Stress, Coping, Mental Health, and Reproductive Health among Adolescent Girls Transitioning through Puberty in Tanzania

by

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in the Department of
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ABSTRACT

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Abstract

Adolescent girls in sub-Saharan Africa must transition through puberty in the context of heightened risk for reproductive tract infections and mental health disorders. At the same time, girls experience menstrual stigma and a lack of resources to manage menstruation. Although menstruation and other puberty-specific stressors may negatively impact girls' well-being, little is known about the relationships between puberty-specific stressors, coping, mental health, and reproductive health among girls in sub-Saharan Africa. The present dissertation seeks to fill this gap by investigating the types of puberty-specific stressors experienced by adolescent girls and young women in Tanzania, how girls cope with stressors, and the associations between stress and coping and mental health and reproductive health. A qualitative interview study and cross-sectional survey study were conducted to explore stress, coping, and health among adolescent girls in Tanzania. Both studies showed that girls experienced significant and disruptive puberty-specific stressors, with sexual pressure and menstrual pain constituting two of the most common stressors. Stressors were associated with depression, anxiety, and reproductive tract infections. Avoidant coping and active coping showed inconsistent relationships with stressors and mental health. Overall, psychosocial interventions are needed to reduce the negative impact of puberty-specific stressors on mental health and reproductive health among adolescent girls in Tanzania.

Dedication

"There is no greater agony than bearing an untold story inside you." – Maya Angelou

This dissertation is dedicated to all of the women and girls who shared their stories with us and to all those who still have a story to tell.

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1. Introduction

For many girls in sub-Saharan Africa, puberty is a critical transition that introduces novel threats to mental health and reproductive health (World Health Organization, 2014). The three leading causes of morbidity and mortality for adolescent girls in sub-Saharan Africa (SSA) are HIV, maternal mortality, and mental illness (World Health Organization, 2017). In multi-country studies from SSA, 21-37% of adolescents met the criteria for clinical depression, and between 1.2% and 12.4% of adolescents reported suicidal behavior (Kuringe et al., 2019; Neese et al., 2013; Nyundo et al., 2019). In data from Uganda and Tanzania, 30-31% of adolescent girls met the criteria for clinical anxiety (Abbo et al., 2013; Kuringe et al., 2019). Despite high rates of mental health disorders, mental health services are scarce, with some countries having only one psychologist (Okasha, 2002; Wang et al., 2007).

To support girls transitioning through puberty, we must identify the role of puberty in heightening health risks and explore culturally relevant methods to reduce the negative impact of puberty on mental health and reproductive health. The current research seeks to meet this need by exploring psychosocial stress, coping, mental health, and reproductive health among adolescent girls in Tanzania.

1.1 Psychosocial Stressors During Puberty

The onset of menstruation is an important biological, social, and psychological event during puberty. However, in many low-income settings with gender inequity,

menstruation can be a source of stress and risk because girls face stigma and a lack of education, sanitary resources, and social support to confidently manage menstruation (Crichton et al., 2013; Hennegan et al., 2019; Sommer et al., 2016).

Menstrual stigma and resource deficits have been identified throughout sub-Saharan Africa (Chikulo, 2015; Hennegan et al., 2019; Jewitt & Ryley, 2014; Munthali & Zulu, 2007; Phillips-Howard et al., 2015; Rheinländer et al., 2019; Scorgie et al., 2016; Ssewanyana & Bitanihirwe, 2017). To describe these deficits, Chrichton and colleagues (2013) defined the term "menstrual poverty" as "the combination of multiple practical and psychosocial deprivations experienced by menstruating girls and women in resource-poor settings."

Girls in settings with menstrual poverty report being unprepared for menstruation and describe feelings of anxiety, fear, sadness, embarrassment, and shame (Chikulo, 2015, 2015; Jewitt & Ryley, 2014; Mason et al., 2013; Munthali & Zulu, 2007). A lack of access to preferred sanitary materials is associated with the use of non-sterile and leak-prone materials, difficulty taking part in everyday activities, and the potential for urogenital health issues, although research on the link between menstrual management and biologically confirmed health outcomes remains inconclusive (Jewitt & Ryley, 2014; Phillips-Howard et al., 2015; Sumpter & Torondel, 2013). Menstrual taboos are often isolating and restrict girls from working, cooking, and attending religious and social

events, which are key coping strategies for adolescents (Jewitt & Ryley, 2014; Munthali & Zulu, 2007; Mutumba et al., 2016; Puffer et al., 2012; Ramaiya et al., 2016).

Girls report missing school or being unable to concentrate due to the inability to manage menstruation, which can limit educational and vocational opportunities (Boosey et al., 2014; Chikulo, 2015; Jewitt & Ryley, 2014; Montgomery et al., 2016). There is evidence that risk for sexual exploitation is heightened by the economic burden of menstruation (Jewitt & Ryley, 2014). In Kenya, two-thirds of girls using pads received them from sexual partners (Phillips-Howard et al., 2015). Of girls who were under 15, 10% had sex for money to buy pads (Phillips-Howard et al., 2015).

In addition to menstrual stressors that are unique to low-resource settings, many women and girls also experience the more common and potentially disruptive psychological and somatic symptoms associated with the pre-menstrual phase, such as menstrual pain, fatigue, and irritability (Freeman, 2003; Wong & Khoo, 2011). It is estimated that between 13-18% of women of reproductive age experience distressing symptoms of premenstrual dysphoric disorder (PMDD) (Halbreich et al., 2003). Little is known about the rate of menstrual disorders among adolescents in SSA, but in research from Nigeria, the prevalence of PMDD was 6% among university students (A.O. Adewuya et al., 2008). In research among adolescent schoolgirls in Nigeria, 69% had some menstrual disorder, which included dysmenorrhea (painful periods), PMDD, or short menstrual cycles (Nwankwo et al., 2010). Overall, adolescent girls and young

women in SSA may face both the stigma and lack of resources especially prevalent in low-resource settings and the more common physiological disorders faced by menstruators worldwide.

On top of menstruation-specific stressors, girls in Africa face puberty-related stressors such as limited power in relationships, social role changes, early marriage, sexual pressures, and a multitude of other interacting factors contributing to growing gender inequities during puberty (Clark, 2004; Decker et al., 2015; Hallman et al., 2015; Luke, 2003; Sommer, 2011). Adolescence is a time of identity development, and girls begin to navigate changing expectations, roles, social status, and relationships with others as they incorporate notions of sexuality, fertility, and gender into their self-concept (Greif & Ulman, 1982; McMahon et al., 2011; O'Sullivan et al., 2007; Sommer, 2010). As girls enter puberty, they may be seen as sexually mature despite their young age, which makes them vulnerable for sexual assault, harassment, and coercion (Mason et al., 2013; Rashid & Michaud, 2000; Sommer, 2009). Girls entering puberty may also feel increased desire to engage in sexual intercourse and romantic relationships, but often do not have the knowledge or self-efficacy to implement condom use or other safe sex behaviors (Sommer, 2009). Health risks among girls are further exacerbated in settings with poverty and gender inequality (Sa & Larsen, 2008; Weiss et al., 2000; World Health Organization, 2017).

1.2 Defining Stress

It is clear that puberty and menstruation may be significant stressors for adolescent girls in SSA, although more research is needed to quantify the impact of these stressors. In order to engage in this research, it is first necessary to provide a clear definition of how the present research defines "stress" and "stressors."

One commonly cited conceptualization of stress in the adult literature is the definition posited by Lazarus and Folkman (1984) in the Transactional Model of Stress and Coping. In this conceptualization, stress is the result of the interaction between an environmental demand and an individual's cognitive appraisal of that demand as potentially overwhelming their coping resources and causing harm.

Grant et al. (2003), propose a definition of "stressor" that focuses on the objective occurrence of external threats: "environmental events or chronic conditions that objectively threaten the physical and/or psychological health or well-being of individuals of a particular age in a particular society." The current study will use the word "stressor" in accordance with Grant et al.'s (2003) definition, while the word "stress" will refer to the transactional definition, which includes an individual's dynamic psychological and physiological response to a stressor (Lazarus & Folkman, 1984).

1.3 The Negative Impact of Stress on Mental Health and Reproductive Health

Research consistently shows that across populations and topics, chronic stress shows a negative impact on both mental health and physical health (Compas et al., 1993; Fagundes et al., 2013; Lemieux & Coe, 1995; Segerstrom & Miller, 2004; Vanitallie, 2002; S. J. Weiss, 2007). Chronic or traumatic stress can cause dysregulation of the hypothalamic-pituitary-adrenocortical axis, the sympathetic-adrenal-medullary axis, the hypothalamic-pituitary-ovarian axis, and the gut-brain-axis (Moloney et al., 2015; Segerstrom & Miller, 2004; Vanitallie, 2002). In periods of short-term stress, these systems regulate the "fight or flight" sympathetic stress response in ways that can be adaptive. However, in cases of chronic or traumatic stress, these systems can become dysregulated.

Longer-term activation of stress-related systems negatively impacts the immune system and causes maladaptive neurobiological changes related to mental health, including alterations in the hippocampus, dysregulation of neurotransmitter systems, and neuroinflammation (Segerstrom & Miller, 2004; Vanitallie, 2002; Weiss, 2007). Individuals may also cope with stress by engaging in health risk behaviors, which may cause further harm (Brody et al., 2010). In line with these findings, stress has been linked to poor mental health across sub-Saharan Africa (Hadley et al., 2008; Neese et al., 2013).

Furthermore, stress and mental health may show relationships to reproductive health through behavioral and immune-related pathways. Stress, mental distress, and

depression have been associated with sexual risk behavior, reproductive tract infections, and changes in the vaginal microbiome in the US and sub-Saharan Africa (Irving et al., 1998; Mazzaferro et al., 2006; Sontag & Graber, 2010; Turpin et al., 2019).

Overall there is evidence from research among adults and adolescents globally and in sub-Saharan Africa that stress is associated with poor mental health and reproductive health. Furthermore, there is evidence that poor mental health is associated with poor reproductive health. This suggests the need to explore these relationships further and develop methods to intervene on the link between stress, psychopathology, and poor reproductive health outcomes.

1.4 Theories of Stress and Coping

Although stress can negatively impact mental health and physical health, not all individuals respond similarly to potentially stressful situations. The way an individual appraises and copes with a situation is essential in determining whether or not a demanding situation becomes stressful (Folkman & Moskowitz, 2004; Lazarus & Folkman, 1984). Lazarus and Folkman (1984) define coping as "constantly changing cognitive and behavioral efforts to manage a specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person." In the Transactional Model of Stress and Coping, the impact of an external demand on an individual is influenced by how they appraise the demand, how they appraise their

ability to cope with the demand, and whether they use adaptive or maladaptive coping strategies (Lazarus & Folkman, 1984).

Research using the transactional model as a framework has provided evidence that coping may serve as a moderator or mediator between stress and individual outcomes (Compas et al., 1993; Folkman & Lazarus, 1988; Grant et al., 2003; Pruchno & Resch, 1989; Sontag & Graber, 2010). When coping is conceptualized as a moderator, it serves as an external factor that influences the strength of the relationship between stress and negative outcomes; for example, adaptive coping may provide a "buffer" against the negative impact of stress. When coping is conceptualized as a mediator, characteristics of the stressor influence the choice of coping strategy, and this coping strategy accounts for the relationship between a stressor and a negative outcome. For example, among adolescent girls in the US, disengagement coping partially mediated the relationship between peer stress and internalizing distress (Sontag & Graber, 2010).

1.4.1 Comparing Moderation and Indirect Effects Models

It is unclear to what extent differences between child and adult coping styles are dependent on cultural influences, and it is unknown whether a moderation or mediation model is more appropriate for use with adolescents in Tanzania. However, the relationships between stress, coping, and mental health outcomes are complex and dynamic, with coping strategies able to take on moderating qualities over time as they become fixed patterns. This is supported by research showing that coping strategies may

serve as mediators for children and moderators for adults in the same parent-child dyad study (Wadsworth et al., 2005).

The present research seeks to explore if coping serves as a moderator that influences the strength of the relationship between stressors and mental health or if coping accounts for an indirect relationship between stressors and mental health outcomes. Although the latter description is sometimes described as mediation, "indirect effects" is more appropriate terminology when using a cross-sectional, non-randomized approach.

1.5 The Impact of Coping on Health

Regardless of whether coping acts as a moderator or mediator, research across topics has shown that certain strategies of coping are typically maladaptive. Avoidant coping is characterized by distancing, distraction, withdrawal, and trying not to think about a stressor. In high-income countries, avoidant coping shows extensive relations to mental distress, depression, risk behaviors, and poor disease-related outcomes among adolescents and adults (Gore-Felton & Koopman, 2008; Herman-Stahl et al., 1995; Kato, 2015; Sikkema et al., 2009; Simoni & Ng, 2000; Talley & Bettencourt, 2011).

Among adolescents, maladaptive coping, disengagement coping, emotional suppression, avoidance, and denial are typically associated with poor mental health outcomes (i.e., internalizing and externalizing symptoms) (Compas et al., 2017). Although the majority of studies show a relationship between disengagement coping

and worse mental health, there are some studies in which disengagement coping is associated with better outcomes among adolescents (Compas et al., 2001). Compas (2001) hypothesizes that one potential explanation for this finding is that disengagement coping is a better match for uncontrollable stressors.

1.6 Coping Among Adolescents in Sub-Saharan Africa

Although most of the research on coping among adolescents in low-income settings in sub-Saharan Africa is not focused on menstruation or puberty, there is a growing body of literature on how adolescents in sub-Saharan Africa cope with issues such as HIV, poverty, and other general stressors. To summarize, research shows that adolescents use a variety of maladaptive and adaptive coping methods, including religious coping, emotion-focused coping, problem-solving, avoidance, social support, and cognitive strategies (Magaya et al., 2005; Mutumba et al., 2016; Neese et al., 2013; Puffer et al., 2012; Skovdal & Daniel, 2012).

1.7 Coping with Puberty and Menstruation Globally

Research from Kenya, Australia, Bangladesh, India, and Nepal provides evidence that girls engage in pragmatic, problem-focused coping strategies, emotion-focused coping strategies, and avoidant coping strategies to manage their menstruation. Methods include using a sweater to hide period stains, skipping or leaving class, engaging in sex work for menstrual supplies, seeking practical help from family or friends, getting approval from others to relax rules about certain activity restrictions,

resting, self-medicating, using home remedies, avoiding thinking about menstruation, using deception or denial to keep menstruation hidden, seeking diversions, avoiding problems, developing self-reliance and optimism, taking a positive view of what they have learned, envisioning a better future for girls, justifying certain restrictions as unrealistic, managing stigma, reframing stigma as traditional cultural practice, labeling stigma as discrimination, re-framing restrictions to be positive, and venting (Anitha & Sinu, 2015; Crichton et al., 2013; Jewitt & Ryley, 2014; Mason et al., 2013; McMahon et al., 2011; Moore, 1995; Rashid & Michaud, 2000; Rawat et al., 2015; Seiffge-Krenke et al., 2009).

There is research from high and low-income countries specifically on coping with dysmenorrhea or menstrual pain. In Ghana, coping strategies to manage menstrual pain included ignoring the pain, self-medicating, exercising, relaxing, applying heat, and using herbs (Acheampong et al., 2019). In research from Japan, more flexible coping with menstrual pain, which involves replacing ineffective coping strategies with novel strategies, was associated with having less depressive symptoms (Kato, 2017).

There is also a growing body of research from high- and low-income settings on women who have clinically significant premenstrual syndromes, such as premenstrual dysphoric disorder. Findings suggest active coping may be adaptive in some scenarios, although there is a need for women to engage in more tailored coping strategies matched to a particular situation (Cha & Nam, 2016; Weise et al., 2019). However, this

literature may not be applicable to non-clinical samples because women with premenstrual syndromes are more likely to be impacted by stressors than healthy controls (Fontana & Badawy, 1997).

Overall, there is some research on the types of coping girls and women use to manage menstruation in low-income settings, but there has been little examination of the link between coping and health outcomes. From high-income settings, there is research on the relationship between menstrual coping and mental health among healthy controls, among women with dysmenorrhea, and among women with premenstrual disorders. However, it is unknown if these findings are relevant to non-clinical populations in SSA. Thus, there remains a need to examine the link between menstruation- and puberty-specific stressors and the ways stressors and coping impact mental health and reproductive health among adolescent girls in SSA.

1.8 The Setting: Tanzania

Data collection for this dissertation occurred in Tanzania, a low-income country in sub-Saharan Africa. Tanzania is an ideal location to study these issues, because reproductive health risks, mental illness, and difficulties engaging in recommended menstrual practices pose threats to the well-being of adolescent girls throughout the country, and Tanzanian girls lack the resources and support to safely manage menstruation (Allen et al., 2010; Baisley et al., 2009; Ministry of Health, Community

Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland] et al., 2016; Nyandindi, 2008; Ramaiya et al., 2016; Sommer, 2009).

1.9 Objectives

There were three main objectives for the present dissertation.

Objective 1: Identify stressors related to puberty and menstruation and describe girls' coping behaviors.

Objective 2: Test if menstrual/puberty stressors relate to (1) mental health or (2) reproductive health

Objective 3: Examine mechanisms through which menstrual/puberty stressors, coping, mental health, and reproductive health may be related.

These objectives were met through the conduct of two separate studies, which were implemented concurrently.

Study A involved qualitative in-depth interviews with ten menstruating adolescent girls 14-19 and ten local adult experts (i.e., stakeholders) who work with girls, such as teachers, healthcare providers, and parents.

Study B involved quantitative, self-report cross-sectional surveys with 581 menstruating adolescent girls and young women enrolled in schools in secondary school.

A secondary aim of the present dissertation was to examine the appropriateness of the Transactional Model of Stress and Coping for use with girls in Tanzania. Figure 1

shows how Study A (qualitative) and Study B (quantitative) examined different aspects of the Transactional Model of Stress and Coping.

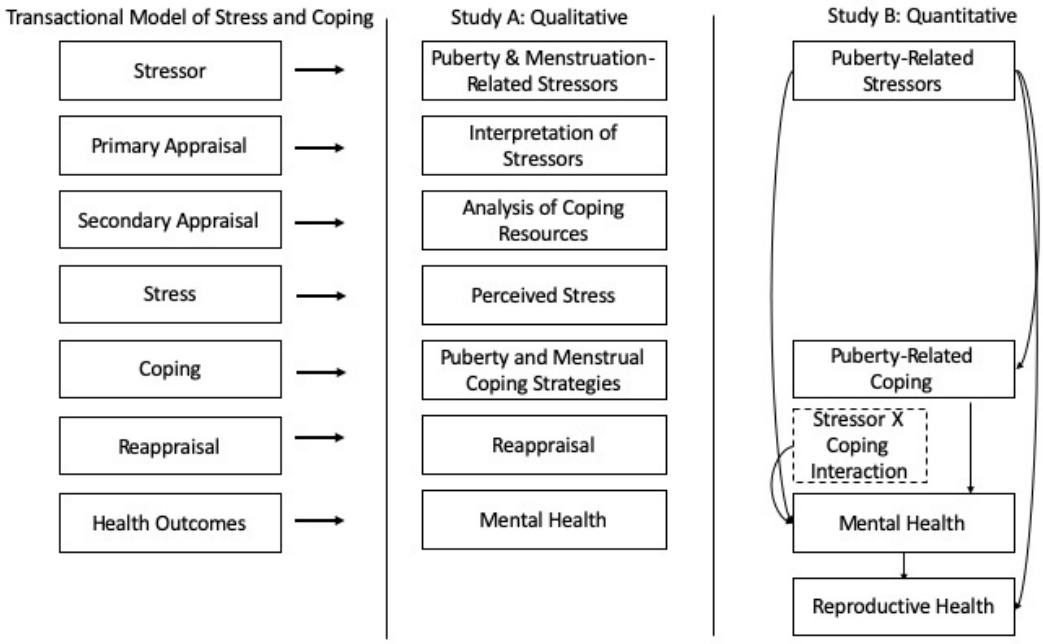

Figure 1: The Transactional Model Stress and Coping as it Applies to Study A and Study B

2.0 Study A: Qualitative Interviews with Adolescent Girls and Local Experts

The goal of Study A was to interview 10 adolescent girls and 10 local experts to understand girls' experiences with puberty and identify the types of stressors experienced by girls, the ways girls appraise stressful situations and choose coping mechanisms, the types of coping strategies employed by girls, and the perceived outcome of coping strategies. Interviews with local experts were conducted to provide additional information on the social context and resources influencing girls.

2.1 Methods

2.1.1 Measures

Interview guides included questions adapted from UNICEF and Emory University's guide for conducting research on menstrual hygiene management (Caruso, 2013). We developed additional questions in consultation with local staff and through a review of the current literature. After the first round of interviews, we added interview questions to gain a more detailed understanding of menstrual pain and anger. The full interview guide can be found in Appendix A.

Selected examples of open-ended and closed-ended questions can be found in Table 1.

Table 1: Selected Interview Questions

Adolescent Interviews	Adult Interviews
• How has getting older and beginning to menstruate impacted your life? • In general, what are the greatest challenges/stressors in your life? • How do you try to manage these challenges/stressors? • Are there any difficulties, challenges, or stressors that you've encountered due to puberty or menstruation? • If there are any difficulties, how do you manage these? • How does menstruating impact your mood or emotions? • Do you experience physical problems during or right before menstruation? • Tell me about the first time/most recent time you got your period – what made it easier or harder to manage your period? • Is there anything else you would like to add to the conversation that we have not yet covered?	• What is your role in working or living with adolescent girls/young women? • How does a girls' life change when she goes through puberty and starts to menstruate? • What challenges do girls face due to puberty/menstruation? • What are the resources available for girls to manage challenges? • What could parents/families/others do to support girls as they manage menstruation/puberty? • What can girls do to manage physical symptoms during menstruation? • Are you aware of any mental health resources in Tanzania – what are they? • How can girls best learn about menstruation, and what should they learn? • Is there anything you would like to add to the conversation that we have not yet covered?

2.1.2 Research Team and Reflexivity

The principal investigator for this study was a doctoral student in clinical psychology. Two young adult female Tanzanian research assistants with bachelor's level education and prior research experience were responsible for interacting with the adolescent girls and local experts in this study, including recruitment, consent, and conducting one-time interviews. One of the research assistants was from Moshi, and she

may have had casual established relationships with the local adult experts due to living in the same community, but there was no established relationship between the other research assistant and local expert participants or either research assistant and adolescent participants. Research assistants did not describe reasons for personal interest in this research topic, but they did note the scientific rational as part of the consent process. The principal investigator and two research assistants from the United States coded the interviews. All team members were trained in qualitative research methods and research with adolescents, and we engaged in regular supervision and discussions on reflexivity (e.g., how our backgrounds may impact our coding decisions) and positionality (e.g., how our role as principal investigator or research assistant may impact group discussions) to reduce bias.

2.1.3 Theoretical Framework

The general qualitative theoretical framework used in this study was thematic content analysis. This method was chosen due to having *a priori* theories of interest (i.e., the transactional model of stress and coping), as well as specific research questions about stress and coping. However, certain methods from a grounded theory approach were used to capture any emergent or unexpected themes. This included reviewing interviews and adding questions to subsequent interviews as needed, using purposive sampling to capture a range of diverse experiences, and analyzing the entire interview rather than just sections related to primary research questions (Cho & Lee, 2014).

2.1.4 Participant Selection

A sample size of 10 local experts and 10 adolescent girls was chosen *a priori* to include a diverse range of experiences while reaching saturation of themes (Guest et al., 2006). At the end of the planned sample, it was determined based on the repetition of key themes and the lack of novel minor themes that saturation was reached to the best of our knowledge.

We used non-random purposive sampling strategies to ensure a diverse sample. We collaborated with Tanzanian research assistants to develop an initial list of organizations and individuals to contact about recruitment for the interviews. Through conversations with organizations and other local contacts, we added additional potential recruitment sites to this list. Efforts were made to include sites that would increase the diversity of the sample, so we intentionally recruited in locations where we could find girls 14-16 and 17-19, girls in school and out of school, girls who had been pregnant, girls who were married and unmarried, Christian girls, Muslim girls, girls from rural areas, girls from urban areas, girls living in poverty, and girls with greater monetary resources. Furthermore, we aimed to include at least one of each of the following for the local expert interviews: teacher, healthcare worker, NGO worker, local community/government leader, religious leader, mother, and father. We hoped to include male local experts because men often determine the availability of coping resources for girls. As interviews were completed, we would note which demographic

characteristics we had not yet covered and purposively sample to ensure a diverse sample. We recruited participants from local organizations (including schools, NGOs, orphanages, churches, mosques, hospitals, and local offices) and markets and other public spaces in neighborhoods based on suggestions from local community leaders. Participants were approached using face-to-face and telephone methods. A total of 20 participants agreed to take part in the study. No potential participants declined to take part in the study. Participants were provided with a small bar of soap and a package of reusable menstrual pads as compensation for their time. They were also provided reimbursement for transportation to private offices for interviews if needed.

