National Income Inequality and Adolescent Motherhood: A Multilevel Analysis in 36 Sub-Saharan African Countries

Adebiyi Germain Boco[a]

[a] Prentice Institute for Global Population and Economy, University of Lethbridge

July 31, 2019

DRAFT- Do Not Cite without Author Permission

Paper prepared for presentation at the IUSSP Research Conference on Population, Poverty and Inequality at University of Michigan, Institute for Social Research, Ann Arbor (MI), United States, 27-29 June 2019

Corresponding:
Adebiyi Germain Boco
Prentice Institute for Global Population and Economy
University of Lethbridge
4401 University Drive West
Lethbridge, Alberta, Canada T1K 3M4
Email: germain.boco@uleth.ca

Abstract

This study explores the association between country-level income inequality and adolescent motherhood in sub-Saharan Africa, the region with the highest fertility rates among teens. Individual-level data from a national sample of 105,666 adolescent female respondents (15-19 years of age) to the Demographic and Health Surveys (DHS) in 36 countries in 2006–2018 are merged with country-level data from several sources. Income inequality is measured by the Gini coefficient at the national level. Multilevel logit regression models are used to estimate the association between country-level income inequality and the likelihood of adolescent motherhood, while simultaneously controlling for individual characteristics of respondents-household wealth, sex of household head, education level, use of family planning methods, exposure to media, marital status-, and other country-level factors. Findings suggest that adolescents in nations with higher levels of income inequality have an increased risk of becoming mothers (odds ratio [OR] = 1.62, 95% confidence interval [CI] = 1.08 to 2.42) in comparison to those in countries belonging to the lower 30th percentile of income inequality. Modeling cross-level interaction shows that adolescent women living in the households with the lowest wealth level in high-inequality countries are at the highest risk of becoming mothers. This study demonstrates that income inequality appears to be related to motherhood among adolescent girls in the context of sub-Sahara Africa.

Keywords:
Income inequality; Adolescent motherhood; Adolescents; Fertility; Sub-Saharan Africa; Multilevel modeling

Introduction

Adolescent motherhood- i.e., having become a mother before the age of 20- is a global public health concern (Nagata, 2017) that negatively affects the well-being of adolescents, children born to adolescents, and society as a whole (Kane, Morgan, Harris, & Guilkey, 2013; Ramaiya, Kiss, Baraitser, Mbaruku, & Hildon, 2014; Williamson & Blum, 2013). Each year an estimated 16 million women aged 15–19 years give birth worldwide (World Health Organization (WHO), 2019), and more than 50% of these births take place in Sub-Saharan Africa (Ramaiya et al., 2014). Although fertility in sub-Saharan Africa (SSA) remains the highest in the world (Bongaarts, 2017), substantial variations in adolescent birth rates exist across countries (United Nations, 2019). The most recent reliable estimates indicate that the national adolescent fertility rate (births per 1000 women ages 15–19) in 2010-2015 ranges from a low of 40.5/1000 in Rwanda and 60.7/1000 in Burundi to high of more than 175/1000 in Chad (178.2/1000), in Mali (178.9/1000), in Niger (200.7/1000) (United Nations, 2019).

The risk factors associated with adolescent childbearing are multilevel in nature, including a number of individual (e.g. socio-demographics), family, community and national levels characteristics (Browning, Leventhal, & Brooks-Gunn, 2005; Chung, Kim, & Lee, 2018; Gausman, Langer, Austin, & Subramanian, 2019; Magadi, 2017). The persistent, wide disparity in adolescent birth rate across countries suggests that structural and environmental factors play a large role in influencing childbearing during youth (Browning, Soller, & Jackson, 2015; Sommer & Mmari, 2015). A key contextual factor in understanding disparities in adolescent childbearing within and between countries is the socio-economic context in which the girls reside (Penman-Aguilar, Carter, Snead, & Kourtis, 2013; Santelli, Song, Garbers, Sharma, & Viner, 2017). Cross-national differences in early childbearing may be attributed to variations in a society's extent of income inequality (not just individual income levels) (Decker, Kalamar, Tunçalp, & Hindin, 2017; Gold, Kennedy, Connell, & Kawachi, 2002; Huynh, Parker, Harper, Pamuk, & Schoendorf, 2005; Santelli, Baldwin, & Heitel, 2015). This study raises the question how a nation's income inequality affects adolescent childbearing in Sub-Saharan African (SSA), the region with the highest fertility rates among teens.

Global inequality is rising, and the available data indicate that countries in Sub-Saharan Africa have a much more unequal income distribution than most other developing countries (Beegle, Christiaensen, Dabalen, & Gaddis, 2016; Odusola, Cornia, Bhorat, & Conceição, 2017). Ten of the 19 most unequal countries in the world are located in sub-Saharan Africa (Odusola et al., 2017). According to the World Bank Africa Poverty Report 2016, "Poverty in Rising Africa," the Africa-wide Gini index (i.e., the gap between poor and rich) increased from 0.52 in 1993 to 0.56 in 2008. Further, the most recent household surveys indicate that Gini indexes range from 0.31 (Niger and São Tomé and Príncipe) to 0.63 (South Africa) (Beegle et al., 2016, p. 122). The variation in the country-level income inequality in SSA has provided us an opportunity to examine the following two questions in this study: (1) Is the level of income inequality associated with the likelihood of becoming an adolescent mother, controlling for individual-level characteristics? (2) Does the potential effect of county-level income inequality on motherhood vary across adolescent household socio-economic status (SES)?

Previous research have shown that growing up in a highly unequal society *precipitates* a number of problematic behaviors during adolescence (Kearney & Levine, 2014; Wodtke, 2013). Theoretically, the two main mechanisms through which income inequality are hypothesized to increase the risk of adolescent motherhood include the psychosocial pathway and the policy pathway (Mollborn & Morningstar, 2009; Wilkinson & Pickett, 2019; Wilkinson & Pickett, 2017). According to the leading advocates of the *psychosocial theory* of inequality effects (Kawachi & Kennedy, 1999; Wilkinson & Pickett, 2009; Wilkinson, 1997), social relationships (e.g., social connections and social interaction) are key to understanding the association between inequality and negative outcomes (Kawachi, Kennedy, Lochner, & Prothrow-Stith, 1997). Especially, Wilkinson and Pickett (2009) conceptualize inequality as a *contextual social stressor* that translates through social comparison processes (van Deurzen, van Ingen, & van Oorschot, 2015). In the same line, Pare and Felson (2014, p. 436) point out that, in disadvantaged neighborhoods, poor people compare their outcomes to the outcomes of their reference group and if their own outcomes are worse they "feel deprivation". In short, income inequality produces social isolation because people from different SES groups have fewer opportunities to share common goals (Lancee & Van de Werfhorst, 2012). Importantly, most people, including adolescents, from lower wealth households have relatively limited social networks and, compared to their richer peers, are more likely to experience the type of "toxic" stress that can harm health outcomes (Kawachi et al., 1997). Empirical research have found that among the poor teenagers group, experiencing high levels of distress markedly increased the probability of becoming a teenage mother (Mollborn & Morningstar, 2009). In contrast, a research review by Bunting and McAuley (2004) show that social support (e.g., family, partner, and peers) tends to improve a number of negative outcomes associated with teenage parenthood.

