were moderated by a trained Research Officer in English and/or Kiswahili based on the participants' preference. Permission was asked from participants to take notes and to audio record the discussions and interviews conducted.

Both the qualitative interview guide and the FGD guide were developed with guidance from the World Health Organization and the Centers for Disease Control and Prevention documents, (WHO, 2015; CDC, 2015) to cover a wide

range of adolescent health risk behaviors such as SRB, behavior resulting in unintentional and self-harm, alcohol use behavior, smoking, drug use, poor dietary, physical activity and poor hygiene behaviors. For each form of behavior, respondents' perceptions were explored using a general open-ended question, followed by additional probing, that asked them to explain the specific forms of risky behaviors which they perceive as commonly undertaken by adolescents aged 10-19 years in Kilifi. We only probed further on specific examples or context of SRB that were raised by the participants and thus all the perceptions documented in this manuscript were spontaneous views from the participants. We also collected respondents' demographic information, such as age, sex, education status, residence, position held/affiliation and religious background.

Data analysis

The audio-recorded interviews and discussions were transcribed verbatim by a professional team and later translated into English. Two of the authors (D.S. and P.N.M.) critically scrutinized the scripts and developed initial codes from a priori and emergent issues. The final round of coding was conducted in NVivo 11 software (QSR International Ltd, Southport, UK) by D.S. Through a series of meetings within the research team, the codes were discussed and consensus reached on how these should be brought together into themes with guidance from the Ecological Model of Adolescent Behavior (Blum et al., 2001). Charting was then done by D.S. using a case and theme–based approach in Microsoft Excel. This framework was reviewed, discussed, and agreed upon by the research team to inform the ongoing analysis and interpretation of the results.

Results

A total of 11 FGDs were held, of which 8 were sex disaggregated and conducted among school going-adolescents. The rest were not sex disaggregated and involved adolescents living with HIV, those who dropped out from school, and young adult community representatives. Also, 10 in-depth key informant interviews were conducted with 4 employees of community based organizations, 2 County hospital staff, 3 teachers responsible for guidance and counselling affairs and 1 County government staff. The total number of participants in this study were 95, of whom 77.9 percent were Christians and the rest were Muslim (see Table 4.1)

Table 4.1. Socio-demographic characteristics of participants

Participants	Total	Age range (Median age)	Sex	Education level
Key Informants	10	27 – 51 (31)	4 Males, 6 Females	University degree (5), Post-secondary level (5)
Young adult community representatives	7	22 – 28 (25)	3 Males, 4 Females	College level (4), Secondary level (2), Primary level (1)
Primary school adolescents				
Peri-urban male students	7	10 – 14 (14)	Males	Class 5 – 8
Peri-urban female students	7	10 – 13 (12)	Females	Class 5 – 8
Rural male students	8	12 – 16 (13.5)	Males	Class 5 – 8
Rural female students	8	13 – 16 (14.5)	Females	Class 5 – 8
Secondary school adolescents				
Peri-urban male students	8	16 – 19 (17)	Males	Form 1 - 2
Peri-urban female students	6	15 – 17 (16)	Females	Form 1 - 2
Rural male students	9	16 – 18 (17)	Males	Form 1 - 2
Rural female students	9	15 – 18 (16)	Females	Form 1 - 2
Adolescents living with HIV	9	12 – 19 (13.5)	5 Males, 4 Females	Class 3 – Form 1
School drop-out adolescents	7	12 – 18 (14)	5 Males, 2 Females	Class 2 – Form 2

Prevalent forms of sexual risk behavior

The perceived forms of SRB are summarized in Table 4.2. Many of the participants had a general opinion that many of these forms of SRB, including transactional sex, cross generational sex, early sexual debut, coerced sex and multiple sexual partnerships, are common within Kilifi. Overall, there was agreement about the high occurrence of transactional sex and that this occurs in both sexes. These sexual relationships were described as occurring outside marriage or commercial sex work, but structured by an assumption that sex will be exchanged for material benefit or status (Stoebenau et al., 2016). Participants mainly cited gifts exchanged for sex as including: school fees, transport to school, sanitary pads, money, food, footwear, and clothes. As one participant described,

> *Teenagers are getting sugar mummies who finance their lifestyles in return for the teenagers offering them sex (Group 3, male student, rural secondary school).*

Likewise, sexual violence and forms of sexual exploitation were characterized by age and economic asymmetries, and 'sugar daddy/mummy' situations were commonly talked about. Adolescent girls were considered most vulnerable to these injustices, as explained by a participant:

She was forced by the father to have sex….a lady can be abused by the father, they have no right in the local region here (referring to the girls). As long as they are poor, anyone who comes there can use them. (KI, medical social worker, male, 28 years)

Early sexual debut coupled with multiple sexual partnerships and unprotected sex were also described across a majority of the participant groups:

> *Boys here in school, in fact they are very frank. They can tell you, "Madam, if I move with this girl today (referring to sexual relationship), next week I do not have that girl, I will leave that girl for someone else, I will go to someone else" so they keep on moving (KI, secondary school teacher, female, 32 years).*

Notably, some perceived that the age of sexual debut could be as early as ten years:

> *It is extremely shocking that you find 10 year old, 11 year old, 12 year olds, they are sexually active and they are moving around with boys (KI, CBO director, female, 46 years).*

Risk and protective factors for SRB

Participants discussed a range of predisposing and protective factors for SRB, most factors predisposed to risk, and fewer protective influences were noted. Following the Ecological Model (Blum et al., 2001), a majority of risk factors acted at a social environment level, followed by those functioning at individual- and family-level influences. In contrast, most protective factors described operated at school, social and family levels (see Figure 4.1). These influences are described in the following paragraphs.

Table 4.2. Perceived forms of SRB among adolescents in Kilifi

Sexual risk behavior	Number of FGDs where SRB described (N=11 FGDs)	Number of key informants describing SRB (N=10 KIs)
Transactional sex (gifts for sex)	11	10
Cross generational sex	11	9
Forceful sexual intercourse (an adolescent is the victim)	11	9
Early sexual debut	10	8
Multiple sexual partnerships	9	6
Unprotected sexual intercourse	8	8
Males having sex with males	3	5
Forceful sexual intercourse (an adolescent is the perpetrator)	5	1
Prostitution	3	2
Other forms:		
Sexual harassment	3	0
Sex under influence of drugs	1	0

Social Environment factors

Health services. The current state of ASRH services was perceived as critical in both protecting from and in generating higher risks of SRB for adolescents in Kilifi. This was dependent on the extent to which the participants perceived accessibility, quality and comprehensiveness of these services within the county. Where young people and key informants perceived ASRH services in Kilifi to be poor in quality and not adolescent-friendly, they expressed fears about seeking these services at government health centres. Some adolescents described that their peers chose to take condoms from health facilities at night when no one would notice. Poor prioritization of adolescent specific services by sexual health service planners and providers was also described as underpinning SRB. Further, a lack of effective behavioral change communication methods and forums for girls to learn about contraception and safe sex was discussed:

> *It is like educating the youth about this issue (AIDS) has been neglected… many people here assume contraceptive matters are for those who already have children" (Group 11, male, community representative).*

> *We talked to the girls and we said they need a professional counselor. And I think they also need some clips to show (referring to audio-visual ASRH messages), if they see unlike just hearing, I think they change their mind (KI, secondary school teacher, female, 32 years).*

However, accessibility to ASRH services was also discussed as a protective factor by both young people and stakeholders. During their discussions, a mix of ASRH services and their providers were identified by the participants. For example, adolescents mentioned private clinics, public health facilities and peer educators as sources of services such as condoms, ASRH information, emergency contraceptives (e-pills) and long-term birth control methods. The key informants also mentioned similar examples in addition to teens' club, condom dispensers in recreational places such as pubs and the chief's office as sources of ASRH.

Social events. Particular social events, especially traditional ceremonies like parties at funerals and weddings, were often perceived as occasions during which many adolescents might either engage in SRB or face a risk of sexual exploitation. During such events unprotected sex, sexual violence, cross generational sex and other behaviors were described as common, related to limited monitoring by parents and other authorities, and the use of drugs and alcohol:

> *…. in that matanga (a local word referring to funeral ceremonies), there is free sex. …You see it is a chance for these adolescents to engage in sex. You don't care about who your partner is because it is like a sex orgy (KI, secondary school teacher, female, 51 years).*

Economic activities. Engaging adolescent girls in potentially unsafe economic activities, particularly businesses selling alcohol was cited. Girls are asked by their parents to serve in such business which sometimes is the family's main source of income or they find employment in other alcohol serving premises where they encounter various forms of sexual advances and harassment from male patrons:

> *Some women involve their girls in their business of selling mnazi (a local alcoholic brew) even overnight. …as the young girls interact with the drinking customers they might be raped (Group 3, males, rural secondary school).*

But what the older women do now, they call young women to come around to help in serving; just as a way to attract the wazee (meaning older male patrons) (KI, CBO employee, male, 27 years)

… and they do not drink the beer, but the men there can get the girls (KI, secondary school teacher, female, 51 years).

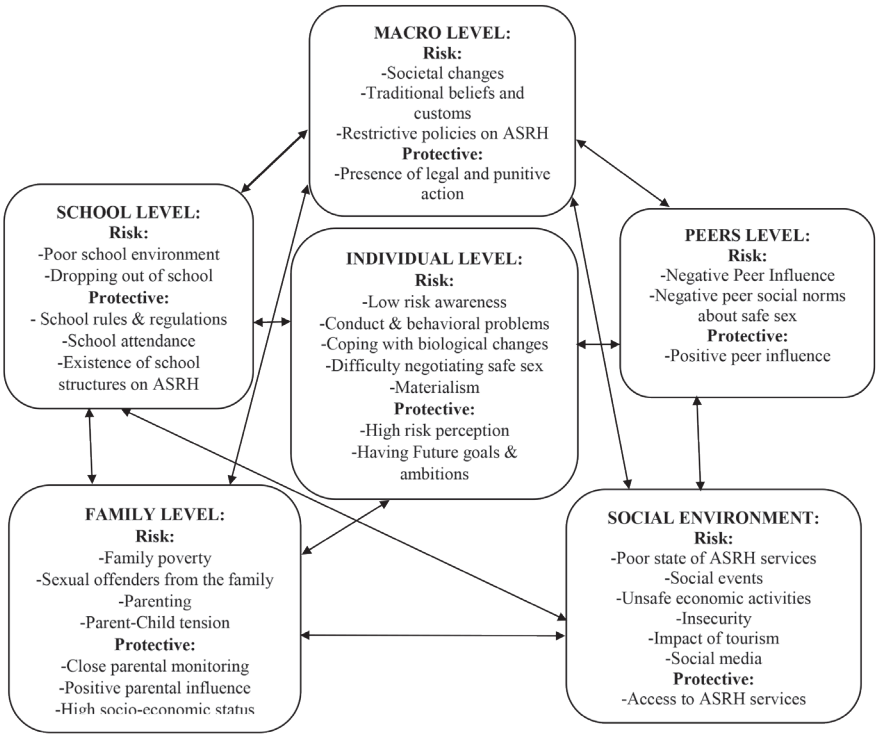

Figure 4.1. A diagram of young people's and stakeholder's perceived risk and protective factors for sexual risk behavior among adolescents living in Kilifi County

Insecurity. Adolescents and young adult participants described forms of insecurity within their neighborhoods as risk factors for sexual violence, including that sexual crimes often happen in evenings or at night, for example when girls walk home late from school, or on routes to social events that young women attend:

They look for school girls and they know that those girls come out of school late in the evening, so they hide somewhere during those hours... to threaten the girl. (Group 2, female, rural primary school).

...if a person is sent to the shop at night or a girl might be sent, by bad luck she comes across boys who take her by force and rape her (Group 6, female, peri-urban primary school).

The tourism industry. This industry was perceived by some young people and stakeholders as having a substantial impact on adolescent SRB in Kilifi. The presence of tourists was seen as increasing risks of sexual exploitation of minors locally. In addition, some young people were described as seeking sexual relationships with tourists, based on perceptions of financial benefits that would follow:

...the girls might have more elderly people; the wazungu [a term used locally to refer to Caucasian people] ..., because they have a good figure, when they go there to the beaches, the wazungu get attracted to them then the wazungu start (meaning sexual relationships)... because the most people believe that wazungu have more money than the locals (Group 5, male, peri-urban primary school).

Social media. Increased access to certain forms of social media and digital communication platforms was considered a predisposing factor for SRB. Some adolescents were thought to have easier access to sexual networks through these channels, especially when they owned mobile phones or had access to social media platforms like Facebook ©. In this situation, 'grooming' was also described as a potential risk:

...in other cases you may meet someone in Facebook. You may become friends in that you arrange for dates. The person may turn not who you expected and he may force you to have sex (Group 8, female, peri-urban secondary school)

Other participants suggested that SRB is influenced by watching videos and movies with pornographic content.

To a lesser extent, some additional social environmental risk factors were mentioned and these included: observing and learning SRB from other community members; and also the geographical area of residence was thought to influence SRB although both rural areas and more urbanized areas were described as increasing risk by different participants. Some key informants and young people felt that female adolescents living in the rural part of Kilifi are more likely to face injustices of sexual exploitation like early marriage and coerced sex. However, one key informant also felt that Kilifi town's fast rate of urbanization can be linked to increase of various cases of SRB such as prostitution.

Individual level factors

Low risk awareness. Adolescents were seen to have low awareness of the risks of contracting sexually transmitted infections through unprotected sexual activity, a characteristic associated with SRB. It was shared that, for many sexually active adolescents, the fear of getting pregnant was greater than that of contracting sexually transmitted infections. In this situation, adolescents were seen as more likely to use birth control methods, such as emergency contraceptive pills, that give little or no protection against sexually transmitted infections instead of using condoms. Moreover, adolescents were seen to make judgements in ways that reflected their immediate concerns and interpretations of risk, and were not necessarily well informed:

> *…we got 5 girls who told us… What they use is the morning after pills. They said, "We fear giving birth unlike contracting HIV/AIDS. With HIV/AIDS, we know after getting it, there are ARVs. Life will continue, but with the baby, I think our dreams can be shattered." (KI, secondary school teacher, female, 32 years).*

> *Some boys may assume that a girl is free of diseases depending on where they come from or who they have slept with, and not use protection. When they have some doubts or they know of a girl's relative who is sick that is when they may use protection (Group 3, male, rural secondary school).*

However, a few adolescents felt that some adolescents possess a high perception of risk for HIV infection or unwanted pregnancy, and as a result they may refrain from risky sexual practices like unprotected sex.

Coping with and response to biological changes. Many young people perceived that adolescents face challenges in coping with their own physical and psychological developmental changes during adolescence or those of their opposite sex. These may influence their responses, sometimes in ways that predispose them to SRB. In relation to physical changes, some described that the development of secondary sexual characteristics in young women could increase the risks of their becoming targets for sexual harassment. It was thought that some young men may experience a very strong sexual attraction to girls who have developed secondary sexual characteristics in ways that they (the men) find difficult to control.

> *So the girls might have big breasts and the hips. So when a boy sees that, he might have that feeling to go and have sex." (Group 5, male, peri-urban primary school).*

Other biological risk factors for SRB described by participants included: (i) age, where older adolescents were seen as more likely to take risks than younger adolescents; and (ii) personality characteristics, for example, that being adventurous may involve exploring new experiences that predispose to SRB.

Difficulties in negotiating safe sex. Some young people and stakeholders perceived that adolescent girls often do not have control over the way that sexual relations are conducted, and therefore face challenges in negotiating safe sex. These challenges were seen to result from men's (who in many cases are older) direct refusal to use condoms or due to manipulation and accusations about unfaithfulness from the male partners:

> *The girls usually prefer using protection but some of the men are the ones who refuse. Very few men use protection (Group 6, female, peri-urban secondary school)*

Conduct and behavioral problems. Some young adults and students perceived conduct and behavioral problems, for example disobedience, and failing to follow parental guidance or teachers' instructions, as risk factors for SRB among adolescents. Likewise, alcohol and other substance use behavior was also seen as predisposing to SRB.

Materialism. Some participants described materialism as an attitude underpinning individual sexual risk behavior, referencing (as before) that sex may be seen as a form of transaction, allowing adolescents to acquire goods they could not otherwise afford:

> *So because a boy has promised to buy you heels, a pair of heels and another one has promised to be doing for you all your makeups … every boy will propose to you for as long as he will meet your daily needs…" (Group 6, female, peri-urban primary school)*

Family level factors

Family poverty. This was widely perceived to predispose adolescents to SRB. Poverty was described in terms of a failure by caregivers to provide for a young person's basic needs such as school fees, clothing, food, sanitary pads to adolescent girls, transport fare, and pocket money. As before, this can lead adolescents to engage in transactional sex to acquire these necessities:

> *Like when we girls are on our periods and you have requested your parents to give you money but they refuse, at that point you really don't know what to do so you are forced to go out and search from the sugar daddy (Group 2, female, rural primary school).*

Characteristic of family poverty, overcrowding and poor housing were also linked to a lack of privacy that may lead adolescents to learn about and imitate their parents' sexual behaviour at an early age:

> *The environment a child is brought up in matters. If they are raised in a small room where the parents sleep with them they get to learn about sex from watching their parents (Group 1, male, rural primary school).*

Sex offenders being close family members. Perpetrators of sexual violence were also perceived sometimes to be close family members. These views were shared by young people and stakeholders who described that a number of cases of forced sex, incest and sexual harassment are perpetrated by family members; most of whom are fathers, step fathers or male siblings:

> *Most of the perpetrators (of sexual crimes)….are known people, it can be a cousin, a brother, even can be a father (KI, medical social worker, male, 27 years).*

Such crimes were often thought to be revealed long after they have occurred. In addition, children were seen to be particularly vulnerable to these forms of sexual exploitation since they were dependent on their parents for all their basic needs:

> *In my view, also parents molest their kids. Also, the kid fears that in case the parent gets caught, she has nobody to provide for her (Group 4, female, rural secondary school).*

Parenting. As the preceding paragraphs indicate, the form that parenting takes was perceived as important in both protecting from and in predisposing adolescents in Kilifi to SRB. While some parents' behaviors could directly put their children at risk of sexual exploitation, both young people and other stakeholders in this study felt that parents' roles were very important in guiding their children towards behaviors likely to be protective against SRB. Positive parental influences included encouraging sexual abstinence and keeping track of their children's movements, friendships and pastimes. As an example of mothers modelling responsible contraceptive practices, a female peri-urban secondary school student explained,

> *They will get to know about family planning pills from their mothers… so they buy them to avoid pregnancies…. they are buying those medicines because their mothers have shown them… (Group 8, female, peri-urban secondary school).*

Showing complexity in the way that parent-child relationships could impact SRB, some participants noted that adolescents may be reluctant to utilize certain ASRH services because this could cause tension between them and their parents. In addition, a few participants felt that parents at times may pressurize their children into risky behavioral choices such as early marriage.

Peer level factors

Peer influence. For many of the risk factors described earlier, peer influence or pressure was perceived as an important additional influence on adolescents' behavior. Young people explained that some adolescents may have friends who engage in some forms of SRB, and for them to fit into the group, they may engage in such forms of risky behaviors. This influence is coupled with negative peer social norms surrounding the use of contraceptives. These views were also shared by stakeholders:

One was maybe influenced by a friend who practiced these sexual behaviors, then find him/herself trying to practice the same (Group 4, female, rural secondary school).

Most of the young girls who have no money supply, they usually get influenced by their colleagues to have sex for money (KI, CBO employee, male, 27 years).

At the same time, peer influence was seen to sometimes, if less often, to act in positive ways. As a key informant explained:

...there were 3 youngsters who were around the ages of 15, 13. ...then they were talking about how the boy should get condoms and carry the condoms with him if he wants the girl (KI, secondary school teacher, female, 51 years).

School level factors

School environment. Young people and stakeholders perceived the school environment as a source of both protective and risk factors for SRB among adolescents in Kilifi. Risks related to the school environment were seen as important potential risk factors. Some adolescents described situations where school teachers have sexually abused students:

There is a child in one of the schools in Kilifi.... she was raped by a teacher. That teacher was making her stay behind all the times and then the girl did not know because she was young ... she was in class six... (Group 6, female, peri-urban primary school).

Some key informants also described sexual relationships between pupils at school as an important and common risk factor for sexual health. One clinician explained this situation as follows:

...especially when school opens, like in September when ... there are burst condoms, unprotected sex and increase in prostitution (KI, clinician, female, 30).

In connection to protective benefits, some adolescent boys attending primary schools in peri-urban areas felt that enforced rules and regulations would make sure that students focused on their studies, and would be less likely to engage

in SRB. School attendance itself was perceived by young people as a protective factor, through enhancing ASRH knowledge and prompting safer sexual behavior. Additionally, some stakeholders felt that specific school structures or programs with an ASRH aspect offered significant protection against SRB, including school clubs, and school counseling and guidance services. As one school teacher explained,

> *You see also in our school, guidance and counseling is being emphasized. …we are encouraging them, we have this club of child rights. And we also have some signs which we are looking at from the girls. It is easy to identify that such a girl is undergoing torture; may be sexual abuse, physically, psychologically." (KI, primary school teacher, male, 48 years)*

School dropout. Furthermore, dropping out of school was discussed in a few adolescent FGDs as contributing to sexual risk-taking. For this group, the difficulty in finding paid employment typical of the area could lead adolescents to take on transactional forms of sex to obtain gifts or money.

Macro level factors:

A few participants (including two teachers, two CBO employees and a clinician) discussed macro level risk factors, that is, factors that operate at a population level.

Societal changes. Among the macro level factors noted was the perception that a set of changes in society over time have together promoted risky sexual behavior. These changes included that adolescents normalize early sexual behavior, a deteriorating quality of parenting and a general sense that society has lost its moral basis. As one key informant shared,

> *I can go to a rural place there, and am sure this lady has a boyfriend or is married, but if I have money I can just take the lady from him… that is the problem with the society now days. It is about you being financially stable. It is not about the traditions and morals anymore (KI, CBO employee, male, 27 years).*

Restrictive ASRH policies. Also, some policies surrounding ASRH were considered restrictive. Some stakeholders explained that although there is demand by adolescents for certain ASRH services, like longer term contraception, the present policy framework prohibits provision of such services to those under 18 years:

> *This injection that women get. In fact it is the most preferred contraception among the girls….the private doctors will give them. It is an illegal thing but you realize that most of the girls will be using it (KI, secondary school teacher, female, 51 years).*

Another participant who is a clinician also stated,

> *…the issue was with the policies. We couldn't give contraceptives to those under 18 (KI, clinician, female, 30 years).*

Traditional customs and beliefs. Some key informants suggested that certain traditional beliefs and customs, particularly those encouraging early marriage, may infringe adolescents' rights and freedom of choice, as well as predispose to SRB. As described earlier, this issue also acts at the level of the family, highlighting diversity between family contexts and the interrelated nature of categories within the Ecological Framework drawn on in this article:

> *One which is common is the old men taking young girls. In our culture that is very common. The Mijikenda men, they believe that after a certain age such as 40 and above, a man should have a younger wife. We call such a wife Kiboma (KI, primary school teacher, male, 48 years).*

Legal and punitive action. Some young people and key informants shared the views that presence of legal and punitive action for sexual crime perpetrators partly helps to minimize sexual related violence and other forms of SRB. They gave various scenarios in which the local authorities such as the local police and Chief's office took action when such crimes were reported in Kilifi. One for example narrated,

Somebody sleeps with his own daughter… until she becomes pregnant, the case is taken to the Chief… There is one who was imprisoned just the day before yesterday (Group 11, male, young adult).

Discussion

Young people and stakeholders' perceptions suggest that a range of SRBs occur amongst adolescents in Kilifi, especially transactional sex, early sexual debut, unprotected sex and multiple sexual partnerships. Similarly, sexual violence is reported as common and the adolescent girls seem to bear the brunt. The occurrence of SRB and violence among Kenyan adolescents (Juma et al., 2014, Marston et al., 2013) and adolescents from other parts of SSA (Moore et al., 2007) is widely documented. Our findings support those of reports from the Kenya Demographic and Health Survey (KNBS, 2014) that show a high occurrence of teenage pregnancies and payment for sex in Kilifi County, although this health survey data did not comprehensively explore factors underlying these behavioral patterns.

Our findings also indicate that the social environment presents a milieu for a majority of the risk factors. Significant among these factors is the lack of pragmatic youth-friendly ASRH services. We suggest that the difficulties in safe sex negotiation, and insufficient knowledge and misconceptions about sexual health described by participants in this study are likely consequences of poor ASRH services. Similar to our findings, socio-psychological factors such as concerns about confidentiality, fear and embarrassment, and poor accessibility and unaffordability have been described as serious bottlenecks for youth-friendly services targeting adolescents from Kenya (Godia et al., 2014, NCAPD et al., 2011) and across SSA (Geary et al., 2014, Biddlecom et al., 2007). With only 7 percent of Kenyan health facilities providing youth-friendly services (NCAPD et al., 2011), the need for comprehensive adolescent-friendly ASRH remains urgent.

Furthermore, our participants' views underscore the devastating impacts of household poverty on ASRH. These effects are cross-cutting and may link to certain social environment factors like engagement of adolescent girls in risky commercial activities, dropping out of school and sexual exploitation of adolescents by tourists following the pursuit for financial and material gains. Likewise, poverty may propagate materialistic tendency portrayed by some adolescents as earlier reported under the individual level factors. Indeed, survey data from across Kenya shows that adolescents from the most poor households are most likely to be engaged in sexual activity and not to be using contraceptives both in rural and urban areas (KNBS, 2014). Although this is the case, the evidence is mixed in that some studies indicate that household

income may or may not predict certain forms of SRB and that these effects may vary from one country to another, or by sex and age of the adolescent (Handa et al., 2016, Berhan and Berhan, 2014, Madise et al., 2007). This points to a need for more research to delineate the effects of household income on adolescent sexual health.

Additionally, parenting style was another topic of discussion with views that 'neglectful' parenting predisposes adolescents to SRB, and that there are opportunities for parents to support safer behavior in relation to sexual health. We propose that this factor is linked to other perceived risk factors such as: negative modeling; school drop-out; and attendance at 'risky' social events. Correspondingly, a study from rural western Kenya identified poor caregiver monitoring as a predisposing factor for SRB among adolescents (Puffer et al., 2011). To this end, findings from other parts of SSA also indicate that low levels of parental monitoring and poor parent-adolescent communication are associated with elevated risk of adolescent sexual activity for both male and female adolescents (Biddlecom et al., 2009). This highlights the need for SRH interventions to incorporate aspects of parental or care-giver involvement.

The current findings also suggest that insecurity within the community facilitates the occurrence of various forms of sexual violence, especially against adolescent girls. More worrisome is that home and school environments where the majority of the adolescents spend most of their time are perceived as unsafe. These views are consistent with other findings from Kenya which indicate that home environment may often be unsafe for adolescents and that perpetrators of sexual crimes are most likely to be close family members such as fathers and siblings, or peers and teachers at school (UNICEF et al., 2012, Ruto, 2009).

Emerging from these issues, our findings highlight that gender inequality is a major concern in relation to adolescent SRB and human rights more broadly. In our data, varying risk factors associated with gender cross ecological domains to reinforce susceptibility to SRB especially for the female adolescents. Among these risk factors are the Mijikenda patrilineal culture that supports male dominance, thereby creating power asymmetries at environmental and family levels; poverty that disproportionately exposes girls and young women to sexual harms and exploitation; and gendered cultural practices such as early girl marriage. Gender inequality has also been highlighted in other studies from Kilifi with examples such as maternal blame for health problems within the family and the lack of autonomy for females to participate in certain health

programs without permission from men within the household (Marsh et al., 2011, Kamuya et al., 2015). These findings emphasize the need to incorporate an intersectional perspective (Shields, 2008) in delineating the cross cutting influence of gender for risk factors surrounding ASRH. This is important because differences in individual's control over resources and power are often embedded within social identities such as gender, age, and ethnicity (Shields, 2008). These power dynamics can generate unfair or negative beliefs, attitudes and values surrounding sexual behavior.

Our findings also underscore the enormous impact of negative cultural beliefs, norms, and customs on adolescents' SRB. Their views indicate that some existing customs and beliefs such as early marriages infringe on adolescents' rights and freedom while others practices during events like burial ceremonies predispose them to high risk experiences. These experiences concur with findings from other parts of Kenya (Juma et al., 2014, Njue et al., 2009) as well as SSA (Wadesango et al., 2011, Boyden et al., 2012), where such practices have been linked to poor health and social livelihood. Thus, ASRH interventions need to consider the specific socio-cultural dynamics that impact adolescents' sexual health.

Concerning protective factors, few opportunities were discussed by participants and this may reflect the poor state of ASRH services in this region or a general lack of awareness of available services and structures for ASRH. Nonetheless, some participants acknowledged the existence of certain protective factors, especially school-based ASRH services and structures like teen clubs, guidance and counseling teachers, and functional school regulations. Indeed, school attendance has been attributed with large protective effects for early sexual debut among Kenyan adolescents (KNBS, 2014, Handa et al., 2016), which emphasizes the need to enable school attendance and strengthen existing school structures by incorporating opportunities for ASRH promotion. There is a need to identify and strengthen both formal and informal systems that can be protective and promotive factors for ASRH in our context and similar contexts.

Besides, much as ASRH services are not yet comprehensive or adolescent friendly (NCAPD et al., 2011), access to some form of ASRH services remains an important protective factor. These findings indicate that there is a mix of private, non-profit organization and public service providers offering a range of ASRH services like short and long term contraception methods. While some

of these services are free or subsidized for adolescents, more needs to be done in making the relevant ASRH services more usable, accessible and affordable for adolescents. These are also major issues that adolescents grapple with from other parts of SSA and the rest of the world, and have been earmarked for much needed intervention (Bearinger et al., 2007).

These findings highlight the perceived importance of legal or punitive action for sexual offenders in handling and addressing sexual violence and injustices against adolescents in Kilifi. Indeed, the Kenyan laws on sexual offences have been recently amended (Ndungu, 2007, NCLR, 2014) to extensively define sexual violence beyond mere focus on morality. New themes that had not been clearly addressed in the older laws include criminalization of sexual harassment, child sex tourism, child pornography, gang rape, incest, and child prostitution (NCLR, 2014). There are also provisions for the protection of vulnerable witnesses, entitlement of both victims and perpetrators to treatment and professional counseling, and long-term supervision of dangerous sexual offenders after serving their prison sentences (NCLR, 2014). Notwithstanding, sexual crime is still problematic in Kilifi (NCRC, 2014), and this may partly be tied to low levels of awareness by the public about their rights and existing laws on sexual crime but also low levels of awareness by key stakeholders such as police and public administrators who are in charge of implementing these laws (Ndungu, 2007). Overall, while evidence surrounding the effectiveness of legal action for sexual perpetrators remains scanty, especially in the SSA context, restorative justice or human rights approaches for handling sex offenders are clearly important (McAlinden, 2005, Ward et al., 2007).

This study has several strengths. Our participants were a diverse mix of adolescent sub-groups, that is, primary and secondary school adolescents, those who had dropped out of school and adolescents living with HIV. They were also recruited with a representation of both rural and peri-urban settings in Kilifi County. In addition, findings were triangulated across the different methods used to consider those from FGDs and key informants. At the same time, in interpreting our findings, it's important to take account of limitations for this study. First, the views shared by our participants may be specific to adolescents living in Kilifi at the Kenyan coast. Although similar views about SRB may be shared from other geographical contexts, we are not in position to ascertain the relevance of these findings to other groups or populations. Additionally, as for qualitative methods in general, data collection, analysis and interpretation are subject to individual influence; we have countered this

effect through maintaining reflexivity and ensuring the active contribution of a multi-disciplinary research team in all stages of this research.

Conclusion

Our findings stress that SRB is a significant problem among adolescents at the Kenyan coast. Many of our findings highlight the generalizability of risk factors that have been documented in studies in other regions of Kenya and beyond, particularly the gendered nature of such risks. However, novel risk factors in the Kenyan coastal context include: the negative impact of the tourism industry on adolescents' sexual behavior, the severe implications of family poverty such as engagement of adolescent girls in risky commercial activities, and the negative consequences of certain customary events like funeral ceremonies. Moreover, these factors coexist or interplay across different ecological levels. Important measures to counter SRB in this and similar contexts are likely to include the following: useful and accessible ASRH services for adolescents; improved safety within the adolescents' neighborhood, home and school environments; responsible parenting; tackling oppressive and potentially harmful cultural norms and customs; ensuring that legal and other regulatory processes are recognized and enacted in these settings; and addressing poverty within households. Gender inequality remains a major concern that should be explored and addressed with special attention to the intersectionality of its aspects across ecological domains. Opportunities for improving ASRH exist. First, many Kenyan adolescents are school goers and thus could be accessed with a range of ASRH services through the education system. Second, a presence of diverse private, public, and civil society service providers in the region presents existing platforms for resource mobilization and through which improvement in access plus quality of ASRH can be realized. Third, a comprehensive legal framework and national guidelines for management of sexual violence in Kenya exist and thus need more public awareness and more effective implementation. To this end, intervention research should focus on delineating effective program and policy action to tackle these drivers of adolescent SRB at different ecological levels in Kilifi and other geographical settings.

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Acknowledgements of authors' contributions

DS designed the study, developed the tools, coordinated and took part in data collection, conducted the coding/data analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript as submitted. P.N.M took part in data collection, coding/data analysis and approved the final manuscript. V.M revised the manuscript and approved the final manuscript. I.J took part in data collection and approved the final manuscript. A.vB revised the manuscript and approved the final manuscript. C.R.N was involved in the protocol development, revised the manuscript and approved the final manuscript. A.A designed the study, revised the manuscript and approved the final manuscript.

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Chapter 5

Perspectives on underlying factors for unhealthy diet and sedentary lifestyle of adolescents at a Kenyan coastal setting.

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Abstract

Unhealthy diet and physical inactivity are among the key modifiable risk factors for non-communicable diseases such as diabetes and cardiovascular disease. Although such diseases often only appear in adulthood, these behaviors are typically initiated or reinforced already during adolescence. However, knowledge on underlying factors for adolescents' unhealthy dieting and physical inactivity in sub-Saharan Africa (SSA) is poor.

We conducted in-depth interviews and focus group discussions to explore the perceptions of a diverse group of 78 young people of 10-19 years of age, which also included some adolescents living with HIV, as this is an emerging group in the HIV/AIDS epidemic in many parts of SSA. In addition, 10 stakeholders, such as teachers, clinicians and staff from organizations at the Kenyan coast and seven young adult community representatives informed us on: (i) adolescents' unhealthy food choices and their forms of sedentary behavior; (ii) predisposing factors; and (iii) protective factors against unhealthy food choices and sedentary behavior of adolescents living in Kilifi County.

The findings reveal that adolescents occasionally access nutritious foods like fruits, vegetables and animal protein. However, there is a growing tendency to consume unbalanced diets with high intake of carbohydrates, oily foods and consumption of sugar dense processed foods and drinks. Sports and domestic chores were found to be major sources of physical activity. Sedentary lifestyles characterized by sitting long time and chatting, watching sports games and movies were described. Adolescents living with HIV did not indicate any divergent perceptions from those of other adolescents relating to diet and physical activity, but mentioned health related conditions such as, medication, asthma and low body weight as a risk factors for sedentary lifestyle. Using a Socio-Ecological model, our findings suggest that risk factors are numerous and inter-related, especially at intrapersonal, interpersonal and community level. The negative influences at an intrapersonal level were: body image concerns, attitudes and misconceptions, substance use behavior, and taste for unhealthy foods. In the interpersonal domain, household poverty and parenting practices that condone unhealthy habits were identified risk factors. Availability of affordable unhealthy foods, high prices for nutritious food, farming practices, gambling, and influx of transportation alternatives in the community were interrelated but also had relationships with intrapersonal and interpersonal risk factors. Modernization and poor implementation of policies were discussed

as enabling factors especially by stakeholders from a societal perspective. Seasonality and farming practices, school attendance, community-based services, and regulations mitigating adolescents' engagement in gambling were identified as potential protective factors.

Our findings provide a unique qualitative insight of the factors underlying adolescents' dietary and sedentary lifestyle and highlight the need for ecological intervention approaches to address these forms of health risk behavior in a rural African setting.

Introduction

Poor dietary behavior and insufficient physical activity rank among the key risk factors for the non-communicable disease (NCD) burden, such as diabetes and cardiovascular disease (Beaglehole et al., 2011, PRB, 2009). Although such diseases often appear in adulthood, their associated behaviors are typically initiated or reinforced already during adolescence (10-19 years) (Neumark-Sztainer et al., 2011, Jasik and Lustig, 2008). To this end, a global strategy on diet, physical activity, and health was endorsed by the World Health Organization in 2004, with the aim of increasing awareness, guiding policy, and action plans, monitoring underlying factors and thus reducing the risk of NCD that stem from unhealthy diet and physical inactivity (WHO, 2004). It is more than a decade since this global strategy was endorsed and yet almost 81% of the global adolescent population is insufficiently physically active and policies to reduce this current state were operational in just 56% of the WHO member states as of 2013 (WHO, 2017). Studies have suggested a rapid global nutrition shift from consumption of traditional diet or staple foods rich in starch, plant protein, and dietary fiber towards a less healthy diet linked to NCD (Popkin, 2006, Steyn and Mchiza, 2014). Adolescents are vulnerable as they progressively gain more control of what, when, how and where they eat; moreover their preferences and personal choices may gain priority over eating habits that are nurtured within the family setting (Delisle, 2005).

In sub-Saharan Africa (SSA), which is home to 19% of the global youth population (UN, 2015), the burden of NCD is projected to have the greatest increase compared to any other region by 2030 (PRB, Steyn and Damasceno, 2006). Already, research has pointed to an increasing trend in overweight and obesity overtime among adolescent girls and boys from SSA (Muthuri et al.,

2014a), which potentially suggests early initiation of poor dietary behavior and physical inactivity. In a systematic review, higher body weight was reported among girls compared to boys and for both groups staying in an urban setting and in households of higher socio-economic, status was linked to greater risk for overweight (Muthuri et al., 2014a). In comparison to urban school-aged adolescents, their rural counterparts engaged in more active transportation like walking to school and spending more time in activities of daily living such as domestic chores, although the urban dwellers engage in more organized sports activities (Muthuri et al., 2014a). Furthermore, a report that compiled studies from the African region on risk factors among young people (age 10-24 years) stressed the current scarcity of data particularly on physical inactivity and unhealthy diet in this region, which presents limitations towards intervening with the unprecedented rise in NCD burden (Bureau, 2009). Rapid urbanization characterized by changes in traditional transport modalities, more hours spent on socio-media, and influx of less healthy commercialized food options are linked to poor diet and physical inactivity in SSA. Other underlying factors of poor diet and physical inactivity in SSA include individual level factors, such as preferences, attitudes and beliefs, cultural practices, agricultural practices, political environment, price, availability and accessibility (Steyn and Damasceno, 2006, Muthuri et al., 2014a, Muthuri et al., 2014b). Furthermore, adolescents living with HIV are an emerging group in HIV/AIDS epidemic in many parts of SSA (Lowenthal et al., 2014). Their HIV status adds a burden to their development, including issues of health risk taking behavior, and food insecurity (Woollett, 2016). This sub-population, therefore, needs to be included when thinking about health policies and designing studies on health behavior.