2.1.5 Data Collection

Data were collected between August 2018 - November 2018. All recruitment, consent, and interview activities occurred in Swahili. Interviews consisted of a single session lasting between 30 minutes to an hour. Interviews were audio recorded, except for one instance in which permission to audio record was not granted, in which case notes were taken instead. Interviews took place in a private and safe space convenient for the participant. If necessary, participants were reimbursed for transportation to the study offices. Only the participant and researchers were present for the interviews. Interviewers were trained how to conduct interviews on sensitive topics.

2.1.6 Qualitative Data Analysis

Thematic analysis was used to explore themes in the interviews. Interviews were transcribed and double-translated (e.g., transcribed twice, to check for discrepancies between translators) into English. Research assistants from the United States assisted the principal investigator in coding the qualitative interviews, for a total of three coders.

The adolescent interviews and local expert interviews were coded and analyzed separately. NVivo was used to facilitate qualitative coding. The coding team first read through the interviews to gain familiarity. Each member of the team helped develop an initial coding scheme for the adolescent interviews and local expert interviews separately, and discrepancies in coding were resolved using group discussion until unanimous conclusions were reached. When examining the subset of codes pertaining to stress and coping, there was initial disagreement in coding for 2.8% of coded sections for the adolescent interviews and 6% of the coded sections for the local expert interviews, which was resolved using group discussion. Some larger themes (e.g., stressors) were identified in advance, whereas other themes and more specific codes (e.g., isolation) were derived from the data. The interviews were coded in their entirety. Attention was paid to repeated themes, negative cases, and minor themes. An example of the coding tree can be found in Appendix B.

Codes were grouped into themes, and connections between themes were explored. Transcripts were not returned to research participants for correction, and

participants did not provide feedback on the coding, because their contact information was not saved for repeated contact. However, after an initial description of themes was developed, findings were discussed in presentations with community members in Tanzania (e.g., medical providers, pharmacists, local NGOs, researchers, parents, teachers), who reported that they concurred with the findings.

2.1.7 Ethical Procedures

Ethical approval for research with human subjects was obtained from institutions in the United States and in Tanzania, including the Duke University and Kilimanjaro Christian Medical College Institutional Review Boards. Government approval to conduct research in Tanzania was granted by the National Institutes of Medical Research. Approval for the involvement of foreign researchers was approved by COSTECH. All participants provided written informed consent. A waiver of parental consent was obtained for girls under 18 because the study was non-invasive and the only risk to confidentiality was others finding out they are taking part in the study. The waiver allowed girls under 18 to provide their own written consent without the need for a parent present. All data were de-identified.

2.2 Qualitative Results

2.2.1 Sample

The sample of adolescent girls included 10 girls 14-to-19 years old (Mean age = 16.6). Three had been pregnant, five were from rural areas, and four were enrolled in

school. All three participants who reported a prior pregnancy were 18- to 19-years old, and one of these participants was married. All girls reported not knowing their HIV status or being HIV-negative.

Local experts included 10 adults between the ages of 30-60 years old. Three participants were male. Occupations included three NGO staff members (e.g., shelter staff, educators), two teachers, a religious leader, a pharmacist, two medical doctors, and a mother of young adult women. Altogether, six of the local experts had children.

2.2.2 Adolescent Interviews

Adolescent participants discussed the following broad themes: 1) neutral or positive changes, 2) stressors, 3) coping strategies, and 4) suggestions for future interventions (see Table 2).

Table 2: Major Themes in Adolescent Interviews

Theme	Neutral / Positive Changes	General Stressors	Puberty Stressors	Menstrual Stressors
Sub-theme	Transition from child to adult	Interpersonal conflict	Sexual pressure	Pain / physical symptoms
	Role changes	Resource deficits	Pregnancy	Anger
	Social changes			Stigma
	Increased confidence			Resource deficits
				Restrictions

2.2.2.1 Neutral or Positive Experiences

All participants described puberty as the time when a girl changes from a child to an adult. This transition was characterized as rapid, and there was no discussion of adolescence as a transitional stage between childhood and adulthood. Participants described adulthood as a positive experience, resulting in happiness, self-awareness, and bravery.

Changes in roles and responsibilities included a new emphasis on cleanliness, increased independence, increased organization, increased self-awareness, and preparing for motherhood and marriage. Participants reported changing how they interact with their peers as they grow older. This included changing the types of games they play, changing the age of their peers, and spending less time with boys and men. A few participants reported that they became less shy and more confident and firm in their decisions since reaching menarche. Overall, although girls reported a number of serious stressors, there were also many positive aspects of puberty related to a growing sense of confidence, independence, self-awareness, and self-control.

2.2.2.2 Challenges and Stressors

2.2.2.2.1 General Life Stressors

Interpersonal Conflict: Participants were distressed by conflict with peers, family members, teachers, and community members. This included direct conflict, such

as being disciplined by parents, as well as indirect conflict, such as being gossiped about by friends. Fear of gossip prevented girls from seeking out contraceptives, but participants reported that becoming pregnant would result in gossip as well. Girls also worried about their own behaviors towards others. For example, many girls isolated themselves when angry so that they wouldn't take out their anger on family or friends.

Resource Deficits: About half of participants discussed a lack of resources, including money, food, and other basic necessities. Girls reported needing resources both for themselves and for their children.

2.2.2.2.2 General Puberty Stressors

Sexual Pressure: The most commonly discussed stressor related to puberty was increased sexual pressure, including both external sexual pressure from men and increased sexual desire. External sexual pressure from boys and men included harassment, coercion, and sexual assault. Two participants noted that girls are most at risk when they are walking along the road. One participant noted not only do men harass her while walking, but it is an expectation in their culture that she should respond.

> *"Normally a man would call me on the road and he wants to talk to me […] He might call you, and if you ignore him he can do something bad to you, and in our culture there is a saying that says 'you can refuse the word, but you must acknowledge the call.'" – A*

In addition to external pressure from men, participants also discussed having increased sexual interests and urges. Most participants reported these experiences as

challenging, because they felt sexual activities put them at risk for pregnancy and HIV. Participants noted they were given some strategies to cope with sexual feelings, such as exercising or reading, but these did not appear to be particularly effective.

> *"The challenges are many, because once you reach your menarche it makes you, as a girl, to change and therefore you find that you face temptations to have sex, and that is a big challenge." – B*

Pregnancy/Motherhood: Participants described motherhood as interrupting their life goals and plans for the future, and they noted the difficulty of providing financially for their child. Completing school was particularly difficult, because girls were forced to leave school because of childcare responsibilities and national law prohibiting mothers from returning to government schools.

> *"The challenges I faced are […] that boys were pestering me, and in the end, I got a child before achieving my other goals." – C*

2.2.2.2.3 Menstruation-Related Stressors

Pain: Almost all participants reported experiencing disruptive menstrual pain (n = 9). For some participants, pain was their biggest menstrual- and puberty-related stressor. Pain intensity ranged from mild to debilitating. Some participants described being unable to walk. Other participants had concurrent heavy bleeding, vomiting, fatigue, and headaches. Many participants reported being unable to do work or chores and staying home from school because of menstrual pain. Multiple participants linked pain to feelings of anger and frustration. Although pain was a negative experience for

participants, it also allowed them to predict when their menstrual period was about to start.

> *"To start with the bad things, I normally go through severe pain/abdominal cramps. I mean I get sick, and sometimes I don't go to school, and I have to stay at home until I get well. Much blood gets out. I mean it causes me a lot of discomfort, and it is something that really annoys me." - A*

Other less common physical symptoms included discomfort (n = 4), fatigue (n = 4), headaches (n = 2), heavy bleeding (n = 2), and irregular periods (n = 1). Heavy bleeding and irregular periods increased the risk of menstrual leaks and difficulties preparing for menstruation.

Anger: More than half of participants reported feeling anger, irritability, or annoyance during their menstrual periods. Reasons included menstrual pain, worries about leaks, and frustration about the lack of resources. Multiple participants reported being irritable around other people and being concerned that they will negatively impact others. As a result, participants said they isolated themselves from other people.

> *"For example, I am someone who likes to tell stories, but when I am in my period, I don't like this. I do not like noise around me, and then I become angry easily." - D*

Stigma: Participants reported feeling stigma, shame, embarrassment, fear, or shyness due to menstruation. Two participants noted that the reason they feel stigmatized is because they are not allowed to be inside a mosque or a church when they are menstruating. Three participants explained that it is embarrassing or shameful if other people find out they are menstruating.

"Yes [restrictions] have bad effects, because if I as a Muslim do not go to the mosque people know that I didn't go to the mosque because I am in my [menstrual period], and therefore I see myself as a lonely person, as if people have stigmatized me because I am in my period." - E

Six participants reported keeping menstruation a secret. Some participants kept menstruation a secret because they thought others would think they had done something wrong, such as having had sex. Other reasons for secrecy included embarrassment and a lack of family communication.

"The hardest thing was to tell people since I was afraid, and I thought that people would say that perhaps I did a bad thing with the boys and that is what caused me this. I was afraid, and so I didn't tell anyone else except my sister, and even I was afraid to do so." - F

Girls had varying experiences of teasing due to menstruation or puberty. Three participants reported being teased for having their period or for other physical changes during puberty. One participant reported being afraid of teasing but had not experienced it herself, and one participant reported she had not seen anyone teased at school. One participant told a story about being teased because of a menstrual leak at school:

"I felt very bad and felt very lonely and I wasn't able to go back to the classroom, so I ask for permission and went back home because I felt shy." - E

Resource Deficits: Resource deficits included a lack of knowledge, absorbent materials, money, water, and time and space for changing and washing. However, within each category, a lack of resources was not universal, as some girls had adequate access to menstrual resources and other did not.

There was a varying level of access to sanitary pads and cloth. Five participants had access to sanitary pads, and four participants had access to cloth. Some participants could not afford sanitary pads, and two of these participants reported missing work or school due to a lack of pads. Even when girls have access to pads, one participant noted there is a lack of space or equipment for storing pads. Multiple participants reported being worried about leaks, which could be due to inadequate absorbent materials. Participants noted that girls going through puberty require purchases other than just pads, such as clothing to feel clean and attractive. Multiple participants reported that other girls rely on men to acquire basic needs, and one participant connected transactional sex to the spread of STDs. However, no participants reported that they themselves had been in a relationship with a man to ensure their basic needs were met.

> *"[There are girls who are] very poor, and you find that her parents cannot provide her with the services, and therefore that leads them to get involved in sexual practices in order to get money to buy the equipment for their menstrual period. The government should look into such families who are very poor so that it can help them, because this causes sexually transmitted diseases to spread here in Tanzania." - D*

Menstrual Restrictions: Many participants reported missing out on activities due to menstruation. Primary reasons for missing activities and the types of activities missed are listed in Table 3.

Table 3: Reasons for Missing Activities and Types of Activities Missed During Menstruation

Primary Reasons for Missing Activities (n)	Types of Activities Missed (n)
Pain or sickness (6)	School (6)
Not being allowed for religious reasons (2)	Chores / work (4)
No sanitary products available (1)	Physical Activity (3)
Fatigue (1)	Social activities (3)
Avoiding male peers (1)	Religious Activities (2)
Not able to move around due to pain or leaks (1)	
Embarrassment (1)	

Although some girls reported missing school, they primarily missed school or left school early only when the pain was most intense or when bleeding was particularly heavy, but not necessarily for their entire menstrual period. Multiple participants reported that missing out on these activities makes them feel sad, stigmatized, or dislike menstruation.

> *"When I was little I used to like to play a lot, and therefore there are times when I find my fellow girls are playing a very good game, but I cannot join in, because maybe I am in my period and because they are jumping around, and I cannot do that. It makes me sad, and I hate it." - F*

2.2.2.3 Coping Strategies

Based on the coping strategies reported by participants, coping was differentiated into three general categories: 1) emotion-focused coping, 2) problem-focused coping, and 3) avoidant coping (See Table 4). Emotion-focused coping was

defined as a strategy that seeks to change the emotional response to a stressor, such as emotion regulation or cognitive reappraisal. Problem-focused coping was defined as a strategy that seeks to manage a changeable aspect of a stressor itself, such as planning ahead or recruiting practical support. Avoidant coping was defined as any strategy that involves withdrawal, distancing, denial, emotional suppression, or an attempt to distract oneself from a stressor or the emotional response to that stressor, without a plan to re-engage in active coping.

Table 4: Coping Strategies Reported by Adolescent Girls

Category	Sub-Category	Quote
Emotion-Focused	Acceptance	In your mind, you build a certain picture that [menstruation] is one of the stages of growing in the life of a woman, and this becomes a normal thing, and so it cannot cause you much stress any longer. – G
	Emotion Regulation	I go away from the area completely, I go somewhere else and rest or listen to some music, I watch television or go to exchange ideas with my friends and this helps me a lot. - H
	Cognitive Reframing	I said to myself, 'I am a girl and therefore this must happen', and so I started seeing it as a normal thing. - A
	Emotion-Focused Support	If you are living with people who continue to encourage you, and comfort you, and be nice to you, cooperating with you in everything, it makes you feel that this is a normal thing. - G
Problem-Focused	Planning Ahead	Some of the signs are very helpful because once you have the abdominal cramps you know absolutely that I am approaching my period and therefore you must take proper precautions by keeping your sanitary pads close by. - H
	Using Resources	When I cannot get the sanitary pads at all, I normally use pieces of cloth as I was taught by my mother.- F
	Practical Support	It was easy when I told my guardian and she explained things to me…and they started buying the sanitary pads for me. - B
	Pain Coping	When I have stomach pain sometimes I drink hot/warm water, which helps relieve the pain. - B
	Working for Money	I am involved in small businesses: I sew clothes, and if I get some money I put a budget aside for buying sanitary pads. - E
Avoidant Coping	Isolation	I refused to get out of bed, and I just lay there, and I didn't want to talk to anyone – F
	Sleep as Avoidance	I: What do you normally do [to cope with anger]? P: I usually go to sleep. – I
	Missing Activities	I felt very bad and felt very lonely and I wasn't able to go back to the classroom, so I asked for permission and went back home because I felt shy. - E
	Not Coping	I: Is there anything you use to reduce the pain? P: Nothing, I don't use anything, although they advised me to use medicine, but I refused. - D

2.2.2.3.1 Emotion-Focused Coping

Acceptance: Many participants reported that puberty and issues such as menstruation or acne became less stressful over time, as they began to accept menstruation and puberty as a normal part of growing up, and they became accustomed to managing it.

Emotion Regulation: Participants engaged in short-term activities to reduce the intensity of negative emotions, such as crying to express emotion, engaging in exercise, listening to music, dancing, watching tv, or reading something entertaining. These activities differed from avoidant coping because they were focused on intentionally improving emotional responses to a stressor to cope more effectively with that stressor, rather than avoiding thinking about a stressor altogether.

Cognitive Reframing: Participants engaged in cognitive reframing when they intentionally changed how they thought about a stressor. For example, one participant reported she focuses on positive things she has learned because of puberty. Six participants were able to reframe menstrual cramps and breast pain as a useful sign that menstruation is about to begin, which may be helpful for pain coping.

Emotion-Focused Social Support: Emotional social support was defined as receiving comfort, validation, or another source of encouragement to improve emotional responses to a stressor. Girls noted the importance of being around family and friends who are encouraging, validating, friendly, and humorous.

2.2.2.3.2 Problem-Focused Coping

Menstrual Resources: Participants reported that menstrual resources were important for effectively coping with menstruation. Menstrual pads were the preferred absorbent material desired by girls. However, participants coped with lack of access to pads by using cloth instead, which did not present a major barrier.

Planning Ahead: Most participants reported planning ahead to ensure they were prepared to manage menstruation. Common examples included tracking their period by using a calendar or monitoring for physical symptoms such as cramps, having enough menstrual pads, doing chores ahead of time, and preparing emotionally to overcome challenges. Participants reported that planning ahead makes menstruation less irritating or significantly reduces challenges.

Pain Coping: The most common method of coping with pain was to rest or sleep, which was reported by six participants. Three participants reported increasing their exercise, and five participants reported drinking hot water. A variety of traditional and modern medicines were used to treat menstrual pain, but only one participant received a first-line treatment (i.e., an non-steroidal anti-inflammatory drug or hormonal birth control) (Milsom et al., 2002; Zahradnik et al., 2010). Participants reported hearing a number of negative beliefs about medicine. For example, some believed that painkillers are bad for the body, that pain medicine can cause long-lasting or repetitive periods, and that contraceptives can permanently prevent fertility.

Practical Social Support: Participants reported receiving practical social support in the form of education and the provision of supplies, including menstrual supplies and medication for pain management. Eight participants reported that receiving education from others allowed them to cope more effectively with menstruation and puberty. Education included a variety of topics, listed in Table 5. Six participants reported receiving education in schools, while other sources of social support and education included mothers, sisters, other caregivers, pharmacists, medical doctors, female friends, other female community members, and television/radio programs.

Table 5: Education Topics Received by Girls

Education Topics	
How to use and wash cloth/pads (8)	Pregnancy prevention/STIs, sexual urges, and how to interact with men (3)
Pain management (5)	How to track the menstrual cycle (2)
Menarche (4)	New Responsibilities (1)
How to stay clean/hide stains (3)	

Although education made it easier for girls to anticipate challenges and effectively cope, not all information was accurate, particularly in the domain of pain management. For example, one participant noted that her teacher told girls medicine was harmful and unnecessary.

> *"the teacher answered that medicine is not good in the body because it becomes poison…" - J*

Working for Money: Three participants discussed the benefits of working for money to take care of menstrual needs. The jobs mentioned by participants included small businesses, working in shops, and household jobs.

2.2.2.3.3 Avoidant Coping

Isolation: Almost all (n = 9) participants reported some form of isolation as a coping strategy. Five participants described avoiding other people specifically to manage anger or irritability. Examples of isolation included sitting by oneself, finding a quiet place, staying in bed, not talking to anyone, avoiding people, and staying indoors. Participants did not describe re-engaging after isolation; as such, this coping mechanism was not categorized as a temporary means of emotion regulation, but rather as a way to avoid feeling a particular emotion (e.g., anger) or facing interpersonal stressors.

Sleeping or Resting: Three participants used sleep as a mechanism to avoid feeling anger or irritation.

Missing Activities: Four participants reported leaving school early or staying home from school for reasons such as teasing, menstrual leaks, menstrual cramps, and not having menstrual supplies.

Not Coping: Seven participants reported not coping, tolerating pain, or giving up coping with an issue.

2.2.2.4 Suggestions for Interventions

Participants were asked how their community could better support girls during puberty. Responses fell into the domains of education and supplies.

2.2.2.4.1 Education

Eight participants discussed the need for more education about menstruation and sexual health. One participant felt the best age for education was 9-10 years old, while another proposed they be at least ten years old. Two participants wanted boys and girls taught separately. Table 6 shows the suggested delivery methods for education programming.

Table 6: Suggested Delivery Method for Educational Interventions

Suggested Delivery Method	N
Schools	7
Parents / Mothers	6
Doctors	2
Churches	1
Peers	1
Government	1

2.2.2.4.2 Supplies

Two participants felt the best way to ensure access to menstrual products was to help girls start their own small businesses, with one mentioning the need for job training and education. Four participants recommended that supplies, including menstrual pads and pain management medications, should be given to schools and families.

2.2.2.5 Models of Stress and Coping

Overall, the interviews showed support for the Transactional Model of Stress and Coping and the relationship of stress and coping to health outcomes. In Table 7, quotes are presented that represent each stage in the transactional model. It is clear from the interviews that although participants reported similar stressors, there were differences in how stressors were appraised and which coping strategies were used.

Table 7: Qualitative Findings as Compared to the Transactional Model of Stress and Coping

Stage	Example
Environmental Demand	Menstrual Pain
Primary Appraisal *(Is it relevant and harmful?)*	"It depends on the month. You find that in one month you get very tired, and you have much pain. But when you feel normal, it doesn't affect you in any way and causes no problem, and you continue doing your work."
Secondary Appraisal *(Do I have the resources to manage the demand?)*	"There are some [challenges] that I manage and others I cannot overcome."
Stress *(Imbalance between demands and coping resources.)*	"Another challenge is also abdominal cramps/pain of the stomach below the navel, which makes you feel uncomfortable because some of the medicines do not help you to feel better."
Coping *(Behavioral or cognitive strategy to manage stress).*	"When I have stomach pain sometimes I drink hot water which helps relieve the pain, or I use painkillers such as Panadol."
Reappraisal *(Did coping work?)*	"Sometimes you can use the medicine but the next day the pain comes back and I go back to the hospital where they change your medicine."
Mental/Physical Health Outcomes	"Most of the time I become angry when I have the pain, but after using hot water and the medicine the anger goes away and I become normal."

Successful coping appears to diminish the negative impact of stress. This is particularly true of coping methods such as acceptance or cognitive reframing, which

only change the emotional response to menstruation, rather than eliminate the stressor. One girl highlights the importance of coping:

> *"If you know the challenges that you come across when you enter the period; it becomes easier for you to cope" and "[when] given more education concerning menstrual period – the way it happens, the things she needs to cope with; this makes things easier for her."- G*

The qualitative findings also provide support for the theory that stressors influence coping and coping influences mental health. There was some evidence that characteristics of a stressor influenced participants' choice of coping strategy. Table 8 provides examples of characteristics of stressors that showed a pattern of being paired with a specific response. Overall, there is evidence to support the role of coping as a buffer between stress and mental health and as a process that is impacted by a stressor.

Table 8: Characteristics of Stressors and Related Coping Responses

Characteristic of Stressor	Coping Response	Quote
Uncontrollable	Acceptance	"There is nothing you can do. The condition is here to stay, and you have to learn how to deal with it." - G
Unchangeable	Cognitive Reframing	"I see [my child] as a gift to me, because there are people who are trying to have children but haven't succeeded yet." - C
Interpersonal	Avoidance	"[in response to being teased] I felt very bad and felt very lonely and I wasn't able to go back to the classroom, so I ask for permission and went back home because I felt shy. - E
Predictable	Planning Ahead	"Because you know that you are going to get your period on this particular day, you prepare yourself and you do all your chores so that you will not become angry or be told off." - I
Overwhelming	Emotion Regulation/ Distraction	"When I listened to music, I felt like the things were disappearing, and I would feel good again." – C
Emotional	Isolation / Distraction	In response to anger: "Most of the time I like to sit by myself, and maybe I will watch a movie, or perhaps I take my books and start to read stories." - A
Somatic / Physical	Passive / No Coping	"I just put up with the pain." – I

2.2.3 Local Expert Interviews

Local experts described girls' coping behaviors and the types of practical and emotional support currently available to girls, as well as suggestions about how to better support girls during puberty.

2.2.3.1 Stressors

Table 9 lists the stressors that were described by local experts as impacting adolescent girls.

Table 9: Stressors Reported by Local Experts

Stressor (n)
Restrictions during menstruation (7)
Menstrual stigma (6)
Difficulties staying in school (5)
Menstrual pain (5)
Lack of education (5)
Secrecy (4)
Sexual assault (3)
Difficulties with interpersonal relationships (3)
Poverty (3)
Sexual pressures (2)
Lack of materials (2)
Anger as a result of pain (2)
Other physical side effects (e.g., diarrhea, fainting, vomiting) (2)
Sadness (2)
Early marriage (2)
Teasing (1)
Menstrual leaks (1)
Contraceptive costs (1)

Local experts noted that restrictions result in social isolation and have negative psychological effects on girls because they feel segregated from society. Examples of

restrictions included not being allowed to cook, farm, engage in religious practices, have sex, and attend work or school. In contrast, two local experts felt there were no restrictions or that restrictions have lessened over time. This highlights cultural diversity in the types of restrictions practiced or enforced.

2.2.3.2 Coping

Table 10 shows the coping strategies reported by local experts.

Table 10: Coping Strategies Reported by Local Experts

Coping Strategies (n)
Using menstrual hygiene resources (e.g., cloth/pads) (6)
Taking medicine (5)
Muscle Relaxer (1), Buscopan (2), Acetaminophen (4), Ibuprofen (3)
Seeing a medical professional (3)
Acceptance (3)
Isolation (3)
Planning ahead (2)
Resting/sleeping (2)
Self-empowerment (1)
Seeking counseling (1)
Drinking hot water (1)
Physical activity (1)

Note. Buscopan is an anticholinergic agent indicated for gastrointestinal cramping, Acetaminophen is an analgesic, and Ibuprofen is an non-steroidal anti-inflammatory drug.

Local experts mentioned various sources of social support, including family members and NGOs that provide education and menstrual resources.

2.2.3.3 Suggestions for Interventions

Local experts provided suggestions on how to better support girls and young women as they transition through puberty. Suggestions fell into the categories of 1) provision of supplies, 2) education, and 3) mental health resources.

