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# Prevalence and Drivers of Stalls and Reversals in Age at First Marriage in Sub-Saharan Africa

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## Abstract

The occurrence of stalls and reversals in age at first marriage despite ongoing education expansion is a salient and understudied demographic paradox of sub-Saharan Africa (SSA). Using Demographic Health Survey data, we contribute novel comprehensive evidence that illuminates this puzzle. First, we provide a systematic overview of stalls and reversals in age at first marriage among women born 1945–1999 in four broad SSA regions and 33 individual countries. Second, we test whether stalls and reversals in first marital age occurred because education expansion (a) dominated primary schooling, which is compatible with early marriages (compatibility hypothesis), or (b) led to changing socioeconomic conditions, which facilitated early marriages (diminishing returns hypothesis). We find that the median age at first marriage (MAFM) either stalled or reversed in 19 countries. At the regional level, MAFM stalled in Central and East Africa and reversed in Southern Africa. Stalls and reversals occurred primarily among the birth cohorts from 1965–69 through 1985–89. We find evidence for either hypothesis, yet mechanisms are context-dependent. We discuss the heterogeneity of education-marriage linkages across SSA and their implications on policies and programs aiming at eradicating early marriages in this region.

**Keywords** Union formation · Age at marriage · Female education · Sub-Saharan Africa

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## Introduction

Marriage is one of the key markers of transition to adulthood in sub-Saharan Africa (SSA). The timing of this event can predefine an individual's life course trajectory: Women who marry at younger ages face a higher risk of early child-bearing (Jensen & Thornton, 2003), have higher lifetime fertility (Yaya et al., 2019), and experience more pregnancy-related complications (Althabe et al., 2015; Grønvik & Fossgard Sandøy, 2018). Early union formation is also linked to a higher likelihood of experiencing intimate partner violence and union dissolution (Clark & Brauner-Otto, 2015; Kidman, 2017), which adversely affects women's socioeconomic and health outcomes. Thus, understanding changes in marital timing over time, space, and across generations, and illuminating the factors that explain such behavioral change, particularly in settings where early marriages are common, is crucial for improving women's reproductive health and socioeconomic outcomes.

In SSA, marriage was marked as early and universal, at least until the mid-twentieth century (Garenne, 2014). The median age at first marriage (henceforth, MAFM) among women varied between 15 and 19 years in most countries (Garenne, 2004; Westoff & Macro, 2003). This pattern is slowly shifting, with the age at first marriage rising in several countries (Garenne, 2004; Hertrich, 2017; Mensch et al., 2005; Posel & Rudwick, 2013). Prior research linked these changes to female education expansion, amongst others (Bongaarts et al., 2017; Mensch et al., 2005; Shapiro & Gebreselassie, 2014). This connection is mainly theorized to operate through the postponement of marriage until after schooling is finalized (Glynn et al., 2018; Lloyd & Mensch, 2008; Zuilkowski et al., 2019). Thus, age at marriage is generally anticipated to increase as long as female education expansion occurs via educational compositional change. Grant (2015) termed such expectations "the demographic promise of expanded female education." (p.2).

However, in some SSA countries such as Burkina Faso, Chad, Ethiopia, Madagascar, Malawi, and Zimbabwe, girls' school participation expanded substantially without considerable marital timing delays (Bongaarts et al., 2017; ICF, 2015). Mensch et al. (2005) observed a similar pattern, noting that in about one-third of SSA countries, the level of the observed decrease in the proportion of women married before age 18 was merely less than half of what they predicted (using a regression model) based on observed changes in educational attainment. Stalls have also been observed concerning the timing of other reproductive events, such as first births (Grant, 2015). Thus, the paradox of stalls or reversals in the timing of first marriage or first birth despite female education expansion has emerged in SSA.

Few studies have discussed this paradox. They have linked it to conditions associated with female education expansion—particularly, poor quality of education following the introduction of free primary education in the 1990s and 2000s, the change in age patterns of school enrolment and completion, or the loss of selectivity for delayed marriages among educated individuals (Bongaarts et al., 2017; Grant, 2015). Grant (2015) discussed this paradox regarding changes in the

timing of first birth in Malawi, while Bongaarts et al. (2017) discussed it in relation to the results they observed in Ethiopia when analyzing the role of education on the timing of first marriage, first sex, and first birth across the Global South. Bongaarts et al. (2017) work was not primarily set to assess the linkages between female education expansion and stalls in the timing of reproductive events. Indeed, their discussion of this paradox can be regarded as building hypotheses open for empirical investigation.

A systematic empirical investigation of this paradox across all of SSA countries is, thus, necessary for a better understanding of changing patterns in age at first marriage in this region and how they are connected to educational expansion. Therefore, we use Demographic and Health Surveys (DHS) data to shed more insights into this paradox. First, we perform a systematic empirical investigation of the prevalence of stalls and reversals in age at first marriage in four broad SSA regions (West, Central, East and Southern Africa) and 33 individual countries. We identify SSA regions and countries which experienced stalls or reversals in age at first marriage and identify birth cohorts and the ages over which such stalls or reversals occurred.