Kenya is among the countries within SSA where a transition in physical activity and nutrition has been documented (Steyn et al., 2012, Keding, 2015, Onywera et al., 2012) and it is the country of focus in this study. Adolescents in Kenya bear the brunt of this transition as national survey data shows that 61% of adolescent girls and 36% of the adolescent boys (15-19 years) do not optimally engage in continuous physical (KNBS and Macro, 2015). Prevalence of overweight was also documented at 11% among the adolescent girls (KNBS and Macro, 2015), and other studies indicate an increasing consumption of processed foods in Kenya (Rischke et al., 2015). Disproportionately higher prevalence of physical inactivity and overweight have been documented at the Kenyan coast. For instance a prevalence of 71.9% of physical inactivity among adult women (15-49 years) at the Kenyan coast was much higher than

that in the Western (39.1%) and Nyanza (51.4%) regions of Kenya (KNBS and Macro, 2015). This stated, research on the topic of diet and physical activity within the Kenyan context has not focused explicitly on adolescents, despite systematic investigation of the underlying factors for this burden (Steyn et al., 2012, Keding, 2015, Onywera et al., 2012, KNBS and Macro, 2015, Rischke et al., 2015). Furthermore, research focused on diet and physical activity behavior of Kenyan coast dwellers remains limited. In such coastal settings where the majority of the population resides in peri-urban and rural settings characterized by extreme poverty (17), there is an urgent need for a systematic investigation of which factors and how they influence young people's diet and physical activity. Specifically, published research is almost non-existent among adolescents at the Kenyan coast and yet this developmental period is a window of opportunity during which interventions can readily contribute to breaking a vicious cycle of poor dietary behavior, sedentary lifestyle, poverty and chronic disease (Delisle, 2005, Bureau, 2009, WHO, 2004).

To improve understanding of the underlying factors for poor dietary and physical activity in adolescents, and to guide the design of suitable interventions to tackle such behaviors, it is crucial to utilize a robust approach such as the ecological model (Bronfenbrenner, 1977). To address this gap, we first conducted a qualitative study with an ecological approach to understand young people's and stakeholders' perspectives on unhealthy diet and sedentary lifestyle of adolescents (10-19 years) in Kilifi County at the Kenyan coast. To inform future work, which will involve health risk behavior tool adaptation and validation for adolescents in Kilifi, this study's participants comprised of a diverse group of young people, such as school going adolescents, adolescents living with HIV and adolescents who had dropped out of school from Kilifi County. Specifically, we explored perceptions regarding: (i) adolescents' unhealthy food choices and their forms of sedentary behavior; (ii) predisposing factors; and (iii) protective factors against unhealthy food choices and sedentary behavior among adolescents. We explore the variety and the convergence of the participants' perspectives and the factors underlying unhealthy diet and sedentary lifestyle of adolescents within this setting.

Theoretical framework

This study draws on the Social Ecological model by McLeroy and colleagues (1988) to examine the factors underlying unhealthy diet and physical inactivity of adolescents in Kilifi. The model borrows from earlier work of Bronfenbrenner (1977), which explains that human development is influenced

by a multi-person system of interaction and several aspects of the environment beyond the immediate situation of the individual. The Social Ecological model hypothesizes that there are 5 levels that interact to determine human behavior: intrapersonal factors that comprise biological and personal history factors like attitudes, income, education level and knowledge; interpersonal factors which include support systems like family, and friendships, and formal or informal social networks; institutional factors which include social institutions with organizational characteristics, formal or informal rules and regulations; community factors which involve relationships among informal networks, organization, and institutions; and public policy factors which include local, state and national laws or policies. For the purpose of our study, we merge the institutional and community factors into a single level that we refer to as community or institutional factors. The use of the Social Ecological model has gained popularity and it has been used in various public health studies for instance on chronic diseases (Bae et al., 2008, Schwartz et al., 2011) and substance use behavior (Connell et al., 2010, Vantamay, 2009).

Materials and Methods

Participants

This study encompassed of two groups of participants: 78 adolescents and informants, consisting of young adult community representatives and 10 adults working with adolescents in Kilifi county, for example, employees of community based organizations (n=4), teachers (n=3), county government staff (n=1), and clinicians (n=2). More details of the participants are provided in the results section (see **Table 5.1**).

Procedures

This specific study was part of a larger qualitative study conducted between August and November 2016 at KEMRI-Wellcome Trust Research Programme (KWTRP). The study was conducted in Kilifi County at the Kenyan coast, specifically within the Kilifi Health and Demographic Surveillance System (KHDSS) (Scott et al., 2012). A detailed description of the recruitment of study participants and data collection procedures for this qualitative study has been documented elsewhere (Ssewanyana et al., 2018). In summary, a snowballing process was used to recruit the study participants. A small number of researchers at the KWTRP in Kilifi whose work involved adolescents were initially contacted and they recommended additional key informants with

experience working with adolescents in the similar setting. This process was repeated with all new interviewees so as to identify more participants sharing relevant perspectives for the study. In the schools, head teachers suggested a teacher who served as a key informant. Young adults were purposively selected as informants using an existing data base of around 200 community representatives in the Community Engagement department at KWTRP (Kamuya et al., 2013), taking into account their residential area (peri-urban or rural settings), education status, biological sex and religion so as to reflect the diversity of the population.

School going adolescents were purposively identified from two primary and two secondary schools in the KHDSS area. These schools were chosen through consultation with the Kilifi County Education Office and researchers at the KWTRP with ongoing work within the school setting. Specifically, these schools were located in either a peri-urban or rural setting, and these were day schools attended by both male and female students. Kilifi town centre was the reference peri-urban setting and areas within ten or more kilometers and having limited social services were considered as rural settings. Upper-primary school students (i.e. from Class 5 to 8) and lower-secondary school students (i.e. from Form 1 and 2) were purposively recruited from class records with a specific consideration of sex, religion, and age.

Adolescents who dropped out of school were recruited with assistance from the County department of Public Health's community support staff. Recruitment of the school dropout adolescents was done by purposively selecting them from two community health catchment units of Kilifi with consideration of age, sex and religious diversity.

The recruitment of adolescents living with HIV was done through the youth club at the HIV care clinic at Kilifi County Hospital and some were recruited directly from the community through home visits to families of HIV infected adolescents by a worker from the clinic.

All adolescents, their caretakers, young adults and key informants that took part in this study were appropriately informed about what the study entails, potential risks and benefits of their participation prior to obtaining their written informed consent.

We conducted focus group discussions (FGDs) lasting about 75-120 minutes with the adolescents and young adult community representatives. Each key informant was also administered to a 60 to 90 minutes in-depth interview at their time of convenience in a preferred venue.

The FGD guide and qualitative interview guide were both developed utilizing materials on health risk behavior from the World Health Organization and the Centers for Disease Control and Prevention documents, (WHO, 2018, CDC, 2016). We utilized an open ended question followed by further probing that asked participants to explain specific forms of risk behavior which they perceive as commonly undertaken by adolescents aged 10- 19 years who live in Kilifi. The views documented in this manuscript were spontaneous. Permission was asked from all participants to take notes and to audio record the discussions and interviews conducted.

Data analysis

Verbatim transcriptions of the audio-recorded interviews and discussions were conducted by a professional team which were later translated into English. The translated scripts were scrutinized by two authors (D.S. and P.N.M.) who also developed initial codes from *a priori* and emergent issues. Using NVivo 11 software (QSR International Ltd, Southport, UK), final coding was conducted by D.S. This was later followed by a series of discussions by the research team about the codes and consensus was reached on developing them into themes with guidance from the Socio Ecological model (McLeroy et al., 1988). A case- and theme-based approach was used to chart the data using Microsoft Excel. This framework was later reviewed, discussed and agreed upon by the research team and used as a basis for interpretation of the results. A descriptive analysis summarized participants' demographic characteristics and the perceptions identified during FGDs or key informant interviews.

Results

A stratification of the study sample by age, biological sex and education level is summarized (See Table 5.1). In total, 78 young people took part in 10 FGDs (eight of these were sex disaggregated). Also one FGD was done with seven young adults and 10 in-depth key interviews were held with three teachers in charge of student guidance and counseling; four employees of community based organizations; one County government staff; and two County hospital staff.

Table 5.1. A stratification of the study sample by age, sex and education level

Participants	**Age range (Median age)**	***N* (Sex)**	***Education level***
Primary school adolescents			
Peri-urban male students	10 – 14 (14)	7 (Males)	Class 5 – 8
Peri-urban female students	10 – 13 (12)	7 (Females)	Class 5 – 8
Rural male students	12 – 16 (13.5)	8 (Males)	Class 5 – 8
Rural female students	13 – 16 (14.5)	8 (Females)	Class 5 – 8
Secondary school adolescents			
Peri-urban male students	16 – 19 (17)	8 (Males)	Form 1 - 2
Peri-urban female students	15 – 17 (16)	6 (Females)	Form 1 - 2
Rural male students	16 – 18 (17)	9 (Males)	Form 1 - 2
Rural female students	15 – 18 (16)	9 (Females)	Form 1 - 2
Adolescents living with HIV	12 – 19 (13.5)	9 (5 Males, 4 Females)	Class 3 – Form 1
School drop-out adolescents	12 – 18 (14)	7 (5 Males, 2 Females)	Class 2 – Form 2
Stakeholder Key Informants	27 – 51 (31)	10 (4 Males, 6 Females)	University degree (5), Post-secondary level (5)
Young adult community representatives *(informants)*	22 – 28 (25)	7 (3 Males, 4 Females)	College level (4), Secondary level (2), Primary level (1)

Forms of unhealthy diet prevalent among adolescents in Kilifi

Overall, there was general agreement that certain foods are unhealthy, though favorite among adolescents at school or in the community. For example, in 72% of the FGDs and 90% of the key informant interviews, deep fried potatoes such as street prepared "viazi karai" and potato chips sold in restaurants and hotels were discussed as commonly consumed by adolescents despite being unhealthy foods. Likewise, in 55% and 70% of the FGDs and key informant interviews respectively, commercially processed juices and sugar dense confectionaries like cakes, sweets and ice-cream were discussed:

> *Here my boys and girls in class 8, you find that instead of them buying 'ugali' (staple food made from maize flour) and beans, you find them buying a bottle of juice made from that chemical (referring to a certain brand of processed juice) and deep fried potatoes (KI, primary school teacher, male, 48 years).*

Furthermore, three key informants who were secondary school teachers, and young people from 45% of the FGDs (mainly male primary school students, young adults, HIV infected adolescents and adolescents who had dropped out of school) pointed out that even when it comes to typically traditional meals, there is a common tendency for adolescents to consume an unbalanced diet, especially dense in starch or carbohydrates although this dietary practice was mainly associated with poorer households and rural dwellers:

> *For food, you ideally are supposed to be changing it now and then, but you may find the food is expensive, then you'll be forced to eat 'sima' (staple food made from maize flour) daily and not any other food (Group 10, adolescent who dropped out of school).*

Forms of sedentary behavior common among adolescents in Kilifi

Various forms of perceived sedentary behaviors were identified by the participants and these have been summarized by number of FGDs and in-depth key interviews during which these forms of behavior were discussed (see **Figure 5.1**). One noteworthy behavior is gambling, which was discussed among 36% of the FGDs especially young adults and rural primary and secondary students, and by 40% of the key informants as an emerging form of sedentary activity which takes up adolescents' time for physical activity, especially in the town centres. Among the common gambling activities mentioned were card games (locally referred to as 'kamare'), sports betting and a form of casino which they described as portable small gambling machines increasingly common in the town centres:

> *I realized it was a casino, I could count thirty boys and am sure even if you drive there now, you will find them there. They put twenty shillings then they play the casino (KI, Clinician, female, 30 years).*

Underlying factors for unhealthy diet among adolescents in Kilifi

Respondents' views surrounding both risk and protective factors for an unhealthy diet of adolescents are categorized into intrapersonal, interpersonal, community or institutional, and public policy domains of the Socio Ecological model (McLeroy et al., 1988). Overall, a comparable number of risk factors was discussed at the intrapersonal, interpersonal and community levels, with fewer issues raised regarding the public policy domain. With the exception of

the factors at the community level, there was hardly any mention of protective factors at other levels (See **Figure 5.2**).

Intrapersonal factors regarding unhealthy diet

***Individual preferences*:** Participants from 5 of 11 FGDs (primary and secondary school students, adolescents living with HIV, adolescents who dropped out of school, young adults) and three key informants indicated that the taste of certain foods, as well as their method of preparation are important factors that compel adolescents towards making unhealthy food choices. They discussed that fatty foods and processed products have an appealing taste, as compared to traditionally prepared foods:

> *Nowadays people don't like taking the traditional foods, they despise the 'mboga' (green vegetables), they say it's not sweet. So they prefer taking the junk food like pizzas. They take junk food over the traditional food (Group 6, female, peri-urban primary school).*

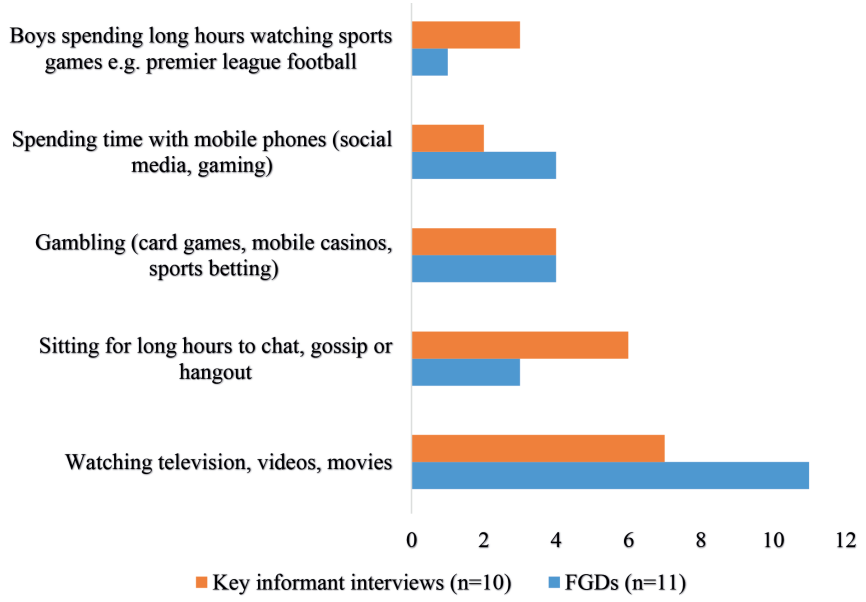

Figure 5.1. A summary of perceived prevalent forms of sedentary behavior in adolescents in Kilifi.

Attitudes and misconceptions: Particular negative attitudes were thought to discourage adolescents from consuming healthier traditional food stuff. Among those mentioned were the tendency to associate consumption of traditional foods with being a person of low social status:

> *It gives them a feeling that if you are a modern person of this era you have to take things like ice-creams and the sugary foods not knowing that its almost opposite with your health (KI, County government staff, male, 30 years).*

Disposable incomes: Two key informants (a secondary school teacher and a CBO employee) and several primary and secondary school students from three FGDs pointed out that when adolescents access money either as direct handouts from parents for upkeep or through casual labor, they can readily access the earlier discussed unhealthy foods.

> *Some parents are working for long, from morning to evening and during lunch time, they will give their child money for food. He will go and buy junk food because junk food is always ready (Group 5, male, peri-urban primary school).*

Drug and substance use: Some peri-urban primary and secondary students discussed that the loss of appetite resulting from use of addictive substances such as khat and cigarettes contributes to poor dietary behavior:

> *There are some drugs like khat which when used, you will lose the appetite of eating. So when somebody uses them and then goes to the hotel, he may even just eat one 'chapatti' (a common form of bread beaked from flour) (Group 8, female, peri-urban secondary school).*

It can be noted that some factors in this domain may co-occur or be casually related. For instance, when adolescents have disposable income, they are likely to be able to afford certain unhealthy diets and may use substances which may negatively impact on their dietary behavior.

Interpersonal factors regarding unhealthy diet

Household socioeconomic status: In 46% of the FGDs (rural primary and secondary students, adolescents living with HIV, adolescents who dropped out of school and young adults) and in 30% of the key informant interviews, the

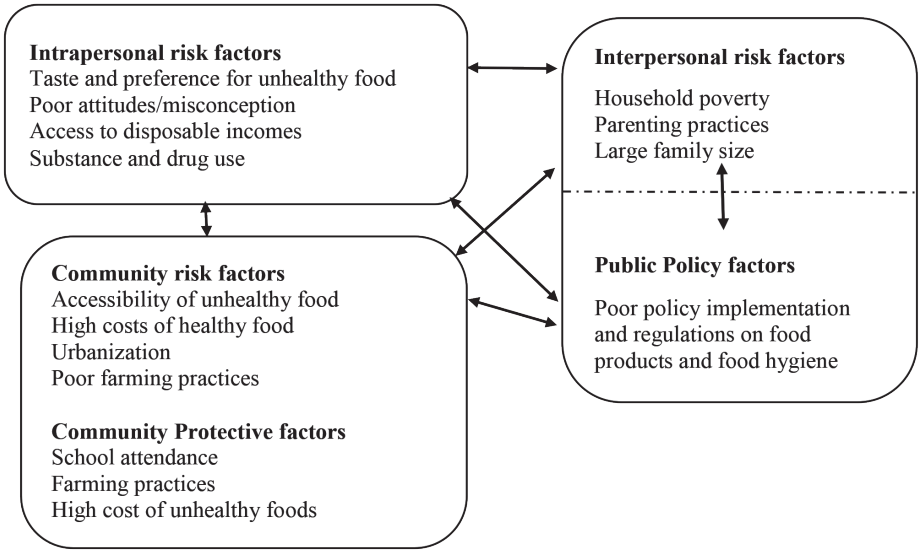

Figure 5.2. Factors suggested to underlie unhealthy diet among adolescents in Kilifi

lack of household income to purchase nutritious food or ensure food security in the home was discussed as a major risk factor for poor dietary behavior such as low fruit and vegetable intake, and the consumption of an unbalanced diet dense in carbohydrate:

> *The good foods that one is supposed to take, they do not if their family cannot afford, so one eats what they can afford (Group 3, male, rural secondary school).*

On the contrary, two peri-urban secondary school adolescent girls expressed that wealthy households are more likely to consume unhealthy diets such as sweetened confectionaries like cakes and ice-cream. Thus, they urged that better household socio-economic status could as well predispose adolescents to unhealthy dietary behavior.

Parenting practices: Views from a medical social worker, female secondary school teacher, and a few male students from a peri-urban school around parenting pointed to a number of predisposing factors, such as the lack of strict parental monitoring of adolescents' dietary habits; parents' tendency to spend less time together with their children; some family heads wasting their finances on unnecessary expenses and thus failing to provide food in the

household; and the practice of some parents providing money to their children instead of providing them prepared foods.

It is important to note the inter-relatedness of these factors within this domain for example household poverty, as well as intrapersonal factors like adolescents' access to disposable incomes. Parenting practices may as well play a major role in shaping certain attitudes and norms surrounding dietary choices.

Having a large family size: To a lesser extent (i.e., by two key informants), having a large family size was discussed as one of the risk factors for poor dietary behavior. They pointed out that it is common to find large sized extended families in Kilifi, and that this creates challenges for optimally addressing the nutritional needs of family members.

Community or institutional factors regarding unhealthy diet

Food accessibility: Discussions regarding factors related to the community domain were dominated by considerations of various aspects of accessibility. Adolescents in six of the 11 FGDs (peri-urban primary schools, rural and peri-urban secondary schools and adolescents who dropped out of school) and three key informants indicated that there is a wide variety of unhealthy food products, which can be easily accessed in the Kilifi community. They also highlighted that unhealthy foods are increasingly affordable, even for people of lower socio-economic status. Peri-urban primary students also stressed that the cost of certain healthy foods is high which discourages their consumption:

> *I think sodas are doing well and that's keeping people off from taking healthy juices and I think also they are affordable compared to a glass of juice. And junk foods or fast foods also, they are available and they are cheap (KI, Clinician, female, 30 years).*

Several rural primary school male students and one male peri-urban primary school teacher expressed divergent views that in Kilifi nutritious and traditional foods, like vegetables, fruits and cereals, are readily accessible, especially in the rural settings. In addition, a key informant who headed a CBO reported that many unhealthy food products such as fast foods are expensive and unaffordable to many adolescents in Kilifi.

Farming practices: Both risk and protective factors related to farming practices were discussed. Two key informants who were employees of CBOs expressed that that poor farming practices characterized by the lack of vegetable and fruit gardening in many homes in Kilifi which limits their accessibility to nutritious diets.

A rural primary and secondary school participant and two key informants had divergent views and pointed out that keeping livestock and poultry, and subsistence farming are common in Kilifi and avail healthy food products for many households. They further emphasized that, during a good harvesting season, fruits and other foods is in plenty supply and readily accessible by adolescents in Kilifi.

Urbanization: This was noted as an important risk factor by one key informant who was a peri-urban primary school teacher. He explained that urbanization comes with increased supply and demand of unhealthy foods and also an increase in infrastructure like supermarkets, kiosks and restaurants where such food products are accessible.

School attendance: This was cited as a protective factor by one key informant who was a secondary school teacher. He reported that schools are important in enabling healthy diets; through educating adolescents on proper dietary behavior, as well as ensuring that school meals provided to students are well balanced.

Public Policy factors regarding unhealthy diet

One key informant, who was a peri-urban secondary school teacher, highlighted that policy and regulations regarding food products and food hygiene were poorly enforced, which results in rampant marketing of unhealthy and unhygienic food product in the community:

> *The idea of food here is not regulated, even the hygiene. Anybody can sell anything at any point and the person is not answerable. In fact that is one of the major failure we have here. There are no designated of food eateries (KI, secondary school teacher, female, 51 years)*

Factors regarding sedentary lifestyle among adolescents in Kilifi

Discussions regarding perceived underlying factors for sedentary lifestyle were mainly dominated by intrapersonal and community level factors. Minimal factors were mentioned at the interpersonal and public policy level (See **Figure 5.3**).

Intrapersonal factors regarding sedentary lifestyle

Domestic chores: Although there were some views that some domestic chores are forms of physical activity, some adolescents who comprised rural secondary school students, adolescents who had dropped out of school and adolescents living with HIV, as well as two key informants pointed out that these activities may result in some level of physical inactivity in some adolescents, especially girls to some level of physical inactivity. They said that some of this work is strenuous, is too much and consequently diminishes young people's time and opportunity for exercising:

> *Most house chores involve washing clothes so if the clothes are many you get busy washing them leaving no time for exercise (Group 3, male, rural secondary school).*

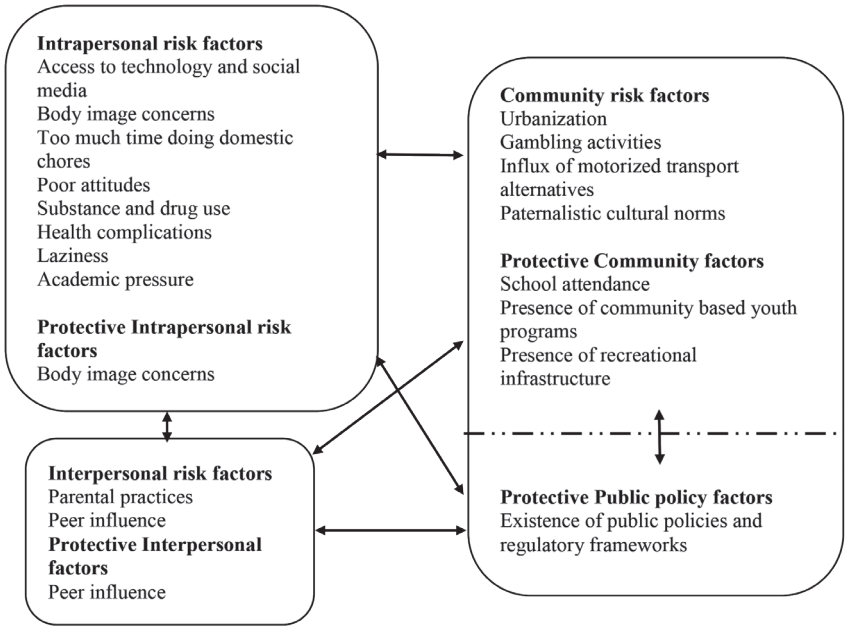

Figure 5.3. Factors suggested to underlie sedentary lifestyle among adolescents in Kilifi

Increased access to technology and social media by young people in Kilifi: This was discussed in 40% of the key informant interviews and in 3 FGDs comprising rural secondary, peri-urban primary and peri-urban secondary school students as an important risk factor for a sedentary lifestyle. Through personal access to gadgets like mobile phones, increased presence of entertainment and internet service providers in the area, and access to devices like televisions at home, adolescents were presumed to spend long sedentary hours using such technology and media:

> *So many people chat to an extent that they end up forgetting about exercising. That is because they are always busy with their phones chatting (Group 4, female, rural secondary school).*

Body image concerns: Some examples of body image concerns such as, shyness to expose certain body parts during games and physical activities especially by adolescent girls were raised during discussions with peri-urban primary and secondary school students and adolescents living with HIV. They also expressed that the feeling of embarrassment about some adolescents' body weight (for example those who are overweight) would hinder their engagement in physical activity.

However, there were some divergent views from a few peri-urban primary and secondary school students who said that some of the adolescents actually exercise because they are not comfortable with their body image and would want to become physically fit (i.e. build muscles, or reduce body weight) and more attractive.

Drug and substance use: The consumption of alcohol, marijuana, cocaine and tobacco by adolescents, was discussed in five out of 11 FGDs with young people and by three key informants as a predisposing factor for a sedentary lifestyle. They explained that substance use leads to weakness, dizziness, and sleepiness, resulting in physical inactivity:

> *Especially once you take a puff of bhang, you just feel dizziness and you just sleep and forget about doing physical exercises (Group 1, male, rural primary school).*

Health complications: Asthma, underweight and using medication were some factors cited by adolescents living with HIV, and rural and peri-urban

primary school students, who felt that such conditions could hinder some of adolescents from taking part in physical activities:

> *Some use drugs (medicines) which they take due to their health status don't allow them to do such exercises (Group 5, male, peri-urban primary school).*

> *There are other who, I mean, their health does not allow them. For example if you have a small body and then you go to do gym, won't you just fall there? (Group 9, adolescent living with HIV)*

Other risk factors for physical inactivity discussed by several study participants included laziness of some adolescents; academic pressure that leads to less or no time for physical activity; being distracted by romantic relationships; and poor attitudes or misconceptions, for instance, that physical activity is a waste of time and may lead to dirtiness.

Interpersonal factors regarding sedentary lifestyle

Parental practices that condone physical inactivity: This was pointed out during five FGDs with rural and primary school students, adolescents living with HIV and adolescents who had dropped out of school, and also in two key informant interviews. These parenting practices included: punishment of children whenever they go for sports; and confining children within the home and refusing to grant them permission to go for sports activities.

Peer influence: This factor was discussed as both a risk and protective element by a clinician and a secondary school teacher, and by adolescents that had dropped out of school. It was pointed out that adolescents sit and hangout or gossip in small groups for long hours without performing any form of physical activity. However, it was also discussed that adolescents, especially males, tend to join sports teams or other activities, such as weight lifting, which keep them physically active.

Community or institutional factors regarding sedentary lifestyle

Gambling: This issue was discussed in 36% of the FGDs and by 40% of the key informants as an increasingly growing problem in Kilifi, characterized by the rapid establishment of affordable gambling options which are poorly regulated, appealing to young people and take up their productive time:

The Asians have brought these casinos and they have put up two or three or whatever number at every bus stop. These ones have greatly contributed to some people not working; they go there at 6am and leave there at 6pm (Group 11, female, community representative).

A paternalistic culture in the community: This was described, by three female key informants and some rural primary school female students, as treating boys differently from girls, whereby boys are not obliged to actively participate in domestic chores (some of which were considered as a form of physical activity). It was also pointed out that boys are less monitored compared to girls and thus may find more time to engage in sedentary behavior, such as watching movies and soccer matches in video cafes.

So you will find that if a girl goes to the movies, when she gets back home she is questioned but when a boy goes he spends all the time and he is not questioned (Group 2, female, rural primary school).

A boy child is raised minus home duties, it is like these activities are for females. They can't wash utensils they can't clean the house. Indeed, most of the times I think male child are not engaged in domestic chores (KI, Clinician, female, 30 years).

Influx of motorized transportation alternatives: The influx of motorcycle taxis (locally known as boda-boda or tuk-tuk), and mini vans was raised by peri-urban primary school students and one secondary school teacher as a factor that interferes with active transportation of many adolescents in Kilifi and thereby contributing to reduced physical activity:

One of the major physical activity that we have here is walking but there is an influx of 'boda-boda' (motorcycle taxi). That is one thing that limits their physical activity (KI, secondary school teacher, female, 51 years)

In the FGDs and key informant interviews, some protective factors at the community level were discussed:

School attendance: This was recognized by rural and peri-urban primary school students and by three key informants as a protective factor which offers various opportunities for learning and engaging in physical activity. For

instance, these participants pointed out that most schools in Kilifi have physical education (P.E.) in their curricula, students have some sports' facilities such as playgrounds, and schools host or participate in local and national sports competitions. These factors were thought to promote adolescents' physical activity. However, there were several peri-urban primary school students who reported that at times schedules meant for physical activity are not observed since certain teachers use that time for extra teaching hours:

> *Some teachers will always take the free time of the children, like physical education (P.E), lunch time, break time and they will come to the class to teach because they want their subject to be the top (Group 5, male, peri-urban primary school).*

***Presence of community based youth services and communal infrastructure*:** The presence of some youth sports clubs, communal infrastructure such as football pitches, and community based or non-governmental organizations (CBOs or NGOs) which provided sports equipment and various social services was discussed by 50% of the key informants as an important protective factor against physical inactivity in Kilifi:

> *But we have another organization which is called Move the Goal Posts. Have you heard about that? Now this one has really trained girls in football (KI, primary school teacher, male, 48 years).*

Public policy factors regarding sedentary lifestyle:

***Existence of government policy and regulations on access to gambling venues by minors*:** Only one key informant who was head of a community based organization in Kilifi discussed a protective factor against physical inactivity at a public policy level:

> *But nowadays the government is very strict. We have a certain age of the boys and girls who are not supposed to be found in these video cafes especially during school time (KI, CBO director, female, 46 years).*

Discussion

Our results show a perceived preference of unhealthy, less traditional diet such as fatty street foods, sweetened beverages, and sugar dense confectionaries, especially among the adolescents in urban settings. Our findings are aligned with reports of high consumption of sweetened beverages, junk foods and inadequate fruit intake among school children (8-11 years) living in the Kenyan capital (Kigaru et al., 2015), and findings from a Kenyan household survey (Rischke et al., 2015). Our findings underscore the increasingly documented nutritional transition in the SSA region (Steyn and Mchiza, 2014, Abrahams et al., 2011).

Extensive hours spent engaging in sedentary activities, especially the use of technology and socio-media, for example, television viewing, use of mobile phones and watching sports, mainly by the young people in urban setting, was seen as a problem. Our findings concur with results from a study in Kenya that reports a high prevalence (13%) of television viewing for more than 11 hours per week among urban children of 9 to 12 years (Onywera et al., 2012), and passive leisure chatting on the phone, accessing web sites and playing mobile-games. Such activities are found to negatively impact engagement in active leisure activities among Kenyan youths (Nyambuga and Ogweno, 2014). Research emanating from other contexts has also emphasized the disruptive effect of technology use (i.e. mobile phones, television screening and gaming) on physical activity, cardio respiratory fitness and other health outcomes among youths (Lepp et al., 2013, Rosen et al., 2014, Boone et al., 2007). However, such research is still limited in developing countries like Kenya.

Our results show that substance use as well as poor attitudes or misconceptions in relation to physical activity and consumption of traditional food are commonly perceived as intrapersonal risk factors for both unhealthy diet and physical inactivity among adolescents in Kilifi. Considering that there is a general increase in alcohol, tobacco and illicit substance use among Kenyan youths, characterized by an early age of onset estimated at the age of 10 years (NACADA, 2012), it is not surprising that negative impacts on diet and physical activity are commonly recognized in this setting. The findings also highlight the perceived co-occurrence of health risk behaviors and a potential for multi-component interventions to address such behaviors (Sychareun et al., 2011, de la Haye et al., 2014). Our findings on adolescents' poor attitudes surrounding diet and physical activity are consistent with findings from a study conducted

among young adolescents in Nairobi, which found that 65% of participants had poor attitudes towards healthy diets, despite that their knowledge on nutrition was good (Kigaru et al., 2015).

At an interpersonal level, parenting behavior, such as providing money as opposed to prepared lunch food for their children, subjecting children to onerous domestic chores and placing unrealistic restrictions on adolescents' time for physical activity, especially for the girls, stand out as commonly perceived, major risk factors for both an unhealthy diet and physical inactivity among adolescents in the Kilifi setting. Similar to our findings relating to parental influence, a 2016 Kenyan national report (Onywera et al., 2016) considered the influence of family and peers on physical activity of children and adolescents (5-17 years) "poor". The authors in the national report pointed out that many Kenyan parents lack adequate knowledge of their children's level of physical activity and dieting, as well as of basic requirements for achieving better physical and nutritional health outcomes (Onywera et al., 2016). Similar concerns have also been reported based on other Kenyan studies (Kigaru et al., 2015, Moyi, 2011), which underscores the need to target parents and caretakers with health promotion messages that emphasize the value of a healthy diet and sufficient physical activity of their children and other family members. Schools need to actively engage parents or caretakers in planning, supporting and decision making on adolescents' extracurricular activities and school-based approaches such as healthy food choices at school canteens, physical activity facilities and designing sports' curricula.

Food availability plays a key role in predicting dietary behavior of adolescents. Availability is principally determined by food prices, prices of alternative food products (i.e., processed foods), demand and supply, seasonality and farming practices. Indeed, studies have found an adverse association between food insecurity and dietary patterns (Morales and Berkowitz, 2016), and lower prices of healthy foods are more likely to predict healthier food choices (French, 2003). Again, this finding points to the relevance of multi-sectorial approaches (i.e. engaging agricultural, public health and other sectors) in addressing dietary behavior of adolescents. Moreover, with poverty being a major concern in the study's context, there is need to prioritize sustainable youth employment policies and programs.

Gambling was another issue highlighted in our findings, and one that is currently documented as a rapidly growing concern in Kenya and other parts

of SSA (PricewaterhouseCoopers, 2014). Studies of Kenyan adolescents are still scant but studies of young adults show a significant burden of gambling problems (Koross, 2016). Our findings are aligned with findings from research in Ethiopian school going adolescents of which almost 73% had ever gambled and 7% were pathological gamblers (Abdi et al., 2015). In addition, common gambling options like card games, casino and other traditional games, access to mobile phones, internet, and social media has made closed forms of gambling alternatives for many young people in SSA (Ahaibwe et al., 2016). A need for collaborative efforts across the private and government sector as well as civil society in implementing feasible social policy and public health interventions to address gambling problems among young people is timely.

Similar perceptions relating to the underlying factors for diet and physical activity of adolescents were held by adolescents living with HIV and those not infected by the disease. We also did not find major differences relating to adolescents' perceptions of underlying factors for sexual risk behavior in another study (Ssewanyana et al., 2018). Noteworthy, both groups recognize that disease related conditions such as, long-term medication and low body weight are risk factors for adolescents' sedentary lifestyle. Other studies also note that chronic conditions such as HIV present a significant risk for sub-optimal adolescent development characterized by psychosocial issues, risk taking behavior, and poor health outcomes (Woollett, 2016, Lowenthal et al., 2014). There is, therefore, a need to consider adolescents with chronic conditions such as HIV when designing studies, programs and policies to address health behavior.

Our findings emphasize the perceived protective role of school attendance for both dietary behavior and physical activity in adolescents and are aligned with those of a Kenyan report on physical activity of children and adolescents that ranked the school environment (i.e., infrastructure, programs and policies) as "fair" (Onywera et al., 2016). This was largely attributed to the Kenyan government policy that requires allocating at least 35 minutes for physical education classes (PE) at least three times a week (Onywera et al., 2016, KNBS and Macro, 2015). Moreover, there is great public support for PE and the majority of Kenyan primary and high school students report having actively participated in such school programs (Muthuri et al., 2014b, Onywera et al., 2012). School food programs have also been found to have a positive impact on school enrollment and nourishment in SSA (Gelli, 2015). In Kenya, more than 1.5 million school children obtain a hot meal each day at school and there

have also been efforts to integrate programs to ensure community food and nutrition security with school food programs, although sustainable financing of school food programs remains a major challenge (WorldBank, 2016).

Limitations

Our study is limited by the reality that some of the views on dietary behavior and physical activity shared by our participants may be specific to adolescents living at the Kenyan coast in Kilifi In other settings, processes may be different and, therefore, our findings cannot be generalized to other settings. Furthermore, since young people's views were perceptions of their peers' behavior, it is likely that some of their understandings were either an underestimation or overestimation of the situation of adolescents in this study's context.

However, it is important to note that we included a diverse mix of adolescent sub-groups who were carefully selected to reflect diversity in the adolescent population of Kilifi and their opinions contrasted with those of key informants who were adults that worked extensively with adolescents in Kilifi County. In addition, we undertook a qualitative study and although we discuss our results in relation to other more quantitative studies, certain findings may need to be replicated in quantitative studies as well. Our findings identify the most important topics that may need to be addressed more specifically in future studies. The value of this in-depth process from a research perspective is that it enables researchers to generate knowledge, design quantitative studies and interventions that are more contextually informed and that focus on the specific challenges identified by the adolescents themselves and the members of the community.

Conclusions

In our findings, a myriad of underlying risk factors was reported by adolescents and stakeholders, which include *intrapersonal* factors, such as substance use behavior, spending excessive amount of time on social media, poor attitudes, and preference for unhealthy diet; *interpersonal* factors, such as parenting practices such as subjecting children to onerous domestic chores and unrealistic restrictions especially on adolescent girls' time for physical activity, and poverty; *community* factors, such as availability of unhealthy food options, gambling, and *public policy* factors including poor implementation of policies and regulations regarding food products and food hygiene. Important opportunities, such as access to infrastructure and equipment for physical activity, education on healthy diet and physical activity, and a school food program emanate from the supportive school environment and the existence

of some community based youth services. In order to counter unhealthy diet and physical inactivity among adolescents in Kilifi, we recommend targeting parents and caretakers with health promotion messages emphasizing the value of healthy diet and physical activity for their children; more active engagement of parents and caretakers in planning and supporting school programs on healthy diet and physical activity; and prioritizing sustainable youth employment policies and programs.

Ethics statement

All adolescents, their caretakers, young adults and key informants that took part in this study were appropriately informed about what the study entails, potential risks and benefits of their participation prior to obtaining their written informed consent. This consent was directly sought from participants aged 18 years, and over but for those aged under 18 years, their parents or legal caretakers provided the consent. Adolescents' assent was also sought from participants aged between 13 and 18 years. We obtained permission from the County director of education and head teachers at each school to involve schools in this study. The study was granted ethical clearance by the Kenya Medical Research Institute Scientific and Ethics Review Unit (KEMRI/SERU/CGMR-C/0047/3263).

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Availability of supplementary data

The supplementary data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgements of authors' contributions

D.S designed the study, developed the tools, coordinated and took part in data collection, conducted the coding/data analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript as submitted. A.A designed the study, revised the manuscript and approved the final manuscript. A.vB revised the manuscript and approved the final manuscript. P.N.M took part in data collection, coding/data analysis and approved the final manuscript. C.R.N was involved in the protocol development, revised the manuscript and approved the final manuscript.