The psychosocial process may be more relevent in adoelescence, a period of life described as critical to learn and aquire skills and values (United Nations Fund for Population Activities (UNFPA), 2005). During that time, young people may become easy prey to sexual exploitation or violence (Kuate-Defo, 2004; Meinck, Cluver, Boyes, & Mhlongo, 2014; Miller-Perrin & Wurtele, 2017; Yahaya, Uthman, Soares, & Macassa, 2013). For example, Reza et al. (2009), Kidman and Palermo (2009), and others show that adolescents in many sub-Saharan Africa settings are highly vulnerable to adverse sexual health outcomes including sexual abuse, child marriage and other harmful practices such as genital mutilation/cutting (United Nations Fund for Population Activities (UNFPA), 2005). A the individual level, mediated-psychosocial factors often modeled to explain links between income inequality and social behaviour outcomes include personal characteristics of adolescents (e.g., personality), family relations (quality of adolescents' relations to their parents), sexual education, influence of peers (e.g., peer presure), as well as behavioral, emotional, and cognitive factors (e.g., knowledge, attitudes, practices of contraception and sexual risk) (Crockett, Raymond Bingham, Chopak, & Vicary, 1996; Santelli, Lindberg, Finer, & Singh, 2007; Stidham-Hall, Moreau, & Trussell, 2012).

The *policy pathway*, also known as resources theory or "neo-materialist" theory, suggests that the adverse influence of income inequality may operate (indirectely) through social and health policies such as reproductive health care, health education policies, and welfare spending (Smith, 1996; Subramanian & Kawachi, 2004). In other words, societies with greater income inequality have fewer collective resources to invest in the educational, medical, and cultural infrastructure, which affect directly well-being and health (Lynch et al., 2004; Präg, Mills, & Wittek, 2014;

Smith, 1996). For example, Wodtke (2013) points out that the lack of local services such as recreational facilities, family centers, childcare centers, and after-school programs, particularly in low socio-economic status communities may constrain *working parents* to leave their children unsupervised (Brooks-Gunn, 1997). In a conceptual framework for early adolescence, Blum et al. (2014) emphasize on political context as a key macro-level factor that may directly impact youth health and development. Blum et al. (2014, p. 323) note, for example, that governments distribute resources through economic and education policies, and these allocations that are critical for young could not be available in the context of a major socio-political crisis. A political instability (e.g., civil conflicts, war, rebellion) in a country may push young people to belong less privileged social networks and take them out of a normal development (Blum et al., 2014). Overall, the framing of this study is that income inequality has a direct or indirect adverse effect on adolescent reproductive health behavior through neo-materialist mechanisms, psychosocial mechanisms, or both (Viner et al., 2012). Our main hypothesis is that income inequality at the national level is positively associated with the risk of childbearing for adolescents.

Growing ecological research links income inequality to adolescent fertility in high-, middle- and low-income countries (Chiavegatto Filho & Kawachi, 2015; Decker et al., 2017; Gold et al., 2004; Santelli et al., 2017). Moreover, research has found that income inequality is significantly related to teenage birth rates. In the United States, Gold and colleagues found that states and counties with greater income inequality have a higher teenage birth rate (Gold, Kawachi, Kennedy, Lynch, & Connell, 2001; Gold et al., 2002). Chiavegatto Filho and Kawachi (2015) analyzed data of 5565 municipalities in Brazil and reported a consistent and positive association between income inequality and adolescent fertility rates. Using a sample of 27 low- and middle-income countries from 1997 to 2013, Decker et al. (2017) evaluated national-level associations of Gross Domestic Product (GDP), GINI index, Human Development Index (HDI) and Gender-related Development Index (GDI) with early adolescent childbearing prevalence. They found in adjusted models that, in recent time period (2008-2013), GINI index is negatively associated with early adolescent childbearing. Using more comprehensive data from 142 nations of all regions over the period 1990-2012, Santelli et al. (2017) reported that higher income inequalities were associated with higher adolescent fertility and with slower rates of decline in adolescent birth rates (Santelli et al., 2017). An important criticism of ecologic research design is that they are often limited in disentangling the contextual effect from compositional effect (Hedman, 2014). Ecological data lack the individual level information required to identify the extent of these disparities. To address this limitation, researchers have used the multilevel approach to show how neighborhood SES and social context influence adolescent sexual and reproductive health beyond the effects of individual socioeconomic and demographic factors (Baba, Iso, & Fujiwara, 2016; Gausman et al., 2019; Magadi, 2017). As Diez Roux (2002) argues “multilevel analysis allows the simultaneous examination of the effects of group level and individual level variables on individual level outcomes while accounting for the non-independence of observations within groups.” (Diez Roux, 2002, p. 591). Over the technical benefits associated with multilevel modeling, differentiating the compositional and the contextual effects of income inequality has important policy implications.

Most cross-country studies on the contextual effects of income inequality on adolescent reproductive health have been focused largely on middle-income and high-income countries

(Pickett, Mookherjee, & Wilkinson, 2005; Sommer & Mmari, 2015; Viner et al., 2012). There have been very few studies that analyze the link between adolescent fertility and income inequality that include data within Africa (Decker et al., 2017; Gausman et al., 2019; Santelli et al., 2017). In particular, the relationship between income inequality and early motherhood has not yet been systematically explored in Sub-Saharan Africa, the region with the worst adolescent health profile (Patton et al., 2012). Further, past research on adolescent motherhood in SSA focused largely on individual teenage mother characteristics (Bingenheimer & Stoebenau, 2016; Gupta & Mahy, 2003; Gurmu & Dejene, 2012; Gyesaw & Ankomah, 2013; Nalwadda, Mirembe, Byamugisha, & Faxelid, 2010; Oyefara, 2011; Palamuleni & Adebowale, 2014; Sánchez-Páez & Ortega, 2018). Such studies often avoid accounting for individual-, family-, community- and country-level factors in tandem. To advance prevention efforts it is important to consider factors beyond the individual such as neighborhood and societal factors that influence adolescent fertility behavior (Gausman et al., 2019; Magadi, 2017; Sommer & Mmari, 2015).