Second, we examine the drivers of such stalls or reversals. Specifically, we assess two competing explanations (compatibility vs. diminishing returns hypothesis) for why marital age at the population level may have stalled or reversed despite ongoing female education expansion. The compatibility hypothesis suggests that stalls or reversals in age at first marriage at the population level emerged because female education expansion dominated primary schooling. If schooling ends at a young age, its expansion is still compatible with early marriages. The diminishing returns hypothesis suggests that the inflow of larger groups into education led to various dynamics which diluted the impact of education on marital postponement. For instance, a lowered quality of education, limited economic opportunities for individuals who fail to progress to higher levels of education, and diminished selectivity for delayed marriages among educated individuals. Such dynamics likely led to the diminishing effect of education on marital timing at the individual level, thereby giving rise to stalls or reversals in age at first marriage at the population level. We evaluate the alignment of the changes in MAFM and female education composition over birth cohorts and use decomposition analyses of cohort changes in marriage rates to evaluate if observed patterns are consistent with either of these two explanations.

## Background

### Marital Timing in Sub-Saharan Africa

In sub-Saharan Africa, marriage was nearly universal and occurred early in women's life courses until about the mid-20th century. Like elsewhere, profound changes in union formation dynamics occurred since the 1990s (Bongaarts et al., 2017; Garenne, 2014; Grant & Kohler, 2022; Shapiro & Gebreselassie, 2014). The median age at first marriage rose across SSA from 17.8 in the early 1990s to 19.2 in 2015–19 (Grant & Kohler, 2022). Yet, there was and is substantial regional variation in both the median age at first marriage and in the pace of change in first marital age

over recent decades. For example, countries in the Sahel, Mozambique, and Madagascar traditionally had and still have the highest proportion of child marriages, with well over 50% of marriages occurring before girls turn 18 (Yaya et al., 2019). The pace of decline in very early marriages since the 1990s has also been slower across these countries than elsewhere (Amoo, 2017; Shapiro & Gebreselassie, 2014), while marital age rose the most in Southern African countries (Garenne, 2014; Shapiro & Gebreselassie, 2014; Yaya et al., 2019).

Several micro- and macro-level factors have been associated with variation in marital age and change therein across SSA. Some are related to cultural practices and indicate varying nuptiality regimes across SSA. Ethnicity was a predictor of marital age both within Uganda and South Africa (Ayiga & Rampagane, 2013), and Muslim background was associated with earlier marital ages, but only in rural regions (Shapiro & Gebreselassie, 2014). Girls who ever experienced the harmful practice of female genital mutilation also had higher odds of experiencing child marriage (Ahinkorah et al., 2023). Another study indicates that detrimental weather shocks, here droughts, increase the child marriage hazard by 3% in SSA (Corno et al., 2020), linking the intersection of cultural practices and economic shocks to marital ages and change therein.

Socioeconomic factors emerged as important predictors of marital age also in other studies. Ahinkorah et al. (2023) found that women from higher-income family backgrounds had higher average marital ages while economic-well-being of the family of origin was linked to later marital ages in rural but not urban areas in another study (Shapiro & Gebreselassie, 2014). More related, several scholars have argued that women's participation in employment, particularly employment that improves women's income levels, is associated with a lower risk of early marriages in SSA (Garenne, 2004; Stevanovic-Fenn et al., 2015). The idea is that women who participate in wage employment are likely to be financially secure and, thus, less likely to opt for early marriages as a means to achieve financial security. There indeed appears to be a general consensus in the literature that the increasing opportunity to participate in wage employment that comes with higher levels of education attainment is one of the key pathways through which education influences marital timing (Amoo, 2020; Garenne, 2004; Stevanovic-Fenn et al., 2015). Consequently, increased access to education without a corresponding improvement in wage employment opportunities is regarded as "incomplete empowerment" that still exposes women to a higher risk of early marriage (Amoo, 2020).

In contrast, macro-level economic conditions such as the GDP or community wealth showed no consistent association with macro-level marital age variation (Ahinkorah et al., 2023; Garenne, 2014). However, education emerged as a key predictor for first marital age variation and change across several studies. One year of additional schooling delayed the entry to marriage by 1.5 years in Madagascar (Glick et al., 2015), formal education was associated with later marital ages across the Sahel countries (Elengemoke & Susuman, 2021), and it also emerged as a predictor of later marriage, albeit in rural regions only, in Shapiro and Gebreselassie (2014)'s study.

A macro-level decomposition study linking education expansion to increasing marital ages showed that both changes in education composition and rising marital

ages within education groups contributed to increases in marital delay (Bongaarts et al., 2017). However, Bongaarts et al. (2017) noted that education expanded in Ethiopia without considerable delays in marital timing. Similarly, other studies indicate a more complex association between education expansion and age at first marriage or other reproductive events such as births. For example, Garenne (2014) find weaker links between education expansion and marital age changes in rural areas and document rising marital ages in urban areas despite no further education expansion, attributing marital age change to other factors than education. Grant (2015) finds even a negative association between grade attainment and age at first birth in Malawi and concludes that declining educational quality despite education expansion may underlie this link. Much as this literature provides important indications of potential stalls in marital timing as education expanded, a comprehensive systematic analysis of the prevalence of stalls or reversals in age at first marriage across all of the SSA region is lacking. Besides, there is a need for a comprehensive understanding of how such stalls or reversals (if indeed any) are connected to education expansion.

### **Expansion of Female Education and Marital Timing Changes in Sub-Saharan Africa**

In SSA, education attainment is tied to the postponement of marriage through at least two dominant pathways. First is the compatibility hypothesis, which postulates that the time women spend in school is directly linked to their union formation timing due to simultaneous school enrollment and family formation incompatibility. School attendance generally means postponing marriages to later ages, while initiating family signals discontinuity of schooling (Glynn et al., 2018; Lloyd & Mensch, 2008; Zuilkowski et al., 2019). The strength of this mechanism is contingent on at least the age at school enrollment, the pace of grade progression, school completion rates, the age at school graduation, and opportunities for girls to proceed further with education beyond the primary and secondary level. A high completion rate would imply staying longer in school – at least for as many years as required to graduate – hence, it would likely lead to the postponement of union formation.