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Chapter 6

Socio-ecological determinants of Alcohol, Tobacco, and Drug use behavior of adolescents in Kilifi County at the Kenyan Coast.

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Abstract

Alcohol, tobacco and other drug (ATOD) use form a risk factor for health and social problems during adolescence. From a Socio-Ecological model, perceptions of 85 young people and 10 stakeholders on types of ATOD used and the predisposing and protective factors were explored; among adolescents at the Kenyan Coast in Kilifi County. We found that the consumption of home brewed alcohol, tobacco and marijuana smoking and khat chewing was common, and requires multi-component and community centered intervention. Countering ATOD use needs enforcement of strong measures to regulate access to ATOD for minors; addressing social and cultural norms; strategies for poverty alleviation; and community empowerment.

Introduction

Adolescence (10 -19 years) is a developmental period that often entails alcohol, tobacco and other drug (ATOD) experimentation, ATOD use reinforcement and vulnerability to substance use disorders (Casey & Jones, 2010; WHO, 2014). Indeed alcohol and illicit drug use are top risk factors for disease burden among young people (10-24 years), globally accounting for 9% of disability adjusted life years (DALYs) (Gore et al., 2011). Also, adolescents who use ATOD have been shown to experience a range of physical, educational and social challenges including poor academic and work productivity (Crosnoe, 2006; Lynskey et al., 2003); an unprecedented burden of injuries (Gore et al., 2011); psychiatric co-morbidities (Chan et al., 2008); risky sexual behavior (Ritchwood et al., 2015); and intimate partner and other forms of violence (Temple et al., 2013).

In sub-Saharan Africa (SSA), a national survey of ATOD use among Kenyan youths reports a general increase in ATOD use, with age of onset estimated at 10 years (NACADA, 2012). Alcohol (11.7%), tobacco (6.2%), khat (4.7%) and bhang (1.5%) were the substances most often consumed by youths (NACADA, 2012). However, only a few other Kenyan studies have explicitly focused on ATOD in this age group and describe a set of major predisposing factors (Mugisha et al., 2003; Ndetei et al., 2010; Otieno & Ofulla, 2009).

Furthermore, at the Kenyan coast the presence of illegal drug production and trafficking (UNODC, 2015) has been linked to serious health and social problems (Beckerleg et al., 2006; Brodish et al., 2011). Influences from ATOD use behavior are drawn from multiple social contexts like family, peer, school, and neighborhood contexts (Ennett et al., 2008). Thus, utilization of a Socio-Ecological approach in examining ATOD use and its contextual attributes is paramount especially for devising sustainable behavior change approaches (Ennett et al., 2008).

Our study was conducted in Kilifi County at the Kenyan coast, aiming at a deeper understanding of ATOD use behavior among adolescents. The study draws on the perceptions of young people and a range of other community stakeholders to understand the diversity and factors underlying, adolescent ATOD use. Specifically, we explored perceptions of: (i) types of ATOD consumed, (ii) predisposing or risk factors for ATOD use, and (iii) protective factors against ATOD use.

Theoretical Model

Our assessment of underlying factors for ATOD use is based on the Socio-Ecological model by McLeroy and colleagues (1988). This model postulates five levels of interacting domains which determine human behavior, namely: (i) intrapersonal factors, which entail biological and personal history factors, like knowledge, skills, attitudes, education, and income; (ii) interpersonal factors, which involve formal and informal social networks plus support systems like family, working groups, and friendships; (iii) institutional factors, which include social institutions with organizational characteristics, formal or informal rules and regulations; (iv) community factors, which entail relationships among organization, informal networks and institutions; and (v) public policy level, which involves local, state and national laws or policies.

Methods

Study setting and participants

This study was conducted in Kilifi County at the Kenyan coast within a well-defined Demographic Health and Surveillance System (KDHSS) between August and November 2016. Briefly, by 2011 the area covered by the KDHSS had 270,000 residents of whom 49% were less than 15 years (Scott et al., 2012). Findings from the Kenyan population and housing census indicated that 22% (271,815) of the residents in Kilifi were adolescents, between 10 and 20 years (KNBS, 2009). A majority of the residents are of Mijikenda ethnicity and their main form of livelihood is subsistence farming. This setting is served by one major hospital (Kilifi County Hospital), a health center and 12 dispensaries (Scott et al., 2012). The study was based at the Kenya Medical Research Institute (KEMRI) - Wellcome Trust Research Programme (KWTRP) in Kilifi.

The study involved the young people and stakeholder groups described below:

(1) Young people comprised adolescents aged 10 to 19 years. These were divided into three sub-groups: school-going (both primary and secondary students); school drop-outs; or adolescents living with HIV and attending an HIV Comprehensive Care Clinic at Kilifi County Hospital (KCH).
(2) Stakeholders comprised key informants, female and male adults working extensively with adolescents within Kilifi, such as, community social workers, clinicians, teachers, employees of community based organizations (CBOs) and staff from the county government. A subset of this group were

themselves young adults, aged between 20 and 30 years; this group were Kilifi residents who were serving as community representatives at KWTRP. These community representatives were asked to participate as they might have a good understanding of youths in Kilifi because they extensively engaged in KEMRI's community research activities (Kamuya et al., 2013).

Recruitment and eligibility

This specific study was part of a larger qualitative study conducted between August and November 2016 at KWTRP. A detailed description of the study is documented elsewhere (Ssewanyana et al., 2018). Briefly, through a snow balling technique stakeholders with extensive experience in working with adolescents in Kilifi were identified. Young adults were purposively selected from a database comprising around 200 community representatives residing in Kilifi (Kamuya et al., 2013). The selection took diversity by sex, religion, education status and residence into account. School going adolescents were purposively identified from upper-primary and lower-secondary educational levels of two primary and two secondary schools situated in Kilifi. Adolescents living with HIV were included as a special group so as to explore and contrast their views on ATOD use to those of the other adolescents. This was to inform our future work that will quantitatively focus on health risk behavior of adolescents, inclusive of those living with HIV. Adolescents living with HIV were recruited from the youth club at the clinic of KCH. Some adolescents with HIV were also directly recruited by a worker from the KCH who paid home visits to known families of HIV infected adolescents. With assistance from the County department of Public Health's community support staff, we purposively recruited adolescents who had dropped out of school from two community health catchment units. Age, sex and religious diversity was again taken into consideration.

Ethical consideration

Prior written informed consent was obtained throughout all recruitment processes. Consent was obtained directly from participants aged 18 years and over. Assent was sought from participants between 13 and 17 years, while their parents or legal caretakers provided consent. Additionally, the County Director of Education and the head teachers at each school involved gave permission to conduct the study within the school setting. Permission was also asked from participants to take notes and to audio record the discussions and interviews.

This study was granted ethical clearance by the Kenya Medical Research Institute Scientific and Ethics Review Unit (KEMRI/SERU/CGMR-C/0047/3263).

Data collection

We utilized a focus group discussion (FGD) approach because it is an interactive process that provides an opportunity for identifying areas of concern or interest that are spontaneously provided without presumptions. Clarification can be acquired when needed during the discussions, more in-depth information can be obtained and personal and group feelings, perceptions and opinions can be captured. Such insights and understanding would be difficult to ascertain with questionnaires.

Focus group discussions comprising between seven and nine participants and lasting approximately 75 to 120 minutes were conducted with adolescents and young adult community representatives. FGDs for school-going adolescents were sex disaggregated and took place at school. Adolescents living with HIV, those who had dropped out of school and young adult community representatives were invited to the KWTRP where their FGDs took place in a private and quiet setting. 300 Kenyan shillings (about 3 US dollars) was reimbursed to compensate for time spent and transport expenses of the participants (young adults) and caretakers of adolescents who were invited to KWTRP. For key informants, in-depth interviews were conducted lasting between 60 to 90 minutes, at their preferred venue and time.

A Research Officer moderated all the interviews and discussions in English and/or Kiswahili as preferred by the participants. Notes were taken and participants' discussions audio recorded.

Study Materials

The researchers developed both the qualitative interview guide and the FGD guide with guidance from the World Health Organization and the Centers for Disease Control and Prevention documents (CDC, 2015; WHO, 2015) to cover a wide range of adolescent health risk behaviors such as alcohol use behavior, smoking, drug use, sexual risk behavior, behavior resulting in unintentional and self-harm, hygiene practices, physical activity and poor dietary behaviors. An open ended question concerning respondents' perceptions about each form of behavior was asked and followed up with additional probing on specific examples or context of behavior raised by the participants. In general, they

were asked to explain the specific forms of risky behaviors which they perceive as commonly undertaken by adolescents aged 10 to 19 years in Kilifi. The ATOD related questions that were discussed during the FGDs with the adolescents are presented in the appendix.

A socio-demographic data capture sheet was also designed and used to collect respondents' demographic information like age, sex, residence, religious background, education status, and position held/affiliation.

Data analysis

Audio-recorded discussions and interviews were transcribed verbatim and translated into English by a professional team. After in-depth reading and reflection on the scripts, an initial coding from *a priori* and emergent issues was conducted by two of the authors (D.S. and P.N.M). We utilized a thematic analytical approach (Braun & Clarke, 2006). Both inductive thematic and theoretical thematic data analysis were applied. An inductive approach was taken to understand participants' views surrounding the types of ATOD used, whereas a theoretical thematic analysis was the basis for categorizing the respondents' views on predisposing and protective factors for ATOD use. D.S. conducted the final stage of coding in NVivo 11 software (QSR International Ltd, Southport, UK). The codes were discussed and consensus was reached through a series of meetings, regarding the themes of the Socio-Ecological model (McLeroy et al., 1988). We categorized the data in four levels reflecting: (i) individual level (representing intrapersonal factors), (ii) relationship level (interpersonal factors), (iii) community level (entails both institutional and community factors), and (iv) societal level (represents public policy factors). A case and theme based charting was then done by D.S. The final analytical framework was reviewed and agreed upon by the research team.

Results

A total of 11 FGDs (eight sex disaggregated) were conducted among 85 young people, and 10 in-depth key informant interviews were held with four employees of CBOs, two KCH staff, three teachers responsible for guidance and counselling affairs, and a county government staff. On average, the FGDs lasted one hour and 45 minutes whereas the key informant interviews lasted 1 hour. A breakdown by age, sex, and education level of the study participants is presented in Table 6.1.

Table 6.1. Age, sex and educational characteristics of the study participants

Participants	Total	Age range (Median age)	Sex	Education level
Primary school adolescents				
Peri-urban male students	7	10 – 14 (14)	Males	Class 5 – 8
Peri-urban female students	7	10 – 13 (12)	Females	Class 5 – 8
Rural male students	8	12 – 16 (13.5)	Males	Class 5 – 8
Rural female students	8	13 – 16 (14.5)	Females	Class 5 – 8
Secondary school adolescents				
Peri-urban male students	8	16 – 19 (17)	Males	Form 1 - 2
Peri-urban female students	6	15 – 17 (16)	Females	Form 1 - 2
Rural male students	9	16 – 18 (17)	Males	Form 1 - 2
Rural female students	9	15 – 18 (16)	Females	Form 1 - 2
Adolescents living with HIV	9	12 – 19 (13.5)	5 Males, 4 Females	Class 3 – Form 1
School drop-out adolescents	7	12 – 18 (14)	5 Males, 2 Females	Class 2 – Form 2
Stakeholders	10	27 – 51 (31)	4 Males, 6 Females	University degree (5), Post-secondary level (5)
Young adult community representatives	7	22 – 28 (25)	3 Males, 4 Females	College level (4), Secondary level (2), Primary level (1)

Types of alcohol consumed by adolescents in Kilifi

Table 6.2 summarizes the characteristics of alcohol as consumed and described by adolescents in Kilifi, including: (i) the origin of production, (ii) methods of production, (iii) potency, and (iv) type of alcoholic beverage (i.e. beer, wine, or spirit).

Many stakeholders and young people emphasized that the local brew was the most consumed alcoholic beverage.

Types of tobacco and other drugs consumed by adolescents in Kilifi

Young people and stakeholders discussed a variety of forms of tobacco and other drugs consumed by adolescents locally, which we classify following categorizations by the United Nations Office on Drugs and Crime (UNODC, 2015). Overall, cannabis, followed by khat and cigarette smoking were the most commonly used substances (Table 6.3)

Factors influencing alcohol, tobacco and other drug use among adolescents in Kilifi

The participants perceived various underlying factors for adolescents' ATOD use behavior. A majority of these acted at "community" and "individual" levels, followed by "relationship" level, while few issues discussed, seemed to operate at a 'society' level (Figure 6.1). Some of these factors were perceived to have both predisposing and protective elements, as presented in the next sections.

Individual Level factors

Access to money or disposable income: Adolescents' access to disposable income was perceived by most of the stakeholders and young people to facilitate easier access and consumption of ATOD. This money is often acquired either from handouts by caretakers, or earned from employment especially riding motorbike "taxis" (often called "boda-bodas") and casual labor. Fairly obviously, some secondary school students in this study described having limited or no access to money as a limiting factor for ATOD use behavior.

Sex: Male adolescents were perceived as more likely to initiate ATOD use at an earlier age, to use ATODs more frequently, and to do so in larger quantities than females. These views were held by a majority of the young people and stakeholders.

Taste and preference: ATODs seen as tastier or better flavored, more potent and fashionable were described as more attractive, often leading to experimentation.

Stress Management: Management of stress arising from academic pressure, problems like conflicts at home, low self esteem and relationship issues such as break-up with romantic partners, were thought to predispose adolescents to alcohol use.

Other perceived benefits of ATOD use by adolescents which participants discussed and which could be related to the type of substance used included relaxation, better academic performance, sexual prowess, remedy for certain ailments like tooth ache and cough, helping them to keep awake for long hours, elevated social status, and being brave.

Table 6.2. Classifications of alcohol consumed by adolescents in Kilifi

Classification of alcohol	Explanation by participants	Examples cited by participants
By origin of Production	Informally brewed or alcohol brewed in homesteads (phrases used by participants included *'local brew'* or '*second class brew*')	Palm wine ('mnazi'), 'matingasi', 'makoko', 'vuta pumzi', and 'changaa'
	Formally recorded or factory/industrialized beverages (phrases used by participants included 'pombe *za kizungu*' (translates to white man's alcohol), *'commercial drinks'* or '*modern drinks*' or '*standardized brews*'	Tusker, Pilsner, Guinness, Guarana, Smirnoff, Safari Cane, Bluemoon, Safire
By method of production	Freshly produced alcoholic beverage which is drank instantly after production without letting it stay overnight	Fresh palm wine ('mnazi')
	Fermented alcoholic beverage which is left overnight to become fermented and presumably more potent	'Kilalo' 'Matingasi', 'mnazi'
	By raw materials used for example from cereal (maize, maize husks) and coconut palm fruit	
By potency	Some participants used phrases such as '*vikali*' (translates to the hard ones) or '*heavy*' or '*steam*' (meaning alcohol effect) while referring to alcohol beverages with high alcohol content	blue moon, Guinness
By type of beverage	Beer, spirits and wine were three sub-categories of alcoholic beverages sponteneously cited by some participants	Tusker, Pilsner, Guinness, Guarana, Smirnoff, Safari Cane, Bluemoon, Safire, Safari Cane

Freedom and idleness: A few students and key informants felt that adolescents are more likely to use ATODs during their free time, especially if they are idle. Others suggested that unemployment has led to adolescents having little to do, and being more prone to irresponsible behavior.

Adolescence as a life stage and its associated psychosocial changes: All participants agreed that ATOD use is mostly initiated during adolescence. Moreover, a few young people and other participants attributed ATOD use behavior to psychosocial changes such as overestimating levels of self-maturity, attention seeking, and adventurousness that they associated with adolescence.

***School attendance*:** Not attending school was perceived to predispose adolescents to ATOD use behavior, as this generates large amounts of un-used time and idleness, without influence of adults such as teachers or their

parents or caretakers. In this way, attending school was perceived to protect aginst ATOD use through ensuring rules and regulations as well as educational messages that may discourage adolescents from using these substances.

Low perception of risk: Only peri-urban primary school adolescents perceived adolescents to use ATOD either because of not being aware of their potential harmful consquences, or because they dismissed the risk of suffering harmful consquences.

Relationship Level factors

ATOD use by close family members: The use of ATOD by close family members such as parents and elder siblings was discussed by both young people and other participants as an important predisposing factor. Family members were thought to expose adolescents to ATOD use through: (i) sending their children to buy alcohol, cigarettes, marijuana, or khat on their behalf; (ii) asking the child to join other family members in consuming ATODs; and (iii) storing substances in places easy to access by adolescents.

As a result, ATOD use was seen as normalised at home, and some adolescents therefore will assume these practices as acceptable.

Also, participants recognized that within Kilifi County, as in much of Kenya, alcohol brewing and selling is an important livelihood. In this case, the "normalization" of alcohol use would be particularly likely. Adolescents from such families were thought to find it much easier to access alcohol and to more likely to perceive alcohol use as acceptable.

Peer influence: The influence of peer groups was seen as importantly predisposing to ATOD use. These influences were described in different ways including: adolescents tend to initiate ATOD use because they want to belong to certain groups; peers team-up and share costs to buy ATODs that they could not afford on their own; older peers are more likely to influence younger ones to use ATODs; and girls are often enticed by boys to use ATODs.

Table 6.3. Reported forms of tobacco and other drugs used by adolescents in Kilifi

Forms of tobacco or other drugs (locally mentioned examples)	Number of FGD where the substance behavior was described (n=11)	Number of key informants that discussed the substance use behavior (n=10)
Tobacco		
Crude or unprocessed products (e.g. tobacco leaves, tobacco powder)	5	2
Shisha	3	4
Cigarettes	9	5
Central nervous system Stimulants		
Khat (miraa, mogoka)	9	5
Cocaine (unga)	3	6
Cannabis (marijuana, bhang, bomu, ganja)	10	10
Opiates (heroin, brown sugar)	2	6
Volatile solvents		
Glue	3	0
Paint/Polish	2	0
Nonmedical use of prescription drugs (e.g. piriton, codeine, paracetamol)	2	4
Other forms of drugs		
Kuber	3	4
Methaqualone (Mandrax)	3	1

Household socioeconomic status: As a predisposing factor, some students noted that home-based alcohol production and consumption characteristically occurred in areas with more poverty, and adolescents from these homes would inevitably have greater exposure to alcohol. Relatedly, this close proximity to premises brewing and selling alcohol would encourage adults in the family to send children or adolescents out to buy alcohol for their own use, particularly since – unlike licensed alcohol sellers that would be more typical sources in higher-income areas – there would be no restrictions on under-age sales.

At the same time, a few participants shared the view that adult behavior in higher economic status families could sometimes increase the risks of alcohol use in adolescents, when normalization of regular consumption of large amounts of alcohol was seen.

Parenting practices: Apart from the influence of parents' own alcohol use patterns, some participants felt that the amount of time spent together and quality of relationships between adolescents and their parents were likely to influence ATOD use, through the amount of guidance and supervision offered by parents or caretakers.

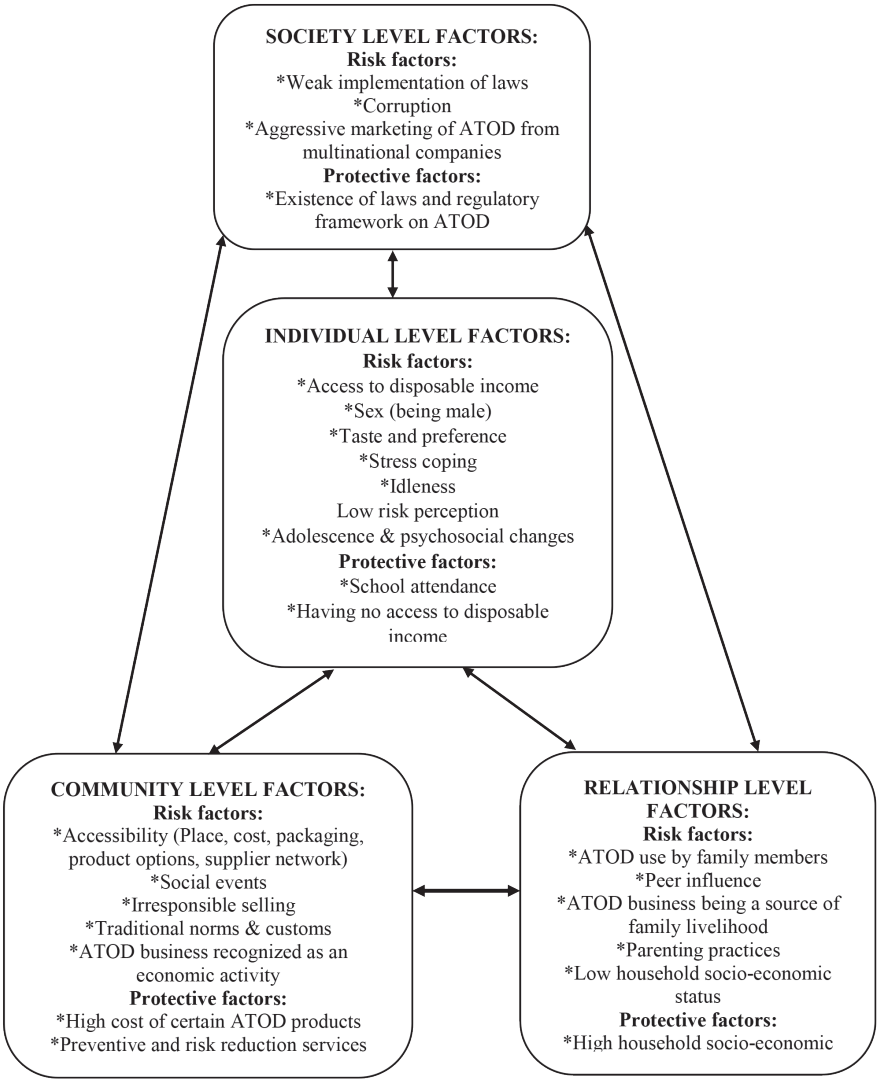

Figure 6.1. Factors influencing alcohol, tobacco and other drug use among adolescents in Kilifi

Community level factors

Accessibility: Accessibility to ATODs was widely discussed by participants as acting as a potential driver for ATOD use. Proximity of supply and the cost of buying ATODs, also emerged as individual and relationship level factors. As a community level factor, proximity of adolescents' homes to premises brewing and selling local alcohol was seen as a cultural and common feature of many neighborhoods.

From a structural perspective, the costs of ATODs were also influential; low cost ATODs, such as local brews, cigarettes and khat, would be more accessible to adolescents.

In the same way, the high costs set for certain forms of ATOD like beers and spirits, cocaine, cigars, and heroin were seen as deterring adolescents from accessing and using these substances.

Three additional forms of accessibility were discussed as an influence on ATOD use in adolescents at a community level, including packaging, product options and supplier networks. In relation to packaging of alcohol, the unit size sold and the appearance of the product were both seen as important. Selling small unit sizes of alcohol (such as sachets or small bottles) would increase accessibility to adolescents through the low cost involved in purchasing. For locally brewed alcohol, larger sizes sold for example in jerry cans might also be relatively affordable. In relation to packaging appearance, the materials, colors and promotional images were thought to be particularly important for adolescents. In addition, the fact that such a large range of ATOD products were available was seen as facilitating their use, given the wide choice in terms of taste, preference or affordability. Finally, the supplier networks were seen as a key aspect of accessibility. Some young people and stakeholders felt that drugs are in high circulation within the community owing to middlemen or peddlers, some of whom were also within school neighborhoods.

Social norms around alcohol use: Social norms for adolescent ATOD use also emerged as key in discussing a range of more structural or community level factors, specifically concerning norms acting through cultural events and gendered expectations. At a higher level, social norms were in turn reinforced by long standing patrilineal traditions within this community and the embedding of practices of alcohol production and sales as an important part of the local economy.

In this community, weddings and funerals are major social events, and alcohol consumption is of symbolic value during such gatherings. Therefore, such social events were perceived by many young people and stakeholders as occasions where ATOD are easily accessed and consumed in excess by adolescents in Kilifi. In addition, offering alcohol may be a common practice in welcoming guests to some homes in the absence of a special event.

A few adolescent participants felt that many selling alcohol in local outlets would act irresponsibly, for example, that they would sell to any buyer able to pay for their drinks, regardless of age.

Alcohol business is a recognized economic activity: Some young people felt that much as alcohol has its disadvantages, the reality is that it cannot be discouraged at the Kenyan coast where the community recognizes it as a source of livelihood and major economic activity of the residents. This being the case, they felt that alcohol will always be accessible to adolescents in this community.

Within local outlets selling alcohol, it would generally be inappropriate for girls or women to be part of the group buying and drinking alcohol. For this reason, boys and young men were seen to be at greatest risk of excess ATOD use, since less judgment would be placed on alcohol consumption by a male compared to a female adolescent.

Existence of preventive and risk reduction services: The presence of some school and community based programs that address youth-related problems was perceived as a protective factor against ATOD use behavior.

Society level factors

Laws and regulatory framework on ATOD use: Some stakeholders and young people suggested that protective laws and policies in Kenya exist, for example, prohibition of use of illicit drugs, restriction of opening times and service hours for drinking establishments, restriction of underage alcohol consumption, and regulation of the alcoholic products marketed. Although these laws were thought to protect adolescents from accessing and consuming ATODs, the participants felt that there are serious weaknesses in the implementation of these laws.

Corruption: Some young people felt that corruption was a significant barrier towards efforts to mitigate ATOD use. They felt that drug peddlers connived with certain authorities in order to conduct their illegal business.

Aggressive marketing and social media influence: A few stakeholders and adolescents discussed that advertisements for products such as cigarettes as well as social media content from videos and movies portrays ATOD use as appealing, thus sending the wrong impression to adolescents.

Discussion

Young people and stakeholders generally recognized that the use of various ATODs is common among adolescents in Kilifi, and attributed this to an interplay of a range of underlying factors across ecological domains. The classifications of consumed alcohol suggest that both informal and formally produced alcohol consumption is common. However, consumption of informal alcoholic beverages takes precedence among adolescents in Kilifi. This is of major concern as informally produced alcohol is often less regulated and cheap, which results in heavy consumption and easier access by minors (WHO, 2014). Also, informally produced alcohol may contain potentially toxic compounds (Lachenmeier et al., 2011; WHO, 2014). Therefore the need to address informal alcohol production in the community and its access for adolescents is crucial.

Furthermore, the use of tobacco, cannabis, and Khat among adolescents in Kilifi is of major concern. Early initiation of tobacco smoking (Peltzer, 2011), cannabis use and Khat chewing (NACADA, 2012; UNODC, 2015) are significant public health concerns in SSA and an important agenda for ATOD use prevention and risk reduction. The fact that tobacco and Khat are licit substances (NACADA, 2012), potentially presents challenges for mitigating use among young people in Kenya. Efforts to limit access to these products by minors should be strengthened.

Our findings also show that broader community factors play a significant role in predisposing adolescents to ATOD use. Noteworthy among these factors is the economic benefit associated with the production and sale of ATOD products like alcohol; and the numerous ATOD access possibilities within the home or school environments especially through peer and social supply networks. This is also seen as a consequence of poverty within Kilifi County, similar to findings

from other studies showing an association between high ATOD use behavior of Kenyan youths of households with poor socio-economic status (Mugisha et al., 2003; NACADA, 2012; Otieno & Ofulla, 2009). This therefore emphasizes the urgent need for program and policy based approaches to poverty reduction in this setting. In addition, social supply networks were seen as facilitators for increased access and use of ATODs among adolescents (Coomber & Turnbull, 2007). Therefore authorities need to understand carefully ATOD social supply network dynamics so as to appropriately craft penalties and guidelines that differentiate social supply from organized drug criminal networks (Coomber & Turnbull, 2007).

Our findings showed the important role that cultural and social norms play towards shaping ATOD use behavior among adolescents. Alcohol is used frequently during social events like funerals and weddings that are highly attended by youths. Also, a Mijikenda patrilineal culture was thought to condone ATOD use among the young males. Other studies have also shown that traditional and gender norms can underlie ATOD use behavior of adolescents. Therefore programs addressing ATOD use behavior of adolescents must pay attention to the potential influence of such norms (Castro et al., 2009).

This findings also indicate that adolescents' coping mechanisms to life stressors and daily needs may involve ATOD use, presuming this has benefits for stress relief, treatment of ailments, relaxation and work/academic productivity. Similar findings have been documented among adolescents in Kenya and other settings (Leonard et al., 2014; Otieno & Ofulla, 2009; Roditis & Halpern-Felsher, 2015). This suggests an urgent need to address adolescents' norms and beliefs surrounding ATOD use and improve their awareness of risks associated with it.

Findings from this study highlight that relationship level factors such as ATOD use of close family members plays a central role in the initiation and reinforcement of it among adolescents, regardless their household socio-economic status. Besides, peer relationship plays a key role in ATOD accessibility and consumption. Likewise, other studies reported parenting practices and family members' ATOD use behavior as a predictor of adolescents' attitudes and consumption of ATOD (Pape et al., 2015; Van Der Vorst et al., 2006). Indeed, this underscores the relevance of simultaneously intervening family risk factors and predisposing factors for ATOD use that arise from peer relationships.

From a societal level perspective, although Kenyan laws prohibiting and regulating ATOD use exist (NCLR, 2012), various ATOD use problems were still raised frequently in Kilifi. This potentially suggests underlying bottlenecks such as complacency and corruption; unethical approaches to ATOD prevention; ethical dilemmas of risk reduction and treatment; and weak regulatory systems which are also documented in other parts of SSA (Derrick & Clark, 2013; UNODC, 2015). Strengthening capacities of law enforcement organs, improving public awareness of such laws and empowering communities to demand for accountability from their leaders are potential solutions to these bottlenecks.

From a protective factors' perspective, our findings show importance of a lack of disposable income, high costs of certain ATOD, positive school environment that mitigates ATOD use, better household socio-economic status, policy and regulations, and existence of positive youth engagement programs or activities. These protective factors belong to various ecological domains within the Socio-Ecological model which emphasizes the need for a "systems approach" while exploring opportunities and strengths for improving effectiveness of ATOD related interventions. Secondly, interventions need to explore existing local resources, empower and build capacity of local communities so that the solutions to prevailing ATOD problems are community centered.

Potentially beneficial interventions to address ATOD use of adolescents in Kilifi could be an intervention program to enhance social competencies of adolescents in order to teach them drug resistance skills, self-management (e.g. stress management) and social skills. Enhancement of social competencies has been found effective in prevention throughout adolescence (Botvin, 2000). Second, a behavioral family intervention focused on strengthening good parenting skills such as parental monitoring and supervision, parent-to-child communication, problem solving, and negotiation may be helpful within the context of Kilifi. This behavioral family intervention may also need to incorporate income generating activities or financial literacy components since poverty was a strong risk factor that overlapped with other family risk factors. Evidence shows that behavioral family interventions address various risk factors for ATOD use and overall improve quality of life in families (Sanders, 2000). Third and more broadly, an intervention focused on social mobilization and advocacy so as to sustain policy implementation and collective responsibility towards ATOD use prevention in Kilifi is necessary.

Strengths and weaknesses

Among the strengths of this study, our participants were a diverse group that involved primary and secondary school adolescents, those who had dropped out of school and adolescents living with HIV. Both rural and peri-urban settings of Kilifi County were represented. Besides, the adolescents' opinions were contrasted with those from key informants who were adults that worked extensively with adolescents in Kilifi County.

Nonetheless, our findings need to be interpreted cautiously. This study is informed by young people's opinions and views about their peers and thus some of their views may have been either an underestimate or exaggeration of the reality. However, adolescents' opinions were corroborated by those from adults who extensively work with young people in Kilifi.

Conclusion

ATOD use among adolescents in Kilifi on the Kenyan coast is well known among the inhabitants. A multi-faceted and community centered approach is needed to counter ATOD use.

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Declaration of conflicting interests

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Acknowledgements of authors' contributions

D.S designed the study, developed the tools, coordinated and took part in data collection, conducted the coding/data analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript as submitted. P.N.M took part in data collection, coding/data analysis and approved the final manuscript. V.M revised the manuscript and approved the final manuscript. I.J took part in data collection and approved the final manuscript. A.vB revised the manuscript and approved the final manuscript. C.R.N was involved in protocol development, revised the manuscript and approved the final manuscript. A.A designed the study, revised the manuscript and approved the final manuscript.

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Appendix:

Examples of information from FGDs and Informant interviews

The most common alcohol here in Kilifi is the mnazi. The mnazi is very common in almost every home. In the rural and even some parts of Kilifi town, most people take mnazi (KI, medical social worker, male, 27 years).

You'll always find the youths drinking mnazi and chang'aa (Group 5, male, peri-urban primary school).

I heard of a school where there was a boy. His parents give him money for lunch but he does not use that money to eat his lunch but he takes the money, buys alcohol and comes to sell to his fellow pupils in class (Group 6, female, peri-urban primary school).

Probably, I can say, they [adolescents] are not influenced to drink strongly because it is expensive for them to buy (Group 5, male, peri-urban primary school).

Myself, I would say the drinking of alcohol among boys is in large amounts. I have seen so many have indulged in drinking alcohol (Group 4, female, rural secondary school).

You find a person with lots of friends smoking this bhang and more of them are young men than young ladies (Group 4, female, rural secondary school).

Somebody may have been left by the girlfriend or boyfriend so she or he will have stress. So she or he will go and buy that bhang to smoke in order to relieve the stress (Group 9, adolescent living with HIV).

From 16 and 17, they use the wines and spirit because they think they're grown ups (Group 5, male, peri-urban primary school).

But those who go to school, they rarely drink because may be of the restrictions from the school (KI, CBO employee, male, 27 years).

Maybe the parent will drink and the bottles (meaning bottles of alcohol) which are remaining, he will keep them in the fridge. Anyone can open it because it is at home (Group 7, male, peri-urban secondary school).

They are just sent to go and buy the alcohol. When they are sent, and because they see that is something the parents can send them for and drink it, then they see it as something which is not bad (Group 11, female, young adult).

In the rich families you might find a house which has everything in it, even a bar. If there are children, they can start using the alcohol (Group 5, male, peri-urban primary school).

They start (ATOD use) from the age of 15, some can even start as early as 10 depending on how they are brought up at home: how strict the parents are, knowing where your child is all the time. In fact some of them do not even know who the friends of their children are (KI, Peer educator, female, 28 years).

Because every place you go you will find 'mangwen' (a local name for alcohol drinking establishment)…so that's the first thing that makes people to start drinking alcohol when they are still very young (Group 10, adolescent who had dropped out of school).

In a village you will find at least 2 drug traffickers for bhang and even near the school, you can find at least 3 or 4 people selling bhang. If they sell around the school, that means they are targeting students (KI, secondary school teacher, female, 51 years).

Once we engage these youth in extracurricular activities, it keeps them off these behaviors of thinking, "I need to go take bhang, I need to go take alcohol"…their minds will be focused on these physical activities (KI, clinician, female, 30).

So politicians contribute to things like these. I mean the chief and sub-chief leaders. He may know very well that within his area of jurisdiction there is a place where bhang is sold or a place where a particular thing (referring to other drugs) is sold, but he will not be bothered despite his children also being in the locality (Group 11, male, young adult).

I know there are some people in power, they take bhang because they have power, they'll distribute to the sellers who they know. Then the seller will take the bhang to the high schools and villages (Group 5, male, peri-urban primary school).

Alcohol, Tobacco and other Drug (ATOD) use related questions used in the Focus Group Discussions with adolescents:

- **Greet** the participants
- **Introduce** yourself
- Give **background information** about the study. Carefully read through the informed consent form and answer any questions. Give **information about the interview**
- Assure that the participants that they **do not have to participate** if he/she does not want to
- Ask for **approval** to participate in the interview
- Tell the participants that **he/she can stop** the interview any time they wish
- Assure **confidentiality**
- Make sure the participants know what the tape-recording procedure is. Ask for **approval**.
- Ask if the participant has any **questions** before the interview
- If the participant agrees to take part please ensure they sign the consent form
- If the participant agrees to take part please ensure they sign two copies of the consent form, give them a copy and keep one copy for our records.
- Check **the tape recording equipment**
- Start the interview
- At the start of the interview, do NOT record *respondents name or any identifier*; just indicate ***the date, time, gender age and educational level of the person being interviewed. Lastly, record where the interview was taking place.***

1. Sometimes adolescents engage in behavior or habits likely to harm their health. In your opinion, which are the examples of such behaviors that adolescents from Kilifi aged 10 – 19 years engage in?

   (For each behavior probe accordingly so that the discussion follows naturally)

   I would like us now to discuss in more detail. Drawing from your experiences and opinions talk about the following habits/behavior in detail with a focus on young people of your age here in Kilifi.

Alcohol use Behavior

(i) Alcohol use is another form of behavior that young people may engage in. ***Here in Kilfi, which are the forms of alcohol use behaviors that you think pose risk to the health and life of adolescents?***

Probes:

*- **Mention** **the** **local names of the types of alcohol consumed by young people in Kilifi***

-Can you share some examples (but do not mention names of persons involved)?

-Who in particular is likely to engage in these forms of behavior (in terms of gender/age or other socio-demographic characteristics)?

-What do you think makes some adolescents here in Kilifi to drink alcohol?

Notes: (Moderator think of: onset, patterns (like heavy drinking, frequent), where it is accessed), some local names

Smoking Behavior

(ii) Smoking is another type of behavior that young people engage in. ***Think about all forms of smoking behavior and describe which of these adolescents in Kilifi may engage in?***

Probes:

-Mention the local names of what is commonly smoked.

-Who is particularly likely to do this (in terms of gender/age or other socio-demographic characteristics)?

-What do you think makes some adolescents here in Kilifi to engage in smoking behavior?

Notes: (Moderator think of: age of onset, local names/slang cigarette use, can they identify brand names, forms of smoking such as Sisha, pipes etc)

Drug Use Behavior

(iii) Drug use is one of the behaviors reported among some young people around Kenya and also here in Kilifi. ***What do you think are some of these drugs used here in Kilifi by adolescents? Mention the local names of these drugs Kilifi***

Probes:

-How are these drugs used? Can you share some examples (but do not mention names of persons involved)?

-Who in particular is likely to engage in these forms of behavior (in terms of gender/age or other socio-demographic characteristics)?

- What are some of the reasons why an adolescent here in Kilifi would engage in drug use behavior?

Notes: (Moderator think of: local names, routes (like injecting, sniffing, smoking, chewing), where they are accessed)

3. Are any other behavior and activities adolescents in Kilifi participate in that are likely to harm their health and that you feel we have not addressed in our discussion? If so, tell us more about these behavior/habits.

Part C:

Developing tools for HRB assessment among adolescents

Chapter 7

Health Risk Behavior among chronically ill adolescents: A systematic review of assessment tools.

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Abstract

Background: Adolescents living with a chronic illness, or chronic illnesses engage in health risk behavior (HRB) which poses challenges for optimizing care and management of their ill health. Frequent monitoring of HRB is recommended, however little is known about which are the most useful tools to detect and measure HRB among chronically ill adolescents.

Aims: This systematic review was conducted to address important knowledge gaps on the assessment of HRB among chronically ill adolescents. Its specific aims were to: identify HRB assessment tools, the geographical location of the studies, their means of administration, the psychometric properties of the tools and the commonest forms of HRB assessed among adolescents living with chronic illnesses globally.