This paper addresses the above-mentioned critical gap in understanding adolescent fertility in low-income countries by exploring the contextual effect of income inequality on childbearing among women aged 15-19 who participated in the latest Demographic and Health Surveys (DHS) across 36 sub-Saharan African countries. Multilevel modelling is used to assess the association between country-level income inequality and the probability of adolescent motherhood, while controlling for individual-level characteristics. In addition, this study seeks to explore whether cross-level interaction between household socio-economic status (SES) and national income inequality is associated with adolescent childbearing in SSA.

Methods

Data

This paper combines individual-level cross-sectional data from the latest Demographic and Health Surveys (DHS) with country-level data from different international sources. The DHS (http://www.dhsprogram.com/) are nationally representative cross-sectional household surveys that use a standardized core questionnaire to facilitate cross-country comparisons. The DHS collect data from women of reproductive age (15-49 years) on a range of subjects related to household characteristics, reproductive health, fertility, and maternal and child health indicators. To generate a large data set with sufficient statistical power to investigate the association between income inequality and the likelihood of motherhood, publicly available data from 36 countries in sub-Saharan Africa were pooled. The sample analyzed is restricted to adolescent women aged 15 to 19 years who were interviewed in the latest survey for each country. The surveys were conducted between 2006 and 2018. The survey sample sizes range from 555 respondents in Sao Tome and Principe to 7818 respondents in Nigeria. Although the World Health Organization (WHO) and United Nations (UN) define adolescents as those aged 10–19, for this paper, I present data for 15–19-year-olds because national survey data on younger adolescents is lacking. Following the practice, I use the term “adolescents” to refer to people in this age group (Phipps & Sowers, 2002). National characteristics for the 36 countries are reported in Table 1.

[Table 1 about here]

Measures

Dependent Variable. Adolescent motherhood status is a binary variable indicating whether a woman respondent aged 15-19 years reported having ever had a live birth at the time of survey.

Independent Variables. The independent variable of primary interest in this study was national-level income inequality measured by the Gini coefficient. I used the Gini index, the most widely used measure of country-level income inequality, which reflects the extent to which the distribution of income among individuals or households within a country deviates from a perfect distribution. The higher the index the more unequal income is distributed. Data on Gini coefficient were drawn from the Standardized World Income Inequality Database (SWIID) (Solt, 2016). SWIID provides comparable Gini-indices of net income inequality based on disposable household income and is hence well-suited for cross-national research. The Gini coefficient ranges from 0 (where all persons presumed to have equal income) to 1 (where one person has all the income and the rest have none). In the sample of countries studied, Gini coefficients range from 0.296 in Ethiopia to 0.682 in Namibia. For easy modeling, Gini values were multiplied by 100 and interpreted in kind. In order to allow a time lag on our outcome variable I used Gini coefficients for the year of 2005 while the individual survey data were collected between 2006 and 2016/17. When no 2005 data were available, I used data for the closest year to 2005 where data were attainable (i.e., Sao Tome and Principe in 2000; Lesotho in 2003; Liberia in 2007). The 30th percentile was used as a threshold to categorize countries into high income inequality versus low inequality (country-level Gini coefficient < 39.7).

To control for the overall economic context within a country, I add two national-level indicators retrieved for every country for the year 2005 from the World Bank's Indicators database (World Bank, 2019). The national economic context is measured by Gross Domestic Product (GDP) per capita in real purchasing power parity (PPP) dollars. The level of development is measured by the human development index (HDI) as calculated by the United Nations (hdr.undp.org). To account for the cultural environment, I included a variable reflecting national religious context measured by the share of Muslim population by country. The percentage Muslim within each country are obtained from the 2010 World Christian Database (WCD) and accessed through the Association of Religion Data Archives (ARDA)(2011). It was calculated by taking the total number of Muslims within each country, dividing by the total population reported by the WCD in 2010, and multiplying by 100. I also included year of survey to adjust for any potential effect of global trends as the period in which the surveys were conducted ranges from 2006 (coded as 0) to 2018 (coded as 12).

Control variables at the individual level included the following demographic and socio economic characteristics: age (centered at 15 years), education level (none, primary, secondary or higher), household wealth index quintiles (from 1= poorest to 5= wealthiest), gender of the household head, current contraceptive method use (current modern contraceptive use, or no), current marital status (never married or in union, currently married or formerly married, i.e. widowed, divorced,

no longer living together/separated), media exposure (listens to the radio, watches television, or reads a newspaper or magazine at least once a week), and urban-rural area of residence. I examine correlation matrices to assess possible multicollinearity among independent variables, using the variance inflation factor (VIF). None of the VIFs are higher than 2.5, indicating that multicollinearity is not problematic in this analysis (Chatterjee & Hadi, 2015).

Analytic strategy

This study used multilevel modeling to explore the association of adolescent motherhood with individual and country level factors simultaneously. The final dataset was structured in two hierarchical tiers, i.e., individual adolescents (level 1) nested in the countries (level 2). Due to the clustering of individuals within countries and the inclusion of country-level variables, the standard logistic regression model violates the assumption of independent errors (Snijders & Bosker, 2012). In addition, adolescent living in the same country may share unobserved characteristics that may introduce bias (Guo & Zhao, 2000). As a result, I use multilevel mixed-effects logistic regression models. Mixed logit models predict the likelihood that an adolescent woman has ever had a birth based on a set of individual- and country-level variables. The two-level random-intercept logistic regression model fitted can be formulated as follows: $\log[P_{ij}(1-P_{ij})] = \beta_0 + \beta X_{ij} + \mu_j + \varepsilon_{ij}$, where $\log[P_{ij}/(1-P_{ij})]$ is the log-odds of becoming a mother for the *i*th individual adolescent in *j*th country; β is a vector of coefficients to be estimated; X_{ij} is a vector of individual- and country-level covariates; μ_j and ε_{ij} are the country level and individual level random effects, respectively. The residual error at country-level is assumed to be normally distributed, i.e., $\mu_j \sim N(0,\sigma^2_\mu)$. σ^2_μ denotes the between-country variance. Over the random intercept, our model takes into account any country-level effects that are not in the model and so enhances any potential omitted variable bias while also ensuring that the standard errors of the country-level predictors are correctly estimated. At the individual-level, the variance is standardized to the logistic variance of $\pi^2/3 \approx 3.29$ (Snijders & Bosker, 2012). As the first step of the multi-level analysis, I estimated the empty model (Model 1) to assess the crude between-country variance in the probability of becoming an adolescent mother without considering any individual or country variables. This model indicates the crude amount of ‘‘clustering’’ of adolescent motherhood by country. Model 2 included the individual characteristics of women. Model 3 added all country-level variables. Finally, Model 4 added cross-level interaction terms between household wealth status and the country-level income inequality to test whether the effect of national-level income inequality varies by adolescent socio-economic status. For the main analysis presented here, the sample included individuals with complete data on all the variables. All analyses are performed with Stata 15.1 (StataCorp, 2017).