However, if school starts at younger ages and progression through grades is rapid, one could complete primary or secondary school education and still marry early. Caudillo (2019) found evidence for this possibility in Mexico, where girls aged 10–17 who experienced advanced grade progression had early initiation of marriage. Similarly, Nguyen and Lewis (2020) observed that women who started schooling at a younger age were 5.5 times more likely to marry during their adolescent years than those who delayed school enrollment in Vietnam. These findings suggest that the benefits of improved school completion rates (corresponding to improved completed years of schooling) in delaying union formation could be attenuated by improvements in age at school entry and grade progression rates, mainly if girls' opportunities to progress beyond primary or secondary education are limited. Thus, the compatibility hypothesis implies that the structure of female education expansion

– i.e. whether it is marked mainly by girls' primary or secondary schooling and early school enrolment and completion – likely shapes the pattern of age at marriage at the population level.

The SSA region witnessed an increase in girls' school participation over the last three decades. However, this expansion mainly dominated primary education, and opportunities for girls to proceed further with education beyond primary or secondary education remain limited (Baten et al., 2021; Graetz et al., 2020; Majgaard & Mingat, 2012). In addition, this education expansion has been marked by declines in age at school entry and falling grade retention rates (Grant, 2015; Lucas & Mbiti, 2012; Ndaruhutse, 2008; World Bank, 2020). Primary and secondary education completion rates also remain low (Majgaard & Mingat, 2012). Thus, women from recent birth cohorts are more likely to graduate from primary or secondary school at relatively younger ages than those born some generations ago. These dynamics suggest that the education expansion in SSA likely remained compatible with early marriages. Thus, we *hypothesize that (compatibility hypothesis) stalls or reversals in age at marriage at the population level emerged because female education expansion dominated primary schooling, which is more compatible with early marriages*. We, therefore, expect that age at first marriage stalled or reversed in SSA regions, countries and over birth cohorts for which female school participation beyond primary education stalled or declined.

The second pathway that connects education attainment and marital timing postponement concerns the influence of education on norms about marital timing, economic opportunities, and changing returns to and self-selection into education. Education exposes individuals to new ideas and brings aspirations and opportunities that challenge traditional family formation values (Caldwell, 1980). In addition, education raises opportunities for girls to participate in wage employment, thus boosting their financial independence and reducing their need for an early marriage as a financial security strategy for their families and themselves (Becker, 1973; Corno et al., 2020). The importance of this mechanism is thus likely dependent on the magnitude of the influence schooling offers in redefining individual perspectives, preferences, and values about marriage timing and boosting individual economic prospects. The education effect on marital timing would diminish if more girls complete their education without acquiring the necessary skills or knowledge (what other scholars have referred to as "enrollment without learning" (Bold et al., 2017) that stimulate a desire to postpone marriages to later ages or increase their wage employment opportunities in the labor market. These dynamics could lead to stalls or reversals in age at marriage within specific education groups and, consequently, stalls or reversals in age at marriage at the population level despite ongoing female education expansion.

The education expansion in SSA has been marked by a deterioration of education quality (Bold et al., 2017; Evans & Mendez Acosta, 2021; Filmer et al., 2020) mainly due to the influx of schools following free primary education. For example, students complete their primary schooling in some countries without attaining the necessary reading and writing skills (Bold et al., 2017). Furthermore, the growth of SSA's economy did not keep up with increasing girls' school participation; the supply of primary or secondary school leavers now exceeds the labour market demand (Al-Samarrai & Bennell, 2007; Filmer & Fox, 2014). Also, the returns to education,



especially to lower education, have declined since the mid-1990s in Mozambique, which likely also applies to other SSA countries (Jones et al., 2023). As education expands, returns to education tend not only to decline but also to become more heterogeneous. The literature on returns to college education indicates larger declines in college premiums among more socio-economically disadvantaged groups as education expansion occurs, e.g. among rural students in China (Guo & Wu, 2024). Hence, education expansion across SSA may not have benefitted all girls similarly but yielded lower returns to girls from rural areas or the most disadvantaged socioeconomic backgrounds. Thus, in many SSA countries, early marriages may still be perceived as a practical means to girls' financial security, even among secondary education graduates and despite ongoing education expansion.

These dynamics imply that, as girls' school participation expanded, the effect of education on the postponement of marriage might have weakened because the composition of women constituting the primary or secondary education group became less selected for ideologies and/or economic activities that inhibit early marriages and because the returns to education may have diminished, especially among girls with primary and secondary education. Such dynamics likely resulted in stalls or reversals in age at first marriage within specific education groups, thereby giving rise to stalls or reversals in age at first marriage at the population level. We refer to this alternative explanation (to the compatibility hypothesis) as the **diminishing returns hypothesis**.

The availability of DHS data in SSA, which contains marriage histories of women born as early as 1936, allows us to assess these two hypotheses and provide more insights into the linkage between education expansion and marriage age in this region.

## Data and Methods

### Data

We use data from 151 DHS conducted between 1986 and 2023 in 34 SSA countries (see Table 4 in the Appendix). DHS are the most used and reliable source of nationally representative information about family formation in this region. They collect two critical pieces of nuptiality information essential to our current analysis – i.e. whether a woman has ever married or lived with a man as married and the date at which such unions were first formed. Women who ever formed a formal or informal union are identified as ever-married. This flexibility is desirable because marriage formation is more of a process than an event in SSA (Chae, 2016; Meekers, 1992).