Methods: We searched in four bibliographic databases of PubMed, Embase, PsycINFO and Applied Social Sciences Index & Abstracts for empirical studies published until April 2017 on HRB among chronically ill adolescents aged 10-17 years.

Results: This review indicates a major dearth of research on HRB among chronically ill adolescents especially in low income settings. The Youth Risk Behavior Surveillance System (YRBS) and Health Behavior in School-aged Children (HBSC) were the commonest HRB assessment tools. Only 21% of the eligible studies reported psychometric properties of the HRB tools or items. Internal consistency was good and varied from 0.73 to 0.98 whereas test-retest reliability varied from unacceptable (0.58) to good (0.85). Numerous methods of tool administration were also identified. Alcohol, tobacco and other drug use and physical inactivity are the commonest forms of HRB assessed.

Conclusion: Evidence on the suitability of the majority of the HRB assessment tools has so far been documented in high income settings where most of them have been developed. The utility of such tools in low resource settings is often hampered by the cultural and contextual variations across regions. The psychometric qualities were good but only reported in a minority of studies from high income settings. This result points to the need for more resources and capacity building for tool adaptation and validation so as to enhance research on HRB among chronically ill adolescents in these settings.

Introduction

Research focusing on health risk behaviors (HRB) among adolescents living with chronic illness has increased over the past few decades. HRB are defined as specific forms of behavior associated with increased susceptibility to a specific disease or ill health on the basis of epidemiological or social data (DiClemente et al., 2013). Examples of HRB include: alcohol, tobacco and drug use, unhealthy dietary habits, sexual behaviors contributing to unintended pregnancy and sexually transmitted diseases, behavior that contributes to unintentional injury or violence, and inadequate physical activity (CDC, 2015, Currie et al., 2009). In the past, it was presumed that chronically ill adolescents are restricted by their ill health from engaging in HRB (Valencia and Cromer, 2000, Sawyer et al., 2007). However, a growing body of evidence shows that chronically ill adolescents engage in such behavior at rates equivalent to (Scaramuzza et al., 2010, Suris et al., 1996, Jones et al., 2006b) or at times higher (Wilens et al., 2011, Choquet et al., 1997, Suris and Parera, 2005, Simpson et al., 2006) than their healthy peers. Some studies for example report higher frequency of cigarette smoking among adolescents with asthma (Rhee et al., 2007, Jones et al., 2006a) and more substance or drug use among adolescents with mental ill health (Wilens et al., 2011, Katon et al., 2010) compared to their healthy peers. In addition, chronically ill adolescents are often victims of behaviors resulting to unintentional injury and violence, such as bullying and sexual assault (Swahn and Bossarte, 2006, Alriksson-Schmidt et al., 2010). Other problematic forms of HRB among chronically ill adolescents include; inadequate physical activity (Nixon et al., 2001, Barbiero et al., 2014, Jones and Lollar, 2008), risky sexual behavior (Choquet et al., 1997, Suris and Parera, 2005), and poor dietary habits (Park et al., 2013).

Engagement in HRB is problematic for chronically ill adolescents because it hinders optimal care and management of ill health (Suris et al., 2004). For example, studies among young people living with HIV report that anti-retroviral therapy adherence rates are poorer among the patients with riskier health lifestyle as compared to their HIV infected peers who live healthier lifestyles (Lagrange et al., 2012, Mellins et al., 2011). Similarly, engagement in HRBs such as tobacco use, recreational drugs use, and risky sexual behavior has been shown to hamper proper management of type 1 diabetes (Silverstein et al., 2005), asthma (Towns and Van Asperen, 2009), and mental ill health (Hawkins, 2009) among adolescents. Poor disease management compounded by direct adverse effects resulting from engagement in HRBs most likely

translates into poorer health outcomes among chronically ill adolescents (Sawyer et al., 2007, Riner and Sellhorst, 2013). Thus, promotion and maintenance of healthier behavioral practices early in adolescence has great potential to enhance positive long-term health outcomes for these patients (Lagrange et al., 2012).

Regarding the public health burden posed by HRB, frequent monitoring of such behaviors is recommended for supporting clinical and preventive efforts directed at improving lives of young people with chronic illnesses and their families (Sawyer et al., 2007, Suris et al., 2008). Although there are numerous measures of HRB, evidence is still meagre on the most frequently utilized HRB measures as well as the psychometric properties of HRB tools among chronically ill adolescents in various geographical contexts. Moreover, without proper adaptation, measurement bias and compromise to various psychometric properties like validity and reliability may arise (Van de Vijver et al., 2003, Abubakar, 2015). Bias also arises from unfamiliar content of the tests, translation challenges and unfamiliar means of tool administration (Van de Vijver et al., 2003). Studies have similarly shown that variations in how questions are administered and how respondents are contacted affects the accuracy and quality of data collected (Bowling, 2005). There is still a lack of knowledge concerning the major forms of HRBs, their commonly utilized assessment tools, their psychometric properties and their methods of administration in studies among chronically ill adolescents.

We therefore carried out this review to determine the current gaps in knowledge about tools to measure HRB. The review synthesizes findings from empirical studies conducted globally among adolescents living with chronic illnesses so as to: (i) identify the commonly utilized HRB assessment tools or sources of items used; (ii) describe the geographical utility of HRB assessments tools; (iii) identify the common means of HRB tool administration; (iv) document the reported adaptation and psychometric properties of HRB assessment tools or items; and (v) summarize the commonly assessed forms of HRB. We expect the results of this systematic review to aid HRB tool adaptation and validation procedures as well as enhance planning of research and interventions targeting adolescents living with chronic illnesses especially in low and middle income settings.

Methods

This systematic review was conducted following recommended guidelines for conducting systematic reviews (Arksey and O'Malley, 2005). We searched for relevant literature in four bibliographic databases: PubMed, Embase, PsycINFO and Applied Social Sciences Index & Abstracts. The search was initially conducted between November and December 31st 2015 and later updated in May 2017. The search strategy was formulated by two reviewers (D.S. and A.A) and comprised of the following non-MeSH terms combined with Boolean operators: *risk behavior* OR *risk taking* OR *health behavior* OR *healthy lifestyle* AND *adolescents* OR *Youth* OR *Teens* AND *Chronic condition* OR *Chronic disease* OR *Chronic illness*. Additionally, other relevant studies were identified by searching the reference lists of the retrieved articles.

In this review, our study inclusion criteria were: (i) empirical studies published in a peer reviewed journal from January 1st 1980 to April 30th 2017; (ii) studies with participants aged 10-17 years; and (iii) studies assessing for both HRB and chronic illness among the same study participants. The chronic conditions considered are those documented by the United States Department of Health and Human Services for the standard classification scheme (Goodman et al., 2013). Only studies published in English were included in this review. Studies were excluded if: (i) they were non-empirical (such as reviews, commentaries, letters to editor, conference abstracts), (ii) their participants had an age range or mean age below or above the 10 -17 years' category and (iii) they assessed only HRB without consideration of chronic illness or vise-versa.

Data extraction was done by two independent reviewers (D.S., & M.K.N). The data were extracted to Microsoft Excel spread sheets with the following details from eligible studies: author and date of publication, country where the study was conducted, age of the participants (mean age), form of chronic illness, assessment tool or source of items on HRB, methods of administration of HRB measures, psychometric properties of the tool (if documented), and form of HRB assessed were extracted. For reliability, we extracted measures of internal consistency, and interrater reliability such as the Cronbach's alpha, intra-class coefficient (ICC) and coefficient of correlation whenever reported. For tool validity, we extracted construct, criterion, divergent or convergent validities whenever reported. We also noted any aspects of tool adaptation such as cultural adaptation, content validity, forward-back translations in case they were reported (refer to Table 4).

Data analysis involved collating and summarizing of results. The synthesis of data extracted from the eligible studies was done narratively. Frequencies and/or percentages were computed in Microsoft Excel program so as to summarize the findings on: the frequency of the various HRB tools/measures reported in studies, geographical utilization of these tools, forms of HRB assessed, methods of HRB tool/item administration and the various chronic conditions reported. Due to the high variation in HRB tools or items used, the tools were classified in to 4 categories namely: (i) full version HRB assessment tools; (ii) modified version of HRB assessment tools; (iii) borrowed items on HRB; and (iv) items on HRB either newly developed or whose source is not specified by the author. Also in situations where more than one eligible manuscript was published using data from the same study, frequencies on HRB tools were collated in order to represent a single frequency count for this reported HRB assessment tool. For purposes of data management the reported chronic conditions were re-categorized in to: respiratory, cardio-vascular, metabolic, hematological, mental, musculoskeletal, neurologic, dermatologic, digestive, physical disability and HIV.

Results

The literature search yielded a total of 1,623 articles and following a systematic appraisal of this literature (refer to Figure 7.1), a total of 79 full articles were eligible for inclusion in this review.

Majority of the eligible studies were conducted in North America (60%) and Europe (24%). The rest of them were from Asia (8%), South America (2%), Oceania (2%) and a few were multi-site studies conducted in both Europe and North America (2%). The study site of one eligible study was not reported in the article (Gold and Gladstein, 1993).

Results of the most frequently utilized HRB tools/items are shown in Table 7.1. Briefly, from a total of 37 full version HRB tools, 7 tools namely: Health Behavior in School-aged Children (HBSC), Youth Risk Behavior Surveillance System (YRBSS), Korea Youth Risk Behavior Web-based Survey (KYRBS), Swiss Multi-centric Adolescent Survey on Health (SMASH), Car, Relax, Alone, Forget, Friends, Trouble (CRAFT) substance Abuse Screening Test, Alcohol Use Disorder Identification Test (AUDIT) and Life and Health in Youth questionnaire were the most commonly utilized. The items on HRB in 12 of the

studies from this review were either newly developed or their sources were not specified (Lagrange et al., 2012, Kyngas, 2007, Tortolero et al., 2014, Schmitz et al., 2002, Shrier et al., 2001, Blum et al., 2001, Bush et al., 2007, Uzark et al., 1989, Kunz et al., 2014, Warren et al., 2017, Wilcox et al., 2016, Kline-Simon et al., 2016).

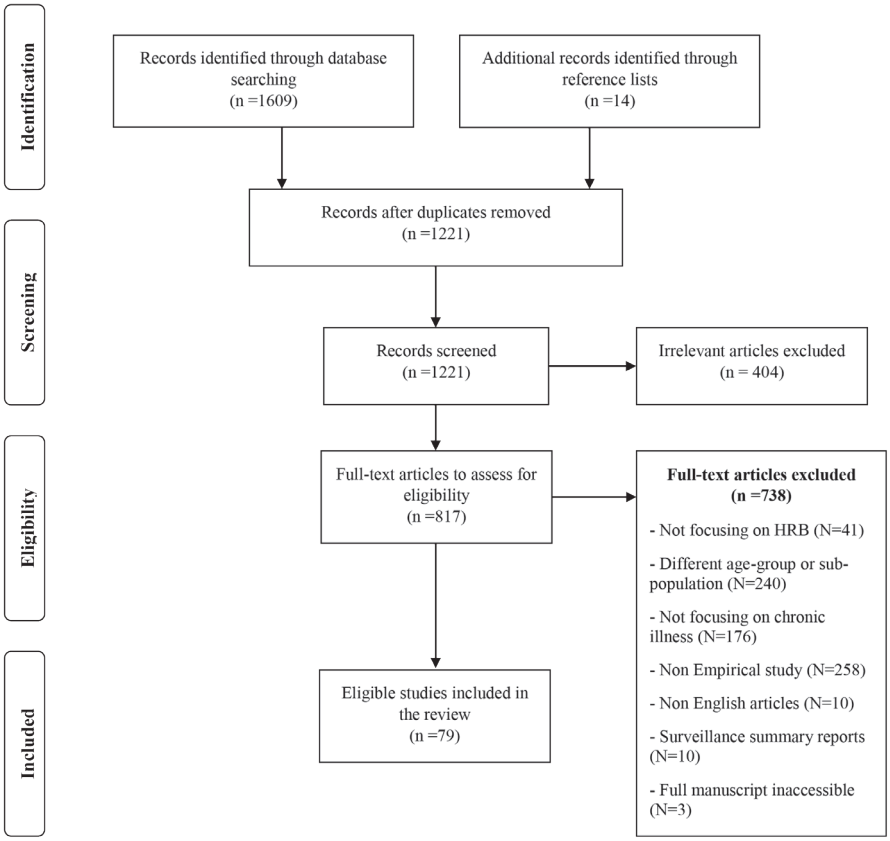

Figure 7.1. A flow diagram representing the article screening process of this review

The HBSC tool is a self-completion questionnaire administered in class room settings to adolescents aged 11 – 15 years and the HBSC study is conducted every 4 years across 44 countries in Europe and North America since its inception in 1982 (Currie et al., 2009). The key health behaviors captured by this tool include; bullying and fighting, oral hygiene, physical activity and sedentary behavior, sexual behavior, substance use (e.g. alcohol, tobacco

and cannabis), weight reduction behavior, behaviors resulting in injury, and dietary habits (Currie et al., 2009). The YRBS tool (Standard and National High School Questionnaires) is developed by the U.S. Centers for Disease Control and Prevention (CDC) to monitor HRB that are considered leading causes of disability, death and social problems among youths in 9^{th} – 12^{th} grade (approximately 14 – 18 years) in the U.S. Students complete the self-administered questionnaire during one class period and record their responses directly in an answer sheet. This tool assesses 6 forms of HRB: sexual risk behaviors, tobacco use, alcohol and other drug use, inadequate physical activity and unhealthy dietary behaviors (CDC, 2015).

Table 7.1. Frequency of utilization of HRB tools and sources of items

HRB tools or items	Frequency (%)
(i) ***Full version of HRB Tool*** *(n=37)*	
Health Behavior in School-aged Children (HBSC)	4 (8.2)
Youth Risk Behavior Surveillance System (YRBSS)	3 (6.1)
Korea Youth Risk Behavior Web-based Survey	3 (6.1)
CRAFT substance Abuse Screening Test	3 (6.1)
Swiss Multi-Centre Adolescent Survey on Health (SMASH) questionnaire	2 (4.1)
Alcohol Use Disorder Identification Test (AUDIT)	2 (4.1)
Life and Health in Youth questionnaire	2 (4.1)
Other tools (n=30)	30 (61.2)
(ii) ***Source of borrowed HRB items*** *(n=14)*	
Youth Risk Behavior Surveillance System (YRBSS)	8 (29.6)
Health Behavior in School-aged Children (HBSC)	4 (14.8)
Child Behavior Checklist	3 (11.1)
Youth Self Report	2 (7.4)
Other sources (n=10)	10 (37.1)
(iii) ***Modified version of HRB assessment tools*** *(n=3)*	
Modified Youth Risk Behavior Surveillance System	1 (33.3)
Modified Self Report of Delinquency	1 (33.3)
Modified Michigan Alcohol Screening Test (MAST)	1 (33.3)
(iv) ***Items newly developed or with unspecified source*** *(n=12)*	12 (100)

Results on the most frequently assessed forms of HRB are summarized in Table 7.2. Overall, Alcohol, Tobacco and Other Drug use and physical inactivity were the most frequently assessed forms of HRB.

Table 7.2. Frequency of HRB assessed among chronically ill adolescents

Forms of HRB assessed	Frequency (%)
Smoking	49 (18.9)
Alcohol use	42 (16.2)
Physical inactivity	35 (13.5)
Drug and other substance use	34 (13.1)
Sexual risk behavior	20 (7.7)
Violence/aggressive/anti-social behavior	26 (10.0)
Poor dietary behavior	18 (6.9)
Self-harm	12 (4.6)
Sedentary behavior	9 (3.5)
Behavior resulting to unintentional injuries	5 (1.9)
Inadequate sleep behavior	6 (2.3)
Poor hygiene	2 (0.8)
Sun exposure behavior	1 (0.4)

The HRB tool/item administration (Table 7.3**)**, adolescent self-completed paper and pencil format, face-to-face interview with the adolescent, and Audio Computer Assisted Self Interview (ACASI) were the most frequently utilized means.

Table 7.3. A summary of methods for administration of HRB tools or items

Method of HRB tool/item administration	Frequency (%)
Adolescent self-completed paper and pencil format	41 (49.4)
Face-to-face interview with the adolescent	10 (12.0)
Audio Computer Assisted Self Interview (ACASI) or Computer Assisted Personal Interview (CAPI)	7 (8.4)
Online questionnaire	5 (6.0)
Telephone administered to the adolescent	5 (6.0)
Mailed Questionnaire	4 (4.8)
Face –Face interview with adolescent & parent/guardian	3 (3.6)
Face – Face interview with parent/guardian	2 (2.4)
Parental filled Questionnaire	2 (2.4)
Telephone delivered to parent/guardian	1 (1.2)
Means not specified	3 (3.6)

Adaptation or psychometric properties of the HRB tools or items among the study population were reported in only 17 studies moreover. Most of these (82%) were conducted in the USA (see Appendix). Five of these studies reported aspects of adaptation such as forward-back translations, content validity, item completeness, and cultural appropriateness but without reporting any psychometric data (Brooks et al., 2002, Asnani et al., 2014, AlBuhairan et al., 2015, Sentenac et al., 2013, Warren et al., 2017). Among those that reported psychometric data, only 6 studies (Nixon et al., 2001, Woods et al., 2013, Wilens et al., 2011, Frey, 1996, Frey et al., 1997, Frazer et al., 2017) reported this data for an entire HRB tool or entire tool from which HRB items were borrowed while the rest reported only data for select items from the HRB tool. Psychometric data for the whole HRB tool was reported for the following instruments: Kriska's Modifiable Activity questionnaire; Modified Self Report of Delinquency; Risk Behavior and Risk Scale; Delinquency Scale; and the Denys Self-Care Practice instrument. Moreover, psychometric properties of Youth Self Report; Child Behavior Check List; and the Structured Clinical Interview for the DSM-IV in the context of HRB evaluation were also reported. The reported psychometric properties of these tools satisfied the recommended thresholds for psychometric rigor for example the internal consistency (coefficients ranged from 0.73 to 0.98) and test-retest reliability (coefficients ranged from 0.58 to 0.85). The psychometric data reported on select HRB items were mainly for items assessing physical activity or sedentary behavior (Schmitz et al., 2002, Elder et al., 2005) and these also had good test-retest reliability ranging from 0.8 to 0.81 and good internal consistency of 0.73.

The HRB tools were largely used among adolescents with the chronic conditions of mental illness, especially depression (21.4%), respiratory conditions such as asthma and cystic fibrosis (13.8%), metabolic conditions such as diabetes (9.4%) and neurological conditions such as autism spectrum disorders, epilepsy and cerebral palsy (6.9%). To a lesser extent, the HRB tools were also utilized among adolescent patients with musculoskeletal conditions such as arthritis, cardio vascular conditions (e.g. congenital heart disease and hypertension), HIV, cancer, digestive tract conditions (e.g. inflammatory bowel disease and gastritis), disabling conditions (e.g. visual, speech and hearing problems) and dermatological conditions such as atopic dermatitis and eczema. The detailed summary of eligible studies is presented in Table 4.

Discussion

This review identified the commonly utilized HRB assessment tools or sources of items used; describing the geographical utility of HRB assessments tools, the common methods of HRB tool administration, the adaptation and psychometric properties; and providing a summary of the forms of HRB commonly assessed. Our findings show that the YRBS and HBSC are the most frequently used tools to assess HRB or sources of items on HRB. This may partly be explained by their high level of comprehensiveness in assessing priority and multiple forms of HRBs thereby being useful in many contexts. While both tools assess for HRB among adolescents, the YRBSS targets an older adolescent age group compared to the HBSC. The HBSC however focuses more on the social and environmental context for HRB such as influence of peers, school environment, and family characteristics. The YRBSS explores HRBs in greater detail compared to the HBSC although the former lacks items on oral hygiene, health complaints and chronic illnesses. Besides the YRBSS and HBSC, a wide range of other HRB tools have been utilized moreover, some of them assess the same form of HRB but in different format. One challenge that this may present is the lack of uniformity or standardized format to compare similar HRB outcomes across different study populations.

Findings from this review also indicate that research on HRB among adolescents living with chronic illnesses in low and middle income countries (LMIC) is still limited. This is unfortunate since majority of the adolescent population lives in LMICs (UN, 2012) where a disproportionately higher burden of HRB occurrence is also reported (Ruiz-Casares, 2009). There are three potential reasons that may explain the limited research on HRB among chronically ill adolescents in LMICs. First, there is limited research that explicitly focuses on the adolescent age-group (Sawyer et al., 2007). Second, research on this subject is not adequately prioritized (Valencia and Cromer, 2000). Nonetheless, research on HRB among chronically ill adolescents has significantly grown over the past two decades (Sawyer et al., 2007, Valencia and Cromer, 2000) though with disproportionately lower prioritization especially in LMICs. The third reason is the scarcity of standardized measures on various health outcomes among chronically ill adolescents (Sawyer et al., 2007). The need for more investment in research on health and behavioral outcomes among chronically ill adolescents especially in LMICs cannot be overemphasized given that the burden of chronic diseases is increasing in such settings (Boutayeb and Boutayeb, 2005).

The use of appropriate and psychometrically sound instruments is essential for having good insight in adolescents' behavior so as to be able to address certain forms of behavior that could be dangerous either for themselves or for others. However, our findings indicate that HRB tool adaptation and psychometric properties are rarely reported among studies on HRB of chronically ill adolescents. Partly, this could be due to the fact that the majority of the studies were conducted in the western context where majority of these tools have been developed. To indicate the adaptation and psychometric properties, some of the authors simply cite studies where similar HRB tools or items have been previously utilized (Britto et al., 1998, Lunt et al., 2003, Nylander et al., 2015). This may not guarantee validity and reliability for a number of reasons. First, some of the tools were previously adapted and validated for use among adolescents without chronic conditions and thus we cannot ascertain if they retain their good psychometric properties when used among chronically ill adolescents. Secondly, some of the original validation or adaptation may have taken place more than two decades previously and considering the evolution of HRB, various behavioral constructs used in these tools may no longer work appropriately. Another observation is that many researchers borrow specific items from previously well validated or standardized HRB tools but without checking the item specific psychometric properties.

Our findings also reveal that there is a tendency for researchers to perform the adaptation processes such as forward-back translation and content review for item completeness, clarity or cultural appropriateness; without performing psychometric evaluations. It should be emphasized that much as adaptation is an important process, psychometric evaluation is equally critical for ascertaining item reliability and validity. Without adequate adaptation and psychometric evaluation we cannot ascertain if the scales and items retain their good psychometric properties following the modifications made. Overcoming such challenges requires a mixed methods approach for tool adaptation and validation (Harachi et al., 2006, Abubakar et al., 2013). For instance, a four step approach has been suggested for adapting tools in LMIC (Holding et al., 2009), which entails: (i) construct definition which can be done through review of literature, and consultation with community or local professionals in order to achieve conceptual clarity and equivalence; (ii) item pool creation which involves preparation of a list of potentially acceptable items in a clear and unambiguous language using feedback from the first step; (iii) developing clear guidelines for administration of the items to ensure operational equivalence; (iv) test evaluation which involves psychometric evaluation to assess measurement and functional equivalence (Holding et al., 2009).

Additionally, findings from this review indicate that there are numerous methods of HRB tool or item administration. Self-administered paper and pencil format was the most popular method and this could have been because of the participants' good level of literacy given that majority of them were school attending adolescents. This method of administration is also preferred as it is associated high level of privacy and ease of administration (Bowling, 2005). On the contrary, its disadvantage arises from its requirement for some literacy levels among the respondents as well as the cognitive burden that respondents face in comprehending and recalling their experiences (Bowling, 2005, Schroder et al., 2003). Face-to-face interviews were also frequently utilized in assessing HRB. This method is linked to high response rates and the benefit of probing participants and clarifying unclear questions (Schroder et al., 2003). Nonetheless, face-to-face interviews are hampered by the lack of anonymity which may result to social desirability bias and impression management (Schroder et al., 2003, Bowling, 2005). Similar to findings from other studies (Vereecken and Maes, 2006, Bowling, 2005), our review shows that there is growing utilization of electronic methods of HRB tool and item administration. Electronic methods (such as the Audio Computer Assisted Self Interview (ACASI), telephone and internet based surveys) are valued for their high level of privacy or anonymity (Bowling, 2005, Schroder et al., 2003) and some of them such as the ACASI have been further designed to benefit people with low literacy levels (Schroder et al., 2003). However, electronic methods require access to electronic devices and services (such as telephone, computer, and internet), may require greater auditory demands and some demand a high level of literacy (Vereecken and Maes, 2006, Bowling, 2005). The presence of numerous HRB tool administration methods presents a wide set of options which can be tailored to suit contextual factors, research skills, resource availability and specific needs of study populations. However, researchers should carefully think through the dynamics surrounding tool administration and data collection procedures in order to identify the most appropriate methods to ensure that high quality data is collected.

Furthermore, our findings show that alcohol, tobacco, drug use behavior and physical inactivity are the most frequently researched HRB among adolescents with chronic conditions. Substance use among chronically ill adolescents is of major concern and many studies report higher or equivalent rates of substance use (e.g. cannabis, tobacco, illicit drugs) among these adolescents in comparison to their healthy peers (Rhee et al., 2007, Erickson et al., 2005, Simpson et al., 2006). This may explain why most of HRB research among

this group focuses on substance use behavior. Our findings also indicate that physical inactivity and sexual risk behavior are frequently assessed. Growing research interest on sexuality of chronically ill adolescents indicates that sexual risk behavior is a concern (Simpson et al., 2006, Suris and Parera, 2005, Choquet et al., 1997, Suris et al., 1996) and this dissents the earlier notion that they are less sexually active than their healthy peers (Valencia and Cromer, 2000). Likewise, physical activity among adolescents with chronic conditions is gaining measureable research interest (Riner and Sellhorst, 2013). This may surround its vital role in appropriate management of chronic illness such as: cardio-respiratory fitness among asthmatic patients and optimization of quality of life among patients with cerebral palsy (Riner and Sellhorst, 2013).

Our results also indicate that violence related behaviors are frequently investigated among chronically ill adolescents. Adolescents with chronic illnesses often fall victim of violence such as bullying, assault and forced sexual encounters (Alriksson-Schmidt et al., 2010, Sentenac et al., 2013); and thus raising the need for increased research on this matter. On the other hand, our findings show that poor hygiene, inadequate sleep and behavior resulting in unintentional injury were the least frequently assessed forms of HRB in this review. This may be due to the reality that most of this problematic behavior is of greater research interest in LMICs (whose representation is still low) where their occurrence is documented to be greater compared high income settings (Ruiz-Casares, 2009, Prüss-Ustün et al., 2014). Our findings on the variation in the frequency of the forms of HRB assessed, may partly imply that there is some tendency to measure HRBs in isolation. However, co-occurrence of adolescent HRB is increasingly documented (Hale and Viner, 2016, de Winter et al., 2016), and thus there's need to assess for HRB in multiplicity.

Our review draws its major strengths from the utilization of a rigorous methodological framework (Arksey and O'Malley, 2005) and also its specific focus on the adolescent age-group in a global perspective. However, we did not appraise the quality of the studies included in our systematic review. Nonetheless, given that our study objectives aimed at describing extent of utilization of HRB tools and providing an over-view of various forms of HRB assessed, we do not expect any major issues arising from the quality of studies to influence our findings.

Conclusion

Overall, most research on health risk behavior among chronically ill adolescents emanates from high income settings such as Europe and North America where the majority of the HRB assessment tools have also been developed. Therefore more investment in research on health and behavioral outcomes among chronically ill adolescents especially in LMICs. Although the YRBSS and HBSC are most utilized, a variety of other HRB tools are used as well, however without documentation of adaptation and psychometric qualities. This poses challenges for researchers and practitioners who are keen to evaluate HRB in LMICs. We recommend the use of the mixed methods approach for tool adaptation and validation, which involves both qualitative approaches (e.g. focus group discussion and in-depth interviews) and quantitative approaches (e.g. psychometric testing) to develop and standardize measures for use by health researchers especially from LMICs. In the industrialized setting, we recommend the use of YRBSS or HBSC owing to their comprehensive approach to assessing multiple forms of HRB. The need for more research on HRB among chronically ill adolescents could translate to significant clinical, public health and social economic benefits, especially for adolescents living with such illnesses and their families.

Declarations

Ethics approval and consent to participate

This study did not require approval from an institutional review board. The researchers did not interact with human subjects as the focus was to review previously published literature.

Consent for publication

Not applicable

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on request.

Competing interests

The authors declare that they have no competing interests.

Acknowledgements of authors' contributions

D.S conceived and designed the study, conducted the database search and abstraction, statistical analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript. M.K.N conducted database search and abstraction, and approved the final manuscript. A.vB revised the manuscript and approved the final manuscript. C.R.N advised on the study methodology, revised the manuscript and approved the final manuscript. A.A conceived and designed the study, revised the manuscript and approved the final manuscript.

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Appendix: A summary of data extracted from the eligible studies included in this review

Author	Country	Age range or mean age (SD)	illness	Form of HRB	HRB tool or Source of HRB items	Adaptation and Psychometric properties
Holmberg and Hjern, 2008	Sweden	10*	ADHD	Behavior resulting into violence	Items adapted from HBSC	NR
Husarova et al., 2016	Slovakia	13 -15	Asthma, Learning disability or Presence of a long term illness	Sedentary lifestyle	Health Behaviour in School-aged Children	NR
Park et al., 2013	USA	15 -17	Asthma	Tobacco smoking, poor dietary habits	2009 YRBSS questionnaire	Convergent Validity: The item on soda-intake from the questionnaire correlated with soda intake from 24-hour dietary recalls (r=0.44)
Kim et al., 2012	Korea	13–18	Asthma	Tobacco use, physical inactivity, sedentary life-style	2007 Korea Youth Risk Behavior Web-Based Survey (KYRBWS)	NR
Rhee et al., 2007	USA	16*	Asthma	Tobacco use, illicit substance/drug use, alcohol drinking	Periodic Assessment of Drug Use (PADU)	NR
Jones et al., 2006b	USA	14 -18	Asthma	Physical inactivity, sedentary lifestyle	2003 YRBSS	NR
Jones et al., 2006a	USA	14 - 18	Asthma	Tobacco smoking, drug/ substance use	2003 YRBSS	NR
Tercyak, 2006	USA	16.1 (±1.6)	Asthma	Tobacco smoking behavior	Adapted from the YRBSS	NR
Swahn and Bossarte, 2006	USA	14 -18	Asthma	Behavior resulting into violence	2003 YRBSS	NR
Lee and Shin, 2017	Korea	12 -17	Atopic dermatitis Depression	Self-harm, Poor sleep behavior, behavior resulting to violence, alcohol drinking, tobacco smoking, physical inactivity	Korean Youth Risk Behavior Survey 2013 (KYRBS)	NR

Oh et al., 2016	Korea	14.8 (±1.8)	Atopic disease (asthma, allergic rhinitis, atopic dermatitis)	Poor sleep behavior	Korean Youth Risk Behavior Survey 2013 (KYRBS)	NR
Lunt et al., 2003	Australia	14.6 (±1.8)	Cardiac disease	Physical inactivity	Items adapted from New South Wales Schools Fitness and Physical Activity Survey	NR
Barbiero et al., 2014	Brazil	2 -18	Congenital heart disease	Tobacco smoking, physical inactivity	International Physical Activity Questionnaire (IPAQ)	NR
Uzark et al., 1989	USA	16.1*	Congenital heart disease	Sexual risk behavior, tobacco smoking, alcohol drinking, physical inactivity	Source of items not clear	NR
Nixon et al., 2001	USA	7 -17	Cystic fibrosis	Physical inactivity	Kriska's Modifiable Activity questionnaire	Convergent Validity: Physical activity measured by HRB tool correlated significantly with measurements by a Caltrac motion sensor (r=0.4, p=0.04) Test-retest reliability: a 3 months period test-retest reliability was ICC=0.77, 0.70, 0.58 for 3 levels of physical activity
Adrian et al., 2014	USA	15 -19	Depression	Tobacco smoking, drug/ substance use, alcohol drinking, poor dietary, physical inactivity, poor sleep behavior	Washington State Healthy Youth Survey	NR
Lampard et al., 2016	USA	14.4 (±2.0)	Depression	Poor dietary habits, tobacco smoking	EAT 2010 survey tool	EAT 2010 survey tool was first pilot tested with 129 students Test-retest reliability of the item used to capture any of these behaviors was ICC=0.85
Frazer et al., 2017	USA	16.1 (±1.3)	Depression	Anti-social acts (delinquent behavior), drug/substance use, alcohol use	Delinquency Scale	Internal consistency (Cronbach's alpha = 0. 84)

Allison et al., 2005	Canada	12 -17	Depression	Physical inactivity	Items extracted from the YRBSS	NR
Tortolero et al., 2014	USA	11.2 (±0.6)	Depression	Behavior resulting into violence	Source of items is not clear	NR
Dube et al., 2013	USA	12 -17	Depression	Tobacco smoking	National Health and Nutrition Examination Survey	NR
Richardson et al., 2012	USA	13 -17	Depression	Drug/substance use, alcohol drinking	CRAFT substance abuse screening test	NR
Katon et al., 2010	USA	13 -17	Depression	Tobacco smoking, drug/ substance use, alcohol drinking, poor dietary habits, physical inactivity, sedentary lifestyle	CRAFT Substance Abuse Screening Test	NR
Simpson et al., 2006	Canada	14 -18	Depression	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, poor dietary habits, physical inactivity, unintentional injuries, behavior resulting into violence	2001/2 HBSC	Construct validity: A one-factor solution with loadings 0.63 – 0.80 indicated the following items: lifetime cannabis use; unprotected sexual intercourse; lifetime use of other illicit drugs; lifetime drunkenness; and present smoking status. Internal consistency: An excellent Cronbach's alpha =0.81 was obtained for the entire HRB tool
Tercyak et al., 2006	USA	14.1 (±2.4)	Depression	Tobacco smoking, physical inactivity, sun protective behavior	Items derived from Youth Risk Behavior Survey (YRBSS)	NR
Elder et al., 2005	USA	15.5*	Depression	Tobacco use, alcohol drinking, poor dietary habits, Physical inactivity, sedentary lifestyle	Items adapted from: 1997 YRBSS, 24 Hour Food Intake Record (FIR), 7 day Physical Activity Recall	Inter-observer reliability for FIR was r=0.72 for 12 key nutrients Test-retest reliability of the items on TV watching in terms of total hours per week was 0.80 at pilot testing

Pronk et al., 2004	USA	13 - 17	Depression	Tobacco smoking, alcohol drinking, poor dietary habits, physical inactivity,	Items adapted from: Behavior Risk Factor Surveillance System and from Recommended Food Score	NR
Brooks et al., 2002	USA	14 -18	Depression	Sexual risk behavior, tobacco smoking, alcohol drinking, substance/drug use, poor dietary, physical inactivity, behavior resulting in to violence	Massachusetts Adolescent Health Survey	-The tool was reviewed by academic experts, adolescent health practitioners and survey researchers for content validity and cultural appropriateness HRB items were pilot-tested among 4 adolescent focus groups and were pre-tested for clarity, length and completeness of closed ended questions
Schmitz et al., 2002	USA	11 -15	Depression	Physical inactivity, sedentary lifestyle	Source of items not clear	The test–retest reliability for the item on physical activity was 0.65 The test–retest reliability for sedentary lifestyle was 0.81 & a Cronbach's alpha of 0.73.
Shrier et al., 2001	USA	17.1*	Depression	Sexual risk behavior, drug/ substance use, alcohol drinking	Source of items not clear	NR
Moradi-Lakeh et al., 2016	Saudi Arabia	15 -19 (majority)	Diabetes mellitus, congestive heart failure, renal failure, cancer	Physical inactivity, sedentary lifestyle, poor dietary habits, tobacco smoking, unintentional injuries	Saudi Health Information Survey (SHIS)	NR
Ohmann et al., 2010	Austria	9 -19	Diabetes	Anti-social acts	Child Behavior Checklist, Youth Self Report	NR
Scaramuzza et al., 2010	Italy	14 (±2.0)	Diabetes	Sexual risk behavior, self-harm, tobacco smoking, alcohol drinking, substance/ drug use	Items adapted from YRBSS	NR
Kyngas, 2007	Finland	13 -17	Diabetes	Tobacco smoking, alcohol drinking, physical inactivity	A newly developed questionnaire	NR

Soutor et al., 2004	USA	9 -17	Diabetes	Poor dietary habits, physical inactivity	24 hour recall interviews	NR
Gold and Gladstein, 1993	Not stated	15*	Diabetes	Tobacco smoking, substance/drug use, alcohol drinking	Modified Michigan Alcohol Screening Test	NR
Timko et al., 1992	USA	10 -11	Juvenile rheumatic disease	Tobacco smoking, drug/ substance use, alcohol drinking,	Health and Daily Living Form	NR
MacDonell et al., 2016	USA	15.8 (±4.9)	HIV	Substance use	The Car, Relax, Alone, Forget, Friends, Trouble (CRAFT)	NR
Elkington et al., 2009	USA	9 – 16	HIV	Sexual risk behavior, tobacco smoking, alcohol drinking, substance/drug use	Adolescent Sexual Behavior Assessment (ASBA), Diagnostic Interview Schedule for Children-IV	NR
Lagrange et al., 2012	USA	17.2*	HIV	Poor dietary habits, physical inactivity, poor sleep behavior	6 questions with unclear sources	NR
Asnani et al., 2014	Jamaica	17 (±1.4)	Sickle cell Disease	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking	Jamaican Youth Risk and Resilience Behavior Survey	Validity of instrument was assured through pretesting it among a youth group and a panel of adolescent health experts
AlBuhairan et al., 2015	Saudi Arabia	15.8 (±3.4)	Mental illness, asthma, hematological disorders, skin disorders, genito-urinal disorders	Tobacco smoking, drug/ substance use, alcohol drinking, poor dietary habits, physical inactivity, sedentary lifestyle, unintentional injuries, behavior resulting into violence	Items adapted from YRBSS and Global School-based Student Health Survey	Items underwent cultural adaptation and culturally inappropriate items were excluded (e.g. on sexual behavior and sexually transmitted infections)

Kline-Simon et al., 2016	USA	15*	Mental ill conditions (depression, bipolar spectrum disorders, personality disorders, dementia, schizophrenia, other psychoses) Asthma, sinusitis, arthritis, rhinitis, diabetes mellitus, inflammatory bowel disease, migraine	Substance use	Source of items not clear	NR
Kunz et al., 2014	USA	16.1 (±1.5)	Cystic fibrosis, inflammatory bowel disease, arthritis, hematologic condition, cardiac condition	Tobacco smoking, alcohol drinking	Source of items not clear	NR
Conner et al., 2013	USA	15.9*	HIV, Depression	Tobacco smoking, alcohol drinking, substance/drug use	Items adapted from Reaching for Excellence in Adolescent Care and Health (REACH)	NR
Olsson et al., 2013	Sweden	15 -16	Rheumatism, autism, epilepsy, diabetes, ADHD, Eczema, mental problem, asthma, visual/ speech impairment, dyslexia	Poor dietary habits, physical inactivity, behavior resulting into violence	2008 Ung I Värmland questionnaire	NR
Singh et al., 2013	USA	10 -17	Asthma, autism, depression, ADHD, learning disability, hearing problems	tobacco smoking, physical inactivity, sedentary lifestyle, poor sleep behavior	National Survey of Children's Health questionnaire	NR