Results

Descriptive Analysis

This study included a total weighted sample of 105,666 adolescent women aged 15 to 19 years from 36 Sub-Saharan African countries. The average age of the respondents in the pooled sample was 16.9 years with a standard deviation of 1.4 years. Most were never in union (77%) and lived

in a rural area (61%). Forty-eight percent (48%) of the sample had completed secondary education and 11% are currently using a contraceptive method (Table 2).

[Table 2 about here]

The map in Figure 1 clearly illustrates that there is a wide range between countries in percentage of women age 15-19 who have had a live birth at the time of survey, but several countries appear to have a very high percentage. National adolescent motherhood rates are particularly high in a number of countries in West and South-east Africa. Mali (2012-13) has the highest percentage of adolescent motherhood (33.2%), and the percentage is also very high in Niger (2012), Chad (2014-15) and Mozambique (2011) (32.8%, 30.1% and 29.3% respectively). Conversely, some countries have relatively low levels, including Rwanda (2014-15) and Burundi (2016-17) with respectively 5.5% and 6.1% of adolescent mothers (see Table 1). The unadjusted multilevel model confirmed significant variation between countries in the prevalence of adolescent motherhood in SSA. The Intra-Class Correlation indicates that 8% of unexplained variance in the probability of becoming an adolescent mother was attributable to differences between countries.

[Figure 1 about here]

Association between income inequality and adolescent motherhood in SSA

Table 3 displays the results from the multilevel logistic regression models predicting the likelihood of adolescents ever having a live birth at the time of survey. Our main interest is in the effect of income inequality. The findings suggest that a greater level of income inequality was associated with increased risk of becoming an adolescent mother. Adjusting for individual- and country-level effects, adolescents who lived in a country with higher levels of income inequality had significantly greater odds of mothering. As shown in Model 4 in Table 3, compared with adolescents living in countries with low levels of income inequality, the odds ratio of becoming a mother for those in countries belonging to the higher 30th percentile of income inequality was 1.62, reflecting 62% increased odds of having a live birth (OR=1.62, 95% CI 1.08 to 2.42).

[Table 3 about here]

This paper shows a consistent graded association between the likelihood of motherhood and the household socioeconomic status. Household wealth was associated with decreased odds of becoming an adolescent mother (models 2, 3 and 4, Table 3). Adolescent respondents in the highest quintile of household wealth had odds of giving birth that were nearly 44% lower (OR=0.56, 95% CI 0.48 to 0.65) than those in the poorest households (models 4, Table 3). The study was also designed to test an additional hypothesis that inequality-mothering association varies across adolescent household socio-economic status. Figure 2 displays predicted probabilities of becoming an adolescent mother by household wealth quintiles separately for countries below the 30th percentile of Gini coefficient, and for the countries at or above the 30th percentile of Gini coefficient. Findings suggest that adolescents from the same household wealth status tend to have very different adjusted likelihood of giving birth depending on the levels of

income inequality of the country in which they live. The most dramatic differences occur among poorest adolescents. Those in high-income inequality countries have a predicted probability of having birth of 24%, compared with 16% for those in low-inequality countries (Figure 2). The figure 2 also shows that the decreasing trend in adolescent mothering associated with household wealth was slightly stronger in high-inequality countries than in low-inequality countries.

[Figure 2 about here]

Discussion and conclusion

Summary of results and consistency with other research

This is the first multilevel study to assess the contextual effect of income inequality on the likelihood of motherhood in a sample of adolescent females aged 15-19 across 36 Sub-Saharan African countries. Substantial variations exist in the prevalence of adolescent motherhood across nations. Significant findings indicated that adolescents living in the high-income inequality countries were more likely to become mothers in comparison to those living in more equal countries, independently of household wealth status and national income level, and other country-level and individual-level characteristics. In addition, this paper showed that adolescent women from poorest SES households were more likely to have a live birth when they live in higher-inequality countries compared to poorest SES women in lower income inequality countries.

Our finding of a strong positive relationship between national income inequality and the risk of adolescent childbearing across SSA is in the line with several ecological studies, which show that higher income inequality was associated with the high teenage birth rates in high-income countries (Gold et al., 2004; Gold et al., 2002; Pickett et al., 2005; Santelli et al., 2017) and middle-income and low-income countries (Chiavegatto Filho & Kawachi, 2015; Santelli et al., 2017). Various theories have been proposed to explain associations between societal income inequality and adolescent sexual and reproductive health outcomes (including childbearing) (Kearney & Levine, 2014; Viner et al., 2012; Wilkinson & Pickett, 2017). The dominant interpretation, the "Income Inequality Hypothesis", is that higher income inequality is associated with poorer population health because "income inequality produces adverse psychosocial environments, and because more unequal societies devote fewer resources to ensure the well-being of their less well-off members." (Gold et al., 2001:161). In the same line, Kearney and Levine (2014:9) summarize several influential works from the social science literature and highlight the critical role of "economic hopelessness and marginalization" in driving the childbearing of adolescent women. In addition, research has reported that living in economically and socially challenging environments can otherwise be psychologically harmful for youth (Aneshensel & Sucoff, 1996; Gore, Aseltine, & Colten, 1992; Guzzo, Hayford, & Lang, 2019; Mollborn & Morningstar, 2009; Park et al., 2018; Sucoff & Upchurch, 1998).

These channels through which income inequality can influence adolescent childbearing are close to the *structural inequality hypothesis* (SIH) (Harling, Subramanian, Baernighausen, & Kawachi, 2014), which emphasizes on the idea that the structure of unequal societies harms the health of

everyone within them, including youth. Rising inequality erodes growth, not just social cohesion. Harling et al. (2014:175) point out that weak social ties can lead to lower levels of public good provision, either due to failure to work together to secure such goods or because community members have less in common, thus lowering the likelihood of a majority supporting provision of any given good (Kawachi & Berkman, 2014). Several countries may delay their spending during an economic crisis to provide adequate social infrastructure that enables all segments of society to access opportunity. One of the consequences in these countries for example is that invest in family planning services might not be a priority. We know that investing in family planning is critical to achieving the Sustainable Development Goals (Starbird, Norton, & Marcus, 2016), and family planning services play a crucial role in helping adolescents avoid untended and early childbearing (Chabot, Navarro, Swann, Darney, & Thiel de Bocanegra, 2014).

These potential explanations reflect the SSA continent's difficult socio-economic context in the 1980s and 1990s (Beegle et al., 2016), the time period when most girl adolescent respondents in the studied sample were born (the birth cohort of adolescent respondents range from 1986 to 2002). Recent research has pointed out that the "prevailing high levels of poverty and insecurity" have played a major role in the persistently high fertility in SSA (Bongaarts, 2017; Mbacké, 2017). Using the World Bank Indicators database, Bongaarts (2017) has shown that, while economic growth was occurring in the rest of the world, living conditions deteriorated significantly from 1980 to 2000 in many SSA countries.