DHS also asked respondents about their highest educational attainment, coded into four categories: No education, Primary, Secondary, and Higher. We use this information to examine girls' school participation trajectories over birth cohorts. However, we exclude women with tertiary education (4.4% of the pooled dataset of women aged 20–49) because female education expansion was mainly confined to primary and secondary levels in most SSA countries. Furthermore, we limit the analysis to women aged 20+ to exclude those still in primary school at the time of the survey but



who might attain secondary education later. The primary analytical sample consists of 1,226,376 women aged 20–49 with known information about marital status, education level and known date of first marriage among those who ever married.

We grouped the 34 countries included in this analysis into four major geographical regions (Western, Central, Eastern and Southern Africa) following the standard classification (see United Nations (2022)). While single-country estimates reveal more detail, commonalities in marriage dynamics across these regions (see John and Adjiwanou (2021) and John and Nitsche (2022)) justify the groupings and allow larger sample sizes than single-country estimates. Nevertheless, we produced country-specific estimates for some of the analyses and summarized and presented them where necessary.

## Measures and Methods

Our first objective is to identify SSA regions and countries which experienced stalls or reversals in age at first marriage and identify birth cohorts and ages over which such stalls or reversals occurred. For this analysis, we use the MAFM to measure marital timing. We calculate these medians for five-year birth cohorts of women born between 1945 and 1999 (Table 4 in the Appendix) – for all women combined and for specific education groups from survival functions of first marriage fitted using a Kaplan Meier approach (Kaplan and Meier 1958). The Kaplan–Meier approach is a standard statistical procedure for deriving survival functions for time-to-event data that account for censoring. It thus provides robust median estimates since not only individuals who experienced the event are included in the analysis but also those who did not experience the event. To ensure reliable and stable estimates, we only present the results of cohorts with a sample size of at least 200 women (344 out of 351 birth cohorts returned).

A quality assessment of marriage histories collected in DHS reveals that older women tend to shift their age at first marriage towards the survey date mostly due to recall errors (Gage-Brandon, 1995; Mensch et al., 2006). This forward displacement of marriage events may lead to spurious small changes in marital timing estimates over birth cohorts. To alleviate this problem, we calculate MAFM for each birth cohort from a pooled sample of women born during the same period but interviewed at different survey points. Thus, these medians are generally a weighted average of marriage histories reported at younger, middle and older ages.

We set two criteria to objectively identify regions and countries which experienced stalls or reversals in age at first marriage and the birth cohorts and ages over which such stalls and reversals occurred. First, we define stalls to correspond to intervals over which the MAFM for at least three consecutive birth cohorts are closely similar, with a slope between  $-0.01$  and  $0.01$ . These cutting points are arbitrary; nevertheless, we aimed at cutting points close to zero to ensure we indeed capture stalls. Second, we define reversals as intervals over which MAFM consistently declines after an interval of increase/stall for at least two consecutive birth cohorts with a slope of less than  $-0.01$ . Conversely, an increase in age at first marriage corresponds to intervals over which the MAFM for at least two consecutive birth

cohorts increased monotonically with a slope of greater than 0.01 (note that in any case, we calculate slopes using a minimum of three data points).

Our second objective is to describe conditions that gave rise to stalls or reversals in age at first marriage. We evaluate whether the stalls or reversals in age at marriage at the population level emerged because female education expansion dominated primary schooling, which is more compatible with early marriages (*compatibility hypothesis*) or whether they emerged because of diminishing effects of education on marital timing (manifested as stalls or reversals in age at marriage within specific education groups) due to the inflow of larger groups into education (*diminishing returns hypothesis*).

To evaluate these hypotheses, we first assess how the education composition – % with no education, % with primary, % with secondary – and the MAFM for these three education groups are aligned with each other over birth cohorts. We achieve this assessment by plotting education-group-specific MAFM estimates and the education composition distribution over the birth cohorts on the same axis. This graphical assessment allows us to observe patterns suggesting evidence for compatibility or diminishing returns hypotheses. For example, an observation of stalls or reversal in MAFM at the population level when (i) the overall composition of women attaining some schooling increased while the percentage of women with secondary education stalled or declined, and (ii) the MAFM for the primary and secondary education group stalled, would suggest evidence for compatibility hypothesis. On the other hand, stalls or reversals in age at marriage at the population level that mainly emerged due to stalls or reversals in age at first marriage within specific education groups over birth cohorts which experienced substantial increases in girls' school participation would suggest evidence for diminishing returns hypothesis.

Second, we perform a decomposition of cohort changes in marriage rates using the decomposition-of-difference approach (Bongaarts et al., 2017; Kitagawa, 1955; Preston et al., 2001) to quantify the component of change, which is due to changes in education composition and a component due to changes in marital timing within specific education groups. This analysis allows us to formally evaluate the compatibility and diminishing returns hypotheses beyond the graphical assessment described above. The decomposition-of-difference technique involves decomposing the group/period difference in rates into a component due to group/period composition differences and a component due to group/period behavior differences. This is achieved by: (i) Estimating the change that would have been observed if the rates between the two groups/periods had remained the same but the composition (concerning a particular factor) had changed— i.e. change due to composition differences. (ii) Estimating the change that would have been observed if the composition of the two groups/periods had remained the same but the rates had changed – i.e. a change due to group/period behavior differences—see Preston et al. (2001) page 30 for a detailed discussion of this approach.