Woods et al., 2013	USA	11 -16	asthma, persistent bowel problems, diabetes, sickle cell anaemia, and others	Behavior resulting into violence	Youth Self Report (YSR), Child Behavior Checklist (CBCL), Modified Self Report of Delinquency (MSRD)	Test-retest reliability of YSR was r=0.8 and internal consistence, Cronbach's alpha=0.96 Internal consistency of MSRD was Cronbach's alpha=0.98 The internal consistency of CBCL was Cronbach's alpha=0.91 and 0.80 for externalizing and internalizing sub-scales respectively.
Wilens et al., 2011	USA	6 - 17	ADHD, Depression	Tobacco smoking, alcohol drinking, drug/substance use	Structured Clinical Interview for the DSM-IV	Inter-rater reliability of the diagnosis procedures was assessed by comparing findings by assessment staff and those by certified child and adult psychologists who used the audio taped assessment interviews). Kappa coefficient for Substance use disorder = 1.0
Bush et al., 2007	USA	11 -17	Asthma, Depression	Tobacco smoking	Source not clear	NR
Silburn et al., 2007	Australia	12 -17	Asthma, visual & hearing impairment, learning difficulties, speech problems	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, physical inactivity, self-harm	Western Australia Aboriginal Child Health survey	NR
Suris and Parera, 2005	Spain	16.1 (±1.4)	Diabetes, asthma, epilepsy, scoliosis, cancer, arthritis	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking	Catalonia Adolescent Health Survey 2001	NR
Blum et al., 2001	USA	16.2*	Physical disability, learning disability, emotional disability	Sexual risk behavior, tobacco smoking, alcohol drinking, self-harm, behavior resulting into violence	Source of items not clear	NR

Britto et al., 1998	USA	15.6 (±1.6)	Cystic fibrosis, sickle cell disease	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, unintentional injuries, behavior resulting into violence, self-harm	Modified version of YBS	NR
Choquet et al., 1997	France	16.2 (±2.0)	Cancer, hemophilia, arthritis, nephropathy, diabetes, mental disease, metabolic disease, eczema, psoriasis, asthma, cardio-pathy	Sexual risk behavior	Items derived from HBSC and Choquet-Ledoux study	NR
Frey et al., 1997	USA	14.2 (±2.3)	Diabetes, Asthma	Sexual risk behavior, tobacco smoking, alcohol drinking, substance/drug use	Risky Behavior and Risk Scale	Internal consistency ranged from 0.85 to 0.95 for the 3 subscales of the HRB tool
Frey, 1996	USA	9 -16	Diabetes, Asthma	Poor dietary habits, physical inactivity, poor sleep behavior	Denyes Self Care Practice Instrument	Internal consistency ranged from 0.73 to 0.79
Suris et al., 1996	USA	14 -15	Scoliosis, arthritis, muscular dystrophy, diabetes, seizures, asthma	Sexual risk behavior	Minnesota Adolescent Health Survey 1986-7	NR
Nylander et al., 2015	Sweden	15 – 18	Presence of at least one chronic disease	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, physical inactivity, behavior resulting into violence, self-harm	2011 Life and Health in Youth Questionnaire	NR
Warren et al., 2017	USA	16.6*	Presence of comorbid chronic conditions	Poor dietary habits, behavior resulting into violence, Poor hygiene practices	Items borrowed from previous population level surveys	Clarity and understandability of items assessed by expert panel review and cognitive interviews of adolescents
Ardic and Esin, 2016	Turkey	16.0 (±0.9)	Presence of any pre-existing or current chronic illness	Poor dietary habits, Physical inactivity	Adolescent Lifestyle Profile Scale	NR

Nylander et al., 2014	Sweden	15 - 18	Physical impairment or Presence of a chronic disease (yes/ No)	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, behavior resulting into violence, self-harm, anti-social acts	2008 Life and Health in Youth questionnaire	NR
Santos et al., 2014	Portugal	15 (±1.3)	Presence of a chronic disease (yes/No)	Alcohol use, behavior resulting into violence, self-harm	2010 Health Behavior in School-aged Children (HBSC)	NR
Sentenac et al., 2013	Multi-site (Europe and North America)	11 -16	Presence of a chronic disease (yes/No)	Behavior resulting into violence	2005/6 HBSC	Language equivalence was ensured by translation and back translation
Rintala et al., 2011	Canada & Finland	13 -15	Physical disability or Presence of a chronic disease (yes/No)	Physical inactivity	Items adapted from 2001/2 HBSC Moderate-to-vigorous intensity physical activity screening measure	NR
Wilcox et al., 2016	USA	10.4 (±4.2)	Physical disability or Presence of a chronic disease (Yes/No)	Self-harm, anti-social acts, sexual risk behavior, alcohol/substance use behavior	Source of items not clear	NR
Alriksson-Schmidt et al., 2010	USA	15 -18	Presence of a chronic disease (yes/No)	Tobacco smoking, drug/ substance use, alcohol drinking, behavior resulting into violence	2005 YRBSS	NR
Han et al., 2009	Korea	12 -19	Presence of a chronic disease (yes/No)	Tobacco smoking, alcohol drinking, self-harm	2006 Korea Youth Behavioral Risk Factor Surveillance	NR
Jones and Lollar, 2008	USA	14 -18	Presence of a chronic disease (yes/No)	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, poor dietary habits, behavior resulting into violence, self-harm	2005 YRBSS	NR
Suris et al., 2008	Switzerland	17.9 (±1.2)	Presence of a chronic disease (yes/No)	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, poor dietary habits, behavior resulting into violence, anti-social behavior	SMASH questionnaire	NR

Erickson et al., 2005	USA	14.9 (±1.7)	Depression, Presence of a chronic disease (yes/No)	Tobacco smoking, drug/ substance use, alcohol drinking, self- harm	items adapted from the Minnesota Student Survey	The internal consistency of the items on substance use behavior was Cronbach's alpha=0.79
Heflinger and Saunders, 2005	USA	4 -17	Depression, Presence of a chronic disease (yes/No)	Anti-social acts	Child Behavior Checklist, Columbia Impairment Scale	NR
Haarasilta et al., 2004	Finland	15 - 19	Presence of at least one chronic illness, depression	Tobacco smoking, alcohol drinking, physical inactivity	1996 Finnish Health Care Survey questionnaire	NR
Mattila et al., 2004	Finland	12 -18	Presence of a chronic disease (yes/No)	Tobacco smoking, drug/ substance use, alcohol drinking, poor dietary habits, physical inactivity, behavior resulting into violence, poor hygiene/ sanitation	1999 Adolescent Health and Life-style Survey questionnaire	NR
Huurre et al., 2003	Finland	16 (± 0.3)	Presence of at least one chronic illness, depression	Tobacco smoking, alcohol drinking, physical inactivity,	Alcohol Use Disorder Identification Test (AUDIT)	NR
Miauton et al., 2003	Switzerland	15–17 and 18-20	Presence of a chronic disease (yes/No)	Sexual risk behavior, tobacco smoking, drug/substance use, alcohol drinking, unintentional injuries, behavior resulting into violence	Swiss Multi-centre Adolescent Survey on Health (SMASH)	NR
Tremblay et al., 2003	Canada	12 -17	Presence of at least one chronic illness, depression	Tobacco smoking, alcohol drinking, physical activity, poor dietary habits	Canadian Community Health Survey	NR
Huurre and Aro, 2002	Finland	16 (± 0.3)	Presence of at least one chronic illness, depression	Tobacco smoking, alcohol drinking, physical activity	AUDIT	NR
Williams and Shams, 1998	England	14 -15	Presence of at least one chronic disease	Tobacco smoking, drug/ substance use, alcohol drinking, physical inactivity	Health and Lifestyle survey, London	NR

*: Mean age available but standard deviation not report; SD: Standard deviation

Chapter 8

A contextually relevant approach to assessing health risk behavior in a rural sub-Saharan Africa setting: The Kilifi Health Risk Behavior Questionnaire.

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Abstract

Background: Health risk behavior (HRB) is of concern during adolescence. In sub-Saharan Africa, reliable, valid and culturally appropriate measures of HRB are urgently needed. This study aims at assembling and psychometrically evaluating a comprehensive questionnaire on HRB of adolescents in Kilifi County at the coast of Kenya.

Methods: The Kilifi Health Risk Behavior Questionnaire (KRIBE-Q) was assembled using items on HRB identified from a systematic review and by consulting 85 young people through 11 focus group discussions and in-depth interviews with 10 key informants, such as, teachers and employees of organizations providing various services to young people in Kilifi County. The assembled list of HRB items were back and forward translated from English to Swahili and harmonized by a panel of experts. A total of 164 adolescents completed the assembled Swahili questionnaire at baseline and two weeks later 85 of them completed the questionnaire again. A classical test theory approach was utilized for psychometric evaluation. We computed the amount of missing data at item-level to verify data quality. Scaling evaluation was assessed by spread of responses across options at an item-level. Using Gwet's first-order agreement coefficient (AC1), test-retest reliability was assessed using data from the 85 adolescents who answered the questionnaire twice. Observations and completion of a brief questionnaire were done for non-psychometric evaluation of the KRIBE-Q administered via audio-computer assisted self-interview (ACASI) in Swahili language to 40 adolescents.

Results: The KRIBE-Q showed high data quality, good spread of responses across options and a very good test-retest reliability (Gwet's AC1=0.82). It comprised 8 components with acceptable test-retest reliability: behavior resulting in unintentional injury and violence (0.85); tobacco use (0.85); alcohol and drug use (0.96); sexual behaviors (0.94); dietary behaviors (0.60); physical activity (0.74); gambling (0.73); and hygiene behavior (0.89). About 96% of the adolescents found the ACASI private and easy to use. Prevalence of bullying (32%), physical fights (40%) and engagement in gambling (26%) was high.

Conclusion: The KRIBE-Q assembled in this study is a psychometrically sound instrument for adolescents in rural coastal Kenya and feasible to administer via ACASI. This measure may be useful for surveys and planning interventions in similar settings.

Background

Health risk behavior (HRB) significantly contributes to the burden of disease and social problems among young people globally (Gore et al., 2011). HRB encompasses actions and related attitudes and perceptions that underlie people's propensity to engage in activities associated with increased susceptibility to a specific disease or ill health as shown in epidemiological or social data (DiClemente et al., 2013, Lupton, 2007). Although prioritized forms of HRB may vary across geographical and demographic contexts, some of the commonly assessed forms of HRB include: sexual behaviors resulting in unintended pregnancy and sexually transmitted diseases; alcohol, tobacco and other drug use; behavior resulting in unintentional injury or violence; unhealthy dietary behavior; poor hygiene practices; and inadequate physical activity (WHO, 2013, Roberts et al., 2007, Brener et al., 1995).

Health risk behavior is particularly of concern during adolescence (10-19), mainly because this stage of development has been linked with increased impulsivity and propensity for risk taking that might result into disability and fatal outcomes (Steinberg, 2008, Galvan et al., 2007). The leading cause of disability and mortality among adolescents are HRB. More than 3000 adolescents die every day largely from preventable causes such as road traffic accidents, falls, diarrheal diseases, iron deficiency, alcohol use, violence and self-inflicted injuries; most of which are associated with HRB. These preventable causes of mortality are also ranked among the top ten causes of disability-adjusted life-years (DALYs) among adolescents globally (Gore et al., 2011, WHO, 2017). Moreover, adolescence is a period when behaviors (either risky or protective) start or are consolidated and this has major implications for health in adulthood (WHO, 2017). Governments have therefore been called upon to prioritize action and investments in prevention, in accordance with the disease and injury risk factor profiles of their adolescent populations (WHO, 2017).

Understanding HRB of adolescents especially from low resource settings such as sub-Saharan Africa (SSA) is partly hindered by the lack of culturally appropriate measures of HRB, considering that majority of the available HRB tools have been developed and utilized in high income settings (Ssewanyana et al., 2017c). In Kenya, which is also the setting for this current study, there is a growing body of research on adolescents' HRB (Puffer et al., 2011, Embleton et al., 2017, Onywera et al., 2016, Otieno and Ofulla, 2009, Ndetei

et al., 2010, Ruto, 2009, Juma et al., 2014). However, for most of these studies the authors do not explicitly inform the readership about the process of development, sources and psychometric qualities of the utilized HRB items. This status quo may imply that either: i) HRB items are often directly translated for use within the Kenyan context from a different context; or ii) that HRB researchers commonly develop new items and administer them without thoroughly ascertaining their cultural appropriateness and content validity. Although this approach of formulating new items, or using already existing ones with minimal or no modification, is relatively cheap and easy to implement; it is not often culturally informed and potentially may contribute to biased results (Abubakar and van de Vijver, 2017). These issues can include different forms of bias: *item bias* which arises when items function differently or have different meaning in different contexts; *construct bias* which may arise when an instrument partially explores the domains that constitute a construct; and *method bias* that arises from differences in administration procedures or sample characteristics (Abubakar and van de Vijver, 2017). Another challenge for adolescent HRB research within the Kenyan context is that many studies tend to assess HRB in isolation, hence missing out important aspects such as co-occurrence of HRB of adolescents, identified in a few studies (Brener and Collins, 1998, Nelson and Gordon-Larsen, 2006). Regional disparities within Kenya in the burden, forms and specific underlying factors for some behavior and related outcomes (KNBS, 2014) also underscore the need for culturally appropriate and comprehensive HRB tools. An example is Kilifi County at the Kenyan coast where national level data suggests a disproportionately higher burden of sexual risk behavior outcomes e.g. a highest prevalence (21%) of teenage pregnancy (KNBS, 2014). The existence of such differences potentially emphasizes the presence of various context specific underlying factors (Ssewanyana et al., 2018b).

There is a growing body of evidence to guide researchers on steps towards ensuring cultural appropriateness and validity of tests on health outcomes in low resources settings where still scarcity of such tests exists (Abubakar and van de Vijver, 2017, Holding P et al., 2009, Harachi et al., 2006). Adoption, adaptation and assembly of assessment instruments are three alternatives, but the latter two options are preferred compared to adoption since they are more likely to contribute contextually relevant tools (Abubakar and van de Vijver, 2017). Adoption involves translating a measure and using it in another culture or context. Adaptation involves a systematic evaluation of all aspects of an existing instrument and modifying it where needed to suit context. For

assembly, a new measure is either developed directly and informed by local culture and context or alternatively items and procedures are borrowed or modified from various standardized measures (Abubakar and van de Vijver, 2017). Abubakar and van de Vijver (2017) propose a four-step approach to adaptation and assembly of tests which involves: i) a mixed methods approach to construct clarification; ii) item development, which comprises item translation and formulation; iii) scale development, which involves refining a scale by pretesting and piloting; and iv) psychometric and non-psychometric approaches to test evaluation. We explain in depth these procedures in the methodology section of this manuscript.

This present study is conducted in Kilifi County; a rural setting at Kenyan coast, with a main objective of assembling and psychometrically evaluating a comprehensive questionnaire for assessing health risk behavior of adolescents in this environment. Owing to the sensitivity of topics in HRB, we further aimed to ensure that the psychometrically evaluated HRB questionnaire can be answered in a manner that maximizes the adolescents' privacy.

Methods

Ethical consideration

The Kenya Medical Research Institute Scientific and Ethics Review Unit granted ethical approval for this study (KEMRI/SERU/CGMR-C/0047/3263). We obtained written informed consent for all participants during all recruitment processes. Consent was directly sought from participants aged 18 years and over, while for those less than 18 years, parents or legal caretakers provided consent. Permission to involve schools in this study was obtained from the Kilifi County Director of Education and the school head teachers. All data collected during this study was coded with non-personal identifiers to optimize privacy and confidentiality. Since HRB is a sensitive topic, the research team comprised a trained counselor who provided a health talk and also supported participants in the case of emotional distress. Information sheets on referral services (e.g. HIV/STI testing and counseling services, services to address sexual and gender based violence) were also provided to all participants during the study.

Assembling of the questionnaire

We utilized a systematic approach recommended for adaptation of tests for SSA (Abubakar and van de Vijver, 2017) to assemble and psychometrically evaluate the Kilifi Health Risk Behavior Questionnaire (KRIBE-Q) which was developed to be a culturally appropriate for adolescents (10-19 years) living in Kilifi County at the Kenyan Coast. This process comprised four steps that are explained in detail in the following sections.

Construct clarification

A systematic review of published literature on HRB tools commonly utilized among adolescents was conducted to identify the *etic* aspects of tool assembly (i.e., components of the construct that can be assessed from a universalist context), such as, the commonly utilized HRB tools or sources of items on HRB assessment of adolescents, their psychometric properties, and the common means of HRB tool administration (Ssewanyana et al., 2017). We also conducted 11 focus group discussions (FGDs) with 78 adolescents (10-19 years); and consultations with 7 young adults (20-30 years) and 10 local stakeholders who work extensively on adolescent issues for example clinicians, teachers, and employees of community based organizations based in Kilifi County. The FGDs lasted about 75-120 minutes and comprised between 7-9 participants. Of these, 8 sex disaggregated FGDs comprised primary and secondary school-going adolescents and took place at school. The other 3 FGDs involved adolescents living with HIV, adolescents who had dropped out of school and young adults. These 3 FGDs were conducted in a private and quiet setting. Each local stakeholder participated in an in-depth key interview (KI) lasting about 60-90 minutes at their convenient time and venue. The FGDs and KIs were moderated by a Research Officer either in Kiswahili or English following participants' preference. The discussions were audio recorded and notes were taken during these sessions. The FGDs and KIs were guided by a qualitative interview and FGD guide developed to cover a wide range of adolescent HRB like alcohol, tobacco and other drug use, sexual behavior, behavior resulting in unintentional, self-harm and violence, hygiene, physical activity and dietary behaviors (WHO, 2015). An open ended question concerning respondents' perceptions about each form of behavior was asked and followed up with additional probing on specific examples or context of behavior raised by the participants. In general, they were asked to explain the specific forms of risky behaviors which they perceive as commonly undertaken by adolescents aged 10 to 19 years in Kilifi

Through this qualitative component, we explored *emic* aspects (i.e., culture-specific components of the construct) such as forms and specific examples of prevalent HRB; local names, popular terminologies or phrases surrounding specific behavior; substances and drugs; day-to-day experiences of young people in Kilifi; and the underlying protective and risk factors for HRB (Ssewanyana et al., 2018b).

Item development and refinement of the questionnaire

A list of items identified in the systematic review and generated from consultations during the qualitative data collection (see prior section) was prepared. The items were mainly borrowed (with some modification to suit context) from the Youth Risk Behavior Surveillance System (YRBSS) (CDC, 2015) which had been identified as the most commonly utilized HRB assessment tool from the systematic review (Ssewanyana et al., 2017).

These assembled set of items on HRB were translated from English to Swahili language (the national language for Kenya and lingua franca for more than 60 million people in East Africa (UCLA, 2014)) and then back translated to English by two independent persons who were bilingual. A harmonization process of the translated version of the HRB tool was then conducted by a panel comprising two authors of this manuscript (D.S. and A.A) and 4 research assistants from Kenya Medical Research Institute-Wellcome Trust Program (KWTRP). This panel scrutinized these items for clarity (translation and conceptual meaning) and identified specific gaps for improving the questionnaire.

Gaps were identified, mainly about aspects of HRB raised in the qualitative interviews and discussions but missing or insufficiently captured in the YRBSS. Other items were borrowed (with some modification to suit context) from the Global School –Based Student Health Survey (WHO, 2013), Diagnostic and Statistical Manual for Mental disorder-IV-Multiple Response-Juvenile (DSM-IV-MR-J) (Fisher, 2000), the Pittsburgh Sleep Quality Index (Buysse et al., 1989), and the international physical activity questionnaire (IPAQ-Short) (Craig et al., 2003). The borrowed items and modifications are later described in the results section. Relevant items to capture socio-demographic variables such as sex; age; religious affiliation; and educational achievement were then added to the revised draft of the assembled items.

Scale development

D.S. and A.A carefully reviewed the assembled KRIBE-Q and developed the scoring and administration procedures of the questionnaire. This step was guided by a list of questions such as, whom to survey; how to obtain permission; when (part of the year and time of the day) to collect the data; what administration procedures to follow; and how to analyze and report the findings (CDC, 2014). A team of two research assistants was then trained on the administration of the KRIBE-Q. This training covered topics on: the purpose of the survey, the administration schedules; the relevance of ensuring privacy and confidentiality; and the contents of the KRIBE-Q.

Test evaluation

The test evaluation step consisted of both psychometric and non-psychometric evaluation of the assembled Swahili version of the KRIBE-Q. We utilized a stratified random sampling method to recruit adolescents from upper primary classes (class 5 to 8) and lower secondary classes (form 1 to 2) in a classroom setting, during a normal school day in two primary and two secondary schools representative of a peri-urban and rural setting of Kilifi County. All the schools involved in this study were situated within Kilifi Health Demography Surveillance System. Prior to recruitment, upper primary and lower secondary students in these schools had been informed about the study during an afternoon session organized by a school teacher on duty. The participants were aged 10 to 19 years, and Swahili speakers. A total sample of 164 adolescents were initially administered the Swahili version of the KRIBE-Q (Time 1); and after a 14 days' period (Time 2), 85 participants of those who took part at Time 1 were re-administered this HRB questionnaire. The assembled KRIBE-Q was administered within a classroom setting by an interviewer who read out one question after the other while the participants circled their answer options.

The psychometric evaluation of the Swahili version of the KRIBE-Q was conducted using the classical test theory (Crocker and Algina, 1986), which involved: assessment of the data quality; scaling evaluation; and test-retest reliability, similar to steps suggested by Petrillo and colleagues (Petrillo et al., 2015).

The data quality and scaling evaluation utilized baseline (Time 1) item level descriptive statistics (e.g. response rates per item or question). Analysis was conducted in STATA 15 statistical package (StataCorp, 2014). Data quality was verified by computing the amount of missing data at item-level. Acceptable

data quality was achieved when no more than 5% of the data was missing per item or question (Schafer, 1999). Also, a greater trend of missing data towards the end of the questionnaire would likely indicate respondent fatigue, whereas greater amount of missing data by content would suggest problems with content validity (Petrillo et al., 2015). Scaling evaluation (spread of responses across options) was done by assessing how appropriately the item response categories for each question/item were utilized. We considered that at least 60% of the total response categories per item should have been selected by the participants to ascertain optimal scaling evaluation.

Test-retest reliability was assessed using data of 85 adolescents who had completed the assembled Swahili version of KRIBE-Q both Time 1 and Time 2 (after a two weeks interval).

In order to calculate the test-retest reliability and prevalence of HRB, we transformed the HRB categorical variables in to binary format similar to what has been done in various HRB tool psychometric evaluation studies (Brener et al., 2002, Baheiraei et al., 2012, Guedes and Lopes, 2010). We assessed if there were statistically significant differences in HRB prevalence between Time 1 and Time 2 by finding out if there was no overlap of confidence intervals of prevalence rates of the HRB for Time 1 and Time 2 of each item.

Test-retest reliability was computed using Gwet's first-order agreement coefficient [AC1] (Gwet, 2014, Gwet, 2002) in STATA15 software package. Gwet's AC1 is an agreement coefficient that uses a more stable chance-adjusted index to estimate the reliability of categorical variables and has considered an improved alternative to existing inter-rater reliability statistics (Gwet, 2008). We used Gwet's AC1 coefficients instead of Cohen's Kappa coefficient (Cohen, 1968) because of the potential "Kappa paradox" that results when low Kappa coefficient values are found despite high percentage of agreement (Cicchetti and Feinstein, 1990). Conversely, the Gwet's AC1 coefficient provides more stable reliability values than Cohen's Kappa and is less affected by prevalence and marginal probability (Wongpakaran et al., 2013). A benchmark scale proposed by Altman (Bland and Altman, 1991) was used to classify Gwet's AC1 coefficient as: 'very good' (0.81-1.00); 'good' (0.61-0.80); 'moderate' (0.41-0.60); 'fair' (0.21-0.40); and 'poor' (less than 0.20).

Following ascertainment of good psychometric properties of the KRIBE-Q, we wanted to ensure that this paper-and-pencil self-administered HRB questionnaire can be answered in a manner that maximizes the adolescents' privacy. Therefore, with technical assistance from the computer programmers at the KWTRP, the KRIBE-Q was customized into an audio-computer assisted self-interview (ACASI), which is delivered via a touch-screen desktop or laptop computer. A respondent listens to the instructions and questions through a pair of headsets and selects their appropriate response option with their finger on the touch screen. We also conducted a non-psychometric evaluation of the KRIBE-Q administered via ACASI in Swahili language to a sample of 40 adolescents. The non-psychometric evaluation involved ascertainment of face validity during the interview by a research assistant who observed participants' reaction to the ACASI. The research assistant also took note of any form of assistance required by participants during the interview and asked the participants to rank their level of privacy, interest, and easiness in completing the ACASI using a brief questionnaire.

Results

Characteristics of participants

The characteristics (sample size, age, and sex) of the participants that took part in the various stages of the KRIBE-Q assembly and psychometric evaluation are summarized (see Table 8.1).

Table 8.1. A summary of age and sex of the participants for different stages of the study

Stage of tool development	Participants (n)	Mean Age (SD)	Males (%)
Construct clarification (focus groups & key informants)	Adolescents (78)	15.0 (2.4)	54
	Stakeholders (10)	35.8 (2.9)	40
	Young adults (7)	24.7 (1.1)	43
Item development and refinement	Translators (2)	----------	50
	Harmonization Panelists (6)	----------	83
Test evaluation			
Baseline (Time 1)	Adolescents (164)	14.8 (2.4)	49
Retest (Time 2)	Adolescents (85)	14.3 (2.5)	47
Non Psychometric evaluation of ACASI	Adolescents (40)	14.1 (1.6)	43

Construct clarification

From the systematic review, the Youth Risk Behavior Surveillance System (YRBSS) and Health Behavior in School-aged Children (HBSC) were the commonest and most comprehensive HRB assessment tools and sources of items on HRB for adolescents living with chronic conditions (Ssewanyana et al., 2017). Based on the findings from the review (Ssewanyana et al., 2017), the YRBSS questionnaire (CDC, 2015), informed most of our item choices for the assembly of the KRIBE-Q. We also modified the format of the items from the YRBSS to suit the local context in Kilifi and borrowed some items from the Global School –Based Student Health Survey (WHO, 2013), DSM-IV-MR-J (Fisher, 2000), the Pittsburgh Sleep Quality Index (Buysse et al., 1989), and International Physical Activity Questionnaire (IPAQ-Short) (Craig et al., 2003).

Our results from the FGD and the KII in Kilifi showed a number of contextually relevant forms of HRB and specific local names or jargon that we integrated in to the questionnaire. The specific modifications made included:

(i) Modification of items on behavior resulting to injury and violence in order to capture injuries from motorcycles and bicycles, falls, burns and cuts; and cyber bullying (i.e. through phone text messages and social media platforms) which during the focus group discussions were found to be common among adolescents in Kilifi.

(ii) Inclusion of locally relevant examples of tobacco products like *shisha*, *ugoro*, and tobacco leaves or *tumbaku*; examples of locally brewed forms of alcohol like *mnazi*, and *changaa*; and local names of other drugs for example *bangi*, *ganja* and *makushabu* (for marijuana) and *miraa* or *mogoka* (for Khat) in the questionnaire's sections on tobacco use, alcohol and other drug use behavior .

(iii) Specific locally relevant examples of healthy foods for example vegetables like kales (*Sukuma wiki*), amaranthus (*mchicha*), and potentially unhealthy locally or fatty available foods like fried chicken and *viaza karai* that were named by young people were also included under dietary behavior in the assembled KRIBE-Q (Ssewanyana et al., 2018a).

(iv) Gambling was another noteworthy form of behavior discussed by young people in Kilifi (Ssewanyana et al., 2018a) which is not captured by the YRBSS questionnaire (CDC, 2015). Therefore three items assessing gambling behavior were from the DSM-IV-MR-J (Fisher, 2000), with some modifications such as giving specific examples of gambling games such as card games or 'kamare', lottery or scratch

tickets, casino games or 'Mchina' and sports betting that had been mentioned in the discussions.

(v) The need for assessment of quality of sleep behavior followed from engagement in social events such as parties and traditional ceremonies by adolescents, which take place in the night (Ssewanyana et al., 2018b). An item on this aspect was from the Pittsburgh Sleep Quality Index (Buysse et al., 1989).

(vi) Personal hygiene behavior such as poor hand washing practices, poor oral hygiene and general body cleanliness were also mentioned by young people as perceived forms of HRB in Kilifi. We therefore used items (with minimal modification) on personal hygiene behavior (i.e. oral hygiene, handwashing and general body hygiene), from the Global School –Based Student Health Survey (GSHS) 2013 core questionnaire modules (WHO, 2013).

Item development and refinement of the questionnaire

Suggestions from the harmonization panel were that the 5 items on safety (question 8-13) from the YRBSS (CDC, 2015), be replaced with the 3 items about serious injuries with some modification from the GSHS 2013 core questionnaire modules (WHO, 2013). The main reason for this was because the YRBSS questions about safety majorly focused on road traffic safety (especially motor vehicle safety), whereas other forms of injury appeared to be of higher priority in the Kilifi context, many of which are captured in the GSHS questionnaire. Addition of an extra item was also proposed to capture why the identified forms of injuries occurred, and the response options reflected issues discussed by young people: for example being under the influence of alcohol or drugs, being reckless, and having no control over the incident.

Items about violence related behavior that made reference to school property in the YRBSS were modified to reflect occurrence in a general community context in order to optimally include all potential HRB.

The harmonization panel proposed that items on alcohol use behavior from the GSHS be used since they capture various problem drinking related indicators, such as, number of drinks consumed in a day, being in trouble or missing school due to alcohol drinking, and being intoxicated. Additionally, the GSHS items also ask about caregivers' alcohol use unlike those in the YRSS (CDC, 2015, WHO, 2013).

Consensus from the panel was that items on sexual orientation (heterosexual, gay and bisexual) as used in the YRBSS should be dropped from the assembled KRIBE-Q. Asking adolescents about their sexual orientation was thought as a culturally complex subject in the context of Kilifi.

There was preference for items on physical activity that assess vigorous and moderate forms of physical activity as well as sedentary lifestyle. Thus such items were borrowed from the international physical activity questionnaire (IPAQ-Short) (Craig et al., 2003).

Scale development

An instruction manual for the administration of the KRIBE-Q outlining various procedures for observing privacy, seeking permission, scoring the items, handling data collection materials, managing data and reporting was developed. Following consultations with school authorities and the adolescents, we found that it was most convenient to administer the questionnaire at the start or mid-way into the academic term before too much academic work load and examinations. The sports' time was suitable for this activity since this avoided interference with academic activities. Following the training, the research assistants and counselor felt prepared for data collection in the test evaluation phase.

Test evaluation

Of the 214 adolescents who had shown interest during the recruitment stage, 76.6% (164) completed the KRIBE-Q at Time 1, and their data was basis for the data quality and scaling evaluation. Table 8.2 presents the participants' characteristics.

Table 8.2. Characteristics of participants involved in the HRB tool psychometric evaluation phase.

Characteristic	Time 1 (%), N=164	Time 2 (%), N=85
Sex		
Male	49.4	47.1
Female	50.6	52.9
Adolescent group		
Young adolescents (10-14 yrs)	41.5	50.6
Older adolescent (15-19 yrs)	58.5	49.4
School level		
Primary (Class 5-8)	45.4	57.1
Secondary (Form 1-2)	54.6	42.9
Religious affiliation		
Christian	82.2	84.7
Moslem	17.2	15.3
Other	0.6	0.0

Our results of test evaluation include 60 of a total of 69 items on health behavior from the KRIBE-Q (see appendix). We excluded five multiple choice response items from the analysis; four of which were about unintentional injury and violence and one was on alcohol use. We also do not present results from four other items for which the frequency of the response options indicated that the participants had misclassified their responses. The response options of two misclassified items (use of alcohol or drugs prior to sex and use of a condom at most recent sexual intercourse) were rephrased while the other two items (attempted smoking cessation and lifetime use of prescription drugs) were dropped from the final version of the KRIBE-Q.

Data quality and scaling evaluation

None of the items in the HRB questionnaire had 5% or more missing data which indicated that acceptable data quality was obtained. Results from scaling evaluation indicated that about 20% of the items in the questionnaire had less than 60% of their response options utilized by the study participants. Table 8.3 summarizes the 12 items which had less than 60% of their response options utilized and the amendments that were made to these items.

Table 8.3. A description of items with sub-optimal results from scaling evaluation and the specific amendments undertaken.

Item (N=12)	**Utilized response options** (%)	**Amendments following test evaluation**
13.Been threatened or injured with a weapon during the past 12 months	50.0	Retained in its original format. The participants' responses were varied and this item is important in the context of Kilifi.
23.Attempted suicide during the past 12 months	40.0	Retained in its original format. The item is vital for assessing psychiatric and behavioral problems.
26. Smoked cigarettes during the past 30 days	42.8	Item 26 and 27 were pooled into a new item asking about "cigarette smoking or use of any other tobacco products other than cigarettes e.g. shisha, ugoro, cigas, tobacco leaves/tumbaku
27. Used any other tobacco products during the past 30 days	28.6	
35. Has ever drank so much that they were really drunk	50.0	Retained in its original format. The item is crucial for assessing harmful alcohol use behavior
38. Ever used marijuana	40.0	Each of these items was retained in its original format since discussions showed that marijuana is common within Kilifi.
39. Had used Marijuana during the past 30 days	40.0	
40. Ever used any form of cocaine	40.0	Item 40, 42, 44, 47 were pooled into a multiple choice response item as opposed to asking separately about frequency of use of each drug.
42. Ever used heroin	40.0	
44. Ever used methamphetamines	40.0	
47. Ever used a needle to inject illegal drugs into the body	33.3	
51. Number of sexual partners during the past 3 months.	50.0	Retained in its original format. Multiple sexual partnerships were mentioned as common by young people during the construct clarification.

Test-retest reliability

The overall Gwet's AC1 coefficient of the assembled Swahili version of KRIBE-Q was very good (ranging from 0.81 to 0.83 across sex groups) and there were no statistically significant differences in the coefficients across sexes, adolescent age categories and level of education. Across the 8 behavior categories, the Gwet's AC1 coefficient ranged from 'very good' to 'moderate' with majority of the behavior categories (5 out of 8 categories) having very good reliability coefficients (see Table 8.4).

Table 8.4. Mean Gwet's AC1 coefficients and their 95% confidence intervals summarized by participants' demographic and health behavior categories

Characteristic (N=85)	Mean Gwet's AC1	95% CI for Gwet's AC1
Sex		
Male	0.81*	0.66, 0.94
Female	0.83*	0.70, 0.95
Adolescent group		
Young adolescents (10-14 yrs)	0.81*	0.67, 0.94
Older adolescent (15-19 yrs)	0.83*	0.69, 0.95
School level		
Primary (Class 5-8)	0.82*	0.69, 0.94
Secondary (Form 1-2)	0.83*	0.67, 0.96
Risk behavior categories		
Behavior related to Injury and Violence	0.85	0.76, 0.93
Tobacco Use behaviors	0.85	0.77, 0.94
Alcohol and other drug use behavior	0.96	0.91, 0.99
Sexual Behaviors	0.94	0.88, 0.99
Dietary Behaviors	0.60	0.43, 0.77
Physical Activity Behaviors	0.74	0.59, 0.88
Gambling behavior	0.73	0.59, 0.87
Hygiene behavior	0.89	0.82, 0.96

*Mean Gwet AC1 per demographic group and health behavior is based on the 60 items used in test evaluation; CI: Confidence Interval

At an item level, Gwet's AC1 coefficients ranged from 'good' to 'very good' (i.e. 0.63 - 1.00) among 83.3% of the items in the questionnaire while 11.7% had 'moderate' Gwet's AC1 coefficients ranging from 0.46 to 0.59 (See appendix).

Prevalence of behavior

There were no statistically significant differences between prevalence of behavior outcomes at Time 1 and Time 2 (n=85) with exception of a few items on alcohol, tobacco and drug use, dietary behavior and hygiene (See appendix).

The baseline (Time 1) prevalence of unintentional injury and violence related behavior was particularly high, for example, occurrence of serious injuries during the past 12 months (61.1%), feeling unsafe in the neighborhood (14.2%), engagement in physical fights during the past 12 months (39.9%), and experience of bullying (31.7%).

Noteworthy among substance and drug use related behavior were: the early initiation (at 13 years or younger) of cigarette smoking (6%); exposure to second hand smoke (54.3%); having parents or guardians who use tobacco (18.9%); lifetime alcohol use (10.4%); recent alcohol use (5%); and the use of Khat (14%).

From Time 1 data, about 11% of the adolescents were sexually active and 5.5% of the total respondents (representing about 45% of the sexually active) had their first sexual intercourse at the age of 13 years or less. Also 6.1% (equivalent to 43% of the sexually active) did not use any method for prevention of pregnancy during their most recent sexual intercourse.

Other important behavior outcomes were that close to 23% of the adolescents did not engage in vigorous or moderate physical activity within the past 7 days; and almost a quarter (24%) spent 3 or more hours engaging in sedentary activities on a typical day. Engagement in gambling behavior within the past 12 months was common (26%) and so was the lack of adequate handwashing with soap after using a latrine /toilet use among 28.8% of the adolescents.

Non-psychometric evaluation of the KRIBE-Q delivered via ACASI

We collected data on user experience of the customized audio-computer assisted self-interview (ACASI) from 40 adolescents of mean age 14.1 years (SD=1.62), of whom 57.5% were female and 60% were young adolescents (10-14 years). Majority (95%) of the adolescents rated the interview (ACASI) as either ‘very easy’ or ‘just okay’ or 90% found it as either ‘very interesting’ or ‘a bit interesting’. Almost all (97.5%) of the adolescents ‘strongly agreed’ or ‘agreed’ that the interview was confidential and that they were comfortable during the ACASI exercise. From a test administrator’s observation, he either ‘agreed’ or ‘strongly agreed’ that 97.5% of the participants seemed comfortable and confident while using the ACASI. Majority (82.5%) did not require any assistance at all when using the ACASI while the rest needed minimal assistance especially in reminding them how to maneuver to the next item on the computer.

Discussion

Our findings from construct clarification show that adolescents in rural coastal Kenya have either experienced or are familiar with most of the constructs of HRB utilized in measures like YRBSS and GSHS which were developed in other settings. Although this demonstrates good conceptual equivalence, our experience was that in-depth consultations with the adolescents and key informants, combined with a harmonization process are vital procedures especially for identifying priority forms of behavior to focus the HRB tool development and capturing common semantics and idiomatic aspects of HRB utilized by adolescents in the study setting. We also found the harmonization process as fundamental in refining the borrowed items especially in connection to cultural appropriateness and inclusiveness of relevant behavior aspects voiced by the adolescents.

The finding that none of the items had 5% or more missing data suggests that construct clarification and item refinement significantly improved clarity and suitability of the HRB items assembled for the adolescents in the study setting. Moreover, this was further demonstrated by the fact that both young and older adolescents capably completed the assembled HRB questionnaire. The completeness of the items also potentially indicates the absence of response fatigue. However, we found that four of the sixty nine assembled items had some misclassified responses; a problem we attribute to ambiguity of the response options. For example, one of the items which asked a participant whether he or she used a condom during the last sexual intercourse initially had the following response options: “I have never had sexual intercourse”, “Yes”, “No” and we recognized a tendency for participants to select the answer option “No” while they actually meant “I have never had sexual intercourse”. For this item, we finally modified the response options as follows: “A. I have never had sexual intercourse”, “B. Yes, I used a condom”, “C. No, I had sexual intercourse but did not use a condom” so as to reduce the ambiguity. In line with our refinement of the misclassified items, there has been evidence showing that more extensive verbal labeling of response options is associated with higher reliability (Alwin and Krosnick, 1991).