2.2.3.3.1 Provision of Supplies

Seven participants suggested girls should be provided with supplies to successfully navigate puberty (Table 11). Participants reported supplies should be provided by mothers (n = 3), religious organizations (n = 1), and the government (n = 1).

Table 11: Suggested Supplies

Suggested Supply	n
Absorbent materials	5
Basic needs (Food / Shelter)	2
Contraceptives	1
Condoms	1
Pain Medication	1

2.2.3.3.2 Education

Most local experts noted the importance of education, not only for adolescents, but also for healthcare providers and parents. Education for girls was suggested as occurring between the ages of 6-10, with topics tailored to the appropriate age group. Local experts suggested a variety of topics (Table 12) and suggestions for intervention delivery (Table 13).

Table 12: Suggested Topics for Educational Programming

Topics	Examples
Menstruation	Menarche, menstrual hygiene management, menstrual cycle tracking, menstrual pain management, premenstrual symptoms, cleanliness
Sexual Health	Sexually transmitted diseases, sexual assault, sexual urges, physical changes, relationships, condom use, pregnancy prevention
Mental Health	Managing anger and depression, self-esteem
Life skills	Job training

Table 13: Suggested Delivery Method for Education Interventions

Suggested Delivery Method	n
Parents	10
Schools	7
Religious organizations	6
Health centers	5
Health professionals	4
Other female guardians	4
Media (radios, TV)	4
Government officials	3
NGOs	2
Subject matter experts	1
Same-age peers	1
Social workers	1
Sisters	1

2.2.3.3.3 Mental Health Resources

Four participants noted it would be helpful to have more mental health resources, including mental health centers for psychotherapy, counselors in schools, and mental health education.

2.3 Qualitative Discussion

2.3.1 Summary and Integration

The aim of the qualitative study was to explore the types of stress experienced by adolescent girls, the ways girls are coping with stressors, and suggestions for interventions as described by adolescent girls and local adult experts who work with girls. Twenty in-depth interviews were analyzed using thematic analysis. Although puberty was accompanied by positive changes, such as a growing sense of independence, there were many stressors specific to puberty and menstruation that were significantly disruptive to participants' lives. Stressors included issues related to sexuality (e.g., sexual desires, sexual harassment, and fears of pregnancy); interpersonal stressors; a lack of resources for both daily living and menstrual management; and menstruation-specific stressors, such as pain, anger, stigma, a lack of menstrual hygiene resources, and difficulties participating in daily activities due to menstruation. These findings are supported by similar research on menstruation in Tanzania (Sommer, 2009, 2010).

Findings from the adolescent and adult interviews are largely congruent. For example, Table 14 lists the primary stressors reported by both adolescent and adults. However, when comparing adolescents and adult interviews, there were some differences in which stressors were considered the most impactful or prevalent. For example, adults mentioned menstrual restrictions most frequently, while adolescents spoke more often about menstrual pain. Thus, although interviews provided largely the same conclusions, there are differences in perspectives that show how important it is to include adolescent girls in program development to ensure interventions are relevant to their experiences.

Table 14: Stressors Listed by Both Adult and Adolescent Participants

Stressors Listed by Adults and Adolescents
Menstrual pain and other physical symptoms
Anger and sadness
Interpersonal difficulties
Sexual pressure, sexual assault, pregnancy
Lack of knowledge / education
Resource deficits and poverty
Stigma and teasing
Restrictions and difficulties participating in activities

Both adolescents and adults agreed on the need for interventions that include education and provision of menstrual supplies. Both groups suggested schools and parents (particularly mothers) were the best delivery methods for such interventions. Adult participants did have additional suggestions for education content, as they likely had more knowledge than adolescent girls about the scope of topics related to sexuality

and health that could be discussed. Thus, it is useful to get adult perspectives, especially when adults have specialty knowledge about sexual or health education programming.

It is notable that girls reported having strong sexual urges and desires, because expressions of sexuality are typically taboo, although similar findings have been found in previous research in Tanzania (Sommer, 2009, 2010) . Girls reported that parents and teachers had provided them with advice about avoiding sexual urges, but the advice was neither evidence-based nor realistic. In Tanzania, a careful approach to sexual risk reduction must be taken, because although a healthy and shame-free approach to sexuality should be encouraged, there is also considerable risk for HIV and unplanned high-risk pregnancy as a result of unprotected intercourse. Non-abstinence methods to reduce risk may include condoms, hormonal contraceptives, non-hormonal intrauterine devices, microbicides, pre-exposure prophylaxis, and lower-risk sexual activities. In order to support the use of these strategies, there must be open discussion surrounding sexual health and provision of resources in tandem with education, social support, and skills-building activities for both girls and boys. Family-based interventions to improve parent-child communication about sexual risk have shown promising results in Tanzania, and this may be one method to reduce sexual risk and address sexual desire (Kamala et al., 2017).

Many adolescent participants described the importance of keeping themselves clean by frequently bathing and avoiding dirty activities. Although girls said they

enjoyed new knowledge and skills for cleanliness, this may put additional pressure on girls to remain "clean" during their menstrual periods. Unfortunately, in Tanzanian culture, menstruation is often described as inherently dirty, and girls often do not have the resources, such as absorbent materials, clean water, and enough clothing, to keep themselves feeling clean. The cultural emphasis on cleanliness may therefore be an additional burden for girls to manage during menstruation. Research is needed to explore how to reduce this burden while continuing to honor values and beliefs about cleanliness.

In response to stressors, participants reported a number of coping strategies, which included emotion-focused coping, problem-focused coping strategies, and avoidant coping strategies. The richness of the qualitative interviews allows for a more nuanced understanding of adaptive emotion-focused strategies (e.g., acceptance) versus potentially maladaptive strategies (e.g., emotional avoidance). However, it is still difficult to determine if distraction-based strategies (such watching TV) are best described as emotion regulation or avoidance and if these strategies are adaptive or harmful in the context of unchangeable stressors. Longitudinal studies are necessary to gain a better understanding of the function of these behaviors and their long-term outcome on psychological health.

It is notable that girls often used isolation as a method to cope with anger, pain, and interpersonal stress. Although a period of rest can be beneficial for emotion

regulation and pain management, isolation may be a particularly problematic strategy for adolescents, who are in the process of building independent social lives and are likely to benefit from social support and pro-social behaviors (Haroz et al., 2013).

Most adolescent participants reported engaging in resilient adaptive coping strategies, such as acceptance/normalization, emotion regulation, cognitive reframing, planning ahead, and utilization of social support. An effective stress coping intervention should capitalize on these positive coping strategies and improve pain coping to intervene on the cycle of pain and isolation reported by girls.

Our findings support the Transactional Model of Stress and Coping and the potential for coping to be a moderator or a mediator in future quantitative studies (Lazarus & Folkman, 1984). For example, cognitive appraisal appeared to influence whether menstruation was viewed as distressing, with some girls having more positive outcomes than others. In addition, certain characteristics of stressors seemed to show a pattern of eliciting similar coping responses across participants. The most consistent example of this is that feelings of anger or interpersonal stress would lead to isolation as a coping mechanism. As a qualitative study, our findings cannot determine which model fits better than the other. However, they do suggest that coping is nuanced, and that in some scenarios it appears that appraisal of a stressor plays a role in influencing individual outcomes, whereas in other scenarios the type of stressor seems more influential in prompting a coping behavior. Furthermore, the types of resources

available to girls and the cultural messages they have received about coping are two important aspects of coping that may be underrepresented in these models.

2.3.2 Generalizability

Our aim was to increase the likelihood that findings are generalizable to mainland Tanzania by purposively recruiting diverse participants both in school and out of school from urban and rural areas. Our sample in which 30% of girls had been pregnant mirrors the general population of Tanzania where 27% of girls between 15-19 have experienced a pregnancy (Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland] et al., 2016). However, we cannot test whether generalizability was achieved due to the qualitative nature of this study. It is unknown whether findings would apply to regions in costal Tanzania or Zanzibar with a majority Muslim influence, and further research is needed with girls in these areas.

2.3.3 Limitations

One potential limitation of the current study is that participants were asked to discuss sensitive topics and may not have fully disclosed their experiences. Furthermore, it is possible saturation was not truly reached and that we missed important perspectives. There is also an inherent risk of bias in qualitative research, as coding can be subjective, and some themes (e.g., coping) may be interpreted in multiple ways. Lastly, translation from Swahili to English may have caused some meanings to be

unintentionally lost or obscured, and all coders were from the United States. However, steps were made to negate these limitations by using purposive sampling to improve the likelihood of saturation of themes, relying on multiple coders and local interviewers, using multiple translators to confirm translations, and confirming interpretations with Swahili-speaking research assistants and local community members .

2.3.4 Implications for Prevention and Intervention

Both adult and adolescent participants noted the need for additional interventions to improve the well-being of girls during puberty. There is evidence that a multi-pronged approach including psychosocial interventions and financial resources would be most beneficial in supporting girls. Overall, educational programs are needed to address knowledge deficits around reproductive health, and structural-level interventions are needed to improve sustainable and consistent access to women-controlled menstrual resources. Resources are also needed to protect girls from gender-based violence and harassment by men, particularly when walking on the roads.

Psychological interventions are necessary to improve menstrual pain coping strategies, anger coping strategies, and interpersonal effectiveness skills and to reduce the negative impact of stigma and shame.

2.3.4.1 Menstrual Pain Interventions

In high-income settings, pharmacological interventions are first-line treatments for managing primary dysmenorrhea, including non-steroidal anti-inflammatory drugs

(e.g., naproxen and ibuprofen) and combined oral contraceptives (Milsom et al., 2002; Zahradnik et al., 2010). However, there are risks associated with these medications. In particular, the use of NSAIDS has been associated with gastrointestinal complications in adults and children, and it is unknown if intermittent dosing with NSAIDS would impact adolescents in regions with high levels of h. pylori infection, which is a risk factor for gastric ulcers (Berezin et al., 2007; Wolfe et al., 1999).

In addition, our research shows that pain relievers and oral contraceptives are not accepted by girls or local experts in Tanzania, due to myths about the negative effects of medication on health, fertility, and sexual risk. It is possible that educational interventions for healthcare providers would eliminate myths about medication and improve appropriate treatment with hormonal contraceptives or NSAIDS among girls for whom this is not contraindicated. However, there will always be some risks associated with medication use, and as such, non-medication options should be explored.

One potential behavioral intervention to reduce pain is cognitive behavior therapy (CBT) for pain management. CBT for pain management has been extensively studied for chronic pain, and it has been shown to be feasible and potentially effective for abdominal pain among adolescents (Bonnert et al., 2019; Ehde et al., 2014). Although few rigorous studies have evaluated CBT for primary dysmenorrhea in adolescents or young women, a growing body of research shows promising evidence that malleable

cognitive processes such as pain catastrophizing may be involved in menstrual pain, and CBT for menstrual pain could be an effective non-medical intervention (Payne et al., 2015; Yilmaz & Sahin, 2019). In addition, CBT skills can be generalized to improve coping with other stressors, mental health conditions, and medical conditions, and CBT may be appropriate for use in multi-target combined interventions.

2.3.4.2 Interpersonal Interventions

Girls in the interviews noted the negative impact of interpersonal stressors and the benefit of having family and friends as a source of social support. In addition, girls reported withdrawing from friends in times of pain and anger. For these reasons, two interventions that may be appropriate for adolescent girls dealing with interpersonal stress are Social Skills Training (LeCroy, 1994) and Interpersonal Psychotherapy (Fombonne, 1998). Social Skills Training is designed to improve effective interpersonal communication skills (e.g., assertiveness, discussing difficult topics) and social problem-solving skills, while Interpersonal Psychotherapy for depression builds on basic interpersonal effectiveness skills to help adolescents and their caregivers understand and address the connection between interpersonal events, emotions, and depression. As such, both interventions may be beneficial for girls by helping them improve social support and reduce social withdrawal. Further work is needed to examine whether Social Skills Training or Interpersonal Psychotherapy for adolescents could improve interpersonal communication, effectively reduce stress, or improve mental health among

girls in SSA. Interpersonal Psychotherapy was acceptable and feasible when implemented by community health workers in South Africa (Peterson et al., 2012).

2.3.5 Future Research

Further research is needed to develop multi-pronged interventions to improve health education, psychosocial skills, and practical support. Additional research is also needed to explore whether menstrual pain is more prevalent or more severe among girls in SSA compared to other regions. If so, investigators may want to explore whether this is a result of increased stress, somatization of stress, diet, differences in the vaginal microbiome, conditions such as endometriosis, epigenetic factors, or another unknown reason.

2.3.6 Conclusion

This qualitative interview study shows the clear need for interventions to support girls as they manage menstruation- and puberty-specific stressors during puberty. Stressors were common, disruptive, and potentially damaging to girls' mental health and well-being. However, not all girls experienced entirely negative outcomes from puberty. Some girls did not experience severe stressors and were able to easily overcome any potential challenges. Other girls did experience severe stressors but were well-supported or were able to cope through adaptive coping strategies. This suggests that interventions may be effective if they can reduce the severity of stressors experienced by girls, improve social support and practical resources for girls as they

manage stressors, and help girls implement effective coping strategies in response to stress. Future research is needed to explore whether such interventions could enhance mental health and reproductive health among girls in Tanzania.

3. Study B: Quantitative Survey

3.1 Methods

3.1.1 Study Design

Study B included a cross-sectional self-report quantitative survey conducted with adolescent girls and young women across five schools in Moshi, Tanzania. The goals of the survey were the following:

(1) describe participants' self-reported stressors, coping strategies, mental health outcomes, reproductive health behaviors, and reproductive health outcomes

(2) investigate the structural relationships between menstruation and puberty-related stressors, coping, mental health, and self-reported symptoms of reproductive tract infections.

3.1.2 Participants

All data were collected from August 2018 to November 2018 in Moshi, Tanzania. Inclusion criteria included being a girl or young woman in Forms 1-4 (i.e., in secondary school) at any of the schools taking part in the study. Menstruating and non-menstruating girls were included in the overall study, but for the present analysis, non-menstruating girls were excluded from the sample. Study-wide exclusion criteria included anything that would interfere with the ability to provide informed consent.

Age was not used as an exclusion criteria, because we felt that older participants enrolled in school shared a psychosocial context that made them more similar to other

adolescent girls enrolled in school than to 19 to 21-year-old young women outside of school. However, since menstrual regularity is typically established when women are 19 to 20-years-old, we conducted analysis to determine whether older participants (18-21) had different menstrual experiences than younger participants (Hillard, 2002) . If older participants did have significantly different menstrual experiences than adolescent girls, they would be excluded from the final analytical sample. We examined differences in menstrual pain/cramping and whether participants could track their menstrual cycle. No differences were found in menstrual tracking, and menstrual pain showed a small, but positive correlation with age. As such, young women between 19-21 were retained in the sample, and age was controlled for as a continuous covariate when possible.

Research assistants developed a list of secondary schools in the municipality in which we had permission to conduct research. Out of this list, we excluded any schools that had already received a menstrual education session by a local NGO. Although our intent was to use random selection of schools within stratifications of location (urban / rural) and socioeconomic status (high /low), we discovered after our first round of recruitment attempts that this was not practical, as schools from wealthier areas were more likely to decline participation. Random selection would also have also led to underrepresentation of girls who are Muslim, because Muslim girls were more likely to be attending a small number of majority-Muslim schools. For this reason, purposive sampling was used to ensure a diverse group of schools from urban and rural areas

representing higher and lower income regions and Christian and Muslim students. Overall, we approached nine schools, and five of these schools agreed to participate within our timeframe of three months for recruitment.

All girls present at the school who were eligible for participation were invited to take part in the study. Two research assistants explained the study to girls and collected written informed consent from those who wanted to take part in the study. Participants were provided written pen-and-paper survey forms in Swahili, which they anonymously completed by themselves with assistance from research assistants if questions were not understood. Participants were provided with a pencil and soap as compensation for their time, but they were allowed to take these items before finishing the survey so that there was no coercion to actually complete the survey. Research assistants made attempts to go to each school multiple days to reach girls who may have been absent. However, one of the schools did not allow for recruitment of girls in Form 4, as they were taking exams, and this school only offered time to complete the surveys during the school day.

Overall, the study was explained to 1,306 students, and 701 students across five schools (M = 140 per school) consented and completed the survey, for a participant-level response rate of 54%. The low response rate may be in part due to girls not wanting to miss sports/games during school or stay after school to complete the survey, or because younger pre-pubescent girls may not have felt the study was relevant to them. Prior

research suggests that under stringent conditions, assuming skewed responses and sampling error, a minimum response rate of 41% would be needed to reduce response bias (Nulty, 2008). As such, the impact of the response rate on bias is likely to be minimal.

3.1.3 Power Analysis

A priori power calculations were conducted to determine the minimum sample size for an ordinary least squares (OLS) mediated-moderation model, with the aim of a power of .80 to detect small effects with a p-value of .05, and estimated 30% missing data (20% due to non-menstruating girls, and 10% due to skipped questions). Prior research on mediated-moderator models shows that if effect size parameters explain 3% of the variance in the outcome, achieving .8 power with alpha set at .05 requires a minimum of 500 participants (Fairchild & MacKinnon, 2009). Thus, the goal of this study was to collect complete data from 500 participants to achieve .80 power, and we aimed to recruit 700 participants to account for missing data.

Although we completed an *a priori* power analysis for an OLS-based model prior to data collection, we also hoped to conduct exploratory factor analysis and structural equation modeling to explore novel measures and more properly account for measurement error and missing data. For this reason, a power analysis for latent models was completed after collecting data but prior to analysis, to ensure data were sufficient to run structural equation models (SEM) and exploratory factor analysis (EFA) models.

Using guidelines of 20 participants per variable and a minimum sample of 500 for EFA, we had a good sample size for robust results, and using the rule-of-thumb of 10 participants for every indicator variable in SEM, we showed adequate sample size for up to 50 indicator variables (Carpenter, 2018; Kyriazos, 2018). Our most complicated model included 29 indicator variables, which suggests we were sufficiently powered for SEM models.

3.1.4 Measures

Measures were professionally translated from English to Swahili and back-translated and reviewed by local staff fluent in both Swahili and English. When available, we used measures that had already been used with adolescent girls in Tanzania, although this was not always possible. Internal reliabilities can be found in the results section.

The beginning of the survey included instructions on how to complete each type of question, and this was reviewed in detail by research assistants prior to survey completion. Questions with Likert-style response options were accompanied by visual aids.

3.1.4.1 Demographics

Demographic measures included menarche status, school, age, form (i.e., grade), household composition, education, tribe, and religion. Socioeconomic status was

measured by the availability of electricity, water, and cellular phones and employment status.

3.1.4.2 Stress

Novel measures of menstruation- and puberty-related stressors were developed for the present study because prior measures were not designed for use with girls in Tanzania and did not include enough relevant stressors specific to managing menstruation and puberty in a highly stigmatized, low-resource setting. The novel measure of puberty stressors asked about the presence of puberty-related stressors (e.g., physical, social, and emotional changes). The novel measure of menstrual symptoms asked about psychosomatic symptoms immediately prior to or during menstruation (e.g., pain, bloating, fatigue, sadness), as well as other menstrual stressors reported by girls in prior research in SSA (e.g., unavailability of pads, teasing, participation restrictions). Potential stressors were developed from previous literature and in consultation with local staff and topic experts at a Femme International, a local non-governmental organization (NGO) focused on menstrual health education. Response options ranged from 1 = not at all to 4 = most of the time, with greater scores indicating more frequent stressor exposure.

A general life stressors measure was included in the survey to examine general life stressors in comparison to menstruation- and puberty-specific stressors. A modified checklist was developed by combining and adapting a scale used with adolescents in

South Africa and a scale used with HIV-infected adolescents in the United States to measure daily stressful events (Bolger et al., 1989; Otwombe et al., 2011). The final scale included sixteen items, ranging from general daily hassles (e.g., extra chores, transportation difficulties) to significant acute stressors (e.g., losing a loved one).

3.1.4.3 Puberty Coping

Coping with puberty was measured using an adapted coping questionnaire originally developed for use with HIV-positive women in South Africa, which included items from the Brief Cope, the Coping with Illness Inventory, the Ways of Coping Questionnaire, an adapted coping scale by Hansen and colleagues (2013), and culturally specific items designed for use with women in sub-Saharan Africa (Carver, 1997; Folkman & Lazarus, 1988b; Hansen et al., 2013; Sikkema et al., 2018; Tarakeshwar et al., 2005). Responses were on a 4-item Likert scale ranging from "1 = not at all" to "4 = most of the time."

3.1.4.4 Menstrual Coping

We developed a new menstrual coping measure because no existing measures of emotion-focused coping, problem-focused coping, and avoidant coping were specifically designed for adolescent girls in global, low-resource settings with a high level of menstrual stigma. Therefore, a menstrual coping scale was developed for this study based on previous literature from sub-Saharan Africa and collaboration with local staff. Items were also adapted from the Premenstrual Coping Measure (Read et al., 2014).

Participants were asked if they engaged in a list of behavioral or cognitive strategies to deal with menstruation in the past three months. Responses were on a 4-item Likert scale.

3.1.4.5 Mental Health

Mental health included measures of depression and anxiety. Depression was measured using the Patient Health Questionnaire – 9 (PHQ-9), which has been used with adolescent girls in Moshi and provides a continuous scale of the frequency of depression symptoms and categorical cut-offs for moderate and severe depression (Dow et al., 2016; Gelaye et al., 2013; Monahan et al., 2009). Participants were asked how often they have been bothered by problems during the past 2 weeks, with responses ranging from 0 = not at all to 3 = nearly every day. A cut-off of 10 or more was used as an indicator of moderate-to-severe depression, which has been well-supported in other studies, although thresholds of 8 and 11 have also been suggested (Adewuya et al., 2006; Gelaye et al., 2013; Richardson et al., 2010).

Anxiety was measured using the Generalized Anxiety Disorder – 7 item scale (GAD-7), which has been used in sub-Saharan Africa (Löwe et al., 2008; Spitzer et al., 2006). Research with adolescents in Ghana suggests the GAD-7 is reliable and valid with adolescent girls and represents a unidimensional structure (Adjorlolo, 2019). The GAD-7 provides a continuous scale of frequency of anxiety symptoms over the past 2 weeks, with responses ranging from 0 = not at all to 3 = nearly every day, as well as categorical

cut-offs indicating moderate and severe anxiety. A cut-off of 10 or more was used as an indicator of moderate-to-severe anxiety (Spitzer et al., 2006).

3.1.4.6 Reproductive Health

For descriptive purposes, we asked participants about lifetime sexual intercourse, pregnancy history, HIV status, condomless intercourse, contraceptive adherence, concurrent partners, transactional sex, intravaginal risk practices (such as cleaning inside the vagina), menstrual management practices, and menstrual resources.

In the models examining interrelationships between stress, coping, mental health, and reproductive health, the primary outcome was "reproductive tract infection symptoms," a measure of lifetime self-reported symptoms of both endogenous and sexually transmitted reproductive tract infections. Responses were dichotomized into the presence or absence of at least one of 10 different symptoms, such as symptoms of bacterial vaginosis, urinary tract infections, candida infections, herpes, syphilis, gonorrhea, trichomoniasis, and chlamydia (see Table 15).

Table 15: Symptoms of Reproductive Tract Infections

Itchy, white, thick, clumpy discharge
Pain or burning during urination
Heavy bleeding between periods
Green or yellow discharge
Itching or burning in the genital area or inside the vagina
White and frothy vaginal discharge
Vaginal discharge with a strong, bad smell (e.g., fishy smell)
Redness or rash in the genitals
Sores, blisters, or ulcers in the genital area or inside the vagina
Pain or bleeding during sex

3.1.4.7 School-Level Measure

Study staff made observations of water, sanitation, and menstrual management resources at each school.

3.1.5 Ethical Considerations

Ethical approval for research with human subjects was obtained from institutions in the United States and in Tanzania, including Duke University and Kilimanjaro Christian Medical College. Government approval to conduct research in Tanzania was granted by the National Institutes of Medical Research. Approval for the involvement of foreign researchers was approved by COSTECH. Approval to conduct research in schools was obtained from local officials and heads of schools in Moshi, Tanzania. All participants provided written informed consent. A waiver of parental consent was obtained for girls under 18, because the study was non-invasive and the primary risk was a breach of confidentiality if others found out the participant was taking part in a study. All data were de-identified.

3.1.6 Analysis

Data were double-entered into RedCap and checked for accuracy. SPSS 26 was used for data management, descriptive statistics, and linear and logistic regressions. MPlus6 for Windows and Mplus8 for Mac OS were used for factor analysis and structural equation modeling. Table 16 provides a summary of the analyses performed.