To perform this decomposition analysis, we use the first marriage rate before age 20 (hereafter, teenage marriage rate) as a measure of marital timing. First marriage rates and MAFM are closely related, mainly in settings where the formation of first marriage is generally universal, like SSA. For our sample, about 50% to 74% of women were married by age 20 across all birth cohorts, over 75% were married

by age 25, and this proportion is over 95% by age 40 (Table 5 in the Appendix). We prefer using teenage marriage rates for this decomposition analysis for three reasons. First, in SSA, marriages are still generally early; thus, differences in MAFM are more likely to mirror changes in early marriage rates. Second, given the more significant proportion of women already married by age 25, the influence of education on marital timing is likely to be more sensitive to forming early marriages. Third, it is the early formation of marriages which is of practical concern in this region, not the formation of marriages as per se. Nevertheless, we also consider the first marriage rate by age 25, 30 and 35 for robustness.

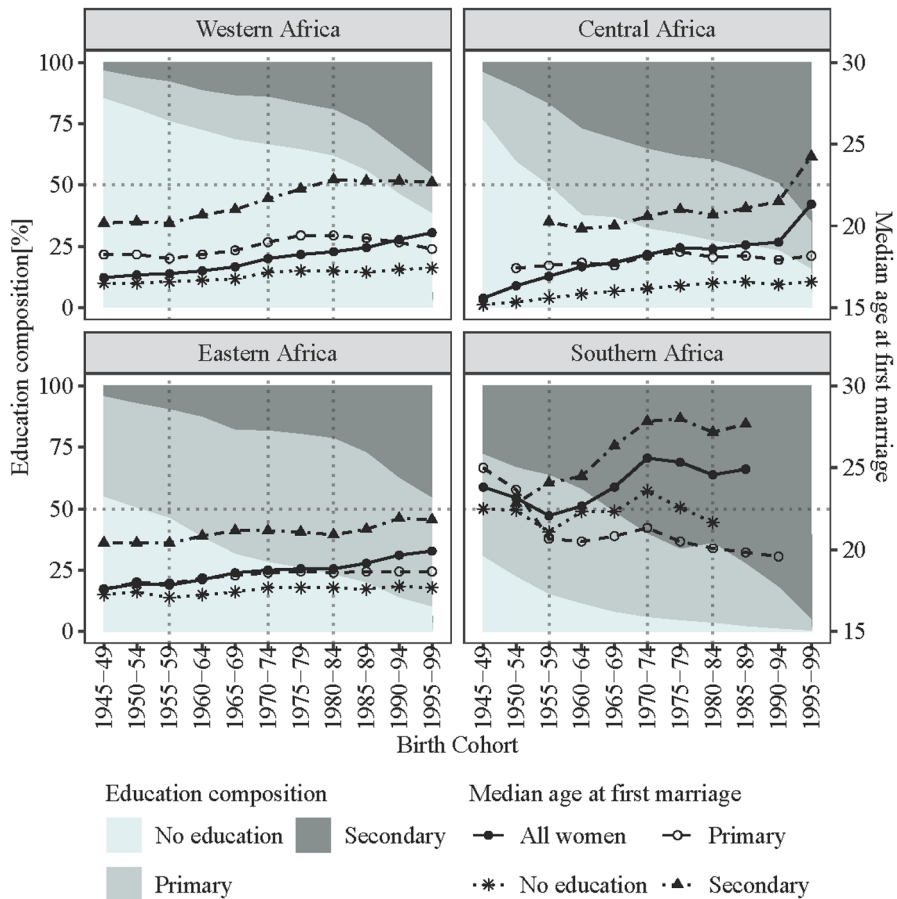
## Results

### Prevalence of Stalls and Reversals in Age at First Marriage

Figure 1 shows MAFM estimates (lines/right axis scale) and female education composition (background area/left axis scale) over birth cohorts in four SSA regions. Similar country-specific plots are in Fig. 4a–d in the Appendix. Our first objective is to identify regions and countries which experienced stalls or reversals in age at first marriage and identify birth cohorts and ages over which such stalls or reversals occurred. Thus, we first focus on MAFM estimates for all women (solid lines in Fig. 1).

The results reveal that MAFM continuously increased in West Africa while it stalled over some birth cohorts in Central and East Africa and reversed in Southern Africa. In West Africa, MAFM consistently increased from 16.8 among women born 1945–49 to 19.6 for the 1995–99 cohort. For Central Africa, MAFM slightly stalled around 18.6 among women born between 1975–79 and 1985–89 (slope=0.017). It stalled after a steady increase from 15.6 among women born 1945–49 (slope=0.104). East Africa recorded a stall in MAFM among women born 1970–74 through 1980–84, at around 18.8 years (slope=0.008). Before stalling, MAFM had increased from 17.6 among women born 1945–49 (slope=0.045), and after the stall, it increased sharply, reaching 19.9 among women born 1995–95 (slope=0.075). In Southern Africa, MAFM reversed after reaching 25.6 among women born 1970–74 – an increase from 22.1 for the 1950–55 cohort.