The majority of the assembled HRB items demonstrate good spread of responses across options however about 20 percent of the assembled HRB items had sub-optimal scaling evaluation. We think this may have been due to very low prevalence of certain forms of behavior such as drug use and suicidal behavior

in this setting, which meant that certain response options were often redundant. Indeed the number of response categories for all these items were within the recommended ranges of four to nine options (Alwin, 1992). Rattray and Jones (2007) advise that although redundant response options may warrant deletion of an item, it is always crucial to refer to the original research question and retain items that are thought to reflect important underlying theoretical domains. We therefore addressed such scaling problems by pooling items on rare forms of behavior into a single item as opposed to asking about the frequency of each single behavior. As an example, instead of asking participants how many times in their lives they had used cocaine, heroin, methamphetamines and steroid pills without a doctor's prescription separately, we pooled them into a single multiple choice objective item asking "During your life, have you ever used the following drugs: A. Cocaine, B. Heroin, C. Methamphetamines, D. Steroid pills without a doctor's prescription".

Our findings support acceptable test-retest reliability of the majority of the assembled items of the KRIBE-Q for the adolescents in the rural coastal Kenyan setting. There was acceptable reliability irrespective of sex, age category and education level as shown by the overlapping confidence intervals of overall mean Gwet's AC1 coefficient across these groups in Table 4. Overall, behavior categories of alcohol and other drug use, sexual activity, tobacco use and dietary behavior demonstrated higher test-retest reliability than the dietary behavior and physical activity categories. These findings are consistent with those reported in a study on reliability of the Youth Risk Behavior Survey questionnaire among high school students in the district of Columbia, USA (Brener et al., 1995). One explanation for the low reliability of dietary behavior items may be that adolescents' diet frequently changes over a short period of time which makes it difficult to reliably recall behaviors related to their nutrition. Another explanation offered by Brener and colleagues is that behaviors surrounding substance use and sexual activity are likely to be more salient to adolescents and thus more reliably recalled compared to dietary behavior or physical activity (Brener et al., 1995).

Although test-retest reliability was high, we suspect that due to very low prevalence of specific forms of behavior, this potentially resulted to no overlap of confidence intervals (statistically significance of differences) of prevalence of some behavior on first (Time 1) and second test (Time 2) especially for items assessing alcohol and drug use behavior. However, the inconsistence in prevalence may also suggest response errors for example arising from recall

bias, social desirability bias or there may be actual changes in prevalence. Thus the results on prevalence of the behavior in our study should be treated with caution and may need much larger sample sizes to determine if there are actual differences.

Our findings indicate that adolescents frequently report occurrence of behavior resulting to intentional and unintentional injuries like bullying and physical fights, however such results need to be replicated in larger quantitative studies in this specific study setting. These findings are however not surprising since other larger studies also report a high occurrence of bullying (between 58% and 82%), conduct problems and involvement in physical fights among Kenyan adolescent students (Brown et al., 2008, Ndetei et al., 2007). High occurrence of early sexual debut and unprotected sex among our sexually active study participants further highlights the need for more sexual and reproductive health research and interventions in rural coastal Kenya; where adolescent sexual health is reported as still poor (Ssewanyana et al., 2018b, KNBS, 2014). Noteworthy, adolescents also endorsed other infrequently researched forms of behavior in the context of rural coastal Kenya such as gambling behavior, poor personal hygiene and physical inactivity. This potentially points to the need for more investment in adolescent health research in this setting.

This study's findings from non-psychometric evaluation of the HRB questionnaire delivered via ACASI highlight the feasibility of using ACASI for collecting sensitive data such as information on HRB among adolescents in this rural low resource setting. In support of our findings, ACASI has previously been used among the adolescent population in Kilifi (Otiende et al., 2017), as well as among an older age-group within the Kenyan setting (Waruru et al., 2005, Van Der Elst et al., 2009). Overall, these studies have found the ACASI to improve quality of response to sensitive questions, to decrease socially desirable responses, and has also suitably been used for collecting data among participants with low formal education (Van Der Elst et al., 2009, Waruru et al., 2005).

As a major strength of our study is seen that we utilized a systematic approach to tool assembly and psychometric evaluation recommended for low resource settings in SSA to develop a comprehensive culturally appropriate measure of HRB for this setting. Nonetheless, one of our study limitations is that we assembled and psychometrically evaluated the KRIBE-Q using a school attending adolescent sample and yet between 83 and 91% of Kenyan adolescents

are enrolled in primary and lower secondary (UNICEF, 2013, UNESCO, 2012). Although this was the case, we believe that we satisfactorily captured important HRB constructs and examples from other young people like adolescents who dropped out of school, young adults, and adolescents living with chronic illnesses during the construct clarification phase. Also given the nature of items and their scoring procedure, it was not possible to perform traditional analysis for construct validity such as factorial analysis. However, this study ascertained the face and content validity as well as reliability of the KRIBE-Q. Future studies may explore predictive or criterion validity of this tool. Another limitation stems from the self-reported nature of HRB assessment utilized in our study as self-reports on sensitive topics are at times associated with self-desirability and recall bias (Krumpal, 2013). Self-reports are however universally applied methods for HRB assessment and in our current study we strictly observed confidentiality to counter bias associated with self-reported behavior. Lastly, some of the results from this study, for example on prevalence of HRB, need replication utilizing a larger and more diverse adolescent sample.

Conclusions

The assembled Swahili version of the KRIBE-Q in this study can be considered as reliable and its content is valid for assessing HRB of adolescents in a rural coastal Kenyan setting. Moreover, its mode of administration via ACASI was characterized as easy to answer; private and comfortable; and an enjoyable experience by the adolescents in this setting. This assembled KRIBE-Q comprises 8 components namely: behavior related to unintentional injury and violence; tobacco use behaviors; alcohol and other drug use behavior; sexual behaviors; dietary behaviors; physical activity behaviors; gambling behavior; and hygiene behavior.

We took a systematic mixed method approach for adaptation of tests for resource poor settings. We therefore expect that this assembled questionnaire will be useful in surveys evaluating adolescents' lifestyle; and in planning and evaluating interventions aimed at addressing adolescent health, especially in resource poor settings at the Kenyan coast where such programs are currently scarce.

Declarations

Ethics approval and consent to participate

We received ethical approval from Kenya Medical Research Institute Scientific and Ethics Review Unit for this study (KEMRI/SERU/CGMR-C/0047/3263). We obtained written informed consent for all participants during all recruitment processes. Consent was directly sought from participants aged 18 years and over, while for those less than 18 years, parents or legal caretakers provided consent. Permission to involve schools in this study was obtained from the Kilifi County Director of Education and the school head teachers. Anonymity of the respondents was ensured at all stages of data analysis.

Acknowledgements of authors' contributions

D.S conceptualized and designed the study, coordinated and took part in data collection, conducted data analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript as submitted. A.vB revised the manuscript, contributed to the interpretation of the results, and approved the final manuscript. C.R.N conceptualized the study, revised the manuscript, contributed to the interpretation of the results, and approved the final manuscript. A.A conceptualized and designed the study, revised the manuscript, contributed to the interpretation of the results, and approved the final manuscript.

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Appendix.

A summary of the scaling evaluation, test-retest reliability and behavioral prevalence at baseline (Time 1) and retest (Time 2) for the items in the Kilifi Health Risk Behavior Questionnaire (KRIBE-Q).

Utilized response categories (%)	Utilized response categories (%)	Gwet's AC1	Over all Time 1 (%) (N=164)	Both phases (%) (N=85)	
				Time 1	Time 2
Behavior related to unintentional Injury and Violence					
7. Been injured seriously during the past 12 months	87.5	0.54	61.1	64.3	50
11. Carried a weapon during the past 30 days	60	0.96	3.1	2.3	5.9
12. feeling unsafe in the neighborhood	100	0.77	14.2	20	7
13. Been threatened or injured with a weapon during the past 12 months	50	0.92	4.3	3.5	3.5
14. Been engaged in a physical fight during the past 12 months	75	0.59	39.9	44	32.1
15. Ever been physically forced to have sexual intercourse	100	0.99	1.8	1.2	2.3
16. Been physically hurt by someone he or she was dating during the past 12 months	66.6	1	3	1.2	1.2
17. Been forced to have sexual acts by someone he or she was dating during the past 12 months	83.3	0.94	5.5	3.5	4.7
18. Been bullied during the past 12 months	100	0.69	31.7	25.9	17.6
20. Felt so sad or hopeless during the past 12 months	100	0.73	20.8	20.2	11.9
21. Seriously considered attempting suicide during the past 12 months	100	0.96	3.7	4.7	1.2
22. Made a plan about how to attempt suicide during the past 12 months	100	0.97	5.5	3.6	1.2
23. Attempted suicide during the past 12 months	40	0.96	3.7	3.5	2.3
Tobacco Use behaviors					
25. Ever tried smoking a cigarette when 13 years or younger	62.5	0.89	6.1	7	7
26. Smoked cigarettes during the past 30 days	42.8	0.95	1.8	2.3	4.7
27. Used any other tobacco products during the past 30 days	28.6	0.95	3.6	4.7	0.0*

29. Had people smoke in their presence during past 7 days	100	0.55	54.3	54.1	50.6
30. Had parents or guardians who use tobacco	100	0.93	18.9	12.9	11.8
Alcohol and other drug use behavior					
31. Ever drank alcohol other than a few sips	87.5	0.95	10.4	8.2	3.5
32. Had at least a drink containing alcohol during the past 30 days	50	0.95	4.9	3.5	5.9
33. Had 3 or more drinks in a row on one or more days during the past 30 days	71.4	0.99	0.6	1.2	0.0*
34. Were able to describe how they accessed alcohol during the past 30 days	75	0.89	6.1	7.1	2.3
35. Has ever drank so much that they were really drunk	50	0.98	1.8	1.1	1.1
36. Has been in trouble with family or friends, missed school or got in to a fight as a result of alcohol	75	0.97	2.4	2.3	2.3
37. Ever used drugs	62.5	0.98	3.1	1.2	1.2
38. Ever used marijuana	40	1	2.4	1.2	1.2
39. Had used Marijuana during the past 30 days	40	-	0.6	0	0
40. Ever used any form of cocaine	40	-	0.6	0	0
41. Ever sniffed glue or aerosol spray to get high	60	0.94	6.1	3.5	4.7
42. Ever used heroin	40	0.99	0.6	0	1.2*
43. Ever used Khat	60	0.93	14	10.6	9.4
44. Ever used methamphetamines	40	0.96	3.1	3.6	0.0*
45. Ever taken steroid pills without doctor's prescription	60	0.99	3.1	0	1.2*
47. Ever used a needle to inject illegal drugs into the body	33.3	-	0	0	0
Sexual Behaviors					
48. Ever had sexual intercourse	100	0.91	11.6	11.8	9.4
49. Had first sexual intercourse when 13 years old or less	77.7	0.96	5.5	5.9	2.3
50. Had 3 or more lifetime sexual partners	71.4	0.95	2.4	3.5	5.9
51. Had 3 or more sexual partners during the past 3 months.	50	0.96	1.2	2.3	1.2
54. Did not use any method for preventing pregnancy during their last sexual intercourse	75	0.95	6.1	4.8	7.1

Dietary Behaviors					
55. Perceived themselves as not about the right weight	100	0.53	44.5	45.9	32.9
56. Is trying to lose or gain weight	100	0.54	62.2	61.2	67
57. Sometimes, most of the time or always gone hungry because food was not enough at home in past 7 days	100	0.74	22.6	17.6	17.6
58. Ate fruits less than 3 times per day during the past 7 days	100	0.66	75.6	72.9	77.6
59. Ate vegetables less than 3 times per day during the past 7 days	100	0.82	85.9	85.7	88.1
60. Drank at least one soda during the past 7 days	75	0.47	79.7	85.9	58.8*
61. Ate fast food or very oily foods during the past 7 days	100	0.46	73.2	69.4	64.7
Physical Activity Behaviors					
62. Did not do any vigorous physical activities in the past 7 days	100	0.71	26.2	23.5	29.4
63. Did not do any moderate physical activities in the past 7 days	100	0.68	20.7	20	24.7
64. Did not walk for at least 10 minutes at a time during the past 7 days	100	0.88	7.9	7	14.1
65. Does not go to physical education (PE) classes/games time in an average week	100	0.63	23.2	29.4	34.1
66. Spends 3 or more hours sitting and watching television, playing computer games, talking with friends, or doing other sitting activities during a typical day	100	0.79	23.9	23.8	19
Gambling behavior					
67. Had taken part in any form of gambling during the past 12 months	100	0.65	26.2	25.9	10.6
68. Found him or herself thinking about gambling or planning to gamble during the past 12 months	100	0.72	18.9	21.2	15.3
69. Ever spent much more than planned on gambling during the past 12 months	100	0.83	15.3	11.9	4.8
Hygiene behavior					
70. Did not brush or clean teeth on at least a day during the past 7 days	83.3	0.98	0.6	0	2.3*
71. Never or rarely washed hands before eating during the past 7 days	100	0.91	3	2.3	5.9
72. Never or rarely washed hands after using toilet or latrine during the past 7 days	100	0.94	4.9	3.5	7
73. Never or rarely washed hands with soap after using toilet or latrine during the past 7 days	100	0.68	28.8	27.3	23.8

74. Never thoroughly washed entire body (bathe) with soap and water during the past 7 days	80	0.96	4.9	1.2	2.3
Quality of sleep at night					
75. Most of the time or always had trouble sleeping during the past 30 days	80	0.82	9.7	11.8	3.5

*Indicates statistically significant differences between first and second measurement

Part D:

Behavioral clusters and underlying factors for HRB of adolescents in an HIV context

Chapter 9

Beyond their HIV status: The occurrence of multiple health risk behavior among adolescents from a rural setting of sub-Saharan Africa.

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Abstract

Introduction: Health risk behaviors (HRB) during adolescence can compromise adolescents' development and achievements. This is especially important for sub-Saharan Africa (SSA), where many adolescents living with HIV are an emerging sub-population. HRB may cluster into patterns that might be predicted by specific factors, among which HIV may have an important role. Therefore, we investigate the clustering of HRB like substance use, sexual risk behavior, injury and violence, hygiene practices, gambling, physical activity, and diet-related risk behaviors among perinatally HIV infected adolescents and their uninfected peers in a rural coastal setting in Kenya. We also investigated the specific predictive factors for HRB clustering within this adolescent sub-population.

Methods: A sample of 558 (36% perinatally HIV infected and 28% HIV exposed) aged 12-17 years participated in this baseline cross-sectional survey in an on-going longitudinal study. The HIV infected and exposed participants were sequentially recruited through contact with specialized HIV treatment clinics, while their HIV uninfected-unexposed peers were randomly sampled from households within Kilifi County. The adolescents were administered a locally validated questionnaire on HRB via Audio Computer-Assisted Self–Interview (ACASI), their executive functions in three domains were assessed, and data on various socio-demographic, biological and psycho-social characteristics were obtained. HRB clustering was identified through latent class analysis on 22 behaviors and stepwise ordinal logistic regression was used to identify predictors of HRB clustering

Results: A four class solution showed an optimal model. The majority (52%) of the adolescents belonged to the low risk group (LRG), whereas 24% belonged to two clusters, High Risk Group (HRG) and Highest Risk Substance Users (HRSU) with the highest burden of HRB. No significant differences were found in behavioral class membership across the three HIV groups (p=0.686). The HRG comprised adolescents with a significantly greater burden of violence and injury related behaviors (11.1-59.6%), substance use (3.0–58.6%), sexual risk behavior (8.1–12.1%), gambling behavior (22.2%), poor fruit and vegetable consumption (31.3%), and inadequate oral and body hygiene (19.9–70.7%) as compared to both the LRG and Moderate Risk group (MRG). The HRSU were characterized by the highest reports of the occurrence most forms of HRB coupled with more than thrice the burden of substance use (alcohol, tobacco,

marijuana, and khat) with exception of other drugs) compared to all the other three behavioral classes. Membership to higher risk behavioral classes relative to LRG was strongly predicted by experience of internalizing problems like fearfulness and mental distress ($p<0.001$), by younger age ($p=0.032$) and adolescents' reports of their caretaker's tobacco use ($p<0.001$). In addition, protective effects of higher executive functioning ($p=0.006$) and school attendance ($p=0.03$) were identified.

Conclusion: Regardless of the adolescent's HIV status, four risk classes of HRB could be identified, two of these with a highest burden of HRB, showing that there is a major variation in patterns of frequent HRB among the adolescents.

This highlights an urgent need for inclusive, multi-component health behavior interventions tailored to different developmental stages. Such interventions could be offered within rural primary health clinics for adolescents living with HIV. The programs need to include assessments and care for internalizing mental health problems, executive functioning and steps to involve family members and communities to address psychosocial risk factors in families.

Introduction

The emergence of a sub-population of adolescents living with HIV (ALHIV), especially in sub-Saharan Africa (SSA) (Idele et al., 2014, Lowenthal et al., 2014), has been met with growing research interest on health risk behavior (HRB) of this group (Ssewanyana et al., 2018c, Toska et al., 2017). HRB is often initiated or consolidated during adolescence (Steinberg, 2008) and heightens vulnerability to sickness and mortality, thereby compromising development and successful achievement of adolescents' expected social roles (Jessor, 1991). Furthermore, sub-optimal HIV care and treatment outcomes like poor antiretroviral therapy (ART) adherence (Kim et al., 2017), sexually transmitted co-infections (Gamarel et al., 2018), and virologic failure (Sithole et al., 2018) among ALHIV, have been linked to HRB like substance use and risky sexual behavior. Most studies on HRB among ALHIV in SSA report a high prevalence (20%-60%) of risky sexual behavior and sexual victimization as well as substance use behavior, especially among older male adolescents (Ssewanyana et al., 2018c, Toska et al., 2017). These findings make HRB an urgent target for intervention among ALHIV.

Amidst the growing body of evidence on HRB of ALHIV in the SSA, most studies only report on a few forms of HRB and usually in an isolated manner (Ssewanyana et al., 2018c, Toska et al., 2017). None of the studies examined the possibility of HRB clustering (Spring et al., 2012) in this sub-population. Clustering refers to an observed proportion of a combination of risk factors which exceeds its expected proportion (Schuit et al., 2002). Notably, HRB clustering or co-occurrence underlies the concept of unhealthy lifestyle (Jessor, 1991), which is linked to heightened risk for future chronic conditions (Lynch and Smith, 2005) and can complicate HIV treatment and care outcomes. HRB clustering is partly attributable to specific shared risk factors, such as, social determinants. Identifying clusters of behavior and their predictors within a sub-population might help to identify the most vulnerable adolescents as well as facilitate the design of more comprehensive health promotion planning and intervention programs (Spring et al., 2012). Besides the fragmented reporting on HRB, many studies on HRB of ALHIV from SSA lack details on response rates, few studies report route of HIV infection (i.e. vertical or horizontal), some do not clarify participants' awareness of their HIV status, and many studies lack appropriate comparison groups (e.g. none compares HRB between perinatally HIV infected (PHIV) and perinatally HIV exposed uninfected (PHEU) adolescents) (Ssewanyana et al., 2018c, Toska et al., 2017).

Susceptibility to HRB among adolescents born to HIV infected mothers (i.e. PHIV and PHEU) in SSA could proliferate, owing to the constellation of psychosocial stressors and structural bottlenecks which they often encounter within their vulnerable families and broader environment (Mellins and Malee, 2013). Some of these vulnerabilities arise from factors at an individual level (like sex, age, mental health, HIV care behavior, and traumatic life events); or relationship factors (e.g. caregiver factors, peer factors, disclosure, and household poverty); or community level (e.g. health system factors, stigma, and cultural/social systems); or at a broader societal level like policy frameworks (Lowenthal et al., 2014, Toska et al., 2017, Abubakar et al., 2016b). Notably, poor executive functioning (EF) in aspects such as processing speed, working memory, planning, attention, cognitive flexibility, inhibition, and problem solving is increasingly recognized in children and adolescents with perinatal HIV infection (Phillips et al., 2016). However, none of the studies on HRB of ALHIV in SSA investigates the potential impact of EF on HRB yet, whereas EF has been shown to play a role in adolescents' behavioral regulation (Steinberg, 2008). EF's significance in adolescents' risk taking has been linked to the dual brain system across the developmental period in adolescence (Steinberg,

2008). The dual brain system is characterized by a temporal lapse between onset of the socio-emotional system at puberty (which increases reward-seeking tendencies) and the maturation of the cognitive control system (which improves individuals' capacity for self-regulation) in later adolescence. This temporal lapse is reported to substantiate why risk taking propensity tends to heighten at the onset of puberty and subsequently decline in older adolescence stage (Steinberg, 2008). It is plausible that early EF deficits could hamper optimal development of the cognitive control system thus heightening vulnerability for engagement in multiple HRB.

Within SSA, Kenya is one of the countries with a large youthful (15-24 years) HIV sub-population (NASCOP, 2016). Nevertheless studies on HRB of ALHIV in Kenya barely exist. Notably, among the rural settings such as coastal Kenya, a high psychosocial burden coupled with suboptimal HIV treatment outcomes are faced by ALHIV (Abubakar et al., 2016b, Hassan et al., 2014), and generally healthcare and social services are poor in this setting (NCPD, 2017). Thus, ALHIV within such settings may experience high vulnerability to HRB; which may adversely impact their HIV treatment outcomes as well as general health. Despite these circumstances, there is still a dearth of evidence on the lifestyles of ALHIV, as well as on the general adolescent sub-population from rural Kenyan settings. In order to reduce the existing knowledge gaps, we investigated HRB clustering among perinatally HIV infected (PHIV), perinatally HIV exposed but uninfected (PHEU) and HIV unexposed and uninfected (HUU) adolescents in rural coastal Kenya. Association of HRB clusters with EF outcomes was also studied, as well as factors that predict HRB clusters.

Methods

Participants and procedures

Data collection was conducted between November 2017 and October 2018, providing a baseline wave in an on-going longitudinal study; the Adolescent Health Outcomes Study (AHOS).

The study was conducted at the Centre for Geographic Medicine Research-Coast at the Kenya Medical Research Institute (CGMRC-KEMRI) and all the participants were residents of Kilifi County at the coast of Kenya. About 1.4 million people resided in Kilifi County by 2016 of whom, the majority (61%) are rural dwellers and 22% are aged 10-20 years (NACC, 2015). Kilifi is termed

as a “medium HIV county” (45 per 1000) and 6,000 (19%) of people living with HIV are adolescents and youth (15-24) (NASCOP, 2016). About 891 square kilometers of Kilifi County is covered by Kilifi Health and Demographic Surveillance System (KHDSS) (Scott et al., 2012); a region with various ongoing CGMRC-KEMRI research activities. Most of the residents of KHDSS and Kilifi County are of the Mijikenda ethnic group, subsistence farmers who commonly speak Giriama and Swahili languages (Scott et al., 2012).

PHIV and PHEU adolescents and their caregivers were recruited through sequential sampling from all families that attended HIV clinic days at eight HIV treatment and care clinics at health facilities (hospitals and health centres) in Kilifi County. Recruitment was done by a trained research assistant in liaison with health workers at the participating HIV treatment facilities. Some of the PHEU adolescents and their caregivers were also recruited by visiting families affected with HIV (with help of a community health worker based at an HIV clinic) within the general community. HUU adolescents were randomly sampled among households within the KHDSS using the KHDSS population register (Scott et al., 2012). For each PHIV adolescent, two controls (a PHEU and HUU adolescent) were recruited.

Medical records at the health facilities were used to confirm PHIV adolescents’ HIV status. As part of the eligibility criteria, the adolescents had to be fully aware of their HIV status and that of their biological mother. HIV exposure of PHEU adolescents was ascertained from maternal medical records confirming HIV infection of the mother during pregnancy. Additionally, recent medical records of the adolescent (if available) were used to ascertain that the PHEU adolescent was HIV uninfected. The PHEU adolescent also had to be aware of his or her biological mothers’ HIV status for study eligibility. HUU adolescents were not directly tested for HIV but recruitment was restricted to those mothers who willingly shared their HIV test results of the time they were pregnant of the participating adolescent. For both PHEU and HUU a brief screening checklist was also utilized, to exclude adolescents who had had severe childhood illness and/or had recurring health problems so as to minimize the possibility of including HIV infected adolescents in the control groups. A more detailed assessment of the adolescents’ medical history was also done by a trained clinician during the assessments for data collection. For all the eligible participants, written parental or guardian consent as well as adolescents’ assent were obtained. All eligible adolescent participants had to be accompanied by a legal caretaker during their appointment for data

collection at the CGMRC-KEMRI. Monetary reimbursement of 300 Kenyan shillings (about 3 US dollars) and a transport fee reimbursement were given to the accompanying caretaker and a snack was provided to all participants prior to the assessments. Ethical approval to conduct this study was obtained from the Kenya Medical Research Institute Scientific and Ethics Review Unit (KEMRI/SERU/CGMR-C/084/3454). We also obtained permission from the Kilifi County government, department of health services (HP/KCHS/VOL. VIX/80).

The current study comprises 558 (199 HUU, 158 PHEU and 201 PHIV) adolescents aged 12-17 years. Initially 638 potentially eligible adolescent participants (227 HUU, 185 PHEU and 226 PHIV) had shown interest in participating, but 560 ultimately took part. Data on HRB outcomes from two participants was missing. Non-response (n=78) was mainly attributable to the silent refusal (i.e. refusal by willing participants to turn up after 3 or more reminders) or failure to turn up for appointment (n=39, 50%), direct refusal of further contact with the research team (n=9, 11.5%), study criteria ineligibility (n=7, 8.9%) and relocation of participants (n=2, 2.6%). Some of the recruited participants were not scheduled for assessment since the required sample sizes for their specific groups had been realized (n=21, 27%). Overall, the non-respondents did not differ by HIV group composition (34.6% HUU, 34.6% PHEU and 30.8% PHIV) and they were 13.9 years old (S.D=1.7) with slightly older HUU adolescents than the others (p=002). Of the non-respondents 54% were male and no significant differences were found in sex across HIV groups (p=0.75).

Measures

Health behavior outcomes:

HRB, the primary outcome of this study, was assessed using an audio-computer assisted self-interview (ACASI) of the Kilifi Health Risk Behavior Questionnaire (KRIBE-Q) in Swahili language. The KRIBE-Q was previously adapted and validated for use among the adolescent sub-population within Kilifi and was shown to be a reliable (Gwet AC1=0.82) measure for adolescents' HRB (Ssewanyana et al., 2018d). Contextually relevant examples and explanations of HRB were utilized in the interviews for clarity. In summary, the behaviors comprised the following:

Injury or violence-related behavior

Six behaviors on injury and violence-related behavior are reported: i) was engaged in physical fights within the past 12 months; ii) was seriously injured within the past 12 months; iii) experienced dating violence (physical and/or sexual) within the past 12 months; iv) was forced to have sexual intercourse; v) was bullied within the past 12 months; and vi) experienced suicidal behavior (ideation and/or attempt) within the past 12 months.

Sexual risk behavior

Three behaviors are reported: i) early sexual debut (initiation of sex before 14 years); ii) engagement in transactional sex (victim and/or perpetrator) in the past 12 months; and iii) condom nonuse during most recent sex.

Substance use behavior

We categorized tobacco and alcohol use into one group of licit substances that are largely accessible within the Kenyan context (NACADA, 2012). Marijuana and Khat were grouped together as central nervous stimulants fairly accessible by youths within the study setting (Ssewanyana et al., 2018a); and a third category were other drugs. The five substance use behaviors reported are: i) lifetime use of tobacco or alcohol products; ii) recent use (past 30 days) of tobacco or alcohol products; iii) lifetime use of marijuana and Khat products; iv) recent use (past 30 days) of marijuana and Khat products; and v) lifetime use of other drugs.

Poor hygiene behavior

Two variables on poor oral hygiene and poor general body hygiene are reported.

Gambling

Gambling behavior is captured by an item asking if the adolescent ever spent much more than they planned on gambling activities within the past 12 months.

Physical activity and sedentary behavior

Three behaviors on physical activity and sedentary behavior are reported: i) number of days of vigorous physical activity (at least 10 minutes at a time) during a regular week; ii) number of days of moderate physical activity (at least 10 minutes at a time) during a regular week; and iii) number of hours spent on sedentary activities during a regular day.

Dietary behavior

Two behaviors on frequency of: i) fruit and vegetable consumption and ii) fatty or fast food intake during a regular week, are reported.

Executive functioning:

Three core EF domains of working memory, inhibitory control and cognitive flexibility (Collins and Koechlin, 2012) were assessed. All EF assessments were administered by a trained research assistant (in psychological and cognitive assessment) and these took place in sound proof properly lit rooms, arranged to minimize any form of distractions. Standardized procedures for administration of each EF test were followed.

Cognitive flexibility

Five trails of the comprehensive trail making test (CTMT) were administered in numerical order following the standardized procedure (Reynolds, 2002). Raw scores for each trail (number of seconds taken by an examinee to complete the trail) were recorded by the assessor. Appropriate T-scores per trail were obtained from the CTMT examiner's manual (Reynolds, 2002) and the overall variable of interest was the *average T-scores* for all completed trails by the examinee.

Inhibitory control

The Stroop color and word test (SCWT) (Golden and Freshwater, 1978) was administered to assess inhibitory control. From the three sections of the test (each timed for 45 seconds): the raw word score (words correctly identified), raw color score (correctly identified colors) and the raw color-word score (correctly identified color of ink for a contrasting name of color) were noted by the assessor per examinee. The overall variable of interest was *interference* which was computed by subtracting the raw color score from the raw color-word score.

Working memory

Participants were administered the backward digit span and the letter-number sequencing (LNS) subsets. These tasks have been previously modified and utilized among children, adolescents and older populations within the study setting (Alcock et al., 2008, Nyongesa et al., 2018). The overall variables of interest were the total number of correct sequences (*total correct raw scores*) for both LNS and backward digit span tasks.

Other variables:
The adolescents' age, sex, current educational level and orphanhood status were captured and ascertained in the presence of their caretaker and from records such as birth certificates.

The adolescents' caretakers were also asked about their household socio-economic status using an assets index that has been extensively utilized in Kilifi context (Abubakar et al., 2008).

Adolescents' weight and height were measured following recommended procedures (WHO, 2005). Body mass index for age (BMI for age) and height for age were then computed using the WHO standards (WHO, 2009).

Items assessing parent-to-adolescent interaction, peer-to-peer relationship and school attachment were borrowed from measures previously utilized in adolescent sub-populations (Armsden and Greenberg, 1987, Dekovic et al., 2002, Abubakar et al., 2016a). The most suitable items for each of the three components were selected based on factor analytic approach.

Furthermore, items on household food insecurity in the past 30 days (if one went hungry because there was not enough food at home), feeling unsafe in their neighborhood, experience of mental distress (feeling sad/hopeless almost every day for 2 weeks or more in a row) within the past 12 month, and use of tobacco products by their caretaker/s were taken from the KRIBE-Q (Ssewanyana et al., 2018d).

A blood sample was taken from the PHIV adolescents and analyzed for CD4/CD8 cell count and HIV viral load concentrations. Additionally, information on ART medication regimen and duration of medication was extracted from the PHIV adolescents' medical records.

Data analytic strategy
All analyses were conducted in the STATA15 software package (StataCorp LLC). First, latent class analysis (LCA) (Hagenaars and McCutcheon, 2002) was performed to identify behavioral classes based on the 22 behaviors described above. Five models varying from 1 to 5 latent classes were generated and the Akaike information criterion (AIC) and Bayesian information criterion (BIC) were utilized to select the model with the best goodness of fit indices i.e. preferred model had lowest BIC values (Nylund et al., 2007). Assignment of participants

to respective latent classes was based on their posterior probabilities of class membership. We further measured entropy to indicate the level of separation between classes. Values of normalized entropy greater than 0.80 indicate that the latent classes are highly discriminating (Tein et al., 2013).

The behavioral characteristics and other factors (socio-demographic, biological and psycho-social) of each class from the optimal model were summarized using descriptive statistics like proportions (%) and means (where appropriate). Bivariate analyses (Chi Square test or Fisher exact test for categorical variables and Analysis of Variance (ANOVA) with Bonferroni correction for post-hoc analysis for continuous variables) were used to compare differences across behavioral classes in relation to behavioral characteristics and other factors (socio-demographic, biological and psycho-social).

ANOVA with Bonferroni correction for post-hoc analysis and non-adjusted ordinal logistic regression were performed to identify differences in EF outcomes across classes and to test for a potential association between EF and behavioral class membership.

Stepwise ordinal logistic regression with a 95% confidence interval (95% CI) was performed to identify predicting factors for behavioral class membership. The initial predictive model was fitted with all the variables that had a p-value of 0.25 and less (Bursac et al., 2008) from the bivariate analyses. Multiple imputation was used for missing data on individual behavioral variables due to non-response (Graham et al., 2007).

Results

Sample characteristics

The final sample comprised 558 (36% PHIV, 28.3% PHEU and 35.7% HUU) adolescents with a mean age of 13.7 (SD=1.6). The PHEU were slightly younger (13.3 (±1.4) years) than the other groups, with the oldest being the PHIV (14.1 (±1.6) years) ($F=11.9$, $p<0.001$). Overall 53% were females and no differences in sex were found across HIV groups ($p=0.72$). Almost all participants (99%) attended school, with majority (93%) being at primary education level. We did not find differences in education across HIV groups ($p=0.06$). All the PHIV adolescents were enrolled on ART of whom about 17.5% were prescribed protease inhibitor based regimen (i.e. second line regimen).

Behavioral classes

The four-class solution was the best fitting model as it had the lowest BIC (12238.06) and adequate power for the entropy measure (0.85) to indicate high level of discrimination by the 4 latent classes (see Table 9.1).

Table 9.1. Model fit information for the latent class models from 1-5 clusters (n=558).

Number of clusters	Degrees of freedom	AIC	BIC	Entropy
1	24	12628.51	12732.3	
2	47	12208.32	12411.57	0.56
3	68	11959.72	12253.78	0.87
4	**90**	**11848.87**	**12238.06**	**0.85**
5	113	11816.23	12304.89	0.80

AIC: Akaike information criterion, BIC: Bayesian information criterion. The optimal latent class model is highlighted in bold

The "low risk group (LRG)" comprised the majority (52%) of the participants whereas the "highest risk, substance users (HRSU)" formed the smallest (6%) class (see Table 9.2).

Overall, participants from the LRG reported the lowest occurrence of injury and violence related behaviors (0-33%), substance use (0-4.8%), sexual risk behavior (0-1.4%) and gambling behavior (2.4%). Nonetheless, the LRG reported significantly lower involvement in moderate and vigorous physical activity (less than 2 days per week) when compared to the "moderate risk group" (MRG) and HRSU. The HRG also reported significantly higher (1.4% vs 0%) occurrence of dating violence and early sexual debut as compared to the MRG.

The MRG was characterized by participants with significantly lower reports of injury and violence related behavior (0-40.7%), substance use (0–11.1%), sexual risk behavior (0-1.5%) and gambling behaviors (11.1%) as compared to both the "high risk groups" (HRG) and HRSU. However, participants from the MRG reported significantly greater occurrence of physical fights ($p=0.005$), experience of bullying ($p<0.001$), lifetime use of other drugs ($p=0.02$), recent tobacco and/or alcohol use ($p=0.01$), fatty food intake ($p= p<0.001$), gambling behavior ($p<0.001$) and sedentary lifestyle ($p<0.001$) as compared to the LRG.

Table 9.2. A comparison of behavioral characteristics across the 4 behavioral clusters.

Variable	Cluster 1 (*Low risk group*) N (%) *n=291*	Cluster 2 (*Moderate risk group*) N (%) *n=135*	Cluster 3 (*High risk group*) N (%) *n=99*	Cluster 4 (*Highest risk substance users*) N (%) *n=33*	P-Value
Injury and violence related behavior					
Had a serious injury during past 12 months (*Once or More than once)*	96 (32.9)^{N,I}	48 (35.6)^{Q,M}	33 (33.3)^{L}	21 (63.6)^{K}	0.006
Engaged in a physical fight in past 12 months (*Once or More than once)*	79 (27.2)^{H,C}	55 (40.7)^{Q,G}	38 (38.4)^{L}	22 (66.7)^{K}	<0.001
Have ever been victims of forced sexual intercourse	6 (2.06)^{B,C}	3 (2.2)^{D,M}	19 (19.2)^{S}	7 (21.2)^{E}	<0.001
Were victims of dating violence (*physical and/or sexual*) in past 12 months	4 (1.4)^{B,C}	0 (0.0)^{D,M}	11 (11.1)^{L}	13 (39.4)^{E}	<0.001
Were victims of bullying in past 12 months	50 (17.2)^{B,C}	47 (34.8)^{D,A}	59 (59.6)^{S}	18 (54.5)^{K}	<0.001
Had suicidal behavior (*suicide ideation and/or attempted suicide*) in the past 12 months	0 (0.0)^{B,C}	0 (0.0)^{D}	13 (13.1)^{S}	8 (24.2)^{E}	<0.001
Alcohol, tobacco and drug use behavior					
Have ever used tobacco and/or alcohol	4 (1.4)^{N,C}	1 (0.7)^{Q,M}	3 (3.0)^{F}	14 (42.4)^{E}	<0.001
Recently (*past 30 days*) used tobacco and/or alcohol	0 (0.0)^{B,C}	4 (2.9)^{J,G}	10 (10.1)^{L}	11 (33.3)^{K}	<0.001
Have ever used marijuana and/or khat	0 (0.0)^{B,C}	0 (0.0)^{D}	11 (11.1)^{F}	19 (57.6)^{K}	<0.001
Recently (*past 30 days*) used marijuana and/or khat	0 (0.0)^{B,C}	0 (0.0)^{J}	7 (7.1)^{F}	17 (51.5)^{E}	<0.001
Have ever used other drugs	14 (4.8)^{B,O}	15 (11.1)^{D,G}	58 (58.6)^{F}	4 (12.1)^{R}	<0.001
Sexual risk behavior					
Engaged in early sexual debut (*before 14 years*)	4 (1.4)^{H,I}	0 (0.0)^{J,M}	8 (8.1)^{L}	11 (33.3)^{E}	<0.001
Engaged in transactional sex in past 12 months	3 (1.0)^{H,O}	2 (1.5)^{J,M}	12 (12.1)^{S}	2 (6.1)^{R}	<0.001
Did not use a condom during their most recent sex intercourse	0 (0.0)^{B,C}	0 (0.0)^{D}	11 (11.1)^{S}	8 (24.2)^{E}	<0.001
Dietary behavior					
Rarely or never eat fruits and vegetables during a regular week	38 (13.06)^{B,O}	11 (8.2)^{D,M}	31 (31.3)^{L}	1 (3.0)^{R}	<0.001
Usually (*5-7 days per week*) consume fatty or fast foods during a regular week	32 (11.0)^{H,C}	44 (32.6)^{J,A}	18 (18.2)^{S}	11 (33.3)^{R}	<0.001

Physical activity					
Days per week of at least 10 minutes of vigorous physical activity	1.5 (sd=1.7)[C,N]	3.9 (sd=2.7)[D,A]	1.8 (sd=2.1)[F]	4.8 (sd=2.4)[R]	<0.001
Days per week of at least 10 minutes of moderate physical activity	1.4 (sd=1.2)[H,C]	6.1 (sd=1.2)[D,A]	0.9 (sd=1.1)[F]	4.5 (sd=1.8)[E]	<0.001
Spend 5 hours or more on sedentary activities during a typical day	29 (9.9)[N,I]	48 (35.6)[D,A]	8 (8.8)[L]	8 (24.2)[R]	<0.001
Gambling behavior					
Spent in excess on gambling activities in the past 12 months	7 (2.4)[B,C]	15 (11.1)[J,A]	22 (22.2)[S]	8 (24.2)[K]	<0.001
Hygiene behavior					
Inadequate oral hygiene (*never cleans/brush teeth or does on only some days in a regular week*)	51 (17.5)[B,O]	22 (16.3)[D,M]	70 (70.7)[F]	3 (9.1)[R]	<0.001
Inadequate general body hygiene (*never or rarely or only sometimes takes a bath with soap and water in a regular week*)	19 (6.5)[H,O]	7 (5.2)[J,M]	19 (19.9)[S]	5 (15.2)[R]	0.001

Other drugs included: cocaine, heroin, methamphetamines, steroid pills/shots without doctor's prescription, and injection of any illegal drug into the body;
sd: standard deviation
Chi Square test or Fisher Exact test (for categorical variables); Bonferroni correction for post-hoc analysis in ANOVA (for continuous variables)
[A]p<0.001 (cluster 1 *vs.* 2); [B]p<0.001 (cluster 1 *vs.* 3); [C]p<0.001 (cluster 1 *vs.* 4); [D]p<0.001 (cluster 2 *vs.* 3); [E]p<0.001 (cluster 2 *vs.* 4); [F]p<0.001 (cluster 3 *vs.* 4); [G]p≥0.001 & p≤0.05 (cluster 1 *vs.* 2); [H]p≥0.001 & p≤0.05 (cluster 1 *vs.* 3); [I]p≥0.001 & p≤0.05 (cluster 1 *vs.* 4); [J]p≥0.001 & p≤0.05 (cluster 2 *vs.* 3); [K]p≥0.001 & p≤0.05 (cluster 2 *vs.* 4); [L]p≥0.001 & p≤0.05 (cluster 3 *vs.* 4); [M]p>0.05 (cluster 1 *vs.* 2); [N]p>0.05 (cluster 1 *vs.* 3); [O]p>0.05 (cluster 1 *vs.* 4); [Q]p>0.05 (cluster 2 *vs.* 3); [R]p>0.05 (cluster 2 *vs.* 4); [S]p>0.05 (cluster 3 *vs.* 4)

The HRG comprised adolescents with significantly greater burden of violence and injury related behaviors (11.1-59.6%), substance use (3.0–58.6%), sexual risk behavior (8.1–12.1%), gambling behavior (22.2%), poor fruit and vegetable consumption (31.3%), and inadequate oral and body hygiene (19.9–70.7%) as compared to both the LRG and MRG.