Table 16: Summary of Statistical Analyses

Type of Analysis	Constructs / Variables	Details
Descriptive	Menstrual and Puberty Stressors, Menstrual and Puberty Coping, Mental Health, Reproductive Health	Data considered missing for summary scores when <80% completed
Exploratory Factor Analysis	Menstrual Stressors, Menstrual Coping, Puberty Coping	WLSMV estimation, pairwise present deletion, geomin rotation
Structural Equation Modeling	Puberty Stressors, Avoidant Coping, Active Coping, Depression, Anxiety, RTIs	MLR estimation, FIML for missing data
Hierarchical Linear Regression & Logistic Regression	Menstrual Stressors, Menstrual Coping, Depression, Anxiety, RTIs	Separate linear models and a logistic regression model using listwise deletion

Note. WLSMV = robust weighted least squares; MLR = robust maximum likelihood; FMIL = full information maximum likelihood.

3.1.6.1 Descriptive Analysis and Exploratory Factor Analysis

Menstruation-related stressors and menstruation-related coping are both novel measures, with a large number of items representing an unknown number of factors. As such, it was determined that at the present stage, it was more appropriate to engage in descriptive analysis and exploratory factor analysis to determine the pattern of indicators for menstruation-related stressors and menstruation-related coping, rather than to include them in a structural model.

Due to the use of a 4-item likert scale, data were treated as ordinal, and we estimated polychoric correlations and used the robust weighted least squares (WLSMV)

estimator. We used geomin rotation because we expected the factors to correlate, and we aimed for a simple factor structure (Sass & Schmitt, 2010). Prior research shows that the CFI and TLI fit indices are most accurate for EFA using categorical indicators, so these were compared across solutions, with the aim of identifying the most parsimonious model with good fit (Garrido et al., 2016).

Items were retained if they had at least 3 intercorrelations with other items at or above r = |0.3| and factor loadings greater than |0.32| (Carpenter, 2018). Items with cross-loadings were either removed or placed in the factor where they made most theoretical sense. Factors were retained if they included at least three indicators and were interpretable.

An EFA was conducted on the overall measure of Puberty Coping to advance measure development for this specific population. However, all of the originally proposed Active Coping and Avoidant Coping items were drawn from prior research, and these pre-determined items were used in the structural equation model to avoid artificially overfitting the model, which would occur if we conducted a confirmatory factor analysis on results of an exploratory factor analysis.

3.1.6.2 Structural Equation Modeling

Structural equation modeling (SEM) was used whenever possible, because SEM explicitly models measurement error via the use of latent factors and allows for simultaneous examination of both moderation and indirect effects within a single model.

In a series of steps, models were tested to explore the structural relationships between puberty-related stressors, active or avoidant coping, depression or anxiety, and reproductive tract infections. Depression and anxiety and active and avoidant coping were included as latent factors in separate models because a latent interaction model with more than three latent factors was too computationally demanding and led to non-convergence. RTI was a binary observed variable synthesized from ten different symptoms of reproductive tract infections.

Models were built in stages to answer the following questions:

1. Do puberty stressors show a relationship to mental health (depression and anxiety)?

2. Do puberty stressors show a relationship to lifetime RTIs?

3. What are the structural relationships in an overall model that integrates the relationships between puberty-related stressors, coping, mental health, and reproductive health for the following models: (a) a moderation model, with coping moderating the association between stressors and mental health and (b) an indirect effects model, with stressors related to both mental health and coping strategies and coping strategies related to mental health.

Figure 2 shows a simplified visual representation of the overall models to be tested, and relevant variables are included in Table 17.

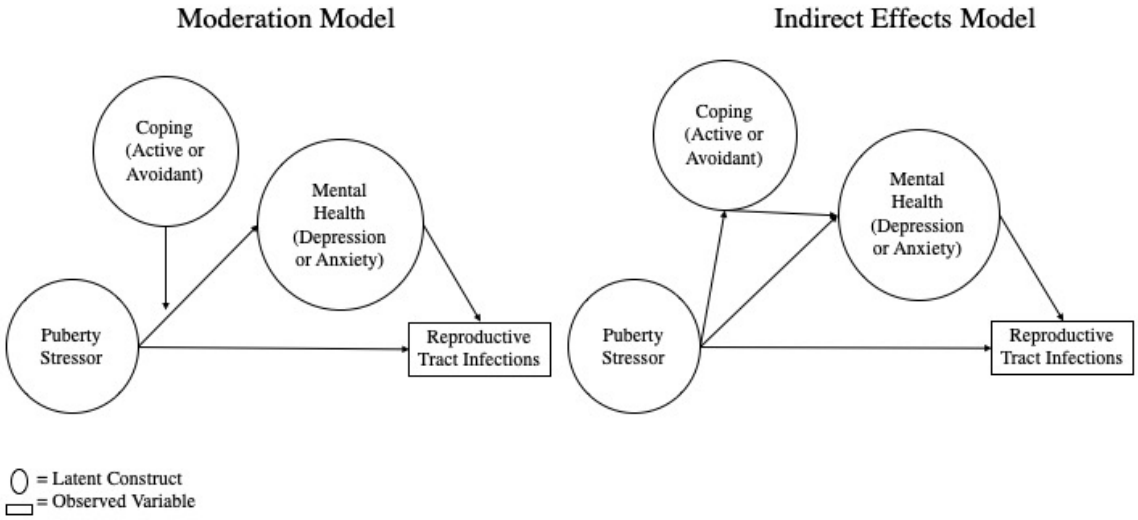

Figure 2: Structural Equation Models For Moderation Model and Indirect Effects Model

Note. Not shown: covariates of school and age, factor loadings and observed variables for latent constructs.

Table 17: Variables to be Included in Structural Models

Variable	Type	Latent / Observed	Role
Avoidant Coping	Continuous Scale	Latent	Exogenous Factor (Moderation) or Endogenous Factor (Indirect Effects)
Active Coping	Continuous Scale	Latent	Exogenous Factor (Moderation) or Endogenous Factor (Indirect Effects)
Puberty Stressors	Continuous Scale	Latent	Exogenous Factor
Coping X Stressors	Continuous Scale	Latent	Exogenous Factor, Interaction Term
School	Nominal Factor	Observed	Four Dummy-Coded Covariates
Depression	Continuous Scale	Latent	Endogenous Factor
Anxiety	Continuous Scale	Latent	Endogenous Factor
RTI	Binary	Observed	Endogenous Variable
Age	Continuous Scale	Observed	Covariate

SEM analysis employed maximum likelihood estimation with robust standard errors (MLR) with Monte Carlo integration. MLR is the primary estimator available for ordinal data involved in a latent interaction. MLR has been shown to provide less biased regression estimates than robust weighted least squares (WLSMV) (Li, 2014). However, unlike WLSMV, MLR with categorical data only provides comparative fit indices (i.e., AIC and BIC), which limits evaluation of global model fit.

3.1.6.3 Linear Regressions and Logistic Regressions for Menstruation Stressors

The measure of menstrual coping was developed for this study and constructs were categorized using exploratory factor analysis, so subscales derived from the EFA could not be included in an SEM due to the risk of artificially overfitting the model. However, it was possible to explore the link between menstrual stressors, menstrual coping, and mental health and reproductive health outcomes through separate OLS-based linear regressions and a logistic regression.

Variables were included as mean scores (for coping and stress), summed scores (for depression and anxiety), continuous scales (for age), or dichotomous dummy codes (for RTI and school). Listwise deletion was employed, such that individuals were excluded from analysis if they had missing data on key constructs. Three separate models were used to examine outcomes of 1) anxiety, 2) depression, and 3) RTIs. The measures of menstrual coping and menstrual stressors were both novel, culturally specific, and did not fit into typical domains of active or avoidant coping. For this reason, there was not enough prior research to support more complicated moderation or indirect effects models. Instead, we took a more parsimonious approach to investigate main effects. These models controlled for demographic characteristics of age and school. The models are outlined in Table 18.

Table 18: Linear Regression and Logistic Regression Models for Menstrual Stressors

Model 1	**Model Type:** Linear Regression **Dependent Variable:** Depression **Independent Variables** School (Dummy Codes), Age, Menstrual Stressors, Health Behavior Coping, Positive Affect Coping, Emotion-Focused Coping, Avoidant Coping
Model 2	**Model Type:** Linear Regression **Dependent Variable:** Anxiety **Independent Variables:** School (Dummy Codes), Age, Menstrual Stressors, Health Behavior Coping, Positive Affect Coping, Emotion-Focused Coping, Avoidant Coping
Model 3	**Model Type:** Logistic Regression **Dependent Variable**: RTI (dichotomous) **Independent Variables:** School (Dummy Codes), Age, Menstruation-Related Stressors

3.1.6.4 Covariates

Although students were recruited in schools, multiple regression modeling rather than multi-level modeling was used to model non-independence due to school clusters. With a cluster size of 5 schools, Muthén (2013) suggests that when using Mplus, a multiple variable approach incorporating the schools as a dummy-coded covariates in the model introduces the least amount of bias and accounts for non-independence of observations. As such, four dummy codes for school were regressed onto each endogenous factor and dependent variable, with School 1 acting as the reference school.

It is possible that age is associated with depression, anxiety, and reproductive tract infections. As such, we hoped to add age as a covariate in all models. However, in the structural models with coping included as a moderator, adding age to the model led to nonconvergence, which could not be resolved by increasing iterations. For this reason, age was not included in the moderation models, although it was included as a covariate in all other models, including the non-SEM models and the indirect effects SEM models.

3.1.6.5 Data Cleaning

Data were checked for outliers and unusual or illogical responses. First, responses were confirmed in the paper surveys to ensure there was not a data entry error.

For the question "age at first sex" there were a few responses that were low enough to suggest participants either did not understand the question or were referring to non-consensual childhood sexual abuse. For this reason, we coded answers below 10-years-old as missing data, since they did not reflect the intent of our question.

There were a small number of cases of participants who said they had not had sex, but endorsed the RTI symptom "pain/bleeding during sex." However, in no cases was this the only RTI symptom they endorsed. In other words, even if we left out the item "pain/bleeding during sex", the dichotomous number of those who had an RTI symptom would remain the same. Illogical responses on this item may be due to

underreporting of sexual intercourse, misunderstanding the RTI question, or mistakes in filling out the form.

There were a small number of cases where participants circled two options on a single Likert scale. In these cases, the midpoint (rounded to the nearest whole number) between two options was used.

3.1.6.6 Treatment of Missing Data

Missing data for individual items in primary constructs of interest (depression, anxiety, stress, and coping) ranged from 1.5% to 12% with an average of 4.78%. Our anticipated level of missing data due to skipped items was 10%, and we overenrolled to account for this missing data. For this reason, it is not anticipated that missing data impacted power.

For scale construction, an average score was only computed when at least 80% of the items for a scale had been completed, otherwise the mean score was considered missing data. The WLSMV estimator used in EFA employed pairwise-present deletion. The MLR estimator employed FIML to manage missing data, except in cases where an observed covariate was missing, in which case pairwise-present was used. Linear and logistic regressions employed listwise deletion.

3.2 Results

3.2.1 Participant-Level Demographics

Survey data were collected from 701 participants across 5 schools in Moshi, Tanzania. The current analysis only includes 581 girls and young women between 13-21 who reported reaching menarche. Table 19 provides demographic characteristics.

Table 19: Demographic Characteristics of the Final Analytical Sample (N = 581)

Demographics	M	SD
Age	16.23	1.40
Primary Caregiver	N	%
Mom or Dad	385	66
Aunt or Uncle	31	5
Grandmother/Grandfather	46	8
Brother/Sister	36	6
Married	9	1.5
Religion		
Christian	342	59
Muslim	208	36
Tribe		
Chagga	210	36
Pare	69	12
Socioeconomic Status		
Worked for money outside the home	52	9
Had electricity at home	459	79
Had piped water inside the home	403	69
Had a cell phone	211	36

Note. 56 tribes represented overall, two most common tribes presented in table.

3.2.2 School-Level Demographics

Five schools took part in this study, with a mean school size of 116 (range = 77 – 131) participants per school. The average student-teacher ratio was 17.43 students per

teacher (range = 13.27 - 22.70). The average student-toilet ratio was 43.04 female students per female-designated toilet (range = 24.74 - 96.75). In our study period, which was in the dry season, all schools had access to clean water and toilets with locking doors. Only one school provided access to soap.

Demographic indicators were compared across schools (see Table 20). Although all schools had both Christian and Muslim students, three schools were majority Christian, one school was majority Muslim, and one school had a relatively equal number of Christian and Muslim students. Schools were compared on four items representing socioeconomic status. Chi-square tests of independence showed that these indicators varied across school. However, there was no clear pattern of any school scoring higher on every indicator.

Table 20: Demographic Indicators by School

Item	School 1	School 2	School 3	School 4	School 5	Chi-Square	Sig.
	Percent of Participants Endorsing						
Working for money	6.5	9	7.8	0	27.9	41.336	.000
Electricity	74.2	85.8	91.7	80.8	86.9	15.757	.003
Piped water	62	69.3	80	70.3	88.8	24.653	.000
Cell phone	33.6	44.9	48.3	14.9	42.4	26.488	.000
Muslim	19.4	13.1	27.5	46.7	97	214.988	.000
Christian	80.6	85.2	71.7	53.3	3	214.988	.000
Parent as Primary Caregiver	67.4	72	71.9	83.6	65	119.105	.000
	Mean					F	Sig.
Age	16.04	16.71	16.41	15.47	16.16	10.754	.000

3.2.3 Stressors

3.2.3.1 Puberty Stressors

See Figure 3 for a list of puberty-specific stressors. When treated as a scale, the mean of five items in the puberty stressors scale was 1.75 (SD = .62), with a range from 1-4, a relatively normal distribution, and acceptable internal reliability (Cronbach's alpha = .712). Means and standard deviations for each item are listed in Figure 3. The most commonly reported stressor was having unwanted romantic or sexual feelings or sexual attention from others.

When treated as a latent factor while controlling for school, a single-factor model showed good fit using WLMSV estimation (X^2 = 44.093, p = .0023, RMSEA = .044, 90% CI [.025-.062], CFI = .968, TLI = .955).

Item	Mean (SD)	Percent Endorsing
Unwanted romantic or sexual feelings or sexual attention from others	2.016 (1.023)	63
Didn't like how my body or physical appearance was changing or not changing enough	1.83 (.926)	53
Had unwanted changes in responsibilities, rules, expectations, or roles	1.83 (.930)	52
Emotions felt too strong or hard to control	1.56 (.839)	37
I was worried that I could become pregnant	1.50 (.827)	33

Figure 3: Puberty-Specific Stressors

3.2.3.2 Menstrual Stressors

See Figure 4 for a list of menstrual stressors. By far the most commonly endorsed stressor was "cramping or pain," which was experienced by 81% of participants.

Interestingly, although feeling embarrassed was endorsed by 62% of the sample, actually being teased was the least common stressor, with only 25% of participants experiencing teasing.

Item	Mean (SD)	Percent Endorsing
Cramping or Pain	2.57 (1.049)	81
Acne	2.21 (1.111)	63
Felt embarrassed	2.12 (1.050)	62
Heavy menstrual bleeding	2.07 (1.008)	62
Was worried about leaks, odor, or pad/cloth falling out	2.46 (1.082)	58
Difficulties doing something you wanted to do	1.88 (.907)	58
Feeling sad or lonely	1.96 (.992)	57
Mood swings	1.94 (.994)	55
Headaches or migraine	1.95 (1.016)	54
Difficulties attending / participating in school	1.88 (1.003)	52
Difficulties getting money for materials	1.95 (1.114)	49
Sore or large breasts	1.86 (1.031)	48
Difficulties eating or preparing food	1.83 (.999)	47
Nausea	1.79 (.965)	46
Difficulties moving around	2.3 (1.102)	45
Difficulties getting information about menstruation	1.79 (.978)	45
Difficulties finding someone to talk to about menstruation	1.76 (.978)	45
Bloating	1.73 (.936)	44
Diarrhea, loose stool, or constipation	1.72 (.981)	40
Difficulties finding water, private latrines, soap	1.7 (.963)	40
Food cravings	1.69 (.947)	40
Difficulties with the rules and restrictions	1.62 (.881)	39
Was teased	1.43 (.818)	25

Figure 4: Menstruation-Specific Stressors

3.2.3.3 General Life Stressors

A checklist of general life stressors was used to examine the prevalence of non-menstrual and non-puberty stressors. The most common stressor was having extra work, household duties, or chores, which was endorsed by 35% of participants. All other general stressors were endorsed less frequently than menstruation and puberty-specific stressors. See Table 21 for a list of stressors and the frequency at which they were endorsed.

Table 21: General Life Stressors

Item	N	%
Extra work, duties, or chores	206	36
Close to someone who died	200	34
Family struggled with money	179	31
Transportation problems	161	28
Violence or crime in the neighborhood	154	27
Parents argued	155	27
Changed school/moved	149	26
Problems/fights with family, friends, partner	147	25
Parents separated	139	24
Bullied or Teased	135	23
Close to someone with alcohol/drug problem	120	21
You were sick/had a bad injury	117	20
Close to someone who was very sick / had a bad injury	112	19
Did not have enough to eat	96	17
Parent lost job	84	15
Lost home / homeless	56	10

3.2.4 Coping

3.2.4.1 Puberty Coping

Item	Mean (SD)	Percent Endorsing
I've been focusing only on what is most important in my life right now	3.11 (1.034)	87
I have started to see the situation as a normal part of life	3.03 (1.093)	83
I've accepted the reality of the fact that it has happened and I am learning to live with it	2.81 (1.085)	82
I read religious writings or listened to religious teachings for inspiration	2.7 (1.11)	80
I knew what had to be done, so I worked even harder to make things work	2.73 (1.112)	80
I came up with a couple of different solutions to the problem	2.4 (1.034)	76
I prayed to find strength or guidance	2.55 (1.15)	74
I made a plan and have taken steps to improve the situation	2.46 (1.113)	73
I asked someone for advice or to find out more about the situation	2.42 (1.079)	72
I went to a place of workship or participated in religious activities	2.52 (1.173)	72
I found opportunities to help or encourage other women/girls like myself	2.31 (1.116)	67
I've wished that the situation would go away or somehow be over with	2.32 (1.119)	67
I did things to avoid addressing my problems (e.g., watched TV, read, or slept)	2.28 (1.145)	65
I tried to push the thing from my mind	2.17 (1.092)	63
I talked with others with problems like mine	2.14 (1.071)	62
I looked at the situation from another side, to see if it could lead to something positive	2.02 (1.043)	58
I generally avoided being with people	1.9 (.983)	54
I criticized myself	1.89 (1.014)	50
I believed traditions were important and have positive benefits	1.92 (1.036)	49
I treated someone badly who did not deserve it because I was feeling bad	1.76 (.995)	43
I've been saying to myself "this isn't real"	1.78 (1.1025)	42
I've been giving up trying to deal with it	1.63 (1.009)	40
I talked to a member of the clergy	1.69 (1.009)	37
I planned ways to hurt myself	1.47 (.875)	26
I tried to make myself feel better by drinking or using drugs or having sex	1.42 (.82)	24

Figure 5: Puberty-Related Coping

Puberty-related coping items can be found in Figure 5. An exploratory factor analysis was conducted on the Puberty Coping measure. An examination of the polychoric correlation matrix showed only one item did not have at least 3 correlations above 0.3, so this item was removed. Solutions with 1-6 factors were compared. The solutions for 3-6 factors showed adequate-to-good fit. The three-factor solution made the most theoretical sense and had an adequate number of items per factor (X^2 = 535.788, RMSEA = .057, CFI = .946, TLI = .926).

Factors were defined as Avoidant Coping, Active Coping, and Religious Coping. When controlling for school, Avoidant Coping was weakly associated with Active Coping, $F(5, 551) = 8.621$, $p = .000$, b = .2), Religious Coping was strongly associated with Active Coping, F(5, 554) = 42.207, p = .000, b = .713, and Religious Coping was weakly associated with Avoidant Coping, F (5, 551) = 8.621, p = .000, b = .200). This suggests active and avoidant coping strategies were independent constructs rather than opposite dimensions of a single construct. Religious Coping and Active Coping were endorsed more frequently than Avoidant Coping. The final factor loadings, summary scores, and reliability statistics are in Table 22.

Table 22: Puberty-Related Coping Exploratory Factor Analysis

	Indicator	Loading	Cronbach's alpha	Observed Mean (SD)
Avoidant Coping			.768	1.75 (.60)
	Self-harm	.880		
	Substance Use/Sex	.879		
	Denial	.710		
	Gave Up	.635		
	Treated Others Bad	.594		
	Self-Criticized	.576		
	Pushed from Mind	.526		
	Avoided People	.424		
Active Coping			.812	2.56 (.68)
	Acceptance	.919		
	Normalization	.839		
	Focused on most important things	.829		
	Came up with solutions	.560		
	Made a plan	.529		
	Helped others	.518		
	Talked with others	.508		
	Worked harder	.492		
	Cognitive reframing	.395		
Religious Coping			.739	2.59 (.93)
	Religious activities / worshiped	.752		
	Religious writings / content	.746		
	Prayed	.371		

3.2.4.2 Menstrual Coping

Figure 6 shows various methods used to cope with menstruation. The most commonly endorsed method was trying to keep emotions under control.

Item	Mean (SD)	Percent Endorsing
I tried to keep my emotions under control	2.73 (1.111)	73
I thought about menstruation as natural, normal, or a sign of good health	2.53 (1.104)	72
I thought about how women and girls go through the same thing	2.48 (1.074)	71
I thought about how menstruation is only temporary	2.52 (1.091)	70
I thought about how it is okay to be feeling different when I am menstruating	2.45 (1.067)	69
I tracked when menstruation would start or end	2.47 (1.145)	69
I received support from friends or family or other people	2.34 (1.087)	66
I took a positive view of what I have learned and saw benefits to what I have experienced	2.28 (1.057)	65
I tried not to think about menstruation	2.16 (1.042)	60
I changed how often I bathed or cleaned inside or around the vagina	2.29 (1.18)	60
I exercised more	2.26 (1.147)	59
I kept menstruation hidden	2.21 (1.144)	59
I took time to rest, sleep, or relax	2.1 (1.084)	56
I thought about a better future where girls like me do not face similar problems	1.97 (1.019)	52
I exercised less	1.95 (1.002)	52
I believed traditions were important and have positive benefits	1.92 (1.036)	49
Avoided doing something I usually do	1.84 (1.009)	48
I took pain medication or traditional / herbal medicine	1.84 (1.045)	45
I did not focus on menstruation, because there were more important things to worry about	1.79 (1.004)	42
Ignored certain restrictions or got permission from others to ignore restrictions	1.73 (.969)	39
Changed what I ate or drank	1.63 (.879)	38
I used heat for pain	1.67 (.944)	38
I went to a healthcare provider	1.67 (.975)	36
I thought about menstruation as dirty, bad, or a sign of bad health	1.64 (.945)	35
I used symbols or signs to let my partner know I was menstruating	1.45 (.813)	26

Figure 6: Menstrual Coping

An exploratory factor analysis was conducted on the menstrual coping items (see Table 23). Prior to factor analysis, one item about having a partner was removed because it was not relevant to the final sample, since most girls reported not having a partner. One item was removed from the final factor because it did not fit theoretically with the others in the factor. Three items were removed due to low inter-item correlations. Solutions with 1-6 factors were compared. Solutions with 2-6 factors showed adequate-to-good fit. The five-factor solution showed the best fit and interpretability (X^2 = 202.116, RMSEA = .037, CFI = .979, TLI = .965).

Four factors were retained for sub-scale development, as the 5th factor only had two items. The Health Behavior Coping (Cronbach's alpha = .735) and Emotion-Focused Coping (Cronbach's alpha = .748) sub-scales showed good internal consistency. The Positive Affect Inducing and Avoidant Coping scales showed middling internal

consistency (Cronbach's alpha = .623 and .612). This is likely due to low factor loadings among items in these sub-scales. This suggests further work is needed to refine these scales.

Overall, a comparison of mean scores indicates that emotion-focused strategies are used most frequently, and health behavior coping strategies were used least frequently.

Table 23: Menstrual Coping Exploratory Factor Analysis

Indicator	EFA Loading	Cronbach's Alpha	Observed Mean (SD)
Health Behavior Coping		.735	1.72 (.68)
Used heat	.785		
Changed what I ate / drank	.726		
Took medicine	.673		
Went to a healthcare provider	.614		
Skipped activities	.594		
Positive-Affect Inducing Activities		.623	2.27 (.73)
Thought menstruation was good	.500		
Took a positive view	.486		
Engaged in social support	.482		
Believed traditions were important	.365		
Emotion-Focused Coping		.748	2.55 (.82)
Thought about how it is temporary	.741		
Controlled emotions	.731		
Thought about how it was okay to feel different	.724		
Thought about how others go through same	.716		
Avoidant Coping		.612	2.00 (.71)
Tried not to think about menstruation	.499		
Exercised Less	.496		
Rest, slept, or relaxed	.451		
Didn't focus on menstruation	.410		

3.2.5 Mental Health

3.2.5.1 Depression

Depression was measured using the PHQ-9. The mean score on the PHQ-9 was 8.2 (SD = 5.42), with a range from 0-27. Internal consistency was good (Cronbach's alpha = .83), and summary scores were normally distributed. Thirty-six percent (n = 209) of participants met the criteria for clinically significant depression. About 49% (n = 282) of

participants endorsed having "thoughts that you would be better off dead or of hurting yourself in some way" at least several days to nearly every day over the past two weeks.