Strengths and limitations

Adolescent childbearing is a complex behavior that involves the interaction of multilevel factors at the individual, social and environmental level. However, prior work has focused largely on aggregate-level or individual-level determinants, and only in separate studies. This study used multilevel analysis to model the effect of national income inequality while simultaneously controlling for individual characteristics of respondents. Multilevel modelling addresses the ecological fallacy in the aggregate level analysis. This paper is theoretically grounded and used an appropriate statistical approach with recent high-quality data to assess the potential role of income inequality in influencing the risk of adolescent childbearing. However, our findings should be interpreted considering some important limitations. First, cross-sectional data were used for this investigation, therefore the temporal order of income inequality and the individual motherhood status could not be confirmed. Nevertheless, to allow a time-lag effect by income inequality on the risk of childbearing I used Gini coefficients for the year of 2005 while the individual survey data analyzed were collected between 2006 and 2017. This allows results to be prospective, although a longitudinal design is needed to establish causality.

Second, despite that adolescent reproductive behavior is a cultural, context-dependent construct (Caldwell & Caldwell, 1987; Furstenberg, 1987), individual cultural characteristics were not included in this analysis. A 2007 WHO report clearly states that the "social and economic consequences of adolescent pregnancy and childbearing depend upon the adolescent's particular cultural, family, and community settings" (World Health Organization, 2007). Although the Demographic and Health Surveys still richer and better-quality comparable data available for studying demographic behaviors in SSA, a number of variables are absent for certain countries.

For example, ethnicity-related measure was not available for 12 out of 36 countries included in this study (Angola, Burundi, Comoros, Lesotho, Madagascar, Namibia, Niger, Rwanda, Sao Tome and Principe, Eswatini (formerly known as Swaziland), Tanzania, and Zimbabwe). In addition, women's religious affiliations were missing in the latest DHSs conducted in the countries such as South Africa and Niger. However, to capture the cultural environment, the national religious context (measured by the religious group's population share) was included in the models. In addition, by using a two-level random model, this study accounts for other contextual factors in explaining adolescent motherhood by allowing the presence of correlated unmeasured country-level effects. Despite these limitations, this paper adds additional support to the growing body of evidence that suggests that reducing inequality is beneficial for improving adolescent reproductive health in high-income countries as well as in the low and middle income countries (Decker et al., 2017; Santelli et al., 2017; Wilkinson & Pickett, 2019).

Implications and conclusion

An understanding of risk factors associated with adolescent childbearing in SSA is vital for policy makers who are concerned with reducing rates (Darroch , Singh , Woog , Bankole, & Ashford, 2016; Gates, 2016; Hindin, Christiansen, & Ferguson, 2013). Although a large literature suggests that economic inequality increases risk of a variety of health and social problems in adolescence after controlling for absolute levels of wealth or income (Elgar, Gariépy, Torsheim, & Currie, 2017; Viner et al., 2012), very few have demonstrated it in the low-income countries. Recent findings indicate that sustained exposure to poor neighborhoods and in the high rates of HIV/AIDS context substantially increases the risk adolescent childbearing (Gausman et al., 2019; Magadi, 2017). Our findings support the income inequality hypothesis by showing that, above and beyond the national wealth and household socioeconomic status, income inequality within the countries predicted risk of adolescent motherhood. Adolescents living in countries with more unequal income distribution have higher risk of having children.

Pickett and Wilkinson have reviewed more recent studies, which provide substantial new evidence to suggest that income inequality in a society affects *everyone's* health (both the richest and the poorest inhabitants), regardless of particular income level (Wilkinson & Pickett, 2019). However, as noted by Burns et al. (2017), other studies have suggested that the negative health effects of income inequality are confined to certain populations such as women (Pabayo, Molnar, & Kawachi, 2014) and those in both the lowest and the highest socioeconomic strata (Choi, Burgard, Elo, & Heisler, 2015). In many SSA countries both poverty and income inequality co-existed side by side (Beegle et al., 2016). Our study suggested that the poorest adolescents were more likely to give birth compared with those belonging the wealthiest households, regardless the levels of income inequality. Further, they faced a double jeopardy, i.e., the harmful effects of household poverty on adolescent's likelihood of having a live birth before age 20 were intensified for those who lived in higher income-inequality countries.

In conclusion, findings from this study suggest that income inequality is associated with an increased risk of becoming adolescent mothers living in SSA. These findings provide guidance for policymakers seeking to improve the adolescent reproductive health and well-being across

countries. A number of national and regional initiatives exist that attempt to accelerate the fertility transition in Africa (Chandra-Mouli, Camacho, & Michaud, 2013; Hindin, Kalamar, Thompson, & Upadhyay, 2016). For example, two regional initiatives have been launched recently to strengthen family planning and reproductive health programs in Middle and Western Africa (May, 2016; Mbacké, 2017): the Sahel Women's Empowerment and Demographic Dividend (SWEDD)(UNFPA, 2016), a World Bank initiative targeting mainly six Sahelian countries, and the Ouagadougou Partnership (Ouagadougou Partnership, 2017), which involves nine francophone countries, for which family planning programs are among the weakest in the region. As mentioned by Nagata (2017), the reduction of adolescent childbearing through universal access to sexual and reproductive health care services also appears to have been part of the two key global health strategies, including the 2030 Agenda for Sustainable Development (United Nations, 2015b) and the United Nations Global Strategy for Women's, Children's, and Adolescents' Health (United Nations, 2015a), both launched in 2016. In the same line, this study suggests that efforts to alleviate gaps between poor and rich and increase socio-economic opportunities for adolescents and their families may help to break what Mbacké (2017) calls "African exceptionalism", namely, the persistence of high fertility in sub-Saharan Africa.