The HRSU were characterized by the highest reports of the occurrence most forms of HRB coupled with more than thrice the burden of substance use (alcohol, tobacco, marijuana, and khat) with exception of other drugs compared to all the other three behavioral classes. They reported significantly more occurrence of serious injuries in the past 12 months ($p=0.002$), fights ($p=0.005$), dating violence ($p=0.001$), both recent and lifetime use of tobacco/alcohol and marijuana/khat ($p<0.001$ – $P=0.004$), early sexual debut ($p<0.001$) and sedentary hours ($p=0.014$) compared to the HRG. However, adolescents from the HRSU reported the lowest occurrence of both inadequate oral hygiene (9.1%) and poor fruit and vegetable consumption (3%). Their engagement in physical activity was also significantly higher than that reported by the HRG and LRG.

Socio-demographic, biological and psycho-social characteristics of the four behavioral classes

Results from bi-variate analysis of various factors across the behavioral classes are summarized in Table 9.3.

There were no significant differences in HIV group distribution across the four classes ($p=0.69$). Noteworthy is that almost a quarter (26% of PHIV, and 20% of PHEU) of each HIV group and 25% of the HUU belonged to the two highest risk classes (i.e. HRG and HRSU).

The majority of the HRSU were male and generally older ($p=0.004$) than the adolescents in other behavioral classes. Across all four behavioral classes, the HRG comprised the greatest proportion of early adolescents with the lowest educational achievement (75% below upper primary school) and the most frequent occurrence of nutritional stunting (all differences were statistically significant). There were significantly fewer reports of caretaker tobacco use (15.1%) and adolescents' mental distress in the past 12 months (11.7%) among the LRG compared to all the other three behavioral classes. School attachment and socio-economic status were only significantly better among MRG versus LRG ($p=0.008$) and MRG versus HRG ($p=0.026$), respectively. Both LRG

and MRG had significantly fewer reports for both food insecurity and feeling unsafe in the neighborhood in comparison to the two riskier classes (i.e. the HRG and HRSU).

Executive Functioning outcomes across the four behavioral classes

Significant differences in performance on all the four EF tasks across the behavioral classes were seen (see Table 9.4). Across the four behavioral classes, participants from the HRG had the lowest scores ($p<0.001$) on both tasks of working memory (i.e. backward digit span and LNS). Participants from the HRG also had the lowest mean T-scores (cognitive flexibility) and the highest Stroop interference, but these differences were only statistically significant in comparison to those scored by participants from the low risk classes (i.e. LRG and MRG), but not the HRSU.

We found a significant association between behavioral class membership and adolescents' performance on working memory and cognitive flexibility tasks. For both EF outcomes, the odds of membership to higher risk behavioral classes relative to the LRG, decreased with improved performance on these tasks.

Predicting factors for behavioral class membership

Predictive factors for behavioral class membership are summarized in Table 9.5.

The results indicate that the odds of belonging to a class of higher behavioral risk relative to the LRG, increase with the age of the adolescent, and that the odds are twice or higher among adolescents who feel unsafe in their neighborhood, who experienced mental distress within the past 12 months and for those who lived with a caretaker/s that used substances (i.e. tobacco products).

Finally, we found that being in mid-adolescence relative to early adolescence, performing higher on the LNS (working memory), and school attendance were all protective against membership of a higher behavioral risk class relative to the LRG.

Table 9.3. Socio-demographic, psychosocial and biomedical characteristics of participants in the 4 behavioral clusters

Factors	**Cluster 1 (*Low risk group*)** N (%) *n=291*	**Cluster 2 (*Moderate risk group*)** N (%) *n=135*	**Cluster 3 (*High risk group*)** N (%) *n=99*	**Cluster 4 (*Highest risk substance users*)** N (%) *n=33*	**P-Value**
HIV status	$p^{N,O}$	$p^{Q,M}$	p^{S}	p^{R}	0.686
HIV uninfected unexposed (HUU)	103 (35.4)	47 (34.8)	38 (38.4)	11 (33.3)	
Perinatally HIV exposed uninfected (PHEU)	90 (30.9)	37 (27.4)	21 (21.2)	10 (30.3)	
Perinatally HIV infected (PHIV)	98 (33.7)	51 (37.8)	40 (40.4)	12 (36.4)	
Adolescence stage	$p^{H,O}$	$p^{J,M}$	p^{L}	p^{R}	0.027
Early adolescence (10-14 years)	195 (67.1)	92 (68.1)	79 (79.8)	18 (54.5)	
Mid-adolescence (15-17 years)	96 (32.9)	43 (31.9)	20 (20.2)	15 (45.5)	
Sex (*males*)	126 (43.3)^{N,I}	67 (49.6)^{Q,M}	46 (46.5)^{L}	24 (72.7)^{K}	0.013
Age (*years*)	13.7 (sd=1.5)^{N,I}	13.8 (sd=1.5)^{Q,M}	13.4 (sd=1.6)^{L}	14.5 (sd=1.5)^{R}	0.004
Education	$p^{B,O}$	$p^{D,M}$	p^{L}	p^{R}	0.001
Not attending school	2 (0.7)	0 (0.0)	2 (2.0)	1 (3.0)	
Special school	2 (0.7)	0 (0.0)	1 (1.0)	0 (0.0)	
Lower primary school (pre-primary to class 5)	139 (47.7)	59 (43.7)	71 (71.7)	11 (33.4)	
Upper primary school (class 6-8)	134 (46.1)	62 (45.9)	23 (23.3)	17 (51.5)	
Secondary school	14 (4.8)	14 (10.4)	2 (2.0)	4 (12.1)	
Orphanhood	$p^{N,O}$	$p^{Q,M}$	p^{S}	p^{R}	0.492
Both parents alive	191 (65.6)	98 (72.6)	65 (65.7)	22 (66.7)	
Only mother alive	52 (17.9)	24 (17.8)	20 (20.2)	5 (15.2)	
Only father alive	28 (9.6)	4 (2.9)	5 (5.0)	3 (9.1)	
Both parents died	20 (6.9)	9 (6.7)	9 (9.1)	3 (9.1)	
Caretaker uses substances (*tobacco use*)	44 (15.1)^{H,I}	37 (27.4)^{Q,G}	28 (28.3)^{S}	12 (36.4)^{R}	0.003
Caretaker-adolescent positive interaction (*total score of tool ranges from 0 to 72*)	46.9 (sd=7.7)^{N,O}	47.2 (sd=8.6)^{Q,M}	45.7 (sd=8.7)^{S}	44.3 (sd=7.3)^{R}	0.180

School attachment (*total score of tool ranges from 0 to 16*)	12.4 (sd=2.3)[N,O]	13.2 (sd=2.1)[Q,G]	12.5 (sd=2.7)[S]	12.5 (sd=2.1)[R]	0.013
Peer to peer positive relationship (*total score of tool ranges from 0 to 12)*	9.1 (sd=2.3) [N,O]	9.3 (sd=2.3) [Q,M]	8.8 (sd=2.8) [S]	8.9 (sd=2.3) [R]	0.359
Social economic status (*total score of tool ranges from 0 to 9)*	1.6 (sd=1.4)[N,O]	2.0 (sd=1.7)[J,M]	1.4 (sd=1.3)[S]	2.2 (sd=1.9)[R]	0.006
Food insecurity in past 30 days (*always/most of the time/sometimes going hungry due to no food at home*)	32 (11.0)[H,I]	23 (17.0)[Q,M]	20 (20.2)[S]	8 (24.2)[R]	0.037
Feeling unsafe in their neighborhood	47 (16.2)[B,C]	24 (17.8)[J,M]	36 (36.4)[S]	15 (45.5)[K]	<0.001
Mental distress in past 12 months (*feeling sad or hopeless almost every day for two weeks or more in a row*)	34 (11.7)[B,C]	28 (20.7)[J,G]	39 (39.4)[S]	13 (39.4)[K]	<0.001
History of any other medical conditions (*Epilepsy, Cerebral Palsy, history of an acute illness, Sickle cell disease, Stroke, any hospital admissions*)	85 (29.2)[N,O]	40 (29.6)[Q,M]	36 (36.4)[S]	13 (39.4)[R]	0.222
Being stunted	78 (26.8)[B,I]	31 (22.9)[D,M]	46 (46.5)[L]	7 (21.2)[R]	<0.001
BMI for age	p[N,O]	p[Q,M]	p[S]	p[R]	0.847
Thinness	52 (17.9)	22 (16.3)	20 (20.2)	3 (9.1)	
Overweight or obese	15 (5.2)	5 (3.7)	4 (4.0)	1 (3.0)	
CD4 Cell count (*PHIV specific n=190*)	p[N,O]	p[Q,M]	p[S]	p[R]	0.925
≤ 200 cells/mm^3	13 (13.3)	4 (7.8)	5 (12.5)	1 (8.3)	
HIV viral load concertation (*PHIV specific n=163*)	p[N,O]	p[Q,M]	p[S]	p[R]	0.643
≤ 1000 copies/ml	38 (48.1)	14 (35.9)	16 (45.7)	4 (40.0)	

BMI: Body Mass Index; **sd**: standard deviation

Chi Square test or Fisher Exact test (for categorical variables); Bonferroni correction for post-hoc analysis in ANOVA (for continuous variables)

[A]p<0.001 (cluster 1 *vs.* 2); [B]p<0.001 (cluster 1 *vs.* 3); [C]p<0.001 (cluster 1 *vs.* 4); [D]p<0.001 (cluster 2 *vs.* 3); [E]p<0.001 (cluster 2 *vs.* 4); [F]p<0.001 (cluster 3 *vs.* 4); [G]p≥0.001 & p≤0.05 (cluster 1 *vs.* 2); [H]p≥0.001 & p≤0.05 (cluster 1 *vs.* 3); [I]p≥0.001 & p≤0.05 (cluster 1 *vs.* 4); [J]p≥0.001 & p≤0.05 (cluster 2 *vs.* 3); [K]p≥0.001 & p≤0.05 (cluster 2 *vs.* 4); [L]p≥0.001 & p≤0.05 (cluster 3 *vs.* 4); [M]p>0.05 (cluster 1 *vs.* 2); [N]p>0.05 (cluster 1 *vs.* 3); [O]p>0.05 (cluster 1 *vs.* 4); [Q]p>0.05 (cluster 2 *vs.* 3); [R]p>0.05 (cluster 2 *vs.* 4); [S]p>0.05 (cluster 3 *vs.* 4)

Table 9.4. Summary of mean scores of executive functioning (EF) outcomes (backward digit span, letter-number sequencing, Stroop interference, and comprehensive trail making) and their association with behavioral cluster membership

Executive Functioning	**Cluster 1 (*Low risk group*)** N (%) *n=291*	**Cluster 2 (*Moderate risk group*)** N (%) *n=135*	**Cluster 3 (*High risk group*)** N (%) *n=99*	**Cluster 4 (*Highest risk substance users*)** N (%) *n=33*	**P-Value ***	**Crude OR** (95% CI)	**P-Value**
Backward digit span (*total correct raw scores*)	3.7 (sd=2.9)	4.2 (sd=2.8)	2.2 (sd=2.4)	4.3 (sd=3.3)	<0.001	0.94 (0.89, 0.99)	0.048
Letter-number sequencing (*total correct raw scores*)	4.9 (sd=2.3)	5.2 (sd=2.3)	3.3 (sd=1.4)	4.8 (sd=2.3)	<0.001	0.87 (0.80, 0.93)	<0.001
Stroop Interference (*raw scores*)	-16.1 (sd=11.0)	-16.9 (sd=9.9)	-12.8 (sd=10.8)	-15.7 (sd=9.6)	0.025	1.01 (0.99, 1.03)	0.126
Mean T-scores (*trails properly administered*)	24.9 (sd=5.1)	25.5 (sd=5.1)	22.9 (sd=3.9)	24.8 (sd=5.6)	0.0007	0.97 (0.94, 0.99)	0.049

Ordinal outcome with increasing levels of risk taking (*Low risk group, Moderate risk group, High risk group, Highest risk substance users)*

CI: Confidence Interval; OR: Odds ratio; sd: standard deviation

*: Bonferroni correction for post-hoc analysis in ANOVA (for continuous variables)

Table 9.5. Predicting factors for membership to behavioral clusters from multivariate stepwise ordinal logistic regression

Predicting factors	Odds Ratio	95% Confidence Interval	P-Value
Age (years)	1.25	1.02, 1.54	0.032
Adolescence stage			
Early adolescence (reference)			
Mid-adolescence	0.42	0.21, 0.82	0.012
Care taker uses substances *Not using (reference)*	2.04	1.39, 3.00	<0.001
Feeling unsafe in their neighborhood *(Feeling safe- reference)*	2.06	1.38, 3.06	<0.001
Letter-number sequencing (*total correct raw scores*)	0.89	0.82, 0.97	0.006
Mental distress in past 12 months (*feeling sad or hopeless almost every day for two weeks or more in a row*) (*No distress- reference)*	2.71	1.82, 4.03	<0.001
Education *(Not attending school- reference)*			
Lower primary school	0.49	0.25, 0.96	0.039
Upper primary school	0.51	0.27, 0.94	0.032

Ordinal outcome with increasing levels of risk taking (*Low risk group, Moderate risk group, High risk group, Highest risk substance users)*

Discussion

The present study identified four distinct behavioral classes with varying levels of HRB burden and clustering. The majority (slightly more than a half) of the adolescents belonged to the class with the least reports of HRB occurrence and clustering. HIV status was not a risk factor for behavioral class membership, but approximately a quarter of the adolescents per HIV group belonged to the two highest risk behavioral classes.

The heightened vulnerability to HRB among a significant minority potentially highlights a segment of adolescents with shared cumulative risk factors, which underlie unhealthy lifestyle (Spring et al., 2012). Our findings of the four class solution are similar to reports from other HRB clustering studies conducted among rural Chinese adolescents (Ji et al., 2018), Canadian adolescents (Laxer et al., 2017) and Dutch adolescents (Busch et al., 2013). The proportion of adolescents in our highest risk class (5.9%) was close to the proportion of the

highest risk group (4%) found among rural Chinese adolescents (Ji et al., 2018), whose mean age (14.7 years) was also close to the age of participants in this present study (13.7 years). However, we interpret our findings cautiously since the other studies did not focus on ALHIV, were from different geographical settings, and various behaviors were different from those reported in our study. This stated, our findings do emphasize that clustering of HRB among adolescents in rural coastal Kenya is of concern, with a considerable minority at greater risk and thus, targeted risk reduction and prevention interventions are urgently necessary.

Another key finding is that regardless of adolescents' HIV status (and HIV specific biomarkers like CD4 levels and viral suppression), HRB underlying both communicable and non-communicable diseases tends to co-occur. Although studies on HRB utilizing LCA among adolescents within an HIV context are scarce, our findings of lack of difference in HRB outcomes across HIV groups are consistent with previous studies from SSA (Ssewanyana et al., 2018c) and USA (Mellins et al., 2011). This finding stresses that children born to HIV infected women are equally at risk for multiple forms of HRB; which also echoes earlier recommendations on the need for more inclusive health promotion interventions (Mellins et al., 2011).

We found that much as there were various behavioral differences across the four classes, in general a high burden of some injury and violence related behavior, poor hygiene, inadequate physical activity and poor dietary behavior is cross cutting. Similar to our findings, poor sanitation and hygiene conditions (Alexander et al., 2014), dietary and physical activity transition (Keding, 2016) and high burden of violence related behavior, such as, bullying (Brown et al., 2008) are reported among adolescents in Kenya. Moreover, the co-occurrence of such behaviors also highlights that underlying behavioral risks for the emerging double burden of disease in Africa (Marquez and Farrington, 2012) are initiated early in life during adolescence and thus, this developmental stage coincides with a prime period to intervene. Therefore there is a need to capitalize on understanding the links between communicable and non-communicable conditions and to focus on common care needs rather than fragmented healthcare (Marquez and Farrington, 2012).

Our research revealed that a high burden of victimization, internalizing problems and suicidal behavior was distinctive among adolescents within the top two risky behavioral classes. Victimization (sexual, physical, emotional)

(Mwangi et al., 2015), emotional and behavioral problems (Magai et al., 2018) have found to be significant concerns for adolescents within the Kenyan setting. The findings on clustering of victimization, suicidal behavior and other forms of HRB like sexual risk and substance use among the HRSU and HRG, are corroborated by research showing that victimized adolescents may experience an elevated burden of suicidal behavior (Holt et al., 2015) next to maladaptive behavior such as substance use (Pinchevsky et al., 2014). Nonetheless, more research is needed to better understand the pathways and specific associations between victimization and other HRB. Additionally, screening for adolescent victimization and provision of post-violence and mental health services should be incorporated among routine adolescent health promotion programs within this study setting.

Our findings add to the existing literature regarding the link between EF and HRB (Peeters et al., 2015, Romer et al., 2011); better working memory and cognitive flexibility were associated with a lower burden of HRB clustering. Moreover, the protective effects of working memory still persisted after multivariate analysis. Similar to our findings, stronger working memory has been shown to regulate adolescents' HRB, like substance use (Peeters et al., 2015), and sexual risk taking (Khurana et al., 2015). We suggest that the effects of cognitive flexibility could be masked by the effects of educational achievement because these two are closely linked (Yeniad et al., 2013). Our findings stress the need to incorporate interventions that stimulate EF development in preventive/behavioral interventions. However, such interventions are found beneficial when they also address social, physical and emotional needs (Diamond and Ling, 2016).

We found that family level factors of household poverty (shown by low scores on the social economic index, food insecurity and nutritional stunting) and caretakers' tobacco use increased adolescents' vulnerability to a greater burden of HRB clustering. These findings are consistent with findings from earlier studies among adolescents in this study context (Ssewanyana et al., 2018b) and emphasize the need for appropriate interventions that incorporate aspects of parental or caregiver involvement as well as components on poverty alleviation.

Our findings indicated that older adolescent age is a risk factor for membership to a class of higher HRB burden. However this finding was not consistent with that on adolescent's developmental stage which indicated that early adolescents were at greater risk than those in their mid-adolescence. We propose that this result might reflect a curvilinear relationship between age and reward sensitivity

during adolescence (Steinberg, 2008). It is shown that reward sensitivity (which triggers risk taking propensity) tends to increase from the age of 10 years until mid-adolescence (peaking between 13-16) and then starts to decline thereafter (Steinberg, 2008) which is the trend suggested in our findings.

Our findings on the protective role of school attendance against HRB clustering are in line with similar findings from a HRB clustering study conducted among rural Chinese adolescents (Ji et al., 2018). We suggest that the protective effects of school attendance might result from the various opportunities for health promotion like sports, science clubs, health information, counseling and access to healthy school meals, which exist within the school environment. The existence of such opportunities for health promotion among schools has been previously discussed by young people and stakeholders from this study setting (Ssewanyana et al., 2018b). This result further stresses the need for a more inclusive education system as well as the need to encourage caregivers to educate adolescents regardless of their health conditions such as HIV.

Strengths and weaknesses

To the best of our knowledge, this is the first study from SSA that investigates adolescents' HRB clustering, utilizing a variety of behaviors which simultaneously involves adolescents from three HIV groups (i.e. PHIV, PHEU and HUU). The study also elaborates the role of EF in HRB clustering; an area that has not been previously studied within the adolescent sub-population in SSA. Nonetheless, this study was conducted among adolescents from a poor rural setting and of a young age (mean=13.7 years), who may not necessarily be representative of the adolescents living in urban and less impoverished backgrounds in Kenya. Also, the ALHIV were perinatally infected, were all enrolled in HIV care, and had been fully disclosed their HIV status. It is plausible that their HRB outcomes and/or predictors differ from those of adolescents who acquired HIV behaviorally or those who are not enrolled in treatment or not aware of their HIV status. Nonetheless, aggregating PHIV and behaviorally infected adolescent groups could potentially blur unique outcomes, which has been cautioned against (Sherr et al., 2018). Furthermore, our study so far was based on a cross-sectional design, which makes directionality of associations challenging to ascertain. HRB in our study was self-reported and this could have introduced some social desirability bias however, we suggest that such bias was to a large extent countered by the ACASI method of questionnaire administration and our high response rate.

Implications

Despite some limitations, the findings have important implications for clinicians and policy makers. First, adolescents born to HIV infected mothers from poor rural settings are equally as vulnerable to HRB as their uninfected peers. This highlights the urgent need for inclusive and multi-component interventions which are tailored to the adolescents' early or later developmental stage, and simultaneously address multiple forms of HRB. Such interventions could be made more inclusive and comprehensive by implementing them within rural adolescent HIV primary health clinics; by actively involving caregivers and family members through program components that address household psychosocial risk factors like poverty; and by incorporating services to promote mental health and EF development. Future longitudinal studies are needed to examine mechanisms which underlie HRB clustering and the changes in lifestyle that occur across the adolescents' developmental stage.

Competing interests

No competing interests were disclosed

Acknowledgements of authors' contributions

D.S designed the study, coordinated and took part in data collection, conducted data analysis, drafted the initial manuscript, revised the manuscript and approved the final manuscript as submitted. C.R.N conceptualized the study, revised the manuscript, contributed to the interpretation of the results, and approved the final manuscript. A.v. B. revised the manuscript, contributed to the interpretation of the results, and approved the final manuscript. A.S.H, G.T. A.S, FVD & G.S contributed to designing the study, and are currently reviewing the manuscript. A.A conceptualized and designed the study, coordinated the study, revised the manuscript, contributed to the interpretation of the results, and approved the final manuscript.

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Chapter 10

General Discussion

Introduction

In this thesis, four important themes on adolescents' health risk behavior (HRB) are explored in-depth in adolescents living with HIV (ALHIV) and perinatally HIV exposed uninfected (PHEU) adolescents, as well as in healthy adolescents. In *part A* of the thesis, the burden of HRB and its underlying factors among ALHIV and PHEU adolescents were examined using systematic reviews of empirical studies from sub-Saharan Africa (SSA) and the global context, respectively. Thereafter, a series of consultations with young people and stakeholders were conducted to ascertain the forms, burden and underlying factors for HRB of adolescents in Kilifi County (*part B*). In *part C*, a mixed methods approach to developing contextually relevant tools was utilized to assemble a comprehensive HRB measure suitable for use among adolescents in Kilifi. Subsequently, the assembled HRB tool was utilized in a cross-sectional study examining the HRB patterns, their association with executive functioning (EF), and the factors predictive of HRB among perinatally HIV infected (PHIV), PHEU, and HIV unexposed uninfected (HUU) adolescents living in Kilifi County (*part D*). These studies resulted in key findings, clarifying the burden of HRB in both healthy and HIV affected adolescents, their contexts, the underlying factors, as well as in identification of various needs for further research and intervention.

Main findings

Current state of research on HRB among adolescents living with HIV (ALHIV) in SSA

An analysis of the current state of research on HRB (i.e. study and participant characteristics, forms and burden of HRB) of ALHIV in SSA was done. The findings in *chapter 2* indicate that further studies to address HRB among ALHIV are needed, as numerous research limitations and knowledge gaps exist on this topic within SSA.

First, I found that currently few studies on HRB of ALHIV have been conducted in SSA (mainly in Eastern and Southern Africa); indicating a general dearth of evidence on HRB of ALHIV from other SSA settings. Additionally, many of these studies were of cross-sectional design and most lacked important details such as adolescents' awareness of their HIV status, route of HIV infection, clinical characteristics (for example, ART medication, disease staging, and HIV viral loads) and participants' response rates. I also found that research has focused on heterosexual ALHIV, mostly recruited from the clinical and

general population. Such loopholes show prevailing knowledge gaps on HRB of potentially more vulnerable ALHIV, such as those from settings linked to high HIV socio-behavioral risk (Noreña-Herrera et al., 2016, Seeley et al., 2012). Given the fact that some of these factors can uniquely influence adolescents' engagement and vulnerability to HRB, as well as potentially introduce assessment bias, the current evidence on HRB of ALHIV in SSA needs to be interpreted cautiously.

I found a general lack of comprehensiveness in the assessment of HRB of ALHIV in SSA. First, there was lack of variety in the reported HRB forms; mostly only sexual risk behavior (mainly condom nonuse behavior, multiple sexual partnerships, sexual violence, and transactional sex), and substance use (majorly alcohol consumption) were reported. Second, all the studies reported HRB in an isolated manner- without an emphasis on associated lifestyle factors or clustering of HRB.

The findings from this systematic review provide evidence that HRB is a significant problem among ALHIV in SSA. Their (ALHIV) burden of sexual risk behavior and experience of sexual victimization is comparable to that of HIV uninfected adolescents. I found a high burden of unprotected sex coupled with multiple sexual partnerships, early sexual debut and transactional sex among sexually active ALHIV. However, the evidence on substance use behavior was mixed, with a few studies reporting significant differences between ALHIV and HIV uninfected adolescents (Gavin et al., 2006, Jewkes et al., 2006a, Jewkes et al., 2006b).

Current state of research on HRB among Perinatally HIV exposed uninfected (PHEU) adolescents

A growing sub-population of PHEU children (Afran et al., 2014, Filteau, 2009); who eventually transition to adolescence, is largely attributable to the improving access to the prevention of mother to child transmission of HIV (PMTCT) among low resource settings (Stringer et al., 2008). However, the long-term health outcomes of PHEU adolescents are not yet well understood. In *chapter 3* of this thesis, I reviewed literature on forms, burden and underlying risk factors for HRB among PHEU adolescents globally so as to identify areas for future research and intervention.

My findings from this review exposed a major dearth of literature on HRB of PHEU adolescents, especially from low resource settings like SSA. All eligible studies explicitly conducted among PHEU adolescents emanated from two particular cohort studies conducted in the USA. Although participants of studies reporting HRB among HIV/AIDS orphaned or affected adolescents in SSA possibly include PHEU adolescents (Cluver et al., 2011), an assortment of HRB outcomes from varying HIV groups is potentially misleading. The potential differences in the magnitude of psychosocial risk and disease specific factors may result in variations of HRB outcomes across HIV groups. My findings indicate that the current evidence on HRB of PHEU is limited and practically non-generalizable to other regions like SSA which are culturally and socio-economically different from the USA.

Although non-generalizable, my findings indicated that only substance and drug use, and sexual risk behavior have been studied (though in an isolated manner) and found problematic for PHEU. The occurrence of lifetime unprotected sex (but not recent unprotected sex) increased rapidly during adolescence among sexually active PHEU adolescents – potentially suggesting that PHEU adolescents' first sexual intercourse involves a significant burden of risk taking. When compared to PHIV adolescents from the same study setting, there were no differences in the PHEU adolescents' reports of recent unprotected sex and multiple sexual partnerships.

I found that both lifetime and recent substance use (mainly alcohol and marijuana) steeply increased across adolescence and moreover, a significant minority of the PHEU adolescents experienced increased risk for substance use disorder. However, the burden of substance use disorder of PHEU was lower than that of PHIV during one of the follow-up studies, but no differences were found during the other study surveys. This result suggests that early initiation of substance use by PHEU predicts subsequent use throughout adolescence, and for a significant minority, such early initiation may predict future problem substance use behavior. My explanation for this finding is also corroborated by evidence on early substance initiation and its link to subsequent use in the general adolescent sub-population (Magid and Moreland, 2014).

The findings also indicated that older age and PHEU adolescents' emotional and conduct problems, as well as caregiver's mental illness, were shared risk factors (intra and interpersonal) for substance use and sexual risk behavior within PHEU adolescents' immediate social context. The specific immediate

risk factors for substance use were early initiation of substance use by PHEU, and substance use by close family members; and for sexual risk behavior were gender and racial differences. From a broader perspective, social norms and beliefs surrounding sexuality were also linked to PHEU adolescents' sexual risk behavior.

Contextualizing HRB and its potential underlying factors among adolescents in a rural coastal setting of Kenya

My findings from a series of qualitative studies on adolescents' HRB in Kilifi focused on sexual risk behavior (*chapter 4*), diet and physical activity (*chapter 5*) and alcohol, tobacco and other drug (ATOD) use (*chapter 6*). As part of this thesis, I explored views from adolescents, young people and local stakeholders to understand in-depth, the most prevalent forms HRB and their underlying factors among adolescents in Kilifi.

I found that early sexual debut, multiple sexual partnerships, and unprotected sex are commonly recognized forms of sexual risk behavior experienced and perpetrated by adolescents in Kilifi. Noteworthy, especially for female adolescents, the occurrence of risky sexual behavior (e.g. transactional sex, cross generational sex, and sexual assault) was largely characterized by exploitive and violent situations involving age and socio-economic asymmetries. These findings further highlight a dire state of adolescents' sexual and reproductive health in Kilifi County, consistent with other research findings indicating high teenage pregnancy, sexual violence, early sexual debut, and payment for sex in this setting (NACC, 2016, KNBS, 2014). My study enriches the existing literature on sexual risk behavior of adolescents in Kilifi County by presenting more in-depth descriptions on the various forms of sexual risk behavior, contexts in which they are perpetrated and experienced, and the underlying factors, using a more comprehensive ecological approach (Blum et al., 2001).

My findings on adolescents' dietary behavior provide evidence of a prevailing double burden of under and intake of highly processed foods among the adolescent sub-population in Kilifi. Some adolescents' dietary habits were indicative of a nutritional transition (Popkin, 2001); characterized by greater preference and consumption of fatty/oily foods and commercially processed food products than traditional diets. For adolescents especially from poorer households, the consumption of typically traditional meals was common, although more often their diet was unbalanced (dense in carbohydrates) and insufficient due to food insecurity in the households.

The findings on adolescents' physical activity corroborate evidence of a physical activity transition among Kenyan children and adolescents (Onywera et al., 2012). I found similar barriers for physical activity such as, adolescents' increasing use of inactive forms of transport like motorbikes, and engagement in passive leisure activities, such as gambling, long durations of screen viewing and mobile social media use. However, these barriers to physical activity among adolescents in the Kenyan context have been shown to be more prevalent among urban than rural adolescent dwellers (Onywera et al., 2012).

I found that adolescents (mainly males) in Kilifi were more likely to consume licit substances and drugs, especially when public production and supply is poorly regulated. Commonest were informally brewed (home brewed) alcoholic beverages, cigarettes, and some central nervous stimulants- mainly khat and cannabis. Correspondingly, national data on substance use among youths in Kenya indicates that alcohol (11.7%), tobacco (6.2%), and khat (4.7%) - which are licit in Kenya, followed by bhang/cannabis (1.5%) - an illicit drug, are the most consumed (NACADA, 2012).

An analysis of the underlying factors for adolescents' HRB (from chapters 4, 5 and 6) indicates that numerous risk and protective factors are common for sexual risk behavior, poor diet and sedentary lifestyle, and ATOD use. Moreover, the underlying factors mediate HRB from several social ecological levels i.e., intrapersonal, interpersonal, community/institutional and public policy levels (McLeroy et al., 1988). Besides, I found that there is interrelatedness of both risk as well as protective factors within and across the social ecological levels, and that also a specific form of HRB (for example ATOD use) may act as direct or indirect risk factor for another form of HRBs (such as, sexual risk behavior). This finding is suggestive of potential behavioral clustering and further highlights the relevance for more comprehensive health behavior research and approach to intervention (Spring et al., 2012).

My findings on shared risk factors (for all the forms of HRB in chapters 4, 5, and 6) indicate that disadvantaged social circumstances and adolescent developmental changes largely explain the HRB dynamics of adolescents in Kilifi. The major immediate factors (intra and interpersonal) are: biological factors (age and sex differences); inadequate coping strategies when dealing with daily stressors and adolescence developmental changes; poverty and its related consequences (e.g. school drop-out, and unsafe income generating activities); poor social support networks (e.g. sub-optimal parenting behavior

and negative peer influence); and behavioral problems, such as substance use. The broader level factors (community and public policy) were characterized by repressive social norms and customs (like early marriage and patriarchy); unsafe social spaces; adolescents' misuse and exposure to potentially harmful social media; and poor policy framework, and/or weak law enforcement. Nevertheless, my findings also indicated that certain risk factors are unique to specific forms of HRB. In connection to the unique risk factors, immediate factors underlying sexual risk behavior included poor negotiation skills for safe sex, and low perception of risk for sexually transmitted infections. Health complications and body image concerns were identified as unique risk factors for physical inactivity. In addition, large family sizes and misconceptions about proper diet were suggested as underlying poor dietary behavior of adolescents in Kilifi. Many of the risk factors from our study are consistent with identified social determinants (especially proximal determinants) of adolescent health worldwide (Viner et al., 2012).

The findings of the current project also confirm that various protective mechanisms and resources offered within the immediate and broader social contexts of adolescents can improve their resilience and prevent vulnerability to HRB. Most prominently expressed among these protective factors was the presence of good social support networks, such as good parenting and positive peer influence within the adolescents' immediate environment. From a broader context, improved access to healthcare and education (supportive school environment) coupled with proper implementation of adolescent-friendly policies and legal frameworks were linked to healthy behavior.

Literature review on commonly utilized HRB tools among chronically ill adolescents.

In *chapter 7* of this thesis, I synthesized evidence on commonly utilized HRB tools among adolescents living with chronic illnesses. I summarized findings on the geographical utility of these tools, their psychometric properties, and methods of administration.

The review confirms that there is a dearth of research on HRB of chronically ill adolescents in low resource settings. Most of this existing research originated from high income settings (especially Europe and North America) and majorly focuses on the HRB of alcohol, tobacco and other drug use (ATOD), and physical activity. Most of this research involved adolescents living with mental, respiratory, metabolic and neurological conditions. The findings showed that

the majority of the utilized HRB tools originate from high income settings, where they have been developed, tested and generally utilized.

I found that Youth Risk Behavior Surveillance System (YRBSS) and Health Behavior in School-aged Children (HBSC) were the most frequently utilized tools from a variety of HRB assessment tools that have so far been applied for HRB assessment in the chronically ill adolescent sub-population. However, tool adaptation and psychometric properties have been poorly described or rarely reported among many of these HRB studies. In some studies researchers performed incomplete tool adaptation procedures, but also some others borrowed existing HRB tools and items without any form of adaptation.

My findings on HRB tool administration indicate an availability of a variety of methods that researchers may tailor to suit the level of sensitivity of the research, contextual factors, resource availability, research skills, and specific needs of study populations. Self-administered paper and pencil format, and face-to-face interviews were the commonest means of HRB tool administration. Nonetheless, technology based methods such as audio computer assisted self-interview (ACASI) and online/mailed questionnaires were also moderately utilized.

Assembling a contextually appropriate HRB tool for adolescents in Kilifi

In *chapter 8* of this thesis, I present findings from a mixed-methods empirical study I undertook to assemble and psychometrically evaluate a comprehensive questionnaire on HRB of adolescents in Kilifi County. The findings demonstrate that it is feasible to implement an iterative and systematic approach as recommended by other scholars (Abubakar and van de Vijver, 2017), to assemble locally appropriate and reliable tools on adolescent HRB for use in rural settings like Kilifi.

I found that most of the adolescents in our study setting had either experienced or were familiar with most of the constructs on HRB as utilized in measures like YRBSS, HBSC and Global School –Based Student Health Survey (GSHS). This stated, my experience was that the initial process of construct clarification (e.g. consulting with young people and stakeholders) coupled with tool harmonization, are crucial for identifying and incorporating common semantics and idiomatic aspects to achieve contextual relevance of an assembled HRB tool. Beyond the preliminary steps of construct clarification, harmonization

and scale development, I found that test evaluation plays an enormous complementary role in ensuring reliability and validity the assembled items.

The measure of adolescent HRB that my colleagues and I assembled, the Kilifi Health Risk Behavior Questionnaire (KRIBE-Q), was found to have a good spread of responses across options and acceptable ranges for its item test-retest reliability. This measure comprises eight components of HRB: unintentional injury and violence, tobacco use, alcohol and drug use, sexual behaviors, dietary behaviors, physical activity, gambling, and hygiene behavior. The ACASI administered version of KRIBE-Q, with the option to switch between Kiswahili or English languages, was found to be adolescent-user-friendly and to maximize privacy during HRB assessment among adolescents in rural coastal Kenya.

HRB patterns among adolescents in Kilifi within an HIV context

The study described in *chapter 9* of this thesis was conducted to address various knowledge gaps and study inadequacies (documented in preceding chapters) on HRB of adolescents living with perinatally acquired HIV and those exposed perinatally to HIV. Succinctly, I utilized a comprehensive approach of HRB (Spring et al., 2012), to identify patterns of HRB and their predicting factors among PHIV, PHEU and HUU adolescents in a rural coastal Kenya (Kilifi County).