Table 1 identifies countries that experienced stalls or reversals in age at first marriage and the birth cohorts and the ages over which such stalls/reversals occurred. We find that MAFM either stalled or reversed in 19 out of the 33 countries (Angola excluded). Countries that experienced stalls in West Africa mainly did so over the 1970–74 through 1980–84 cohorts. The ages at which the stalls occurred in this region vary between 15.6 years in Niger and 20.0 years in Cote d'Ivoire. For Central Africa, the MAFM stalled in Chad and Congo (DRC) and reversed in Congo. In East Africa, MAFM either stalled or reversed in all countries except Ethiopia, Mozambique, Tanzania and Zambia. The pattern in Ethiopia could be surprising given that Bongaarts et al. (2017) observed small period changes in age at first marriage in this country. Nevertheless, this observation re-emphasizes how period trends could differ from cohort trends. It underscores the need to evaluate the linkage between marital



**Fig. 1** Cohort changes in median age at first marriage (according to the level of education) and in education composition (% with no education, % with primary, and % with secondary education) in four broad sub-Saharan Africa regions

timing and female education expansion from different perspectives (e.g. period vs cohort). The stalls and reversals in East African countries dominated the birth cohorts from 1965–69 through 1985–89 and occurred at MAFM around 17.8–21.1. For Southern Africa, MAFM reversed in South Africa after reaching 31.1 years among women born 1975–79.

Table 1 further reveals that, despite the stalls or reversals, all countries in SSA experienced an increase in MAFM when comparing the 1955–59 and 1990–94 cohorts. Nevertheless, countries that did not experience stalls or reversals in age at first marriage had, on average, a 1.26 times higher gain in MAFM. Liberia, Senegal, Sierra Leone, South Africa and Rwanda are exceptional. The overall gain in MAFM in these countries is substantial despite experiencing stalls or reversals. Indeed, if we excluded these countries, the average gain in MAFM is 2.02 times higher for

**Table 1** Identification of stalls and reversals in median age at first marriage at the population level in 33 sub-Saharan African countries

Region and country	MAFM 1955–59	Onset of increase	Stalled/reversed	Interval of stalls/reversals	MAFM at stall/ reversal (slope)	MAFM 1990–94	MAFM change 1955–59 to 1990–94
<b>Western Africa</b>							
Benin	17.1	1960–64	–	–	–	19.2	2.1
Burkina Faso	18.7	AR	Stalled	1965–69–1980–84	19.0 (0.010)	19.4	0.8
Cote d'Ivoire	17.5	1975–79	–	–	–	18.3	0.8
Gambia	17.8	1965–69	Stalled	1975–79–1985–89	20.0 (0.000)	20.4	2.6
Ghana	17.3 <sup>a</sup>	AR	–	–	–	19.8	2.5
Ghana	18.7	AR	–	–	–	21.9	3.3
Guinea	16.0	AR	–	–	–	17.8	1.8
Liberia	17.5	AR	Stalled	1960–64–1970–74	18.3 (0.008)	21.0	3.5
Mali	16.2	AR	–	–	–	17.3	1.2
Niger	15.0	AR	Stalled	1970–74–1980–84	15.6 (0.008)	15.9	0.9
Nigeria	16.2	1960–64	Stalled	1980–84–1995–99	18.1 (–0.005)	18.1	1.9
Senegal	16.7	AR	Reversed	1975–79–1985–89	19.8 (–0.017)	20.1	3.4
Sierra Leone	17.3 <sup>a</sup>	AR	Stalled	1970–74–1980–84	18.0 (–0.008)	19.3	2.0
Togo	18.4	AR	–	–	–	20.6	2.2
<b>Central Africa</b>							
Angola	16.9	AR	Stalled	1975–79–1985–89	18.6 (0.017)	19.0	2.1
Angola	20.4 <sup>a</sup>	na	na	na	na	20.5	0.1
Cameroon	17.0	AR	–	–	–	19.2	2.2
Chad	15.8	AR	Stalled	1975–79–1990–94	16.0 (0.003)	16.2	0.4
Congo	18.9	AR	Reversed	1975–79–1990–94	20.3 (–0.073)	19.2	0.3
Congo (DRC)	17.5	AR	Stalled	1970–74–1985–89	18.6 (0.003)	18.9	1.4
Gabon	19.0	AR	–	–	–	22.5	3.5
<b>Eastern Africa</b>							
Burundi	17.8	AR	Stalled	1970–74–1980–84	18.8 (0.008)	19.7	1.8
Burundi	19.4	1960–64	Reversed	1965–69–1985–89	20.6 (–0.023)	20.4	1.0
Comoros	18.2	AR	Reversed	1975–79–1990–94	20.9 (–0.022)	20.5	2.3
Ethiopia	15.7	1965–69	–	–	–	18.3	2.7
Kenya	18.3	AR	Reversed	1970–74–1985–89	19.9 (–0.018)	20.2	1.8

Table 1 (continued)

Region and country	MAFM 1955–59	Onset of increase	Stalled/reversed	Interval of stalls/reversals	MAFM at stall/ reversal (slope)	MAFM 1990–94	MAFM change 1955–59 to 1990–94
Madagascar	18.3	AR	Reversed	1965–69–1985–89	18.1 (–0.083)	18.8	0.5
Malawi	17.4	1960–64	Stalled	1970–74–1985–89	17.9 (–0.002)	18.2	0.8
Mozambique	17.0	AR	–	–	–	17.9	0.9
Rwanda	20.2	AR	Reversed	1965–69–1975–79	21.1 (–0.042)	23.4	3.3
Tanzania	17.3	AR	–	–	–	19.8	2.6
Uganda	17.1	AR	Reversed	1965–69–1975–79	17.8 (–0.017)	18.8	1.7
Zambia	17.0	AR	–	–	–	19.5	2.5
Zimbabwe	18.6	1965–69	Reversed	1970–74–1990–94	18.1 (–0.027)	19.0	0.4
<b>Southern Africa</b>	<b>22.1</b>	<b>1960–64</b>	<b>Reversed</b>	<b>1970–74–1985–89</b>	<b>25.6 (–0.055)</b>	<b>24.9<sup>b</sup></b>	<b>2.8</b>
Lesotho	18.2	AR	–	–	–	20.5 <sup>b</sup>	2.3
Namibia	24.4	AR	–	–	–	30.0 <sup>b</sup>	5.6
South Africa	23.0	AR	Reversed	1975–79–1985–89	31.1 (–0.025)	30.6 <sup>b</sup>	7.6