A confirmatory factor analysis was conducted to explore whether depression can be represented as a single-factor construct. When using the WLSMV estimator and controlling for school, a model with 9 items loading onto a single depression construct showed acceptable fit ($X^2 = 213.531$, RMSEA = .067, CFI = .94, TLI = .92).

Due to the concerning level of suicidal ideation and non-suicidal self-harm endorsed by the sample, exploratory follow-up analyses were performed to examine factors that were associated with this item when dichotomized into endorsed versus not endorsed (see Table 24). Chi-square analyses showed that endorsement of suicidal ideation and thoughts of self-harm varied by school, (X^2 (4, N = 560) = 12.167, p = .016), religion (X^2 (3, N = 534) = 11.560, p = .009), anxiety (X^2 (1, N = 550) = 58.432, p = .000), depression (X^2 (1, N = 554) = 131.886, p = .000), and pregnancy history (X^2 (1, N = 183) = 8.930, p = .003). A one-way ANOVA showed that participants endorsing suicidal ideation were typically older (Mean age = 16.6) than girls who did not (Mean age = 15.8), F(1, 529) = 39.719, p = .000. There was no association with primary caregiver or HIV status. Overall, these findings show an especially strong relationship between experiencing a pregnancy or having clinically significant anxiety or depression and endorsing thoughts of suicidality or self-harm.

Table 24: Percent Endorsing Suicidality or Self-Harm Ideation

Variable	n	Percent Endorsing within Category
School		
School 1	68	54
School 2	61	48
School 3	67	56
School 4	25	33
School 5	61	56
Religion		
Christian	154	46
Muslim	117	60
Anxiety		
GAD <10	140	39
GAD 10+	139	73
Depression		
PHQ<10	110	32
PHQ 10+	170	82
Pregnancy Status		
Had been pregnant	24	77

3.2.5.2 Anxiety

Anxiety was measured using the GAD-7. Skewness and kurtosis suggest data were normally distributed, with an internal reliability of .81. Mean score on the GAD-7 was 7.49 (SD = 4.58), with a range from 0 to 21. Approximately 34% (n = 194) of participants met the criteria for clinically significant anxiety.

A confirmatory factor analysis was conducted to explore whether anxiety can be represented as a single-factor construct. When using the WLSMV estimator and controlling for school, a model with 7 items loading onto a single anxiety construct showed acceptable fit (X2 = 145.229, RMSEA = .07, CFI = .95, TLI = .93).

3.2.5.3 Co-Morbid Anxiety and Depression

About half of participants (51%, n = 280) did not meet the criteria for clinically significant depression or anxiety. Approximately 12% (n = 67) met the criteria for just anxiety, 15% (n = 81) met the criteria for just depression, and 23% (n = 124) met the criteria for both depression and anxiety.

3.2.6 Reproductive and Menstrual Health

3.2.6.1 Menstrual Health Practices

See Figure 7 for a description of menstrual health practices. Many girls engaged in both recommended practices (e.g., changing a pad at least every 8 hours) and non-recommended practices (e.g., wearing a product that is not fully dry after washing).

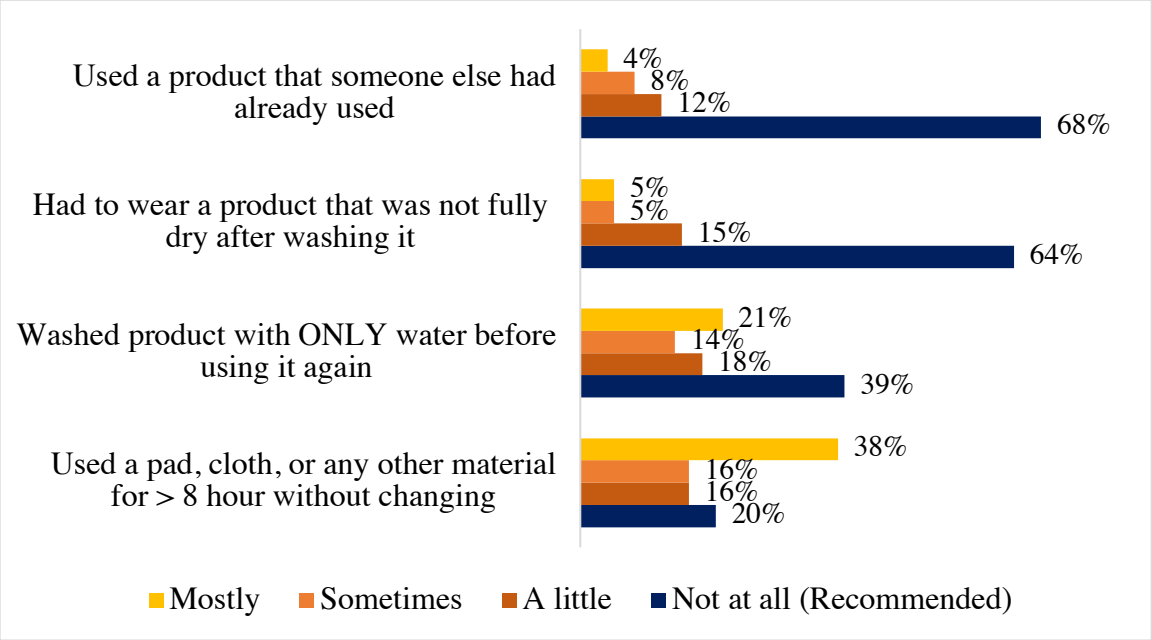

Figure 7: Menstrual Health Practices

3.2.6.2 Menstrual Resources

Pads were the most commonly used menstrual product (see Figure 8).

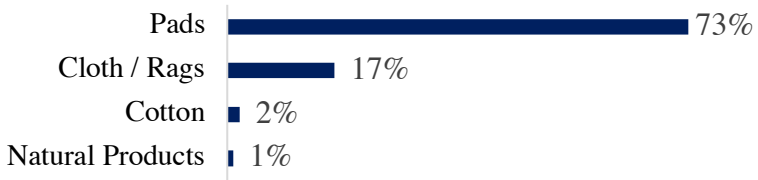

Figure 8: Menstrual Product Most Often Used by Participants

Forty-four percent (44%, n = 253) of participants reported there was a time when they could not afford to buy disposable sanitary pads. About 10% (n = 60) of participants reported buying their own menstrual supplies with their own money. Other sources of

menstrual supplies or money to buy menstrual supplies are listed in Figure 9. Most participants received menstrual supplies from their mother. About 7% (n = 35) of girls reported having sex to receive money to buy menstrual supplies.

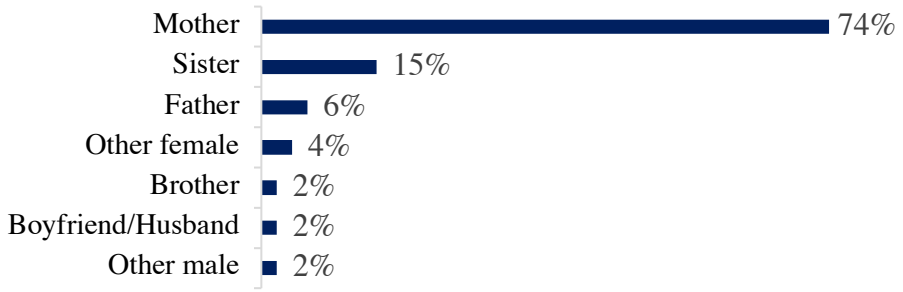

Figure 9: Source of Menstrual Supplies or Money for Supplies

In terms of water and latrines, 25% reported not having piped water inside the home, 5% reported not having clean water at home, and 18% reported not having a toilet where they can change or clean themselves at home.

3.2.6.3 Menstrual Knowledge

Forty-two percent (42%, n = 246) of girls did not know what their period was the first time they had it, and 24% (n = 138) were not able to track when their period would start or end.

Generally, participants were most comfortable talking to a female about menstruation. Table 25 shows the percentage of participants who indicated feeling comfortable talking to someone about menstruation. Ten percent (n = 57) of participants said they were not comfortable talking to anyone about menstruation.

Table 25: People with Whom the Participants Feel Comfortable Discussing Menstruation

Type of Person	N	%
Female family member	355	61
Female outside the family	134	23
Male family member	21	4
Male outside the family	19	3

3.2.6.4 Menstrual Participation

When participants were asked how difficult it is to perform all their normal activities during their period, the majority responded "somewhat difficult" (see Figure 10).

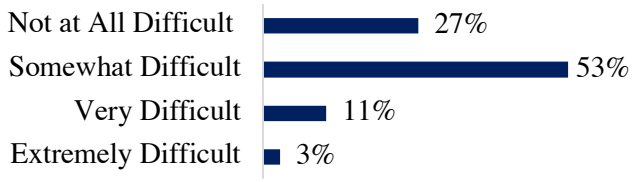

Figure 10: Difficulty of Performing Normal Activities While Menstruating

Figure 11 shows the percentage of participants that reported missing various activities of daily living. The most frequently missed activities were gamed and sports.

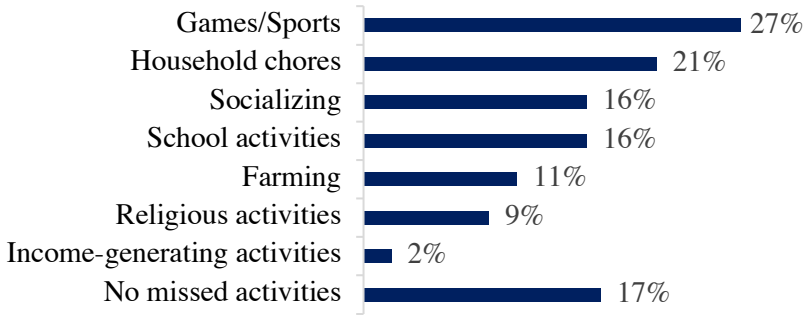

Figure 11: Missed Activities Due to Menstruation

Over the past three months of school, participants reported either missing school or leaving school early because of menstruation 2.07 days on average (median = 1, SD = 3.11), with a range from 0-30 days over the course of 3 months. There was a large amount of missing data for this question (20% missing), and data were non-normally distributed. Thus, this finding should be interpreted with caution.

The primary reason for missing activities was pain: 50% (n = 292) of participants missed activities due to pain or cramping. All reasons for missing activities are listed in Figure 12.

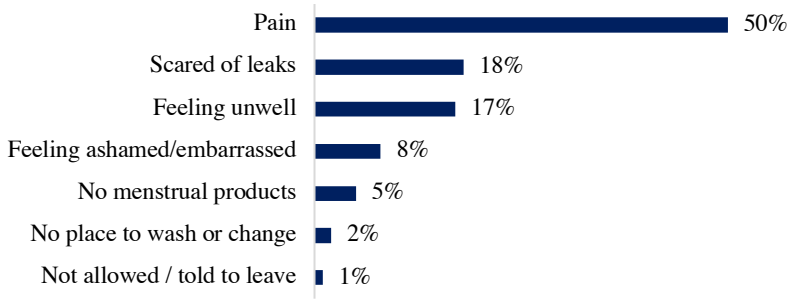

Figure 12: Reasons for Missing Daily Activities While Menstruating

Based on findings from early qualitative interviews, a question was added to ask if there were religious activities participants were not supposed to take part in during their periods. Figure 13 shows the types of religious activities that were prohibited, separated by the two primary religions.

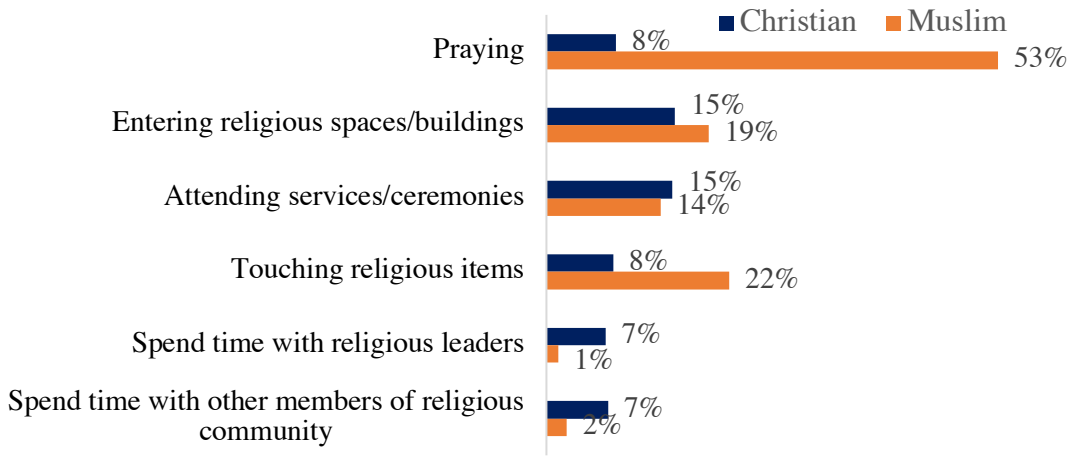

Figure 13: Prohibited Activities During Menstruation Separated by Religion

3.2.6.5 Sexual and Reproductive Health Risk

Fifteen percent (15%, n = 85) of participants reported having vaginal or anal sexual intercourse. However, a small number of girls skipped this question, but endorsed follow-up questions about sexual behaviors. For this reason, results will be reported for both the sample of girls who endorsed sexual intercourse and the overall sample.

The mean age of first sex was 15.24 (SD = 1.58). The median number of lifetime sexual partners was two (M = 2.56, SD = 2.762). A total of 38 participants reported having sex for pads or money to buy pads, which is about 42% of the subsample of girls who had endorsed sexual intercourse, and 7% of the sample overall. Lifetime use of contraceptives was rare: 32 participants (34% of those reporting sex) had used a condom, 10 participants (6% of those reporting sex) had received injectable contraceptives, 8 participants (8% of those reporting sex) had used an oral hormonal birth control pill, 2 participants (1% of those having sex) had used an IUD, and 2 participants (1% of those reporting sex) had used an implant. In the past year, 53 participants (9% of the overall sample and 58% of those who reported having sexual intercourse) had vaginal or anal sex without a condom.

A total of 138 (24%) participants reported engaging in intravaginal practices across their lifetime. Slightly more than 138 filled out the follow-up questions regarding IVP, so they are included in the following results, as they may have skipped the general question about IVP. Reasons for engaging in IVP are listed in Table 26, and items used for IVP are listed in Table 27. IVP was reported both by participants who endorsed sexual intercourse and those who had not.

Table 26: Reasons for Engaging in Intravaginal Practices

Reasons for IPV	N	%
To clean myself	154	27
To remove menstrual blood	38	7
To remove sperm	16	3
To please a partner	17	3
To prevent pregnancy	9	2
To prevent or cure infections / HIV	3	1

Table 27: Items Used for Intravaginal Practices

Items used for IPV	N	%
Water	100	17
Fingers	52	9
Soap	37	6
Cloth, sponge, paper, wipes	10	2
Lemon	13	2
Herbs/flowers	4	1
Vinegar	2	.3
Salt	1	.2
Beer	1	.2

Thirty-three participants (6%) reported a lifetime pregnancy, with six of those who had given birth also being married. About 29% (n = 168) had received an HIV test, with seven participants (1%) reporting knowing they are HIV positive.

Self-reported symptoms of sexually transmitted and endogenous reproductive tract infections were common. Fifty-six percent (56%, n = 329) of participants reported at least one symptom. On average, participants reported about 1.9 of 10 symptoms (SD = 2.11), with a range from 0 symptoms to all 10 symptoms endorsed. Table 28 shows the frequency of symptoms.

Table 28: Symptoms of Self-Reported Lifetime Reproductive Tract Infections

Symptom	N	%
Itchy, white, thick, clumpy discharge	170	29
Pain or burning during urination	114	20
Heavy bleeding between periods	110	19
Green or yellow discharge	112	19
Itching or burning in the genital area or inside the vagina	110	19
White and frothy vaginal discharge	90	16
Vaginal discharge with a strong, bad smell (e.g., fishy smell)	87	15
Redness or rash in the genitals	89	15
Sores, blisters, or ulcers in the genital area or inside the vagina	84	14
Pain or bleeding during sex	58	10

3.2.7 Structural Equation Models

For all structural equation models, full parameter estimates, including factor loadings and confidence intervals, can be found in Appendix C.

3.2.7.1 Are puberty-related stressors associated with mental health?

SEM was used to analyze the relationship between puberty-related stressors and depression and anxiety in separate models. Both models controlled for covariates of school and age.

As expected, puberty-related stressors were associated with depression (b = .853, p = .000) when controlling for age and school. For every unit increase in stressors, predicted depression increased by .85 units, all else held constant. Age and school were also associated with depression, with older age associated with greater depression (b =

.239, *p* = .000) and School 5 showing higher levels of depression than School 1 (b = .464, *p* = .001), all else held constant.

Separately, puberty-related stressors were associated with anxiety (b = .872, p = .000). For every unit increase in stressors, predicted anxiety scores increased by .87 units, all else held constant. Age and school also showed small, but significant relationships to anxiety. Individuals in School 5 had higher predicted levels of anxiety compared to School 1 (b = .381, p = .020). For every year increase in age, predicted anxiety increased by .161 units (b = .161, p = .000), all else held constant.

3.2.7.2 Are puberty-related stressors associated with reproductive tract infections?

SEM was used to analyze the relationship between puberty-related stressors and reproductive tract infections while controlling for age and school.

Puberty-related stressors were associated with a higher likelihood of reporting at least one symptom of a lifetime reproductive tract infection, when controlling for age and school. For a one-unit increase in stressors, the odds of reporting at least one symptom of a reproductive tract infection increased by 79% (b = .586, OR = 1.79). Age and school were also associated with RTI. The odds of reporting an RTI increased by 17% for a one-year increase in age. Predicted probabilities of reporting a reproductive tract infection at low, mean, and high levels of puberty-related stressors are provided in Figure 14. Overall, individuals at high levels of stressors, at the mean age, and in the

reference school show nearly a 70% predicted probability of reporting an RTI, compared to a 41% predicted probability at low stress.

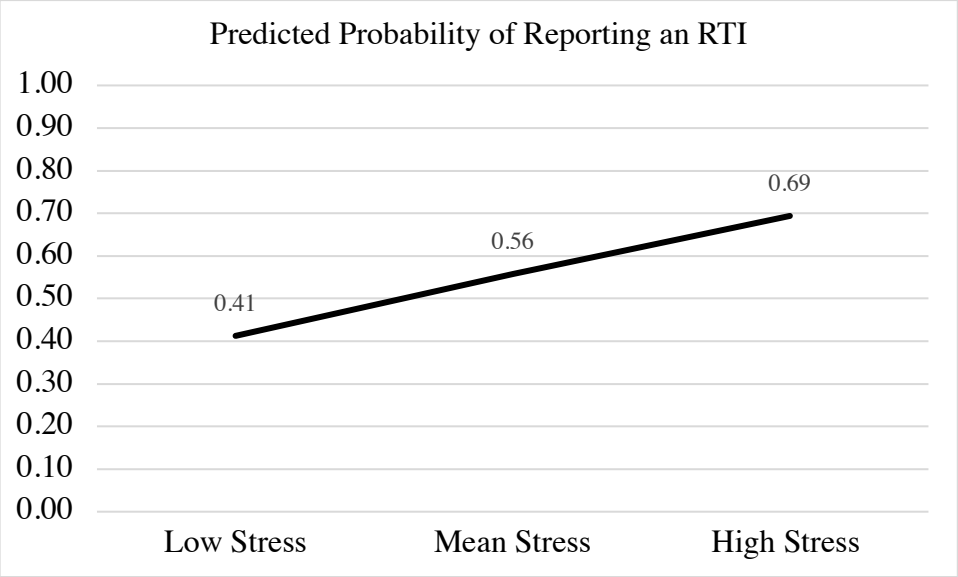

Figure 14: Predicted Probability of Reporting at Least One Symptom of a Lifetime RTI at Varying Levels of Stressors, All Else Held Constant

3.2.7.3 What are the structural relationships between factors for the (1) moderation and (2) indirect effects models?

Coping as a Moderator of the Relationship between Stressors and Mental Health: The following summarizes results from the four models in which active coping and avoidant coping are treated as moderators of the relationship between puberty-related stressors and mental health as measured by depression and anxiety. A summary of structural relations from the four structural equation models can be found in Figure 15. For ease of interpretation, factor loadings are not shown in these tables.

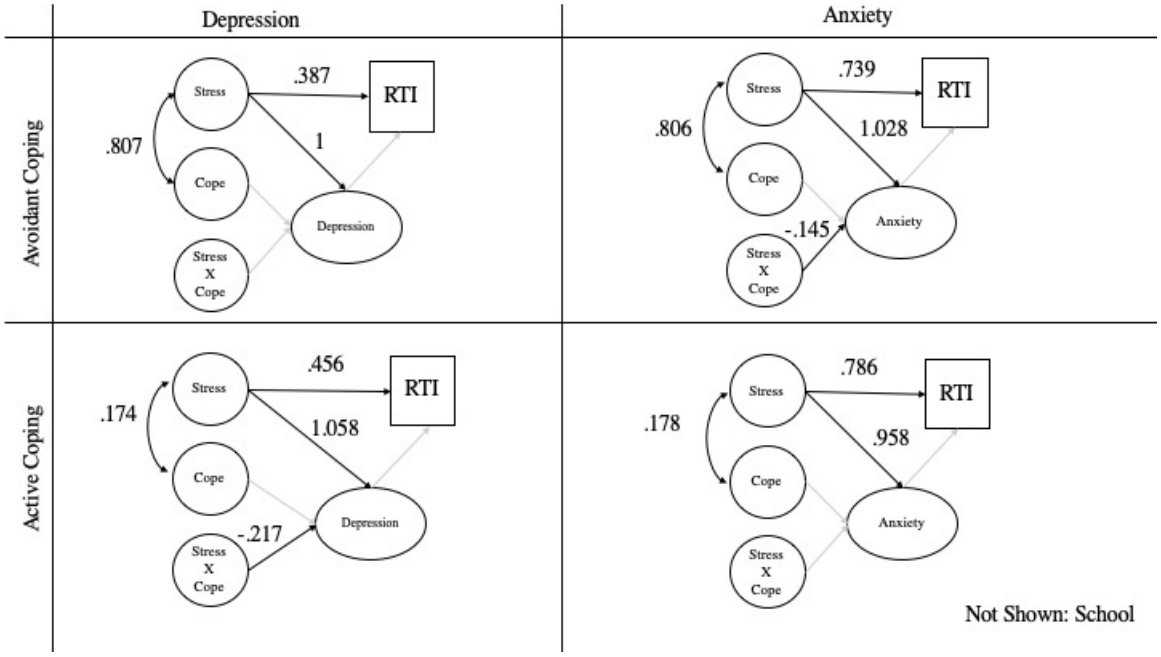

Figure 15: Moderation Models

Overall, avoidant coping did moderate the association between stressors and anxiety, such that for each unit increase in avoidant coping, the slope between stressors and anxiety decreased by .145 units. Interaction plots in Figure 16 show that the association between stressors and anxiety is strongest for those with low avoidant coping.

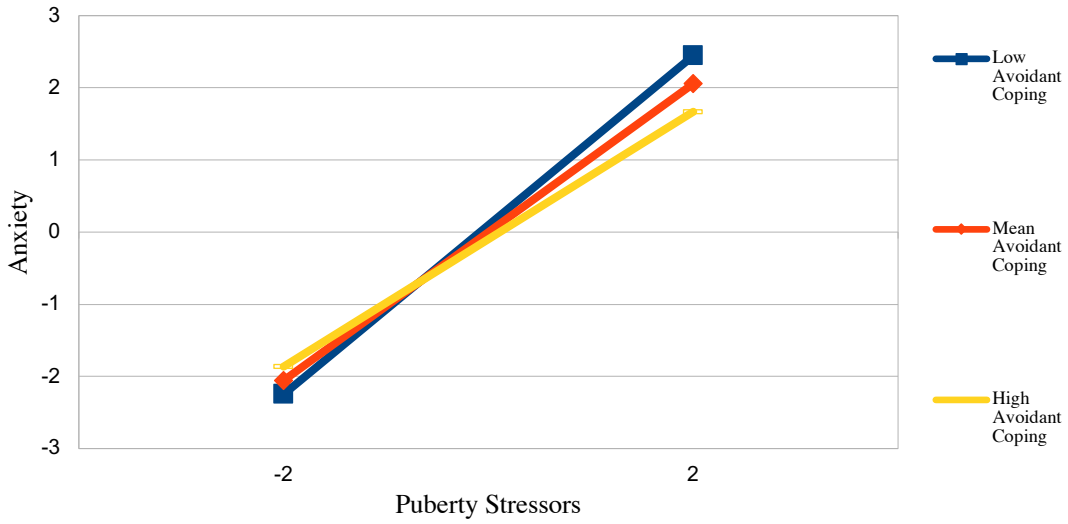

Figure 16: Interaction between Puberty Stressors and Avoidant Coping on Anxiety

Similarly, active coping moderated the association between stressors and depression. For every unit increase in active coping, the slope between stressors and depression decreased by .217. Interaction plots in Figure 17 suggest that active coping may buffer the negative impact of stressors on depression.