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Tables and figures

Table 1 Survey information and selected characteristics for 36 sub-Saharan African countries

Country name	Survey Year	DHS Survey sample size (women ages 15-49)**	Study sample size (women ages 15-19)**	Adolescent motherhood (%)***	Income inequality (Gini index)	Year for Gini index	GDP per Capita (PPP, US $ 2005)	Human Development Index (HDI), 2005	Share of Muslim population, 2010
Angola	2015-16	14379	3444	28.8	58.3	2005	4555	0.406	0.58
Benin	2017-18	15928	3350	15.2	36.4	2005	1547	0.414	25.46
Burkina Faso	2010	17087	3312	18.8	39.7	2005	1128	0.301	51.42
Burundi	2016-17	17269	3859	6.1	34.0	2005	617	0.298	1.38
Cameroon	2011	15426	3589	20.9	40.3	2005	2476	0.453	20.04
Chad	2014-15	17719	3934	30.1	39.9	2005	1593	0.317	57.29
Comoros	2012	5329	1315	10.3	63.9	2005	2115	0.425	98.29
Congo	2011-12	10819	2198	27.2	41.3	2005	4337	0.506	1.39
Congo Democratic Republic	2013-14	18827	4054	21.2	44.7	2005	529	0.258	1.07
Cote d'Ivoire	2011-12	10060	2023	23.1	44.8	2005	2388	0.405	31.37
Eswatini	2006-07	4987	1274	18.5	48.0	2005	6449	0.504	0.65
Ethiopia	2016	15683	3381	10.1	29.6	2005	656	0.316	34.68
Gabon	2012	8422	1784	22.5	42.4	2005	15107	0.653	4.62
Gambia	2013	10233	2407	14.3	48.4	2003	1278	0.375	86.09
Ghana	2014	9396	1625	11.3	41.4	2005	2234	0.491	18.96
Guinea	2012	9142	2023	28.0	40.7	2005	1424	0.331	68.71
Kenya	2014	31079	5820	14.7	42.7	2005	1950	0.472	6.94
Lesotho	2014	6621	1440	15.0	49.9	2003	1705	0.425	0.05
Liberia	2013	9239	2080	25.8	47.8	2007	838	0.301	16.04
Madagascar	2008-09	17375	3956	26.0	43.7	2005	1238	0.467	1.98
Malawi	2015-16	24562	5263	22.2	39.0	2005	773	0.363	13.19
Mali	2012-13	10424	1891	33.2	39.8	2005	1572	0.312	86.77
Mozambique	2011	13745	3061	29.3	43.2	2005	675	0.287	16.62
Namibia	2013	9176	1906	13.8	68.2	2005	6862	0.579	0.24
Niger	2012	11160	1830	32.8	43.2	2005	680	0.269	92.88
Nigeria	2013	38948	7820	17.1	43.3	2005	3672	0.434	45.40
Rwanda	2014-15	13497	2768	5.5	47.0	2005	947	0.377	4.78
Sao Tome and Principe	2008-09	2615	555	17.2	53.4	2000	1961	0.488	0.04
Senegal	2017	16787	3728	12.6	36.4	2005	2390	0.441	89.01
Sierra Leone	2013	16658	3878	22.4	44.0	2005	948	0.315	46.41
South Africa	2016	8514	1427	12.4	57.5	2005	9796	0.604	2.35
Tanzania	2015-16	13266	2904	21.0	37.5	2005	1701	0.395	31.62
Togo	2013-14	9480	1700	13.3	34.7	2005	1021	0.436	19.36
Uganda	2016	18506	4264	19.4	39.9	2005	1123	0.408	10.69
Zambia	2013-14	16411	3625	23.3	53.0	2005	2248	0.399	1.07
Zimbabwe	2015	9955	2199	16.8	53.6	2005	1759	0.352	0.73

Notes. DHS=Demographic and Health Surveys; GDP = gross domestic product; PPP = purchasing power parity.

Gini index from the Standardized World Income Inequality Database (SWIID) (Solt, 2016).

GDP per capita and the Human Development Index (HDI) data were drawn from the World Bank's World Development Indicators (World Bank, 2019)

Share of Muslim population, 2010. Percentage of Muslims population in the country (Association of Religion Data Archives (ARDA, 2011)

** All numbers represent weighted sample size

*** Weighted percentage of women age 15-19 who have had a live birth at the time of survey, by country. Calculations based on individual data from the Demographic and Health Surveys data, 2006-2018)

Table 2. Descriptive Statistics of the variables used in the regression analysis

	Mean	Std. Dev.	Min	Max	N	%
Dependent variable						
Have had a live birth at the time of survey						
No					85308	80.2
Yes					21065	19.8
Individual-level characteristics of women (N=106373)**						
Age of women at time of interview	16.9	1.4	15	19		
Marital status						
Never in union					81515	76.6
Ever married					24858	23.4
Current contraceptive method						
Not using					94831	89.1
Using a least one method					11542	10.9
Mass Media Exposure						
Not using or less than once a week					46642	43.8
At least once a week					59731	56.2
Sex of household head						
Male					74660	70.2
Female					31713	29.8
Highest educational level attained						
No education					17386	16.3
Primary					38215	35.9
Secondary or higher					50772	47.7
Household wealth-index quintile						
Q1 (Poorest)					19667	18.5
Q2					19645	18.5
Q3					20511	19.3
Q4					21528	20.2
Q5 (Wealthiest)					25022	23.5
Area of residence						
Rural					65023	61.1
Urban					41350	38.9
Country-level variable (N=36)						
Income inequality (Gini index), 2005***	44.78	8.26	29.64	68.16	36	
GDP per capita in PPP (current international $), 2005	2522	2863	529	14962	36	
Human Development Index (HDI), 2005	0.405	0.094	0.258	0.653	36	
Share of Muslim population	29.13	32.95	0.04	98.34	36	

Note. The Gini index is a measure of income inequality, in which 0 is perfectly equal income distribution and 100 is perfectly unequal income distribution. GDP = gross domestic product; PPP = purchasing power parity. PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. The Human Development Index (HDI) is a summary measure of human development.

** Number and percentages/mean values were weighted using the Demographic and Health Surveys sampling weights.

*** Gini index in 2005 or the closest year where data were attainable –i.e., Sao Tome and Principe in 2000; Lesotho in 2003; Liberia in 2007).

Share of Muslim population, 2010, Percentage of Muslims popualtion in the country (Maoz, Z.and E.A. Henderson. 2013. "The world religion dataset, 1945–2010: Logic, estimates, and trends." International Interactions 39(3):265-291)

Table 3. Multilevel logit regression models predicting the likelihood of motherhood among adolescent women aged 15-19 in 36 Sub-Saharan African countries, Demographic and Health Surveys, 2006-2018