MAFM= Median age at first marriage

<sup>a</sup>estimate not corresponding to the 1955–59 birth cohort. Gambia’s estimate is for the 1965–69 cohort, Sierra Leone’s estimate is for the 1960–64 cohort, and Angola’s estimate is for the 1965–69 cohort

<sup>b</sup>estimate not corresponding to the 1990–94 birth cohort. Namibia’s estimate is for the 1980–84 cohort, while the other estimates are for the 1985–89 cohort

AR = MAFM was Already Rising over the early birth cohorts – i.e. at least for the first three earliest available birth cohorts

In Comoros, MAFM did not consistently decline. Instead, there was a sharp drop between 1975–79 and 1980–84 after consistently increasing for the birth cohorts 1950–54 through 1975–79. The recent birth cohorts estimate (1985–89 and 1990–94) are below that of 1975–79 and are consistent with the 1980–84 birth cohort. Thus, we still conclude that the age at first marriage reversed in this country, although the pattern does not fit our evaluation criteria

Estimate of the threshold at which MAFM stalled is not the exact estimate; it should read MAFM stalled around the estimate in question. For example, in Malawi, MAFM stalled around 17.9

We do not evaluate stalls/reversals for Angola because its estimates are only based on a single DHS. However, its data is included in calculating estimates for Central Africa

countries which did not experience stalls or reversals than countries where MAFM stalled or reversed.

### Drivers of Stalls and Reversals in Age at Marriage in Sub-Saharan Africa

We now refer to the MAFM-education composition alignments shown in Figs. 1 and 4a–d (in the Appendix), and the results of our decomposition analyses. Our first (compatibility) hypothesis is that age at marriage stalled or reversed because female education expansion dominated primary schooling, which is more compatible with early marriages. The patterns for West and East Africa in Fig. 1 support this hypothesis. In West Africa, where MAFM consistently increased, female education expansion was marked by more girls' participation in secondary schooling rather than only primary schooling. The group size of women with only primary education remained constant or declined over cohorts as the proportion of women enrolling in school increased – reflecting a higher primary-to-secondary progression ratio (46.4% on average (across birth cohorts)). Furthermore, we observe compelling evidence for the compatibility hypothesis in West Africa when considering women born after 1975–79. The MAFM among all women increased sharply despite stalling among women with no formal schooling and secondary education and reversing among women with primary education. This is because the proportion of girls attaining some schooling sharply increased over these cohorts, marked by more girls' participation in secondary education.

The East Africa pattern provides partial evidence for the compatibility hypothesis. MAFM at the population level stalled over the 1970–74 – 1980–84 cohorts when girls' school participation increased linearly but was dominated by primary rather than secondary schooling. On average, the primary-to-secondary progression ratio over these cohorts was only 27.0%. Concerning marital timing within education groups, MAFM stalled for women with no education and those with primary education, while it reversed among women with secondary education. Thus, it appears that the observed stall in this region emerged from a combination of stalls in secondary education expansion and a reversal in age at marriage for the secondary educated group. Hence, partial evidence for the compatibility hypothesis is suggested. It also implies that the East Africa pattern provides partial evidence for the diminishing returns hypothesis, which suggested that stalls or reversals in age at marriage at the population level emerged due to reversals in age at marriage within specific education groups.

Central Africa provides some evidence for the hypothesis of diminishing returns. MAFM slightly stalled over the 1975–79 through 1985–89 cohorts when the age at marriage for the primary education group declined, and that of women with secondary education stalled. The composition of women attaining some education increased during this stall, accompanied by an increasing proportion of women attaining secondary education. The Southern Africa pattern provides compelling evidence for the hypothesis of diminishing returns. MAFM among all women reversed over cohorts



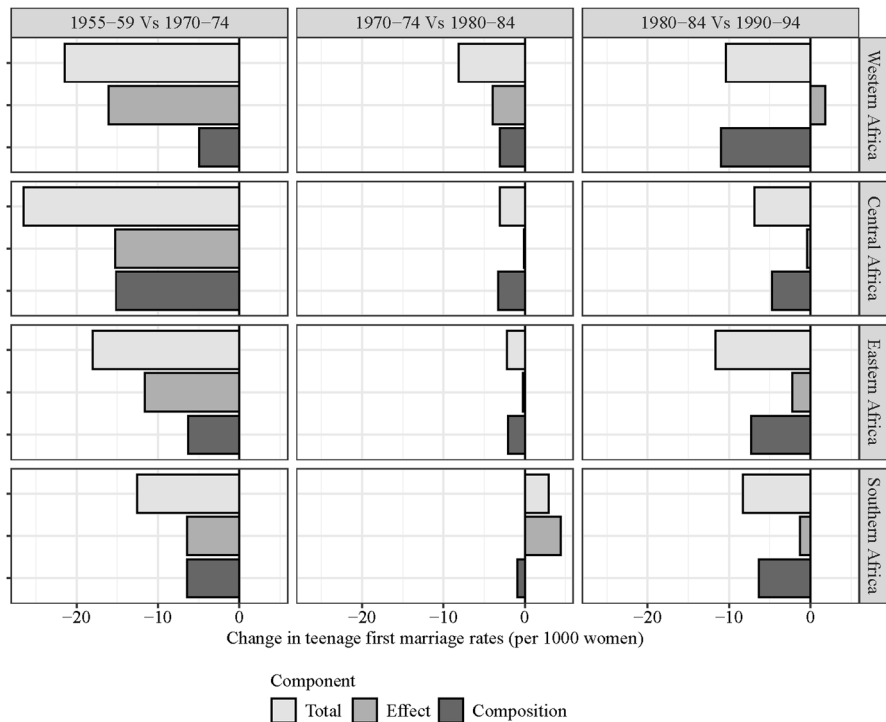
for which it declined within all specific education groups, while the proportion of women attaining primary and secondary education continued rising.