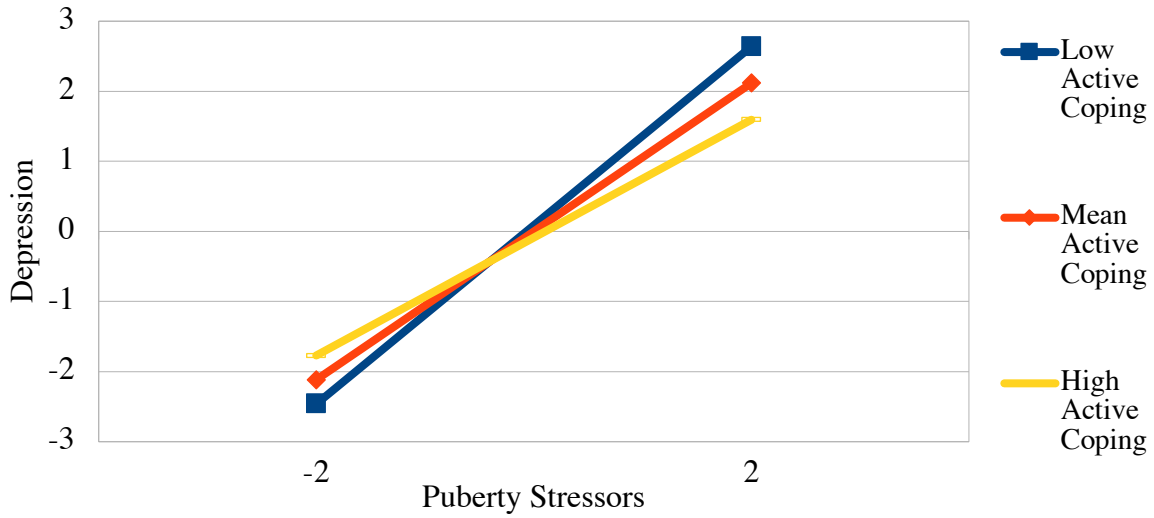

Figure 17: Interaction between Puberty Stressors and Active Coping

Alternatively, no moderation was found when exploring the relationship between avoidant coping and depression or active coping and anxiety. In addition, across all four models, no relationship was found between mental health and RTIs.

An Indirect Relationship of Stressors to Mental Health via Coping. The following summarizes findings from the four "indirect effects" models in which we examined the indirect relationship between stressors and mental health via coping. A summary of structural relations from the four structural equation models can be found in Figure 18.

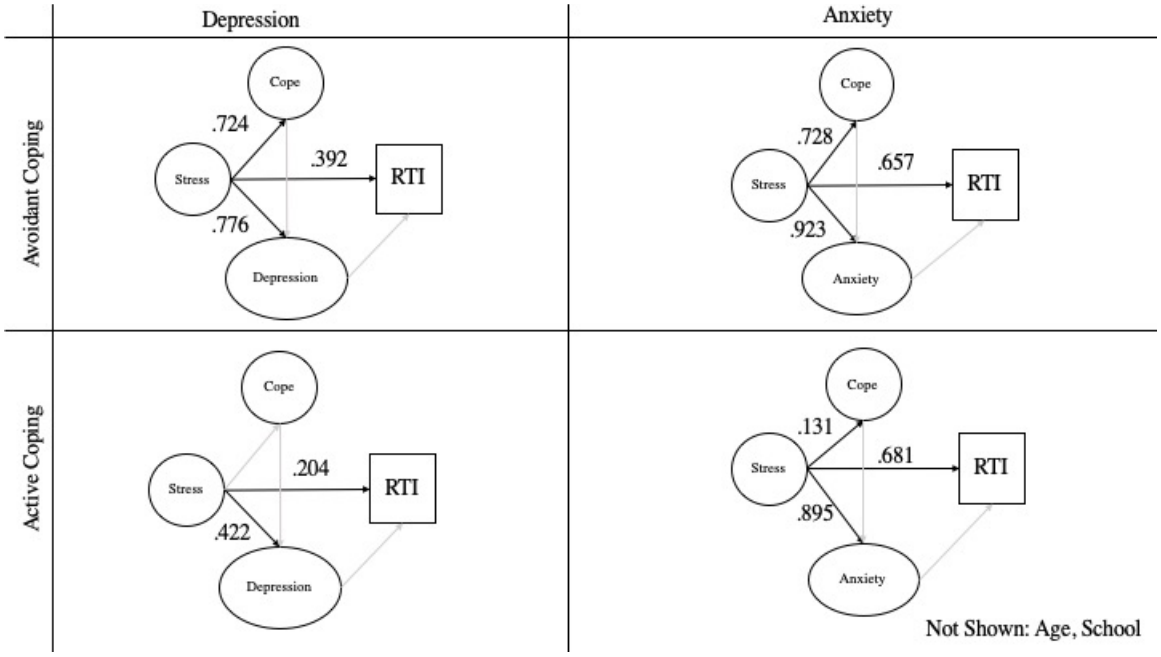

Figure 18: Indirect Effects Models

Stressors were significantly related to avoidant coping. For every unit increase in stressors, avoidant coping increased .724 units in the depression model and .728 units in the anxiety model. Stressors showed a less strong and less consistent relationship with active coping. For every unit increase in stressors, active coping increased by .131 units when anxiety was the focal outcome, but stressors were unrelated to active coping when depression was the focal outcome. Neither active coping nor avoidant coping showed relationships with anxiety or depression. As such, there was no evidence for an indirect effects model, although there is evidence that stressors shows direct relationships with coping, mental health, and RTIs.

3.2.7.4 Summary of Structural Equation Model Findings

Overall, across every model, puberty-related stressors were associated with depression, anxiety, the likelihood of a lifetime reproductive tract infection, and avoidant coping. Avoidant coping moderated the association between stressors and anxiety, and active coping moderated the association between stressors and depression. There was no indirect relationship from stressors to coping to mental health.

3.2.8 Linear Regression Models and Logistic Regression Model for Menstruation-Related Stressors and Coping

Exploratory analyses were conducted to investigate relationships between the different sub-scale means for menstruation-specific coping (health behavior coping, positive-affect inducing activities, emotion-focused coping, and avoidant coping) and mental health, as measured by summary scores for the PHQ-9 for depression and GAD-7 for anxiety. The correlation table can be found in Table 29.

Table 29: Bivariate Pearson Correlations Between Mental Health, Menstrual Coping, and Menstrual Stressors

	1	2	3	4	5	6
1. Depression						
2. Anxiety	.566*					
3. Health Behavior Coping	.417*	.281*				
4. Positive Affect-Inducing	.155*	.136*	.292*			
5. Emotion-Focused Coping	.066	.138*	.116*	.383*		
6. Avoidant Coping	.281*	.173*	.497*	.413*	.273*	
7. Menstrual Stressors	.527*	.469*	.537*	.196*	.165*	.429*

Note. * = significant at $p < .05$

In the first linear model, we examined the relationship between menstrual stressors, menstrual coping, age, and school with anxiety. With all variables in the

model, only menstrual stressors and age showed a significant relationship with anxiety, all else held constant, $F(10, 458) = 14.878$, $p = .000$, Adjusted-$R^2 = .229$. See Table 30 for full results.

Table 30: Linear Regression Results for the Relationship of Menstrual Stressors and Menstrual Coping to Anxiety

						95% CI for b	
Dependent Variable: Anxiety	b	SE	b*	t	Sig.	Lower	Upper
Health Behavior	.215	.370	.031	.580	.562	-.512	.941
Positive Affect	.151	.300	024	.502	.616	-.439	.741
Emotion-Focused	.443	.253	079	1.746	.082	-.056	.941
Avoidant Coping	-.532	.336	.081	-1.584	.114	-1.191	.128
Menstrual Stressors	3.744	.448	.425	8.352	.000	2.863	4.624
Age	.390	.141	120	2.774	.006	.114	.666
School 2	-.140	.547	.013	-.256	.798	-1.215	.935
School 3	.572	.548	052	1.043	.97	-.505	1.648
School 4	-.414	.641	.031	-.645	.519	-1.673	.846
School 5	1.205	.631	092	1.911	.057	-.034	2.444

In the second model, we examined the relationship between menstrual stressors, menstrual coping, age, and school with depression. With all variables in the model, age, school, health behavior coping, and menstrual stressors showed a significant relationship with depression, all else held constant, $F(10, 460) = 18.008$, $p = .000$, Adjusted-$R^2 = .36$. See Table 31 for full results.

Table 31: Linear Regression Results for the Relationship of Menstrual Stressors and Menstrual Coping to Depression

						95% CI for B	
Dependent Variable: Depression	b	SE	b*	T	Sig.	Lower	Upper
Health Behavior	1.454	.390	.182	3.725	.000	.687	2.221
Positive Affect	.098	.314	.013	.312	.755	-.519	.715
Emotion-Focused	-.235	.265	-.036	-.886	.376	-.756	.286
Avoidant Coping	-.074	.353	-.010	-.209	.835	-.768	.620
Menstrual Stressors	3.762	.466	.377	8.065	.000	2.845	4.679
Age	.785	.148	.210	5.312	.000	.492	1.075
School 2	-.067	.574	-.006	-.117	.907	-1.195	1.061
School 3	.297	.576	.023	.516	.606	-.834	1.428
School 4	-.651	.673	-.042	-.968	.334	-1.973	.671
School 5	1.528	.659	.101	2.318	.021	.233	2.823

Logistic Regression was used to examine whether menstruation-related stressors are associated with the likelihood of reporting at least one symptom of an RTI, controlling for demographics. In this model, school and menstruation-related stressors were both associated with RTI. Participants in school 1, 2, and 3 had a lower likelihood of reporting an RTI than students in school 5. Individuals who scored one unit higher on menstruation-related stressors had 4.52 times the predicted odds of reporting an RTI. Predicted probabilities are provided in Figure 19 for each school and for menstruation-related stress at low (-1 SD below the mean), mean, and high (+1 SD above the mean) values, all else held constant. Other findings for the logistic regression can be found in Table 32.

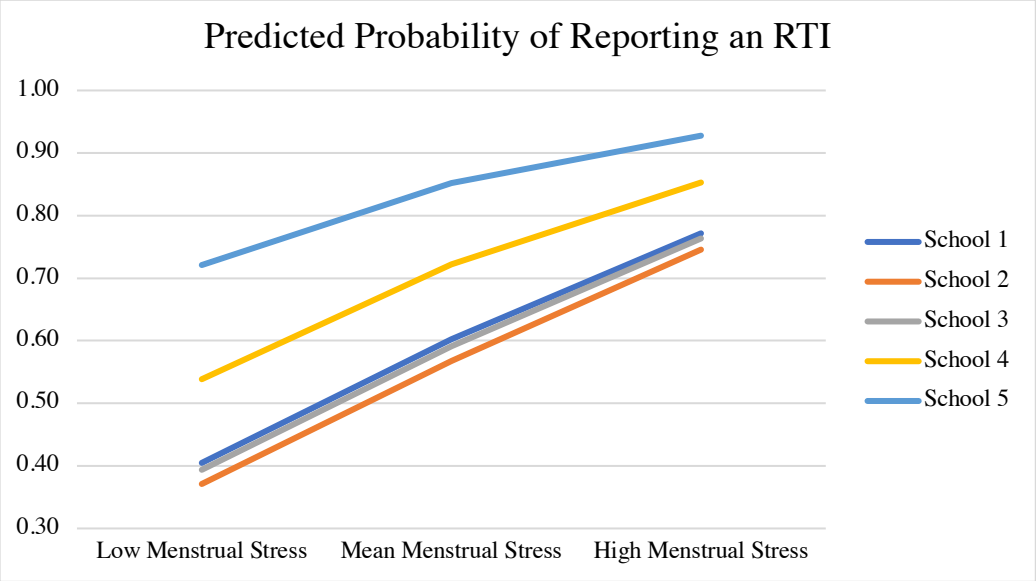

Figure 19: Predicted Probability of Reporting an RTI at Different Levels of Menstrual Stressors, with Age Held Constant

Table 32: Results from Logistic Regression with RTI as an Outcome

	b	S.E.	Wald	df	Sig.	Odds Ratio	95% CI for Odds Ratio	
							Lower	Upper
School 1	-1.335	.372	12.845	1	.000	.263	.127	.546
School 2	-1.477	.377	15.301	1	.000	.228	.109	.479
School 3	-1.381	.378	13.337	1	.000	.251	.120	.527
School 4	-.795	.417	3.634	1	.057	.452	.200	1.023
Age	.121	.078	2.424	1	.119	1.128	.969	1.314
Menstrual Stressors	1.507	.229	43.282	1	.000	4.515	2.881	7.074
Constant	-3.124	1.267	6.073	1	.014	.044		

Note. -2LL = 571.730, Naglekerke R-Squared = .204, Hosmer and Lemeshow Test P = .365, 70% accurately classified.

3.3 Quantitative Discussion

3.3.1 Summary and Integration

This quantitative study sought to describe the relationships between menstrual- and puberty-related stressors, coping, mental health, and reproductive health among adolescent girls enrolled in school in the Kilimanjaro region of Tanzania. Cross-sectional data were collected from 581 menstruating adolescent girls and young women across five schools in Moshi, Tanzania. Participants reported significant menstruation- and puberty-specific stressors, high levels of anxiety and depression, a concerning level of sexual risk concentrated among the subset of participants who had reached sexual debut, and poor menstrual and reproductive health. Menstruation- and puberty-specific stressors were associated with depression, anxiety, and the likelihood of reporting at least one lifetime symptom of a reproductive tract infection. Coping showed nuanced and less-consistent relationships with mental health, and depression and anxiety were not associated with the risk of reproductive tract infections.

3.3.1.1 Stressors

Participants reported a variety of stressors during puberty, with unwanted sexual feelings, sexual pressure, or sexual attention constituting the most frequently endorsed puberty-related stressor, and menstrual cramping or pain constituting the most frequently endorsed menstruation-related stressor. The second most common

menstrual stressor was acne, which has largely been overlooked as a source of stress or diminished self-confidence for girls in low-resource settings.

There was a discrepancy between feeling embarrassed about menstruation, which was endorsed by 62% of participants, and actual teasing experienced by participants, which was reported by only 25% of participants. This highlights the potential negative impact of anticipated and internalized stigma and shame, even when those fears are not fully materialized in the form of teasing. Other mental health-related stressors included feeling sad or lonely and mood swings, which were both endorsed by more than half of the sample.

Participants endorsed concerning levels of potentially life-altering general stressors, such as losing a loved one or dealing with violence in the neighborhood. However, all general life stressors, except for having extra work or chores, were reported less often than menstruation- and puberty-specific stressors. This suggests that menstruation and puberty stressors are more prevalent than general life stressors during adolescence.

3.3.1.2 Coping

For puberty-related stressors, the most commonly used methods of coping were active coping strategies, followed by avoidant coping strategies and religious coping strategies. For menstruation-specific coping, the most common strategies were emotion-focused coping, followed by positive-affect inducing activities, health behavior coping,

and avoidant coping. Although pain was the most common stressor, pain management strategies were rarely utilized.

It should be noted that other studies in sub-Saharan Africa suggest religion typically plays a more prominent role in coping among adolescent girls (Puffer et al., 2012). However, our research found that girls faced increased restrictions on religious activity during menstruation. As such, future research is needed to explore if religious restrictions or religious taboos about sexuality and menstruation prevent girls from using religious coping skills for menstruation- and puberty-specific stressors, and if so, whether this impacts their mental health or well-being.

3.3.1.3 Mental Health

Mental distress, measured by both anxiety and depression, was high in this sample, with about half of participants showing evidence of clinically significant depression and/or anxiety. The high level of depression reported by participants is supported by similar research in East Africa (Kuringe et al., 2019; Neese et al., 2013; Omoro et al., 2006). Our findings are congruent with other research with the PHQ-9 among adolescents in Kenya, which suggests this measure performed well in the Tanzanian context (Omoro et al., 2006).

One particularly worrying symptom is the high rate of suicidality and thoughts of self-harm, reported by 49% of participants. Although other studies employing the PHQ-9 with adolescent girls in Tanzania have found lower rates of suicidality, these

studies are typically among girls enrolled in HIV prevention or treatment studies, where surveys are not anonymous and participants may be receiving a higher level of mental health support than is typical. For example, one study among adolescent girls and young women enrolled in a HIV-prevention trial showed that 20% endorsed the PHQ-9 item on suicidality (Cherenack et al., 2020). In the current study, suicidality and thoughts of self-harm were most strongly associated with having clinically significant levels of anxiety or depression, a history of being pregnant, and identifying as Muslim. Interventions and research to reduce the risk of self-harm should ideally be focused on these high-risk groups. Our findings regarding suicidal ideation were communicated to local community leaders, who concurred with the findings and noted the need for additional counselors in school settings.

3.3.1.4 Reproductive Health

Participants reported mixed levels of access to menstrual resources and variable ability to engage in healthy menstrual health practices. This indicates inconsistent availability of resources and the need to ensure resource delivery is more sustainable, consistent, equitably distributed, and controlled by women and girls.

Participants noted that menstruation impacts their ability to fully participate in activities such as games/sports and household chores. The primary reason for missing activities was pain, which suggests pain should be a primary area of focus to improve quality of life. Both Christian and Muslim participants described religious activities

prohibited during menstruation, although they differed in which specific activities were not allowed.

Only 15% of participants reported having sexual intercourse, but sexual risk was high among those who had reached sexual debut. Among those who reported sex, very few had used contraceptives. Consequently, although the number of participants having sex was relatively low, the risk for STIs and unplanned pregnancy for sexually active women and girls was high.

Symptoms of reproductive tract infections were high among both sexually active participants and participants who denied sexual activity. Symptoms could be indicative of endogenous RTIs and genital-urinary infections, such as candidiasis, bacterial vaginosis, or a urinary tract infection, which do not require sexual activity to develop. Intravaginal practices were also prevalent among girls who denied having sex, which could lead to symptoms of RTIs.

It is possible that some participants misunderstood questions about vaginal discharge – for example, some may have thought normal discharge was the same as "itchy, white, thick, clumpy discharge." However, many of the symptoms endorsed were clearly indicative of illness, such as "pain or burning during urination" or "sores, blisters, or ulcers in the genital area," which were both endorsed by a number of participants. There remains a chance these symptoms could have an alternative explanation, such as dermatological conditions. This work provides evidence that future

research using more costly biomarkers to study reproductive tract infections is warranted, such as vaginal swabs to test for RTIs or examine the vaginal microbiome.

3.3.1.5 Relationships between Stress, Coping, Mental Health, and Reproductive Health

School showed a significant relationship to certain key constructs, including mental health and reproductive health. This suggests that social environment may be one area for intervention, although more research is needed to explore whether there are other confounding factors, such as neighborhood, religiosity, or socioeconomic status, that better account for school-level differences.

Both menstrual- and puberty-related stressors were consistently associated with depression and anxiety and reproductive tract infections across all models, regardless of whether we controlled for puberty-related coping as a moderator, looked at indirect effects of puberty-related coping, controlled for menstrual coping in a multiple regression, analyzed data via latent factors in SEM, or used summary scores in logistic regressions or linear regressions. For this reason, our study adds to the literature showing strong support for the relationship between stressor exposure and mental health and reproductive tract infections.

Depression and anxiety did not show any relationships to reproductive tract infections. Thus, our research did not provide support for the hypothesis that depression and anxiety account for the association between stress and RTIs. The link between stress and RTIs may be reflective of multiple other processes, including 1) the negative role of

stress on immune system functioning and the vaginal microbiome, 2) increased health risk behaviors (e.g., unprotected sex, intravaginal practices) among those who are more stressed, or 3) the stressful nature of having a reproductive tract infection. Additional research is needed to explore the mediating mechanisms connecting stress and RTIs.

Coping was inconsistently related to other variables in the model. Participants with higher active coping showed a weaker relationship between stress and depression. This finding supports the growing body of evidence that increasing active coping is one strategy to reduce depression among girls experiencing stress, and it suggests the need to focus on puberty-related stressors among girls in Tanzania (Martin & Oliver, 2019). For anxiety, those with higher avoidant coping showed a weaker relationship between stress and anxiety. Thus, lower avoidant coping did not show the protective association we had expected.

Although the finding that low avoidant coping was associated with less anxiety when stressors were high is contrary to the original hypothesis, there are a number of compelling explanations for this finding. First, the strength of the moderation was small, so it may be statistically significant, but not practically or clinically significant. Second, prior research suggests avoidance plays a role in perpetuating anxiety, which can occur in the absence of an identifiable or immediate stressor (Borkovec et al., 2004; Kashdan et al., 2006). So, for participants who report a low number of stressors who still have high anxiety, it is possible that avoidance plays a role in the etiology and maintenance of

anxiety, even if it does not play the same role for those with more significant stressors. Third, the role of avoidant coping may be different at high levels of stress. There may be situations where certain forms of avoidant coping provide temporary relief when stressors are overwhelming. There is some evidence for this in research in which depressive symptoms are reduced via "distractive coping" (Morrow & Nolen-Hoeksema, 1990). It is possible that some of the items in the avoidant coping measure may be more accurately described as "distractive coping," which can be adaptive in certain situations. Fourth, it is possible that it is more important to consider coping flexibility than which coping skills are used, and higher scores on avoidant coping may be a marker for more flexible coping strategies (Kato, 2017). Fifth, cultural influences may impact whether avoidant coping is adaptive in a given situation. Lastly, as discussed below and explored in the models of indirect effects, there is evidence that high levels of stressors may influence greater use of avoidant coping strategies, and perhaps moderation is not the ideal model for exploring the link between stress, avoidant coping, and mental health.

In the models examining the indirect effects of coping, there was no evidence in any of the models that puberty-related coping played an indirect role in explaining the relationship between stressors and mental health. However, stressors did strongly associate with avoidant coping in all models. The relationship between stressors and avoidant coping was stronger than the relationship between stressors and active coping,

and there was no relationship between stressors and active coping with depression in the model. This supports the notion that certain types of stress, such as high levels of stress that may feel overwhelming, are more likely to be associated with avoidant coping, although a full indirect effects model was not supported by the current findings. It is possible that high levels of uncontrollable or overwhelming stress prompt distraction strategies in ways that are not actually harmful in the short-term, although the impact on longer-term outcomes is unknown.

Health-related menstrual coping was significantly related to depression, even when controlling for menstruation-related stressors. It is possible that an unmeasured confounding variable, such as somatization, explains both greater reliance on health-related coping and higher levels of depression.

Overall, our research suggests coping shows varying relationships to mental health and that further investigation is needed to determine which methods of coping are adaptive in a particular scenario.

3.3.2 Limitations

This study was completed in a low-resource global setting, and there are some limitations associated with conducting research in this context. For example, translating surveys from English to Swahili may not fully account for differences in cultural meanings, which could lead to measurement error. Pen-and-paper questionnaires may be an additional source of measurement error and missing data due to mistakes.

However, the use of latent factors in structural equation modeling was employed to reduce the influence of measurement error.

Due to the age of our participants and their economic vulnerability, we were particularly careful to avoid any form of coercion to take part in our study beyond the small bar of soap and pencil we provided as compensation for participants' time. Taking part in the study was completely voluntary and in some cases required staying after school or missing out on time for sports/games. In addition, the study was explained to all girls regardless of menstrual and pubertal status. This may have led to lower participation rates than would be ideal.

Although the directionality of our proposed model was drawn from prior theory, our cross-sectional data are not adequate to infer causality. In particular, we measured lifetime symptoms of reproductive tract infections rather than only recent symptoms, because many infections are time-limited or have intermittent flares of symptoms, so measuring recent symptoms had the potential to miss many individuals who had one or more symptoms, albeit not currently. This method has been used in similar studies, but it does prevent us from making statements about causality (Mazzaferro et al., 2006). Our data do provide evidence that more costly longitudinal studies or randomized controlled trials are warranted to explore causality.

Practical considerations limited our sampling strategy to five schools. The small school-level sample made it impossible to conduct multi-level analyses. As such, we

controlled for school by including the schools as covariates. All participants in the study were enrolled in school, which makes it unclear whether findings would generalize to an out-of-school population.