	Model 1			Model 2			Model 3			Model 4		
Characteristic	Odds ratio	Sign.	95% Confidence interval	Odds ratio	Sign.	95% Confidence interval	Odds ratio	Sign.	95% Confidence interval	Odds ratio	Sign.	95% Confidence interval
Individual Level												
Age of women at time of interview (centered at 15 years)				1.86	***	[1.83,1.89]	1.86	***	[1.83,1.89]	1.86	***	[1.83,1.89]
Current marital status												
Never in union				1.00		[1.00,1.00]	1.00		[1.00,1.00]	1.00		[1.00,1.00]
Ever married				14.44	***	[13.78,15.14]	14.45	***	[13.79,15.15]	14.48	***	[13.81,15.18]
Current contraceptive method												
Not using				1.00		[1.00,1.00]	1.00		[1.00,1.00]	1.00		[1.00,1.00]
Using a least one method				3.13	***	[2.96,3.32]	3.13	***	[2.95,3.31]	3.14	***	[2.96,3.32]
Mass Media Exposure												
Not using or less than once a week				1.00		[1.00,1.00]	1.00		[1.00,1.00]	1.00		[1.00,1.00]
At least once a week				0.87	***	[0.83,0.91]	0.87	***	[0.83,0.91]	0.87	***	[0.83,0.91]
Sex of household head												
Male				1.00		[1.00,1.00]	1.00		[1.00,1.00]	1.00		[1.00,1.00]
Female				1.29	***	[1.23,1.35]	1.28	***	[1.22,1.34]	1.28	***	[1.22,1.34]
Highest educational level attained												
No education				1.00		[1.00,1.00]	1.00		[1.00,1.00]	1.00		[1.00,1.00]
Primary				1.08	**	[1.02,1.15]	1.08	**	[1.01,1.15]	1.08	**	[1.01,1.15]
Secondary or higher				0.63	***	[0.59,0.67]	0.63	***	[0.59,0.67]	0.63	***	[0.59,0.67]
Household wealth index quintiles (from 1= poorest to 5= wealthiest)												
Q1 (Poorest)				1.00		[1.00,1.00]	1.00		[1.00,1.00]	1.00		[1.00,1.00]
Q2				0.95	*	[0.89,1.01]	0.95	*	[0.89,1.01]	0.90		[0.78,1.03]
Q3				0.84	***	[0.79,0.89]	0.84	***	[0.78,0.89]	0.83	***	[0.72,0.95]
Q4				0.68	***	[0.64,0.73]	0.67	***	[0.63,0.72]	0.77	***	[0.67,0.90]
Q5 (Wealthiest)				0.47	***	[0.44,0.51]	0.47	***	[0.43,0.51]	0.56	***	[0.48,0.65]
Area of residence												
Rural							1.00		[1.00,1.00]	1.00		[1.00,1.00]
Urban							1.02		[0.96,1.08]	1.02		[0.97,1.08]
Country Level												
Year of survey							0.98		[0.93,1.03]	0.98		[0.93,1.03]
GDP per capita, PPP (current international $)							1.00	***	[1.00,1.00]	1.00	***	[1.00,1.00]
Human development index (HDI)							0.06	**	[0.00,0.84]	0.06	**	[0.00,0.85]
Share of Muslim population							0.99	**	[0.99,1.00]	0.99	**	[0.99,1.00]
Income inequality (national Gini Index)												
Low (Gini Index < 39.7) (Reference)							1.00		[1.00,1.00]	1.00		[1.00,1.00]
High (Gini Index >= 39.7							1.55	**	[1.05,2.29]	1.62	**	[1.08,2.42]
Interaction terms (Income inequality # Household wealth index quintiles)												
Q2 # High income inequality										1.06		[0.91,1.24]
Q3 # High income inequality										1.01		[0.86,1.18]
Q4 # High income inequality										0.84	**	[0.72,0.99]
Q5 (Wealthiest) # High income inequality										0.80	**	[0.68,0.95]
Intercept	0.23	***	[0.20,0.28]	0.03	***	[0.02,0.03]	0.05	***	[0.02,0.17]	0.05	***	[0.02,0.16]
Country-level variance	0.28	***	[0.17,0.44]	0.31	***	[0.20,0.50]	0.17	***	[0.11,0.27]	0.17	***	[0.11,0.28]
Intra-class correlation (rho)	0.08			0.09			0.05			0.05		
Number of observations (un weighted)	106786			106786			106786			106786		
Number of country	36			36			36			36		
Log likelihood	-51449.3			-31664.4			-31653.4			-31645.7		
AIC	102902.6			63354.8			63344.8			63337.4		
BIC	102921.7			63479.3			63526.7			63557.7		

* p<0.10, ** p<0.05, *** p<0.01

Note. GDP = gross domestic product; PPP = purchasing power parity. The Gini index is a measure of income inequality, in which 0 is perfectly equal income distribution and 100 is perfectly unequal income distribution. PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. The Human Development Index (HDI) is a summary measure of human development.

Model 1 analyzed the crude between-country variance in likelihood of having a live birth without considering any individual or country variables.

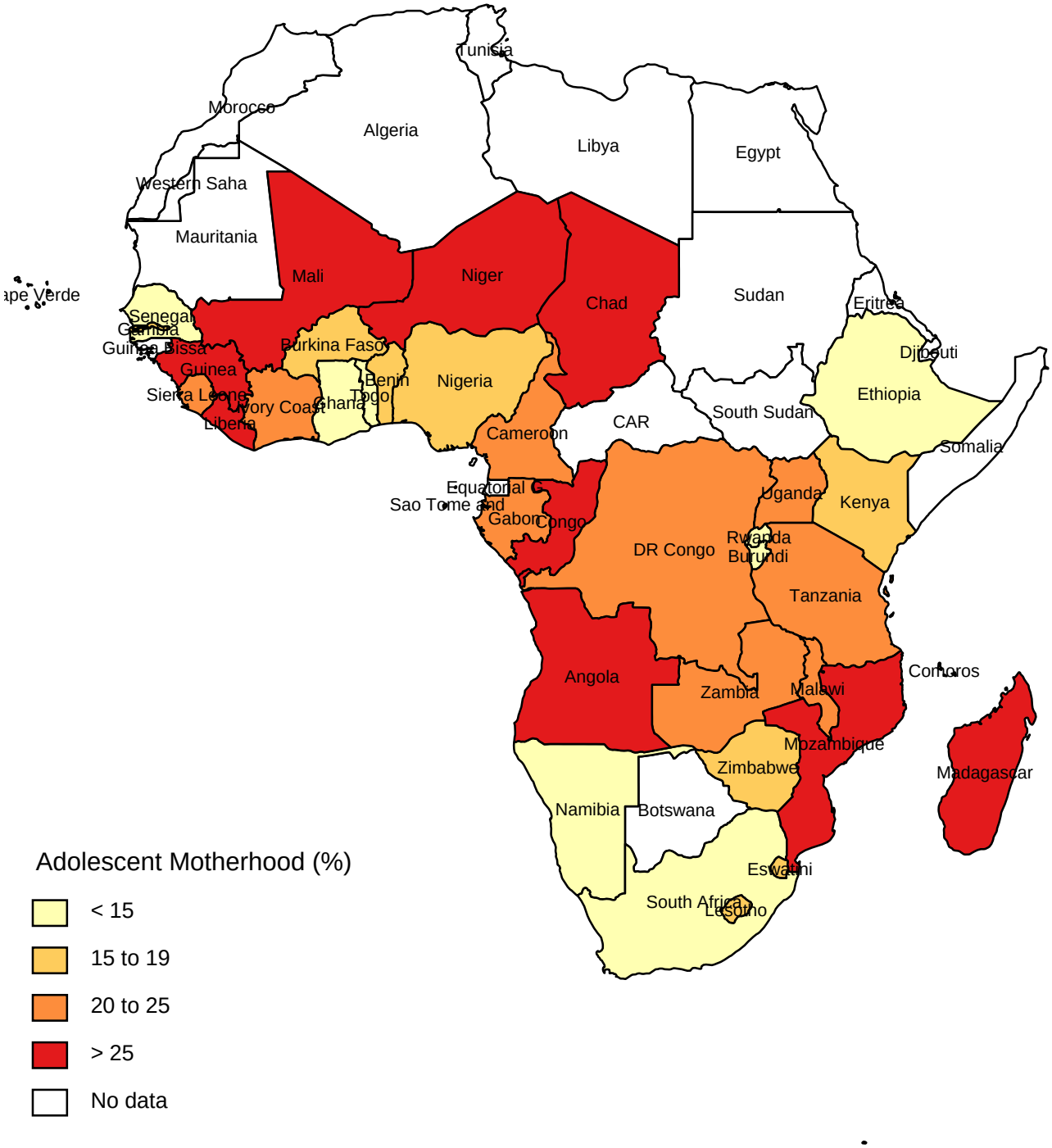
Model 2 Adjusted for individual level variables: : age (centered at 15 years), education level (none, primary, secondary or higher), household wealth index quintiles (from 1= poorest to 5= wealthiest), gender of the household head, current contraceptive method use (current modern contraceptive use, or no), current marital status (never in union, or ever married, i.e. married, living with partner, widowed, divorced, no longer living together/separated), media exposure (listens to the radio, watches television, or reads a newspaper or magazine at least once a week), and urban-rural area of residence.