The findings provide compelling evidence of the tendency for HRB to cluster during adolescence, which highlights the need to shift from isolated approaches towards more holistic HRB research and intervention. Moreover, I found that four unique patterns of HRB clustering existed. Importantly there were no statistically significant differences in distribution of HRB clusters found across the adolescents' HIV status groups (i.e., PHIV, PHEU and HUU). These findings indicated that the majority of adolescents were likely to belong to the low and moderate risk behavioral classes, but a significant minority (24%) grapples with a high burden of multiple forms of HRB.

The findings revealed a huge and disproportionate burden of HRB between the two low risk behavioral classes in comparison to the other two highest risk classes. This suggests that numerous sources of cumulative risks and vulnerability exist within the immediate social environment of the adolescents in the highest risk classes. Noteworthy, the burden of sexual victimization (15-

30% versus 1-2%); suicide behavior (13-24% versus 0%); risky sexual behavior such as condom nonuse at recent sexual intercourse (11-24% versus 0%), and transactional sex (6-12% versus 1-2%); gambling (22-24% versus 2-11%); and inadequate body hygiene (15-20% versus 5-6%) were excessively higher among adolescents in the two highest risk groups (HRG and HRSU) compared to the lower risk groups (LRG and MRG). Similarly, much higher patterns of recent substance use (26% versus 1%) and lifetime use of other drugs (35% versus 8%) were found among the HRSU and HRG compared to the lower risk groups. The patterns of dietary behavior and physical activity were generally similar across the low risk and highest risk behavioral classes. This findings stresses the much needed effort to address multiple forms of HRB while paying more attention to the specific behavioral needs of the more vulnerable adolescents, regardless of their HIV status.

This study also generated evidence on the significance of EF for health behavior during adolescence. Consistent with literature from other studies (Peeters et al., 2015), the findings from our study confirmed a statistically significant protective role of good performance on EF tasks (specifically in the aspects of working memory and cognitive flexibility) against high risk behavioral patterns. Moreover, such protective benefits of EF persisted for the working memory in multivariate analysis.

Coherent with the findings from chapters 4, 5, and 6, the findings on the predictors for HRB clustering, indicated that adolescents who were older, who had experienced mental distress in the past 12 months, who felt unsafe in their neighborhood, and those who lived with a caretaker that used substances were at greater odds of belonging to a behavior class of higher HRB burden. Remarkably but consistent with other literature, being in mid-adolescence relative to early adolescence was protective against membership to a behavior class of higher HRB burden. This finding suggests a curvilinear relationship between age and reward sensitivity during adolescence (Steinberg, 2008). Other protective factors were better performance on the letter-number sequencing (a measure of working memory) and regular school attendance.

Various important factors were found to be significantly associated with HRB class membership at the bivariate analysis level, but they were not significantly predictive of HRB clustering in the multivariate analysis. These factors were: sex (males comprised the majority (73%) of the highest risk class); school connectedness (better connectedness was found among the

two low risk behavioral classes); social economic status (lowest among the high risk group); food insecurity (greater burden was found among the two riskier behavior classes); and stunting (greater burden was found among the two riskier behavior classes). Most of these factors also coherently emerged from the findings in chapters 4, 5, and 6, and the majority are proximal social determinants of adolescent health (Viner et al., 2012).

Methodological reflections

The major strengths of this thesis stem from its application of a mixed methods research approach to assemble locally validated measures of HRB which subsequently are utilized within the study settings to comprehensively study HRB of adolescents. More importantly, my findings combine results from rigorous qualitative studies (driven by ecological theory and involving several participant groups) with quantitative findings from self-reported HRB of PHIV, PHEU and HUU adolescents. This provides a holistic account of forms, burden and underlying factors for HRB of adolescents in Kilifi. Furthermore, my study takes into account co-occurrence of HRB and thus makes it one of few studies conducted within SSA that report on HRB clustering. Additionally, my thesis explores the role of EF in adolescent HRB, which still has not been well researched in HRB studies conducted in the adolescent sub-population of SSA. Another strength is that I studied an emerging adolescent sub-population (i.e. PHIV and PHEU adolescents) in SSA (Idele et al., 2014); whose long-term outcomes, such as HRB during adolescence, are currently not well understood and researched in this geographical setting.

However, the studies in this thesis had some limitations that need to be considered when interpreting the findings. First, the empirical studies were conducted among adolescents from a rural coastal setting with some of the lowest socio-economic and service indicators (NCPD, 2017) within Kenya. Therefore, from both community as well as a clinical adolescent sub-population perspective, these findings may not be generalizable to adolescent dwellers of urban settings in Kenya and beyond. I expect that the patterns and underlying factors for HRB are different among urban adolescents due to better access for them to services, rapid urbanization and higher household income. However, this was beyond the scope of the current project and understanding the specific differences between rural and urban adolescent dwellers requires future comparative research.

Second, the use of self-reports for HRB in the empirical studies may have introduced some level of social-desirability bias. The use of self-reports however, is conventionally acceptable in HRB research (Brener et al., 2003). I reduced the potential bias arising from self-reports by triangulating and contrasting adolescents' views with those from stakeholders (chapters 4, 5, 6) and through the use the ACASI method of questionnaire administration (chapter 9).

Third, all the empirical studies were of cross-sectional design and therefore it was not possible to establish causality and direction of the associations from the study findings. Future longitudinal studies using several time points of data collection during adolescence, will contribute essentially in understanding temporal changes in behavioral outcomes and their underlying factors across the adolescent lifespan. Future results from longitudinal studies will also address the limitation of having conducted the quantitative empirical study only among a young adolescent sample (mean age=13.7 years). Noteworthy, as described in the methods section, this study on HRB in chapter 9, is part of an ongoing longitudinal study which will address these research gaps.

Fourth, from an HIV perspective, the study in chapter 9 focuses on PHIV adolescents; whose behavioral profiles and underlying factors may differ from those of horizontally HIV infected adolescents, as has also been suggested in other literature (Sherr et al., 2018). Besides, our PHIV adolescents were enrolled in care, prescribed antiretroviral therapy (ART), and had been disclosed to about their HIV status. Owing to these factors, it's hard to generalize the findings to PHIV adolescents who are currently non-enrolled in HIV care or who have not been disclosed their HIV status. These limitations highlight a need for future comparative research to involve PHIV adolescents who are not enrolled in HIV care and treatment, in order to identify their behavioral needs and key areas for intervention as well.

Explanations and implications for research, policy and practice

The findings bear numerous research and practical implications for adolescent health and wellbeing. First, an urgent need to prioritize research and interventions on HRB of adolescents, without excluding those born with HIV is underscored. Moreover, the findings also highlighted specific inadequacies and

potential solutions in research and adolescent health behavior programming. I summarize these implications in the following sections:

Towards a more comprehensive approach in adolescent HRB research:

Based upon the studies, five recommendations are made to improve comprehensiveness and feasibility of HRB research among adolescents in rural settings of SSA, similar to our study setting. These five recommendations are described below:

i) *A need to engage young voices in research*

The findings that adolescents' views on HRB and its underlying factors were corroborated by those by stakeholders in Kilifi (chapter 4, 5, and 6) provides compelling evidence that adolescents can reliably recognize their health needs and concerns and therefore need to be meaningfully engaged across all levels of research and health promotion. It is noted that professionals rarely create opportunities for dialogue with young people on health matters (Hadfield and Haw, 2001). However, as was the case in the current study, when meaningfully engaged, young people are often in the best position to talk about being young and share their experiences to professionals in a unique way. Nonetheless, engaging adolescents in sensitive research subjects like HRB, requires careful ethical procedures, maintenance of high confidentiality, and devising appropriate participatory methods.

ii) *Important role of ecological models*

I was able to demonstrate the immense value of applying ecological models (Bronfenbrenner, 1977) to obtain deeper understanding of the complexity of underlying risk and protective factors for adolescents' HRB (see **Figure 10.1**). By analyzing and interpreting HRB's underlying factors from an ecological systems' perspective, I have been able to show that in Kilifi context: (i) most forms of HRB in adolescence share numerous underlying factors; (ii) the majority of these underlying factors emerge from the adolescents' immediate environment (at intra and interpersonal levels), while other broader community and public policy factors also play an important role; and that (iii) many risk and protective factors are interrelated both within and across ecological levels. Moreover, some HRB act as risk factors for other forms of HRB. By using an ecological approach, I find evidence that HRB co-occurrence potentially arises from the shared underlying risk factors across multiple forms of HRB (Spring et al., 2012), and that proximal social determinants of health (Viner et al.,

2012) are more likely to explain vulnerability to HRB among adolescents in Kilifi.

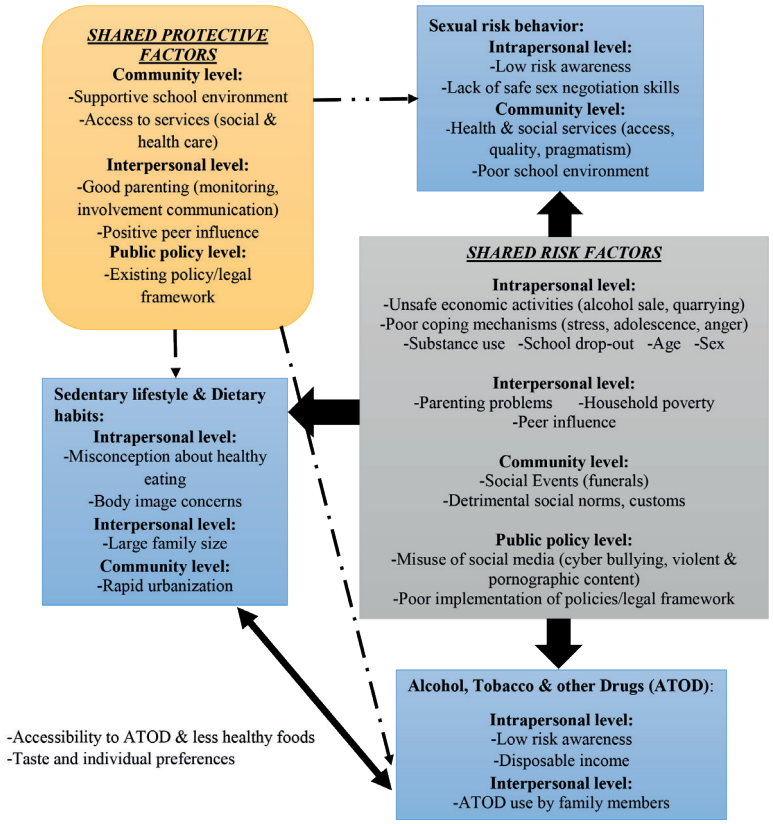

Figure 10.1. Interrelatedness of risk and protective factors that underlie multiple forms of adolescents' HRB in Kilifi.

Noteworthy, the predicting factors for HRB clustering from my multivariable analysis in chapter 9 were also consistent with the ecological systems perspective. However, only a few factors represented in figure 1 above were significantly predictive of HRB clustering (See **Figure 10.2**).

iii) *Beyond isolated HRB analysis and reporting*

The findings from the systematic reviews (chapter 2 and 3) indicated that research on HRB of PHIV and PHEU adolescents tends to focus on specific forms of HRB and that researchers often report these HRB in an isolated manner. However, my experience from using the ecological models (chapter

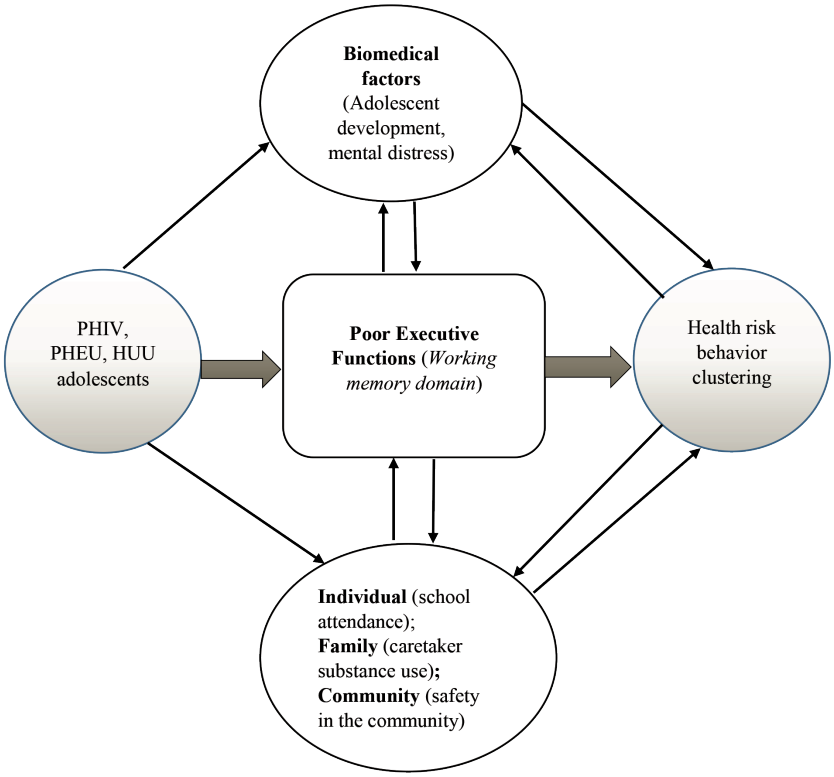

Figure 10.2. Predictive factors for HRB clustering among adolescents in Kilifi

4, 5, 6) and findings from other studies emphasize that HRB tend to co-occur during adolescence (Laxer et al., 2017). HRB co-occurrence underlies unhealthy lifestyle and heightens risk for future chronic conditions (Lynch and Smith, 2005, Spring et al., 2012). Thus, the need for more comprehensive approaches that consider simultaneous analysis/reporting of multiple HRB has been noted (Spring et al., 2012). In the empirical study on occurrence of multiple HRB among adolescents in Kilifi (chapter 9), I demonstrate that indeed, regardless of adolescents' HIV status, HRB which underlies communicable and non-communicable conditions, clusters and that the most vulnerable adolescents are at heightened risk for greater HRB co-occurrence. I demonstrated that by simultaneously assessing multiple forms of HRB through latent class analysis, HRB clusters could be identified. Besides, as latent class analysis is a person-centered approach in contrast to the more traditional variable-centered approaches (Lanza and Cooper, 2016), its significance in HRB research and intervention planning is increasingly acknowledged (Leech et al., 2014).

iv) *Mixed methods approach*

In this thesis, I demonstrated the enormous role of applying a sequential mixed methods research design (Castro et al., 2010) to develop contextually relevant and valid measures for HRB, to identify potentially useful HRB associated factors for future quantitative research, and to generate explanatory evidence from quantitative HRB findings. I found that it is feasible to systematically follow a four-step mixed methods approach (Abubakar and van de Vijver, 2017) to assemble a reliable and valid measure of adolescent HRB (KRIBE-Q) in a rural research setting. Integrating various research methodologies generated more in-depth knowledge of HRB and its underlying factors. The findings from the empirical qualitative studies (chapter 4, 5, 6) for example, provided an account of how HRB is perceived and experienced by adolescents, and which processes generate risk and protective factors for HRB of adolescents in various contexts and circumstances. Understanding such processes and circumstances played a complementary explanatory role in various findings from the subsequent quantitative study on HRB clustering and its predicting factors (chapter 9) in Kilifi.

v) *Research on HRB of adolescents living with chronic conditions like HIV*

With more than 80% of the ALHIV residing in SSA (most being PHIV) (Idele et al., 2014), investment in research on health and wellbeing of this sub-population is crucial. Much as HRB prevention is central to health and wellbeing of adolescents (Kipping et al., 2012), quality research on HRB of PHIV and their PHEU peers in SSA is scarce, and mostly focused on only sexual risk behavior and substance use. In addition, the studies were found to be characterized by numerous weaknesses, which hamper generalizability and intervention planning (chapter 2 and 3). This stated, I find that the burden of HRB among ALHIV (and also explicitly PHIV) and PHEU is substantial and comparable to their uninfected peers.

I suggest that enrollment in HIV care and treatment programs presents an opportunity through which interventions to reduce and prevent HRB, as well as target the most vulnerable adolescents living with HIV, can be channeled. However, more research is needed to understand the acceptability, delivery, coverage, and efficacy of HIV clinic based HRB prevention services since I did not find any differences in HRB patterns of PHIV adolescents enrolled in HIV care/treatment and those of HIV uninfected adolescents from the community setting. Importantly, I identified numerous methodological gaps among the

existing studies which could potentially introduce bias, and that researchers need to address in future related studies.

Executive functioning (EF) and its protective role against HRB during adolescence:

Among the novel contributions of this project is the evidence indicating that working memory and cognitive flexibility, which are core components of EF (Diamond, 2013), predict HRB patterns during adolescence regardless of adolescents' HIV status (chapter 9). Only working memory however, significantly predicted HRB patterns in the multivariate analysis; affirming its key role in mediating behavior during adolescence. This evidence is consistent with findings from other studies of adolescents which have found that good working memory protects against substance use (Peeters et al., 2015), and sexual risk taking (Khurana et al., 2015) during adolescence. Inhibitory control did not play an explanatory role in adolescent HRB outcomes. The findings on the protective role of EF against risk taking, are consistent with evidence from the social-neuroscience theory of adolescent risk taking (Steinberg, 2008).

The curvilinear relationship between stages in adolescence and the burden of HRB clustering that I found (chapter 9) is consistent with the reported temporal gap between arousal of the socio-emotional system and the maturation of the cognitive control system; a phenomenon that explains a decline in risk taking propensity in later adolescent stages (Steinberg, 2008).

The findings, mainly from chapter 9, confirm an existence of a concomitant burden of mental illness and EF deficits, which is disproportionately greater among the significant minority, that are most vulnerable to HRB clustering. This finding corroborates other research showing a link between poor EF performance (especially in working memory and cognitive flexibility) and mental illness during adolescence (Holler et al., 2014). I propose that that this co-existence of mental illness and deficits in EF potentially aggravates adolescents' extent of engagement in multiple HRB. However, more research is needed to delineate the mechanisms and extent of this concomitant burden on adolescents' HRB.

Multiple forms of HRB and potential areas of action in rural coastal Kenya:

Taken together, the empirical studies on HRB of adolescents in Kilifi (chapters 4, 5, 6, 9) confirm that: multiple co-occurring forms of HRB are experienced

in a significant minority (approximately 25%), irrespective of their HIV status. Distinct in the most vulnerable group, is their excessive burden of sexual risk behavior (also comprising experiences of sexual victimization), internalizing behavior, and substance use. My findings suggest that injury and violence related behavior, inadequate hygiene, poor diet, and inadequate physical activity are generally experienced by most adolescents in Kilifi setting. These forms of HRB require both intervention and implementation research (Peters et al., 2013, Hawe and Potvin, 2009) to identify feasible interventions components, resources and processes for effectively addressing multiple HRB of adolescents in this setting.

I suggest that multi-component interventions appropriate for age and sex, are targeted to suit adolescents' varying vulnerability profiles. Such programs are urgently required to address the multiple risk behavior adolescents in Kilifi. Intervention components likely to counter multiple HRB may include the following:

(i) A comprehensive multi-sectoral approach to tackle risks and capitalize on the protective factors that can be identified in various levels of influence across the ecological domains. Noteworthy, important strategies such as mapping key actors and political systems, strengthening leadership and implementation capacity, resource mobilization, mutual learning and implementation research have been recommended for improving multi-sectoral action for health in low and middle income settings (Rasanathan et al., 2018).

(ii) Behavioral family interventions to strengthen good parenting skills and caregivers' knowledge on adolescent health needs. Additionally, such intervention may also benefit from integrating aspects on poverty alleviation for families, such as income generating activities and financial literacy. Indeed, strengthening family connectedness and resilience, and utilizing traditional means of improving parenting and family functioning have been suggested as some family level approaches to address proximal social determinants of health (Viner et al., 2012).

(iii) Enhancement of safe and enabling environments (Svanemyr et al., 2015) through facilitating improved access to comprehensive adolescent-friendly health and social services; empowering adolescents with skills to build self-esteem, confidence and civic engagement; improving awareness on risks surrounding specific norms and practices; and

the enactment and implementation of stronger measures to tackle oppressive and potentially harmful cultural norms and practices.

(iv) Enhancement of school attendance and connectedness, and strengthening existing structures and capacity within school environments that promote adolescent health and wellbeing. Such structures may include: physical activity curricula and facilities, science clubs, social support systems such as counseling programs, and school feeding programs among others. Also essential, is the need to support more inclusive education systems and to encourage caregivers to educate adolescents regardless of their health conditions such as HIV. There is evidence to support that school connectedness (i.e. students' belief that adults in their school care about their learning and as well about them as individuals) and supportive educational environment protect against multiple forms of HRB during adolescence (Marraccini and Brier, 2017).

(v) A need to integrate and strengthen mental health services within routine adolescent primary healthcare (including specialized HIV care and treatment clinics). Such services are likely to be most beneficial if they tackle the identified dual burden of EF and mental disorders (Diamond and Ling, 2016). These services could for example involve: (i) screening for EF deficits, depressive symptoms, and adolescent victimization; and (ii) providing timely linkage to adolescent-friendly post-violence counseling and rehabilitation, programs that aid EF development and psychosocial support systems.

Conclusion

In conclusion, this thesis has demonstrated that HRB is an urgent public health problem, which so far, has received insufficient research and intervention in SSA, especially among adolescents living with chronic conditions such as HIV/AIDS, but also among adolescents dwelling in rural settings. I have shown that it is feasible to develop locally appropriate and valid tools for HRB monitoring and assessment among the adolescent sub-populations in rural SSA, and that such tools can be administered in a private and user-friendly manner, such as audio-computer assisted self-interview. Besides, this work verifies that adolescents in Kilifi experience various forms of HRB. Noteworthy, sexual risk behavior is largely encountered through exploitive and violent circumstances, during which females are more often likely to fall victim. There was evidence

that physical activity and nutritional transition, characterized by sedentary lifestyle and consumption of less healthy diet, is an emerging concern for adolescents in rural settings such as Kilifi. The gambling and the consumption of informal alcohol, khat, marijuana and tobacco especially among males; poor hygiene practices; and injury-related behavior, also further compound the adolescents' unhealthy lifestyle. Remarkably, underlying factors for HRB of adolescents in Kilifi are multi-faceted, generated from various socio-ecological levels, and majority of these factors are interrelated; suggesting potential HRB clustering. Indeed, there was evidence for the existence of distinct HRB clusters among adolescents in Kilifi, regardless of the adolescents' HIV status. This work also generated evidence verifying the important role played by executing functioning, specifically working memory and cognitive flexibility, in protecting against HRB during adolescence. Notably, the burden of HRB among adolescents in Kilifi tends to be greatest in a significant minority (approximately 25%), who were also more likely to experience a higher concomitant burden of executive functioning deficits and mental illness, had poorer educational outcomes, were of younger age, felt insecure in their neighborhood, and whose caregivers used substances such as tobacco products. Finally, this research has resulted in several recommendations for future research as well as interventions for HRB in adolescents, which now need to be continued preferably in longitudinal follow up, as well as in efforts to design and implement measures for prevention of HRB in adolescents.

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Summary

Health risk behavior (HRB) such as behavior resulting in injury, substance use, poor dietary habits and sexual risk behavior, is an important underlying and potentially modifiable risk factor for most preventable deaths and illnesses during adolescence and in later adulthood. Although this is the case, research on HRB explicitly focusing on adolescents is still scarce, especially in low and middle income settings, such as, sub-Saharan Africa (SSA). This dearth of research leaves important knowledge gaps on patterns, antecedents and consequences of HRB in settings like SSA- where young people make up large proportions of the populations. There is also an important sub-population of adolescents living with HIV (majority perinatally HIV infected) steadily emerging in SSA, yet HRB and other important outcomes are still poorly researched in this group. HRB is of importance for this group, as it worsens HIV care and treatment outcomes. In addition, a shortage of standardized and validated measures of HRB presents a hindrance for the quality of HRB research within SSA.

Another knowledge gap relates to the importance of executive functioning (EF) in health behavior/healthy lifestyle of adolescents in SSA. There has been evidence from other settings and from important theories, such as Steinberg's social-neuroscience perspective on adolescent risk taking that delineates the contribution of EF maturation in self-regulation during adolescence. Besides, EF deficits have been linked to greater HRB vulnerability although there are no studies originating from SSA on this topic.

This thesis sets out from a socio-neuro-biological model to study and adapt and validate contextually relevant HRB measures, to describe forms, patterns and underlying determinants of HRB; and to investigate the association between EF and HRB patterns of perinatally HIV infected (PHIV), perinatally HIV exposed-uninfected (PHEU) and HIV unexposed and uninfected (HUU) adolescents in a rural coastal setting of Kenya.

In C*hapter 2*, I conducted a systematic review and meta-analysis of HRB among adolescents living with HIV (ALHIV) in SSA. My colleagues and I reviewed literature from empirical studies conducted between 1980 and April 2016, that quantified HRB among ALHIV. The review indicated that the burden of risky sexual behavior (unprotected sex, risky sexual partnerships and transactional

sex) and sexual violence among ALHIV is high and comparable to that of their uninfected adolescent peers. However, the evidence was mixed on substance use behavior. Notably, I found a dearth of quality research on HRB of ALHIV in SSA. This dearth was also compounded by a lack of variety in reported HRB forms; often focused on only a single or a few forms of HRB. I also found that an omission of important details, such as route of HIV transmission, HIV disclosure status, and study response rates hampers generalizability of current evidence on HRB of ALHIV. Nevertheless, the review provided evidence that HRB is a significant problem and one that requires more rigorous research and intervention among ALHIV in SSA.

The aim of *Chapter 3* was to identify the prevalent forms, burden, and underlying risk factors for HRB of Perinatally HIV exposed uninfected (PHEU) adolescents. I addressed this knowledge gap by reviewing literature from empirical studies published between 1980 and August 2018 across all geographical regions. There was a major dearth of HRB research among PHEU adolescents since all the eligible studies originated from the USA and were part of two large cohort studies. Only sexual risk behavior and substance use behavior were currently studied. There were increasing trends in the occurrence of lifetime unprotected sex, and both lifetime and recent substance use among PHEU adolescents. However, these temporal increments were generally not different from those among the comparison groups of perinatally HIV infected (PHIV) adolescents. Adolescents' older age and internalizing behavior, and mental illness of caregivers were shared risk factors for PHEU adolescents' sexual and substance use behavior. Substance use by close family members was a specific risk factor for PHEU substance use. Gender, racial differences and social norms were identified as specific risk factors of PHEU's sexual risk behavior.

In *Chapters 4, 5, and 6*, I present findings from a cross-sectional qualitative study conducted to understand the common forms of HRB and their underlying risk and protective factors among adolescents in Kilifi County at the Kenyan coast. Using focus group discussions and in-depth key interviews, I explored the perceptions of 85 young people (adolescents and young adults) and 10 professionals like teachers, clinicians and social workers who serve the adolescent population in Kilifi. I utilized an ecological model approach, specifically the Socio-Ecological model and Ecological Model of Adolescent Behavior, to interpret and map out the complexity of the various underlying factors.

In *Chapter 4,* focused on sexual risk behavior, I found that transactional sex, early sexual debut, coerced sex and multiple sexual partnerships are perceived as commonly experienced and/or perpetrated by adolescents in Kilifi. Numerous inter-related risk factors were identified in this qualitative study but most notable ones were: difficulties in safe sex negotiation, and insufficient knowledge and misconceptions about sexual health (from an individual level); negative peer influence and norms (at peer level); a devastating impact of household poverty and poor parenting behavior (at family level); school drop-out (at school level); and a poor state of adolescent sexual and reproductive health services, insecurity within the community, and detrimental social norms and customs, such as gender inequality and early marriage (at social environment level). Key protective factors included: school attendance especially with the existence of sexual and reproductive health promotion services and structures like teen clubs, supportive staff, and functional school regulations; supportive and close parenting behavior; and the presence of a legal framework to address sexual violence.

In *Chapter 5* on dietary behavior and physical activity, I found some indications in this qualitative study, of growing tendency for preference and consumption of oily and sugar dense processed foods among adolescents in Kilifi. However, equally, there were reports of unbalanced traditional diets which often were inadequate in amount, especially among poorer households. There were also views on increased engagement in passive leisure and sedentary activities among a significant minority of adolescents in Kilifi. Notable risk factors at an intrapersonal level included: taste and preference for unhealthy foods, adolescents' body image concerns, and negative attitudes and misconceptions about healthy lifestyle, household poverty, and parenting practices that condone an unhealthy lifestyle were some identified interpersonal level risk factors. Broader community level risk factors included: increasing availability of affordable unhealthy foods, high cost of certain nutritious foods, influx of passive leisure activities and motorized transportation alternatives. Poor implementation of policies enabling a healthy environment was cited as a broader policy level risk factor for poor dietary behavior and physical activity. The most notable promoting factor for dietary behavior and physical activity was the presence of a supportive school environment.

The use of alcohol, tobacco and other drugs (ATOD) by adolescents in Kilifi was presented in *Chapter 6* of this thesis. Consumption of home brewed alcohol, tobacco and marijuana smoking, and khat chewing were considered as the most

common among adolescents. Numerous inter-related risk factors stressed the important role of intrapersonal level factors relating to adolescents' coping mechanisms to life stressors and daily needs. Similar to the other forms of HRB, household poverty, poor parenting behavior and influence from peers and close family members were found in this qualitative study to influence adolescents to ATOD use at an interpersonal level. Broader community level risk factors included accessibility (cost, packing, informal supply); economic benefit associated with the production and sale of ATOD products, such as alcohol; and cultural and social norms that condone ATOD use by adolescents. Some noteworthy protective factors include: high costs of certain ATOD; positive school environment that mitigates ATOD use; better household socio-economic status; and enforcement of protective policy and regulations.

In order to identify suitable HRB measures for modification and future use in this project, I conducted a systematic review to identify commonly utilized HRB measures and their psychometric properties, among chronically ill adolescents globally (*Chapter 7*). I found that there was a scarcity of research on HRB of chronically ill adolescents from low and middle settings. The Youth Risk Behavior Surveillance System (YRBS) and Health Behavior in School-aged Children (HBSC) were the commonest utilized HRB assessment tools. I noted that tool adaptation and psychometric properties are rarely or poorly reported in most of the studies conducted among chronically ill adolescents. I found a variety of HRB tool administration methods, however, self-administered paper and pencil format, and face-to-face interviews were the commonest. To some extent, technology based methods like audio computer assisted self-interviews and mailed questionnaires were popular.

In *Chapter 8,* I followed a 4 step-mixed methods approach to assemble a contextually appropriate HRB tool; Kilifi Health Risk Behavior Questionnaire (KRIBE-Q), for use among adolescents in Kilifi. The construct clarification step involved the identification of etic and emic aspects of HRB based on studies described earlier in *Chapter 7* (for etic properties), and *Chapters 4, 5, and 6* (for emic properties). After conducting the item development, questionnaire refinement, and scale development steps, I performed test evaluation of the Kiswahili version of the questionnaire among 164 school attending adolescents. The KRIBE-Q was found to be psychometrically sound (with good test-retest reliability) and feasible to administer via audio computer assisted self-interview (ACASI) for adolescents in rural coastal Kenya. This tool comprises 8 sections on: behavior resulting in unintentional injury and violence; tobacco use;

alcohol and drug use; sexual behaviors; dietary behaviors; physical activity; gambling; and hygiene behavior.

HRB may cluster into patterns that might be predicted by specific factors, among which HIV may have an important role. Thus, in *Chapter 9* I investigated the clustering of HRB, its association with executive function (EF), and the predicting factors for HRB clustering. The sample comprised 201 perinatally HIV infected adolescents (PHIV), 199 perinatally HIV exposed-uninfected (PHEU) adolescents and 158 HIV unexposed and uninfected (HUU) adolescents from a rural coastal setting in Kenya (mean age=13.7). Using latent class analysis I found four unique behavioral classes with about a quarter (24%) of the total sample belonging to the two clusters with the highest burden of HRB. Adolescents' HIV status was not limited to specific classes. Being a member of a higher risk behavior class relative to the lowest risk group was predicted by adolescents' internalizing problems, such as fearfulness and mental distress, older age, and by adolescents' reports of their caretaker's substance use. The study confirmed an existing inverse association between good EF performance (working memory and cognitive flexibility) and membership to a higher risk behavior class relative to the lowest risk group. However, only working memory retained its protective role against HRB in the multivariate analysis. School attendance as well had a protective benefit against HRB.

The findings from my thesis highlight an urgent need to prioritize research and interventions on HRB of adolescents, without leaving behind those born with HIV. First, I recommend that more comprehensive research in this field will need to: involve young people at all stages to better inform research and intervention needs; utilize ecological models for more systematic appraisal of underlying HRB factors; focus on multiple form of HRB as opposed to reporting only on isolated forms of HRB; employ mixed methods research to cross-validate evidence; and to involve adolescents with chronic conditions such as HIV since they are equally vulnerable to HRB as their uninfected peers. Through this work, I have been able to replicate a four step approach to tool adaptation and validation and shown that it is a feasible and vital step for HRB research. This work has demonstrated that EF plays a crucial role in the improvement of adolescents' healthy lifestyle, regardless of their HIV status. Moreover, the findings show that a concomitant burden of mental illness and EF deficits is likely to heighten vulnerability to HRB during adolescence. Thus, EF deficits and mental illness may need to be addressed concurrently.

This thesis suggests that HRB underlying both communicable and non-communicable conditions, clusters during adolescence. Based on the identified risk and protective factors, I suggest that age and sex appropriate multi-component interventions that are targeted for adolescents' varying vulnerability profiles, are urgently required. I propose that such interventions are likely to be useful if: they involve professionals across sectors in society; involve behavioral family components that strengthen caregivers' capacity to support their adolescents; enhance adolescent-friendly and supportive environments; strengthen school attendance and connectedness; and integrate EF and mental health aspects. Overall, currently there is need for intervention and implementation research to identify feasible interventions and necessary resources to tackle multiple HRB of adolescents in Kilifi and other similar contexts.

Summary in Dutch (Samenvatting)

Gezondheidsrisicogedrag van adolescenten die opgroeien aan de kust van Kenia in relatie tot de sociale, neurologische en biologische determinanten en HIV.

Dit proefschrift omvat acht studies die gericht zijn op het gezondheidsrisicogedrag van adolescenten tussen 12 en 18 jaar, die opgroeien in Kilifi aan de kust van Kenia. De studies zijn opgezet vanuit een socio-neuro-biologisch model. Ten eerste is een systematisch overzicht en een meta-analyse gepresenteerd van het gezondheidsrisicogedrag van adolescenten met HIV die in Sub-Sahara Afrika leven. Ook van de wetenschappelijke literatuur over adolescenten die perinataal aan HIV waren blootgesteld, maar die niet geïnfecteerd zijn, is een overzicht gemaakt dat laat zien wat de meest voorkomende vormen zijn van hun gezondheidsrisicogedrag en welke onderliggende risicofactoren hierbij een rol spelen. Vervolgens is in drie kwalitatieve onderzoeken nagegaan wat de belangrijkste risico factoren lijken te zijn bij adolescenten wat betreft hun seksuele gedrag, voeding en het gebruik van alcohol, tabak en andere drugs. De meetinstrumenten die beschikbaar zijn om gezondheidsrisicogedrag van chronisch zieke adolescenten te onderzoeken zijn ook beschreven in een systematisch overzicht van de literatuur. Al deze onderzoeken leidden tot de samenstelling van de Kilifi Health Risk Behavior Questionnaire (KRIBE-Q), die gebaseerd is op internationaal gebruikte instrumenten en die geschikt is voor gebruik bij adolescenten die opgroeien in de cultuur van Kilifi in Kenia. De KRIBE-Q bleek goede psychometrische kenmerken te hebben. Vervolgens is deze lijst gebruikt in een onderzoek bij 201 perinataal met HIV geïnfecteerde adolescenten (PHIV), 199 perinataal aan HIV blootgestelde maar niet-geïnfecteerde (PHEU) adolescenten, en bij 158 niet aan HIV blootgestelde en niet geïnfecteerde (HUU)) adolescenten, met een gemiddelde leeftijd van 13.7 jaar. In het gezondheidsrisicogedrag van al deze adolescenten waren vier clusters te onderscheiden. De helft van de adolescenten behoorde tot de laag risicogroep, terwijl een kwart in de twee hoogste risicogroepen werd ingedeeld. De HIV status was niet onderscheidend tussen de vier clusters. Adolescenten in de hoog risicogroep hadden in vergelijking met de laag- en matig risicogroepen, vaker te maken met geweld en verwondingen (11.1-59.6%) en

zij gaven meer blijk van alcohol, tabak en drugsgebruik (3.0–58.6%), seksueel risico gedrag (8.1–12.1%), gokken (22.2%), slechte consumptie van fruit en groente (31.3%), en inadequate verzorging van mond en lijf (19.9–70.7%). De hoogste risicogroep werd gekenmerkt door het voorkomen van de meeste vormen van gezondheidsrisicogedrag met een drie keer zo hoge frequentie van alcohol en drugsgebruik in vergelijking met de andere drie groepen. Adolescenten in de twee hogere risicogroepen gaven meer internaliserende problemen zoals angst en spanning aan, zij waren wat ouder en zij hadden vaker ouders die tabak gebruikten. Als beschermende factoren kwamen met name een goed werkgeheugen (als onderdeel van executieve functies), alsook het daadwerkelijk naar school gaan, naar voren.

Deze resultaten laten zien dat onderzoek, opzet en implementatie van interventieprogramma's gericht op het verminderen van gezondheids-risicogedrag bij adolescenten in Kilifi, Kenia, nodig en zinvol is. Dergelijke interventieprogramma's zouden gericht moeten worden op meerdere vormen van gezondheidsrisicogedrag tegelijkertijd, evenals op het verminderen van internaliserende problemen en het bevorderen van executieve functies en het naar school gaan. Adolescenten met HIV moeten niet buiten beschouwing gelaten worden in dergelijke studies en zorgprogramma's.

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Curriculum vitae

Derrick Ssewanyana (1987) graduated from Makerere University in Uganda in 2011, with a bachelor's degree in Environmental Health Science. During his studies in Uganda, he served as a peer service provider for sexual and reproductive health with a student-led association (MUMSA-HOP) at Makerere University College of Health Sciences. He also volunteered on a reproductive health program with Pathfinder International in the post-war region of northern Uganda. Following his graduation, he worked as program assistant supporting community-based water, sanitation and hygiene improvement project activities at the Network for Water and Sanitation (NETWAS), Uganda. He thereafter worked as a health officer and Global Health Corps fellow, supporting quality improvement of primary healthcare in Kyangwali refugee settlement in Uganda. In 2014, Derrick graduated with a Master of Science in Public Health from the University of Southern Denmark, with a specialization in Health promotion. During his studies in Denmark, he served as a biostatistics student instructor at the unit for Health Promotion Research at the University of Southern Denmark. He also took an internship at the World Health Organization, department of Mental Health and Substance Abuse, in Geneva where he updated training materials, took part in grading of evidence for development of guidelines, and in editing of internal documents. In 2015, Derrick relocated to the Centre for Geographic Medicine Research Coast, at Kenya Medical Research Institute, in Kenya, to start his PhD research work. For the past three years, he has developed, coordinated, monitored, analyzed, and disseminated his findings from his two-phased PhD project focused on quantifying the burden of health risk behavior and examining the potential implications of neuro-cognitive deficits (in the light of other determinants) on adolescents' health risk behavior within an HIV context in the rural settings of coastal Kenya.

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