Moderation models examining puberty-related stressors and coping would not converge when age was added to the model, although attempts were made to modify start values and the number of iterations and integration points. The number of iterations that would have been required for convergence was implausible to complete in the latent interaction models, given the existing need for considerable computing power to complete the latent interaction. However, in other models, age only showed small relationships to outcome variables and did not influence the overall findings. As such, we do not expect that leaving age out of the moderation models invalidates the general findings.

We used maximum likelihood estimation with robust standard errors (MLR) because it was the only estimator available for running a latent interaction with ordinal variables, and because MLR is proficient at handling missing data and departures from normality. However, this method uses raw data for analysis, and as such does not provide global fit indices. This makes it difficult to evaluate overall model fit.

Self-report symptom inventories may result in measurement error and are not sufficient for clinical diagnosis. Alternative methods include biomarkers to measure outcomes such as RTIs and recent unprotected intercourse and clinician-implemented

measures to measure mental illness. The present study suggests these higher-cost strategies may be justified moving forward.

3.3.3 Generalizability

In some ways our sample is reflective of the general population in Tanzania, including breakdowns by religion and age at first sexual intercourse (Central Intelligence Agency, 2020; Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland] et al., 2016). However, our findings do suggest participants from the current sample of girls in school report greater socioeconomic resources than women and girls in the general population of Tanzania, which is to be expected (Central Intelligence Agency, 2020; Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland] et al., 2016). For example, demographic surveys indicate 86% of households in urban mainland Tanzania have improved drinking water and 25% of households in urban mainland Tanzania have piped water inside the home/yard, whereas 69% of our sample had piped water inside the home (Demographic). Thus, these findings may not generalize to the broader population of out-of-school girls in Tanzania. However, participants in this sample still report limited resources compared to high-income settings, and the results are likely generalizable to the population of girls enrolled in schools. Although future work should focus on girls out of school, it is still important to

get an understanding of girls in school, because schools are one likely avenue for future interventions.

One potential limitation to generalizability is that response rate was 54%, and we are unable to make inferences about differences between girls who did and did not complete the survey. However, prior research shows a response rate of 54% is well above the minimum required rate to reduce bias (Nulty, 2008).

It is unknown how well our findings generalize to other settings in sub-Saharan Africa. However, prior research on menstrual poverty suggests there are many similarities in the experiences faced by girls across regions, even if some specific cultural practices (such as menstrual restrictions and myths) differ by region, tribe, or religion (Sommer et al., 2015). In addition, findings regarding the impact of stress on mental health and physical health appear to have cross-cultural stability, with relationships between stress and health consistently found across cultures, countries, and populations. For this reason, we feel our findings are likely applicable to other low-income settings in SSA with menstrual poverty, but additional research is needed to confirm this possibility.

3.3.4 Suggestions for Intervention and Prevention

3.3.4.1 Stress-Reduction Interventions to Improve Mental Health and Reproductive Health

The present research suggests interventions to reduce stress may be one method of improving both mental health and reproductive health. Mindfulness-based stress

reduction (MSBR) for adolescents in the United States has been shown to effectively reduce pain, perceived stress, and anxiety, which suggests it could be an efficient multi-target intervention (Ali et al., 2017). Further research is necessary to explore cultural adaptation of MSBR for use with girls in SSA. Examples of other individual-level stress-reduction interventions that have been used with adolescents include cognitive stress-reduction (with a focus on modifying stress-promoting cognitions), stress-reduction guided imagery, meditation, and physical activity (Brown & Siegel, 1988; Hains & Szjakowski, 1990; Weigensberg et al., 2009).

Quantitative findings show that girls with depression may also benefit from interventions to increase active coping, such as behavioral activation for adolescents, which has shown preliminary efficacy in high-income countries but remains understudied in low- and middle-income settings (Martin & Oliver, 2019). Interventions with a specific focus on suicidal ideation and self-harm are needed, due to the high level of endorsement for suicidal ideation and non-suicidal self-harm on the PHQ-9, especially among girls who had been pregnant, girls who are Muslim, and girls with clinically significant anxiety or depression.

Lastly, participants reported high levels of specific stressors, such as sexual pressure, menstrual pain, and acne. Targeted behavioral, structural, and medical interventions to address these issues are warranted.

3.3.4.2 Menstrual Pain Coping Interventions

Many participants experienced menstrual pain, but menstrual pain coping strategies were not frequently used. For these reasons, pain coping interventions are needed, which may include pharmacological treatments or behavioral medicine approaches, such as cognitive-behavioral therapy for pain coping (see section 2.3.4.2).

3.3.4.3 Improving Access to Consistent Resources

Participants reported variable access to menstrual health materials, and most participants engaged in recommended practices at least some of the time. However, most participants did not have the resources to engage in these behaviors consistently. This suggests the need to ensure resources are consistently and predictably available, with a reliable flow of supplies that can be controlled by girls themselves.

3.3.4.4 Sexual Health Interventions for Girls at Highest Risk

Only 15% of the sample engaged in sexual intercourse. However, those that did engage in sexual intercourse faced a high level of risk due to unprotected intercourse and transactional sex. As such, efforts should be made to focus on girls who are sexually active and provide them education, social support, and contraceptives to prevent STIs and unplanned pregnancy. There is a large body of research on interventions to reduce sexual risk among girls in SSA (Toska et al., 2017). Our study provides evidence that girls would also benefit from financial resources or the provision of menstrual supplies to prevent the need for transactional sex for menstruation-related supplies.

3.3.4.5 Diagnosis, Treatment, and Psychoeducation for Reproductive Tract Infections

More than half of the sample reported at least one symptom of a reproductive tract infection. One potential explanation for this is that girls did not understand the questions and are misinterpreting normal vaginal processes. In this case, greater psychoeducation is needed on reproductive health and issues such as vaginal discharge, intravaginal practices, and vaginal health. The other explanation is that girls are experiencing high rates of both endogenous reproductive tract infections and sexually transmitted infections. In this case, there is a need for greater screening for RTIs, education about the prevention of RTIs, and RTI treatment. Girls and their caregivers should be made aware that these issues are common, treatable, and in many cases unrelated to sexual activity or personal hygiene.

4.0 Final Discussion

4.1 Comparing Qualitative and Quantitative Findings

Qualitative and quantitative findings are largely in congruence, which provides evidence for the strength of our findings, since the studies were implemented concurrently. In some cases, interviews provided additional detail that may be useful in refining future measures. In addition, the interviews provide support for the causal structure hypothesized in the structural equation models.

4.1.1 Stress

In both the qualitative and quantitative studies, the most common puberty-related stressor was sexual attention/pressure, and the most common menstrual-related stressor was pain. However, pregnancy was a more common stressor in the qualitative interviews, which is likely due to having a higher percentage of girls who had been pregnant. Interpersonal conflict was not included in the quantitative measure of puberty-related stress, and the interviews suggest this should be added to future research. Likewise, greater attention to anger and irritability would be useful to explore in future surveys.

4.1.2 Coping

The interviews provided ideas for additional coping items that should be added to future measures on coping with menstruation, including additional items on planning ahead, using menstrual resources, specific activities for emotion-regulation (e.g.,

dancing, listening to music), cognitive reframing of menstrual pain, humor, working for money/resources, giving up on coping, and more nuanced questions to delineate practical support versus emotional support and avoidant coping versus energy conservation or emotion regulation.

4.1.3 Mental Health

Besides discussing feelings of anger and sadness, interview participants did not spontaneously bring up mental health as a major stressor or as a negative outcome of stress. This is in contrast to the surveys, which suggest high levels of depression and anxiety. Potential explanations for this include stigma surrounding mental illness, a lack of knowledge about mental health, cultural norms that discourage displays of vulnerability, and a lack of discussion about mental health in daily life.

4.1.4 Causal Model

In the structural equation model, there is no way to test whether puberty-related stressors are causing depression, anxiety, and reproductive tract infections or if these factors increase the likelihood of reporting more puberty-related stressors. However, participants' narratives identified stressful events, such as interpersonal conflict, menstrual pain, teasing, or resource deficits, as the cause of anger and sadness, which suggests it is reasonable to hypothesize that puberty-related stressors impact mental health. It is true, however, that relationships may be bi-directional, and longitudinal models would be well-suited to explore this further.

4.2 Contributions to Models of Stress and Coping

Both studies provided support for the hypothesis that stressors impact well-being and that there are individual-level differences in how girls appraise and respond to stressors via various coping mechanisms.

Findings from both studies combined show that coping is a nuanced construct. It appears that some stressors, such as interpersonal stressors and high levels of stressors, are more likely to prompt avoidant coping strategies. It also appears that active coping can be beneficial for limiting the impact of stress on depression, and in qualitative interviews girls report positive outcomes from using social support coping and active coping. Additional research is needed to explore whether distraction can be an effective coping method, despite falling under the umbrella of avoidant coping. Overall, this study provides evidence that there are complex stress and coping mechanisms impacting adolescent girls in Tanzania, and more research is needed that takes into account specific stressors, coping strategies, and outcomes.

4.3 Next Steps for Research

Taken together, Study A and Study B provide suggestions for future research to determine the best methods to intervene on the link between stress and poor mental health and reproductive health. These findings provide evidence that mixed-methods research should be used to obtain a rich understanding of the complicated context in

which coping occurs and to examine causality using longitudinal or experimental quantitative methods.

In addition to combining qualitative and quantitative research, the most effective studies on reproductive health will likely include biological markers, which can be more reliable and valid than self-report.

Both the interviews and the quantitative surveys show the need for psychological interventions for stress-management, menstrual pain, and sexual risk reduction. Additional research is needed to ensure these interventions are appropriate for use with adolescent girls in Tanzania.

5.0 Conclusions

Overall, this dissertation was designed to explore the types of stressors experienced by adolescent girls as they transition through puberty, the ways girls cope with stressors, and the interrelationships between stressors, coping, mental health, and reproductive health. Through a qualitative interview study and a quantitative cross-sectional survey study, we found that girls experienced significant and disruptive menstruation- and puberty-specific stressors in Tanzania, and these stressors were associated with poor mental health and reproductive health. Our work provides evidence that puberty is a critical time during which adolescent girls could benefit from additional support, and there is a need for community-level, family-level, and individual-level interventions to improve mental health and physical health. Further research is necessary to adapt evidence-based strategies for stress-reduction and pain management for use among adolescent girls in Tanzania. It is only by addressing issues impacting adolescent girls that we can reduce gender disparities during adolescence and improve the well-being of girls and women in global settings.

Appendix A

Interview Guides

ADOLESCENT GIRL INTERVIEW GUIDE - ENGLISH

Original Questions implemented 7/2018, additional probes on pain and anger were added 8/2018 and are noted below.

BOLD = Primary Questions, Non-bold = Suggestions for Probes

MAIN THEME QUESTIONS:

1. **What are the CHALLENGES or STRESSORS relating to puberty and menstruation?**
2. **How are girls COPING or MANAGING these challenges?**
3. **How and why does stress and coping impact MENTAL HEALTH?**

General Follow up probes:

- Can you tell me more about that? Can you explain more about…
- What did you mean when you said….
- Can you give an example? Can you be more specific?

Opening Questions to Build Rapport

- **How old are you?**
- **Are you in school? If no, are you working?**
- **Where do you live?**
- **Who do you live with?**
- **Are you married?**

Stress and Coping

I want to talk about any things that may have been challenging, stressful, or difficult for you as you've become an adolescent and started to menstruate. I would like to know what has been difficult and how you've tried to manage these difficulties. Or if things haven't been difficult, I'm would like to know if there's anything you did to avoid difficulties or manage/cope with difficulties.

- **How has getting older and beginning to menstruate impacted your life?**
    - What important changes have you experienced as you grow older? How does a girl's life change when she starts to menstruate? How have these changes impacted you? Does a girl face any new challenges or benefits due to menstruation? Since you started your period, do you feel any different? Are you expected to do anything different than before?

- **In general, what are the greatest challenges/stressors in your life?**
    - Was there anything especially bad or good that happened? Is there anything you would like to have been different?

- **How do you try to manage these challenges/stressors?**
    - What was your immediate reaction or feeling? What did you do in response? Was there anything you tried doing to feel better? If you felt good, what do you think helped make it a good experience? What would have prevented challenges? What helped you avoid challenges? What resources did you/would you need to be able to cope with this challenge?

- **Are there any difficulties, challenges, or stressors that you've encountered due to puberty or menstruation?**
    - Was there anything especially bad or good that happened? Is there anything you would like to have been different?

- **If there are any difficulties surrounding menstruation or other aspects of puberty, how do you manage these?**
    - What was your immediate reaction or feeling? What did you do in response? Was there anything you tried doing to feel better? If you felt good, what do you think helped make it a good experience? What would have prevented challenges? What helped you avoid challenges? What resources did you/would you need to be able to cope with this challenge?

- **How does menstruating impact your mood or emotions?**
    - As you've gotten older, do you think you've become happier, less happy, or stayed about the same?
    - When you menstruate or right before you menstruate, do you ever feel unusually tired, energized, angry, calm, upset, happy,

or another emotion? Does menstruation or getting older change your self-esteem or the way you feel about your body (confident, proud, ashamed, embarrassed)?
    - If you do feel [emotion], what do you do to manage this emotion?
    - (Added 8/2018): If mentioning anger: What makes you angry? What do you do when you are angry? What makes your anger worse? What makes your anger better? Is there anything you think would help manage your anger better? How does anger impact your relationships or other aspects of your life?

- **Do you ever experience physical problems during or right before menstruation? (Cramps, headaches, acne, tiredness, etc.)**
    - (Added 8/2018): Where in your body do you feel pain? (Clarify if it is back pain, menstrual cramps, stomach ache, nausea, bloating, etc.)What type of pain is it? (e.g., cramping, stabbing, throbbing) When does the pain start? When does pain get the worst? When does pain end? What makes the pain better? What makes the pain worse? Does the pain keep you from doing anything? Does the pain impact your emotions? What do you wish you had to help manage the pain? Who can you talk to about pain? How do you cope with pain even if you can't make it go away right away?

- **Tell me about the first time you got your period.**
    - **What made it harder or easier to manage your first period?**
        - What was your immediate reaction or feeling? If your reaction was negative (you felt bad) was there anything you tried to do to feel better? If your reaction was positive (you felt good), what do you think helped make it a good experience? What did you use to absorb menstrual blood (pads, cloth, tissues, nothing, etc.)? Who/where did you get materials from? Did you tell anyone? Please explain. Was there anything especially bad or good that happened the first time you got your period? Is there anything you would like to have changed about the first time you got your period?

- **Tell me about the most recent time you got your period.**
    - Were you prepared for it? If yes, what helped you? If no, what did you need more of? What did you do and/or use to manage it (pads, cloth)?

Wrap-Up

- **Do you have anything else you would like to add to the conversation that we have not yet covered?**

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Original questions implemented 7/2018, additional probes on menstrual pain were added on 8/2018 and 10/2018 and are noted below.

BOLD = Primary Questions
Non-bold = Suggestions for Probes

MAIN THEME QUESTIONS:

4. **What are the CHALLENGES or STRESSORS relating to puberty and menstruation?**
5. **How are girls COPING or MANAGING these challenges?**
6. **How and why does stress and coping impact MENTAL HEALTH?**

Follow up probes:
- Can you tell me more about that?
- What did you mean when you said….
- Can you give an example?

<u>Opening Questions to Build Rapport</u>
- **What is your role in working or living with adolescent girls/young women?**
    - What is your occupation? If you are a parent, how many children do you have? How long have you worked with or lived with adolescent girls / young women?

<u>Questions about Puberty & Getting Older</u>
- **What is it like being an adolescent girl/young woman in Tanzania?**
- **How does a girl's life change when she goes through puberty and starts to menstruate?**
    - How do girls' lives change as they get older? How are girls expected to act when they start menstruating? Who makes the rules about what girls should or should not be doing? What traditions and restrictions during menstruation are girls expected to follow? What impact do rules/restrictions have on girls? Does a girl's typical day change when she is menstruating? How? Are there positive aspects to traditions? Are there activities girls are not allowed to take part in as they get older? Are there activities girls are not allowed to take part in when they are menstruating? Who

makes and enforces the rules/restrictions about what girls can or cannot do when they are menstruating?

Stressors, Advantages, and Coping Strategies

- **What challenges do girls face due to puberty and menstruation?**
- **What are the resources available for girls to manage challenges?**
    - Overall, what do you think are the biggest challenges girls face? Why do these challenges occur? What resources do girls have to manage these challenges? What resources would girls need to be healthier?
- **What could parents/families/others do to support girls as they manage menstruation and puberty?**
    - What is the best way for (families, teachers, doctors, other sources of support) to ensure girls are healthy and happy? Is there anything you wish you could discuss with adolescent girls/young women but you feel is too embarrassing or uncomfortable to talk about or you feel like you do not know enough about? Do adults ever give permission to ignore certain rules/restrictions?
- **What can girls do to manage physical symptoms (e.g., itching, cramps, fatigue) during menstruation?**
    - Who can girls ask for help? What products/supplies can girls use to deal with physical problems?
    - (Added 8/2018) Have they treated girls for menstrual pain? Is this an important or common issue? What treatments are there (get specific names and examples)? Who can girls talk to if there are problems with menstrual cramps? Do medical professionals receive training on menstruation and menstrual cramps/pain? Do medical professionals feel comfortable discussing these issues?
    - (Added 10/2018) Are oral contraceptive pills ever prescribed to reduce menstrual symptoms or pain? Do providers prescribe ibuprofen or other NSAIDS? Do pharmacists get training about menstruation and menstrual pain/cramps? Would medical professionals be interested in getting more training on menstruation?
- **Are you aware of any mental health resources in Tanzania? If so, what are they?**
    - Is mental health something that is discussed openly among adolescents or adults in Tanzania? Why or why not? What mental health resources do you think would benefit girls?

Menstruation Education

- **How can girls best learn about menstruation and what should they learn?**

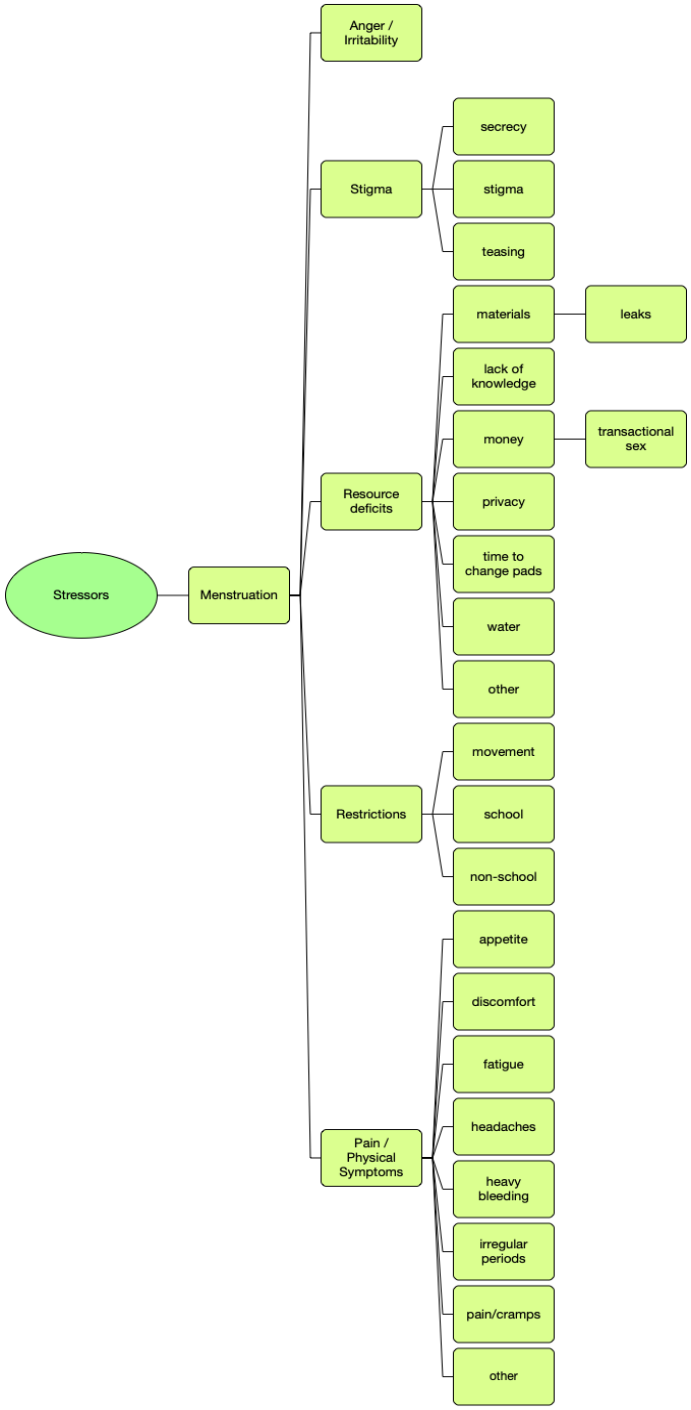
- What do (parents, teachers, healthcare professionals [adapt as needed throughout]) typically share with girls about menstruation? How do adults feel when talking about menstruation? Where do you think adolescent girls can go for the most accurate information about menstruation? When do you think is the best age for girls to start learning about menstruation? Whose job should it be to teach girls about menstruation? Are there certain aspects of your traditions that you believe should be incorporated in education surrounding menstruation?