Model 3 Adjusted for Model 2 and country-level variables: Gini index, gross domestic product (GDP) per capita, human development index.

Model 4 Adjusted for Model 3 and interaction terms between household wealth status and the country-level income inequality.

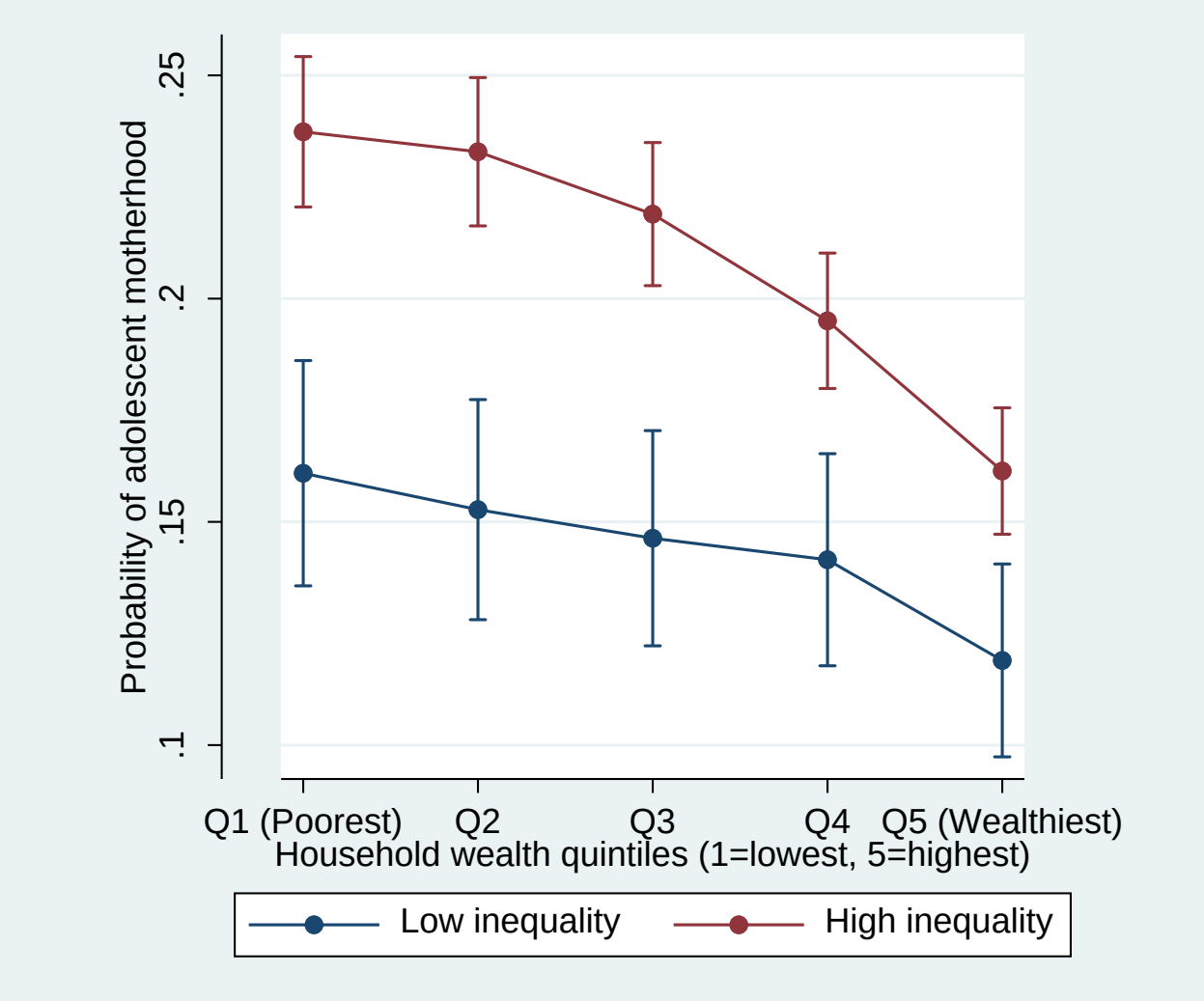
a Intra-class correlations (ICC) is defined as $\rho_{\mu} = \sigma^2\mu /(\sigma^2\mu + 3.29)$ at country-level; where σ2μ represent the variance at the country level, and 3.29 represents the fixed individual variance, which is π2/3 (Snijders and Bosker, 2012:305).

Figure 1. Distribution of adolescent motherhood in Sub-Saharan Africa, 2006-2018



Note. Weighted percentage of women ages 15-19 who were mothers at the time of survey. The shade of the country corresponds to the magnitude of the indicator. Darker shaded countries indicate larger adolescent motherhood prevalence.
Source: Demographic and Health Surveys, 2006-2018.

Figure 2. Predicted probability of adolescent motherhood by country-level income inequality and household wealth quintiles across 36 Sub-Saharan Africa Countries, Demographic and Health Surveys, 2006-2018



Notes. Predicted probability (with 95% confidence intervals) of becoming an adolescent mother for each quintile group of household wealth index in low and high inequality countries. Model adjusted to account for all others control variables at the individual- and country- level (Model 4, Table 3).