Wrap-Up

- **Do you have anything else you would like to add to the conversation that we have not yet covered?**

Appendix B

Example Coding Tree



Appendix C

Structural Equation Model Results

Table 33: Relationship of Puberty-Related Stress to Depression

				95% CI	
	Estimate	S.E.	P	Lower	Upper
Depression BY					
Anhedonia	1	NA	NA	NA	NA
Low Mood	1.25	0.125	0	1.005	1.494
Sleep	1.21	0.134	0	0.947	1.474
Energy	1.27	0.13	0	1.015	1.525
Appetite	1.143	0.129	0	0.891	1.396
Self-Worth	1.316	0.147	0	1.028	1.605
Concentration	1.143	0.134	0	0.88	1.405
Psychomotor	1.217	0.164	0	0.895	1.54
Suicidal Ideation	1.174	0.148	0	0.883	1.465
Stress BY					
Pregnancy	2.042	0.247	0	1.558	2.527
Appearance	1.503	0.165	0	1.18	1.825
Sexuality	1.264	0.138	0	0.993	1.534
Roles	1.717	0.185	0	1.354	2.08
Emotions	1.724	0.195	0	1.342	2.106
Depression ON					
Stress	0.853	0.094	0	0.669	1.037
School 2	0.085	0.143	0.554	-0.195	0.364
School 3	0.175	0.15	0.244	-0.12	0.47
School 4	-0.103	0.17	0.546	-0.436	0.231
School 5	0.464	0.145	0.001	0.179	0.749
Age	0.239	0.017	0	0.205	0.273
Model					
AIC	15684.795				
BIC	15951.897				
N	549				

Table 34: Relationship of Puberty-Related Stress to Anxiety

	Estimate	S.E.	P	95% CI Lower	95% CI Upper
Anxiety BY					
Feeling Nervous	1.17	0.139	0	0.897	1.443
Uncontrolled Worrying	1.514	0.186	0	1.15	1.878
Worrying too Much	1.682	0.172	0	1.346	2.019
Trouble Relaxing	1.069	0.141	0	0.792	1.346
Restlessness	1.213	0.15	0	0.919	1.508
Irritability	0.991	0.102	0	0.791	1.192
Fear	1	NA	NA	NA	NA
Stress BY					
Pregnancy	1.899	0.231	0	1.305	2.351
Appearance	1.484	0.167	0	1.054	1.811
Sexuality	1.351	0.146	0	0.975	1.637
Roles	1.786	0.19	0	1.297	2.158
Emotions	1.746	0.207	0	1.212	2.153
Anxiety ON					
Stress	0.872	0.096	0	0.685	1.06
School 2	0.054	0.165	0.745	-0.269	0.376
School 3	0.264	0.148	0.075	-0.026	0.555
School 4	-0.058	0.202	0.774	-0.454	0.338
School 5	0.381	0.164	0.02	0.06	0.703
Age	0.161	0.009	0	0.143	0.18
Model					
AIC	13791.798				
BIC	14024.14				
N	546				

Table 35: Association Between Puberty-Related Stress and RTIs

	Estimate	S.E.	P	95% CI Lower	95% CI Upper	Odds Ratio
Stress BY						
Pregnancy	2.006	0.255	0	1.506	2.506	
Appearance	1.491	0.167	0	1.163	1.818	
Sexuality	1.281	0.145	0	0.997	1.566	
Roles	1.733	0.19	0	1.36	2.106	
Emotions	1.652	0.196	0	1.268	2.037	
RTI ON						
Stress	0.586	0.125	0	0.341	0.831	1.797
School 2	-0.088	0.269	0.744	-0.616	0.44	0.916
School 3	0.077	0.272	0.776	-0.455	0.609	1.08
School 4	0.325	0.319	0.309	-0.301	0.95	1.384
School 5	0.619	0.296	0.037	0.038	1.2	1.857
Age	0.164	0.07	0.019	0.027	0.301	1.178
Intercept	-2.429					
Model						
AIC	6302.822					
BIC	6419.239					
N	551					

Table 36: Relationship of Puberty-Related Stress and Active Coping as a Moderator with Anxiety and RTI

	Estimate	S.E.	P	95% CI Lower	95% CI Upper	Odds Ratio
Anxiety Factor BY						
Feeling Nervous	1.191	0.139	0	0.918	1.464	
Uncontrolled Worrying	1.503	0.179	0	1.153	1.853	
Worrying too Much	1.712	0.17	0	1.378	2.046	
Trouble Relaxing	1.002	0.131	0	0.746	1.258	
Restlessness	1.168	0.139	0	0.896	1.441	
Irritability	0.941	0.099	0	0.746	1.135	
Fear	1	NA	NA	NA	NA	
Stress Factor BY						
Pregnancy	1.82	0.224	0	1.381	2.258	
Appearance	1.453	0.16	0	1.14	1.766	
Sexuality	1.403	0.151	0	1.108	1.698	
Roles	1.701	0.173	0	1.362	2.04	
Emotions	1.764	0.202	0	1.369	2.16	
Active Coping By						
Advice Seeking	0.768	0.121	0	0.531	1.005	
Working Harder	1.146	0.13	0	0.89	1.401	
Problem Solving	1.339	0.142	0	1.061	1.617	
Planning Ahead	1.274	0.146	0	0.988	1.56	
Cognitive Reframing	0.931	0.131	0	0.674	1.188	
Talked with Others	1.175	0.151	0	0.878	1.471	
Helped others	1.299	0.148	0	1.01	1.589	
Acceptance	2.254	0.27	0	1.725	2.782	
Prioritization	1.97	0.242	0	1.496	2.444	
Normalization	1.73	0.21	0	1.317	2.142	
Anxiety ON						
Stress	0.958	0.092	0	0.778	1.138	
Active Coping	0.072	0.077	0.348	-0.079	0.223	
Stress X Coping Interaction	-0.149	0.078	0.055	-0.302	0.003	
School 2	0.176	0.151	0.243	-0.12	0.472	

School 3	0.358	0.136	0.009	0.091	0.625	
School 4	-0.084	0.181	0.644	-0.439	0.272	
School 5	0.432	0.151	0.004	0.135	0.729	
RTI ON						
Stress	0.786	0.203	0	0.388	1.83	2.194
Anxiety	-0.131	0.133	0.325	-0.391	0.13	0.877
School 2	0.049	0.271	0.857	-0.483	0.581	1.05
School 3	0.137	0.274	0.618	-0.4	0.674	1.146
School 4	0.081	0.315	0.797	-0.536	0.697	1.084
School 5	0.403	0.286	0.158	-1.57	0.963	1.496
Intercept	0.676					
Active Coping WITH						
Stress	0.178	0.065	0.006	0.051	0.305	
Model						
AIC	29123.01					
BIC	29572.579					
N	581					

Table 37: Relationship of Puberty-Related Stress and Active Coping as a Moderator with Depression and RTI

	Estimate	S.E.	P	95% CI Lower	95% CI Upper	Odds Ratio
Depression BY						
Anhedonia	0.938	0.113	0	0.716	1.161	
Low Mood	1.194	0.124	0	0.951	1.437	
Sleep	1.125	0.121	0	0.888	1.363	
Energy	1.173	0.121	0	0.936	1.409	
Appetite	1	NA	NA	NA	NA	
Self-Worth	1.248	0.129	0	0.995	1.502	
Concentration	1.118	0.114	0	0.894	1.342	
Psychomotor	1.19	0.161	0	0.875	1.506	
Suicidal Ideation	1.084	0.127	0	0.834	1.334	
Stress BY						
Pregnancy	1.935	0.234	0	1.476	2.393	
Appearance	1.47	0.157	0	1.162	1.778	
Sexuality	1.331	0.144	0	1.049	1.612	
Roles	1.636	0.167	0	1.309	1.964	
Emotions	1.722	0.188	0	1.353	2.091	
Active Coping BY						
Advice Seeking	0.764	0.121	0	0.526	1.002	
Working Harder	1.151	0.131	0	0.894	1.407	
Problem Solving	1.339	0.142	0	1.06	1.618	
Planning Ahead	1.28	0.147	0	0.992	1.568	
Reframing	0.935	0.131	0	0.677	1.192	
Talked w/ Others	1.167	0.151	0	0.87	1.463	
Helped others	1.287	0.147	0	1	1.574	

Acceptance	2.267	0.27	0	1.737	2.796	
Prioritization	1.989	0.244	0	1.511	2.466	
Normalization	1.73	0.21	0	1.319	2.142	
Depression ON						
Stress	1.058	0.095	0	0.872	1.243	
Active Coping	-0.088	0.072	0.218	-0.229	0.052	
Stress X Coping	-0.217	0.094	0.021	-0.401	-0.033	
School 2	0.31	0.145	0.032	0.027	0.593	
School 3	0.305	0.156	0.05	0	0.611	
School 4	-0.22	0.172	0.2	-0.558	0.117	
School 5	0.474	0.146	0.001	0.189	0.759	
RTI ON						
Stress	0.456	0.195	0.019	0.074	0.838	1.578
Depression	0.215	0.135	0.112	-0.05	0.481	1.24
School 2	-0.047	0.272	0.861	-0.581	0.486	0.954
School 3	0.01	0.264	0.971	-0.508	0.527	1.01
School 4	0.163	0.317	0.608	-0.459	0.785	1.177
School 5	0.236	0.282	0.403	-0.316	0.788	1.266
Intercept	0.198					
Active Coping WITH						
Stress	0.174	0.065	0.007	0.047	0.301	
Model						
AIC	31038.951					
BIC	31523.438					
N	581					

Table 38: Relationship of Puberty-Related Stress and Avoidant Coping as a Moderator with Anxiety and RTI

	Estimate	S.E.	P	95% CI Lower	95% CI Upper	Odds Ratio
Anxiety BY						
Feeling Nervous	1.231	0.146	0	0.944	1.517	
Uncontrolled Worrying	1.571	0.182	0	1.213	1.928	
Worrying too Much	1.778	0.18	0	1.426	2.13	
Trouble Relaxing	1.025	0.132	0	0.766	1.284	
Restlessness	1.215	0.143	0	0.934	1.496	
Irritability	0.958	0.099	0	0.764	1.153	
Fear	1	NA	NA	NA	NA	
Stress BY						
Pregnancy	1.906	0.211	0	1.492	2.319	
Appearance	1.418	0.148	0	1.128	1.708	
Sexuality	1.248	0.131	0	0.992	1.504	
Roles	1.676	0.161	0	1.361	1.991	
Emotions	1.828	0.192	0	1.452	2.204	
Avoidant Coping BY						
Isolation	0.861	0.109	0	0.648	1.074	
Giving Up	1.629	0.164	0	1.308	1.951	
Self-Criticize	1.337	0.133	0	1.077	1.597	
Risk Behavior	2.13	0.282	0	1.577	2.683	
Self-Harm	2.439	0.306	0	1.84	3.038	
Wishful Thinking	0.748	0.096	0	0.56	0.936	
Distraction	0.697	0.098	0	0.505	0.889	
Denial	1.728	0.166	0	1.402	2.054	
Push from Mind	1.1	0.129	0	0.848	1.352	

Treated Others Badly	1.301	0.136	0	1.035	1.568	
Anxiety ON						
Stress	1.028	0.169	0	0.697	1.359	
Avoidant Coping	-0.098	0.154	0.525	-0.4	0.204	
Stress X Coping	-0.145	0.052	0.005	-0.246	-0.044	
School 2	0.191	0.139	0.169	-0.081	0.464	
School 3	0.342	0.129	0.008	0.09	0.595	
School 4	-0.108	0.17	0.526	-0.442	0.226	
School 5	0.345	0.129	0.008	0.092	0.598	
RTI ON						
Stress	0.739	0.188	0	0.371	1.107	2.094
Anxiety	-0.098	0.13	0.452	-0.353	0.157	0.907
School 2	0.037	0.27	0.891	-0.492	0.566	1.038
School 3	0.105	0.271	0.697	-0.425	0.636	1.111
School 4	0.096	0.313	0.76	-0.517	0.708	1.1
School 5	0.303	0.277	0.274	-0.239	0.844	1.353
Intercept	0.192					
Avoidant Coping WITH						
Stress	0.806	0.033	0	0.742	0.87	
Model						
AIC	27150.151					
BIC	27599.721					
N	581					

Table 39: Relationship of Puberty-Related Stress and Avoidant Coping as a Moderator with Depression and RTI

				95% CI		Odds Ratio
	Estimate	S.E.	P	Lower	Upper	
Depression BY						
Anhedonia	0.966	0.11	0	0.751	1.181	
Low Mood	1.229	0.125	0	0.984	1.474	
Sleep	1.164	0.12	0	0.929	1.399	
Energy	1.193	0.117	0	0.965	1.422	
Appetite	1	NA	NA	NA	NA	
Self-Worth	1.313	0.128	0	1.061	1.565	
Concentration	1.138	0.111	0	0.92	1.356	
Psychomotor	1.257	0.16	0	0.942	1.571	
Suicidal Ideation	1.141	0.127	0	0.892	1.39	
Stress BY						
Pregnancy	1.985	0.219	0	1.556	2.415	
Appearance	1.448	0.148	0	1.158	1.738	
Sexuality	1.193	0.129	0	0.94	1.447	
Roles	1.614	0.158	0	1.304	1.924	
Emotions	1.788	0.181	0	1.433	2.143	
Avoidant Coping BY						
Isolation	0.867	0.108	0	0.656	1.078	
Giving Up	1.64	0.165	0	1.317	1.962	
Self Criticize	1.331	0.133	0	1.07	1.591	
Risk Behavior	2.158	0.283	0	1.604	2.712	
Self-Harm	2.419	0.305	0	1.82	3.017	
Wishful Thinking	0.734	0.095	0	0.547	0.921	
Distraction	0.688	0.096	0	0.499	0.877	
Denial	1.725	0.164	0	1.404	2.047	
Push from Mind	1.102	0.128	0	0.851	1.353	
Treated Others Badly	1.316	0.136	0	1.049	1.583	
Depression ON						
Stress	1	0.176	0	0.655	1.344	
Avoidant Coping	0.009	0.162	0.958	-0.309	0.326	
Stress X Coping	-0.097	0.056	0.081	-0.207	0.012	
School 2	0.269	0.128	0.036	0.018	0.52	
School 3	0.241	0.142	0.09	-0.038	0.52	

School 4	-0.261	0.159	0.099	-0.572	0.05	
School 5	0.393	0.133	0.003	0.132	0.654	
RTI ON						
Stress	0.387	0.188	0.039	0.019	0.755	1.473
Depression	0.271	0.139	0.051	-0.001	0.543	1.311
School 2	-0.066	0.273	0.809	-0.601	0.469	0.936
School 3	-0.015	0.263	0.954	-0.53	0.5	0.985
School 4	0.165	0.317	0.602	-0.456	0.786	1.179
School 5	0.164	0.275	0.551	-0.375	0.704	1.179
Intercept	0.229					
Avoidant Coping WITH						
Stress	0.807	0.032	0	0.745	0.869	
Model						
AIC	29058.9					
BIC	29543.387					
N	581					

Table 40: Indirect Effects Model Including Active Coping and Depression

	Estimate	S.E.	P	95% CI Lower	95% CI Upper	Odds Ratio
Depression BY						
Anhedonia	1	NA	NA	NA	NA	
Low Mood	1.261	0.146	0	0.974	1.548	
Sleep	1.234	0.154	0	0.932	1.537	
Energy	1.288	0.149	0	0.996	1.579	
Appetite	1.163	0.151	0	0.867	1.458	
Self-Worth	1.346	0.174	0	1.004	1.688	
Concentration	1.169	0.159	0	0.857	1.48	
Psychomotor	1.248	0.198	0	0.86	1.636	
Suicidal Ideation	1.204	0.182	0	0.847	1.561	
Stress BY						
Pregnancy	1	NA	NA	NA	NA	
Appearance	0.746	0.108	0	0.535	0.957	
Sexuality	0.662	0.115	0	0.437	0.888	
Roles	0.869	0.138	0	0.598	1.14	
Emotions	0.851	0.137	0	0.581	1.12	
Active Coping BY						
Advice Seeking	1	NA	NA	NA	NA	
Working Harder	1.514	0.287	0	0.951	2.076	
Problem Solving	1.661	0.273	0	1.126	2.196	
Planning Ahead	1.632	0.257	0	1.129	2.135	
Cognitive Reframing	1.162	0.2	0	0.77	1.555	
Talked with Others	1.515	0.231	0	1.062	1.968	
Helped others	1.665	0.266	0	1.143	2.187	
Acceptance	2.729	0.635	0	1.485	3.973	
Prioritization	2.55	0.604	0	1.365	3.735	
Normalization	2.127	0.487	0	1.173	3.082	
Depression ON						
Stress	0.422	0.067	0	0.291	0.553	
Active Coping	-0.061	0.087	0.481	-0.231	0.109	
Age	0.231	0.045	0	0.143	0.319	
School 2	0.097	0.141	0.491	-0.18	0.375	
School 3	0.188	0.152	0.217	-0.111	0.487	
School 4	-0.108	0.169	0.523	-0.44	0.223	

School 5	0.444	0.146	0.002	0.157	0.73	
Active Coping ON						
Stress	0.063	0.033	0.056	-0.002	0.128	
Age	0.018	0.026	0.479	-0.032	0.069	
School 2	0.181	0.108	0.093	-0.03	0.392	
School 3	0.319	0.115	0.006	0.094	0.545	
School 4	-0.014	0.136	0.916	-0.281	0.252	
School 5	-0.171	0.115	0.136	-0.395	0.054	
RTI ON						
Stress	0.204	0.095	0.032	0.018	0.39	1.226
Depression	0.213	0.154	0.167	-0.089	0.515	1.238
Age	0.112	0.076	0.142	-0.037	0.262	1.119
School 2	-0.118	0.272	0.664	-0.652	0.415	0.888
School 3	0.025	0.268	0.925	-0.5	0.55	1.025
School 4	0.333	0.324	0.305	-0.303	0.968	1.395
School 5	0.509	0.302	0.092	-0.082	1.1	1.663
Intercept	-2.375					
Model						
AIC	29441.827					
BIC	29946.3					
N	551					

Table 41: Indirect Effects Model Including Avoidant Coping and Depression

	Estimate	S.E.	P	95% CI		Odds Ratio
				Lower	Upper	
Depression BY						
Anhedonia	1	NA	NA	NA	NA	
Low Mood	1.223	0.142	0	0.945	1.501	
Sleep	1.216	0.15	0	0.921	1.511	
Energy	1.245	0.142	0	0.967	1.523	
Appetite	1.131	0.145	0	0.846	1.416	
Self-Worth	1.33	0.169	0	0.998	1.662	
Concentration	1.132	0.15	0	0.837	1.427	
Psychomotor	1.235	0.192	0	0.858	1.612	
Suicidal Ideation	1.195	0.177	0	0.848	1.542	
Stress BY						
Pregnancy	2.04	0.232	0	1.585	2.495	
Appearance	1.481	0.155	0	1.177	1.784	
Sexuality	1.222	0.136	0	0.956	1.488	
Roles	1.706	0.173	0	1.367	2.046	
Emotions	1.78	0.188	0	1.413	2.148	
Avoidant Coping BY						
Isolation	1	NA	NA	NA	NA	
Giving Up	1.746	0.257	0	1.243	2.25	
Self Criticize	1.434	0.209	0	1.025	1.843	
Risk Behavior	2.37	0.438	0	1.512	3.228	
Self-Harm	2.601	0.442	0	1.735	3.468	
Wishful Thinking	0.768	0.142	0	0.489	1.047	
Distraction	0.739	0.126	0	0.493	0.986	
Denial	1.911	0.274	0	1.374	2.448	
Push from Mind	1.176	0.194	0	0.796	1.556	
Treated Others Badly	1.383	0.211	0	0.97	1.797	
Depression ON						
Stress	0.776	0.162	0	0.458	1.094	
Avoidant Coping	0.11	0.158	0.487	-0.2	0.419	
School 2	0.083	0.14	0.552	-0.191	0.357	
School 3	0.167	0.149	0.263	-0.125	0.46	

School 4	-0.108	0.168	0.521	-0.438	0.222	
School 5	0.408	0.149	0.006	0.115	0.701	
Age	0.232	0.045	0	0.143	0.32	
Avoidant Coping ON						
Stress	0.724	0.095	0	0.537	0.911	
School 2	0.016	0.106	0.88	-0.191	0.223	
School 3	0.031	0.108	0.772	-0.18	0.243	
School 4	-0.077	0.126	0.539	-0.325	0.17	
School 5	0.308	0.11	0.005	0.093	0.523	
Age	0.04	0.026	0.128	-0.012	0.091	
RTI ON						
Stress	0.392	0.182	0.031	0.035	0.749	1.48
Depression	0.223	0.15	0.138	-0.072	0.518	1.25
School 2	-0.122	0.273	0.656	-0.657	0.414	0.885
School 3	0.018	0.267	0.946	-0.506	0.542	1.018
School 4	0.328	0.323	0.31	-0.305	0.961	1.388
School 5	0.487	0.298	0.103	-0.098	1.072	1.628
Age	0.109	0.076	0.152	-0.04	0.258	1.115
Intercept	-2.377					
Model						
AIC	27585.858					
BIC	28090.331					
N	551					

Table 42: Indirect Effects Model Including Active Coping and Anxiety

	Estimate	S.E.	P	95% CI		Odds Ratio
				Lower	Upper	
Anxiety BY						
Feeling Nervous	1.094	0.158	0	0.784	1.403	
Uncontrolled Worrying	1.41	0.21	0	0.999	1.821	
Worrying too Much	1.594	0.192	0	1.218	1.971	
Trouble Relaxing	1.003	0.15	0	0.709	1.296	
Restlessness	1.148	0.16	0	0.834	1.461	
Irritability	0.947	0.108	0	0.735	1.158	
Fear	1	NA	NA	NA	NA	
Stress BY						
Pregnancy	1.896	0.234	0	1.438	2.354	
Appearance	1.478	0.166	0	1.152	1.804	
Sexuality	1.403	0.156	0	1.096	1.709	
Roles	1.809	0.193	0	1.431	2.188	
Emotions	1.712	0.204	0	1.312	2.113	
Active Coping BY						
Advice Seeking	1	NA	NA	NA	NA	
Working Harder	1.498	0.28	0	0.95	2.047	
Problem Solving	1.64	0.265	0	1.12	2.159	
Planning Ahead	1.612	0.25	0	1.123	2.101	
Cognitive Reframing	1.149	0.196	0	0.766	1.533	
Talked with Others	1.497	0.225	0	1.056	1.938	
Helped others	1.644	0.258	0	1.138	2.15	
Acceptance	2.717	0.624	0	1.494	3.94	
Prioritization	2.529	0.59	0	1.373	3.684	
Normalization	2.122	0.48	0	1.182	3.063	
Anxiety ON						
Stress	0.895	0.108	0	0.684	1.106	
Active Coping	0.14	0.11	0.206	-0.077	0.356	
Age	0.184	0.044	0	0.097	0.271	
School 2	0.025	0.174	0.886	-0.317	0.367	
School 3	0.232	0.157	0.139	-0.076	0.54	
School 4	-0.05	0.212	0.812	-0.466	0.365	

School 5	0.433	0.181	0.017	0.078	0.788	
Active Coping ON						
Stress	0.131	0.063	0.038	0.008	0.255	
Age	0.03	0.027	0.257	-0.022	0.082	
School 2	0.18	0.108	0.097	-0.032	0.392	
School 3	0.324	0.116	0.005	0.098	0.551	
School 4	-0.001	0.137	0.997	-0.27	0.268	
School 5	-0.172	0.115	0.136	-0.398	0.054	
RTI ON						
Stress	0.681	0.193	0	0.303	1.058	1.975
Anxiety	-0.11	0.127	0.389	-0.359	0.14	0.896
Age	0.182	0.075	0.015	0.035	0.33	1.2
School 2	-0.081	0.271	0.765	-0.612	0.45	0.922
School 3	0.11	0.276	0.69	-0.43	0.65	1.116
School 4	0.308	0.318	0.333	-0.316	0.932	1.361
School 5	0.655	0.306	0.032	0.055	1.255	1.925
Intercept	-2.395					
Model						
AIC	27548.721					
BIC	28018.7					
N	551					

Table 43: Indirect Effects Model Including Avoidant Coping and Anxiety

	Estimate	S.E.	P	95% CI		Odds Ratio
				Lower	Upper	
Anxiety BY						
Feeling Nervous	1.107	0.157	0	0.799	1.416	
Uncontrolled Worrying	1.437	0.209	0	1.027	1.846	
Worrying too Much	1.623	0.192	0	1.247	1.999	
Trouble Relaxing	1.025	0.152	0	0.727	1.323	
Restlessness	1.178	0.164	0	0.857	1.5	
Irritability	0.951	0.108	0	0.738	1.163	
Fear	1	NA	NA	NA	NA	
Stress BY						
Pregnancy	1.951	0.223	0	1.515	2.387	
Appearance	1.458	0.156	0	1.152	1.764	
Sexuality	1.281	0.14	0	1.006	1.556	
Roles	1.768	0.179	0	1.417	2.118	
Emotions	1.798	0.198	0	1.409	2.186	
Avoidant Coping BY						
Isolation	1	NA	NA	NA	NA	
Giving Up	1.724	0.25	0	1.235	2.213	
Self-Criticize	1.433	0.207	0	1.027	1.838	
Risk Behavior	2.319	0.43	0	1.477	3.161	
Self-Harm	2.577	0.435	0	1.725	3.429	
Wishful Thinking	0.783	0.144	0	0.501	1.065	
Distraction	0.747	0.129	0	0.495	1	
Denial	1.9	0.271	0	1.369	2.432	
Push from Mind	1.16	0.191	0	0.787	1.534	
Treated Others Badly	1.354	0.206	0	0.949	1.759	
Anxiety ON						
Stress	0.923	0.18	0	0.569	1.276	
Avoidant Coping	-0.034	0.176	0.846	-0.379	0.311	
School 2	0.05	0.173	0.771	-0.289	0.39	
School 3	0.273	0.157	0.082	-0.035	0.58	
School 4	-0.06	0.208	0.772	-0.468	0.347	
School 5	0.394	0.172	0.022	0.057	0.732	
Age	0.181	0.043	0	0.097	0.266	

Avoidant Coping ON						
Stress	0.728	0.094	0	0.543	0.912	
School 2	0.003	0.106	0.977	-0.205	0.211	
School 3	0.023	0.109	0.832	-0.191	0.237	
School 4	-0.079	0.127	0.534	-0.328	0.17	
School 5	0.304	0.11	0.006	0.088	0.52	
Age	0.05	0.027	0.061	-0.002	0.102	
RTI ON						
Stress	0.657	0.179	0	0.305	1.009	1.929
Anxiety	-0.097	0.124	0.434	-0.341	0.146	0.907
School 2	-0.086	0.271	0.752	-0.617	0.446	0.918
School 3	0.098	0.274	0.722	-0.44	0.636	1.103
School 4	0.3	0.317	0.344	-0.321	0.921	1.35
School 5	0.626	0.302	0.038	0.035	1.217	1.87
Age	0.181	0.075	0.016	0.034	0.327	1.198
Intercept	-2.411					
Model						
AIC	25708.539					
BIC	26178.518					
N	551					

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Biography

Emily Cherenack obtained a bachelor's degree in Psychology from Barnard College in 2012. As an undergraduate, she completed an honors thesis while working at the Center for Health, Identity, Behavior and Prevention Studies at New York University. After graduation, she worked as a project coordinator in the Department of Sociomedical Sciences at the Mailman School of Public Health at Columbia University, where she coordinated multi-site studies sponsored by the Adolescent Trials Network for HIV/AIDS interventions. Emily began her PhD in clinical psychology at Duke University in 2015. During her PhD training, she studied clinical health psychology and global mental health under the mentorship of Dr. Kathleen Sikkema. Emily has published in numerous scientific journals, including *AIDS*, *AIDS and Behavior*, *AIDS Patient Care and STDs*, *Maternal and Child Health Journal, Journal of Urban Health, American Journal of Community Psychology, Health Promotion Practice, and American Journal of Sexuality Education.* As a doctoral student, she was awarded fifteen fellowships, grants, and awards, including the Duke Global Health Institute's prestigious Doctoral Scholar Award. She is a member of the American Psychological Association, including Division 12 (Society of Clinical Psychology) and Division 38 (Society for Health Psychology). Emily will be pursuing a clinical internship in health psychology and behavioral medicine at Alpert Medical School of Brown University.