Next, we decomposed cohort changes in teenage marriage rates into a component that is due to education-composition change and a component due to rate changes in marital timing within specific education groups. We performed three decomposition analyses for each region, comparing the 1955–59 vs. 1970–74 cohorts, the 1970–74 vs. 1980–84 cohorts and the 1980–84 vs. 1990–94 cohorts (Fig. 2). We specified these comparison cohorts (guided by the stalls and reversals in Fig. 1) so that our decomposition analyses capture different phases of marital timing as female education expanded.

We note a substantial reduction in teenage marriage rates from the 1955–59 to the 1970–74 cohorts (corresponding to the early stages of female education expansion, particularly in West, Central and East Africa), which emerged from changes in education composition and within education group marital behaviour. However, the within-education group behaviour was more important in West and Eastern Africa. In Central and Southern Africa, changes in education composition and marital behavior within education groups were equally important.

The decomposition analyses of the 1970–74 vs. 1980–84 and 1980–84 vs. 1990–94 are of particular interest as they concern cohorts over which age at marriage stalled or reversed. We note three key findings. First, the decline in marriage rates within education groups in Southern Africa accounted for all the reversals in age at marriage over the 1970–74 and 1980–84 cohorts (supporting the diminishing returns hypothesis, as noted earlier). Second, in Central and East Africa, marital behavior within education groups nearly neither contributed to a reduction nor increase in marriage rates over the 1970–74 and 1980–84 cohorts. The small observed changes in marriage rates during this interval were due to the small changes in education composition. Because the composition and the effect component are generally not offsetting each other, we can conclude that the slight reduction in teenage marriage rates in these regions, which reflect the stalls in MAFM in Fig. 1, emerged from both stalls in education expansion and stalls and reversals in marital timing within specific education groups. Third, Central and East Africa had almost similar composition changes of women attaining some schooling when comparing the 1955–59 vs. 1970–74 cohorts and the 1970–74 vs. 1980–84 cohorts. However, the contribution of the composition component to the total reduction in teenage marriage rates is higher in Central Africa than in East Africa. This partially reflects the fact that attaining primary or secondary education is associated with more years of marital postponement in Central Africa than in East Africa (see Fig. 5 in the Appendix). Nevertheless, it also reflects that Central Africa had more women progressing to secondary school once they had enrolled in primary school than in East Africa, thus providing partial evidence for the compatibility hypothesis.

Teenage marriage rates declined notably across all regions between the 1980–84 and 1990–94 cohorts, reflecting the increase in MAFM over these birth cohorts documented in Fig. 1. Figure 2 suggests that this reduction is mainly due to changes in education composition. The contribution due to changes in marital timing



**Fig. 2** Contribution of changes in education composition (composition component) and marital timing behaviour within specific education groups (effect component) to the total change in teenage marriage rates, comparing 1955–59 vs 1970–74, 1970–74 vs 1980–84 and 1980–84 vs 1990–94 birth cohorts, in four sub-Saharan Africa regions. *Note.* Tables 6 and 7 in the appendix show changes in education composition and teenage marriage rates, respectively, for each education group by region. As should be expected based on Fig. 1, the results in Table 6 indicate more significant changes in the education composition when comparing 1955–59 vs 1970–74 cohorts and 1980–84 vs 1990–94 cohorts and smaller changes when comparing the 1970–74 vs 1980–84 cohorts. The changes in marriage rates for the second and third decomposition intervals are also generally consistent with the pattern of MAFM in Fig. 1

behaviour is generally minimal in East and Southern Africa regions. In West and Central Africa, changes in marital timing behaviour within education groups offset the contribution of changes in education composition. We refer to this observation later when we further evaluate evidence for the diminishing returns hypothesis in the subsequent sections.

In summary, Figs. 1 and 2 indicate that West Africa supports the compatibility hypothesis, Southern Africa supports the diminishing returns hypothesis, and Central and East Africa support both the compatibility and diminishing returns hypotheses. Table 2 classifies countries that experienced stalls or reversals according to whether they provide evidence for the compatibility, diminishing returns hypothesis, or both. We find that 14 of the 19 countries that experienced stalls or reversals did so in part (6) or solely (8) because marital age reversed within specific education groups.

### **Are Stalls and Reversals in Age at First Marriage Within Specific Education Groups Attributable to Female Education Expansion?**

The stalls and reversals within specific education groups identified in the previous sections cannot be automatically attributed to education expansion. The diminishing returns hypothesis we suggested implies that if such stalls and reversals are indeed attributable to education expansion, they must have occurred over cohorts that experienced larger groups inflow into education. The pattern in Fig. 1 provides mixed findings concerning this proposition. On the one hand, stalls or reversals in age at marriage for the primary or secondary education groups did not always coincide with a substantial increase in girls' school participation. For example, in East Africa, age at marriage reversed among women with secondary education over the 1970–74 and 1980–84 cohorts when the size of this group varied between 18.3 and 21.4%. However, it rose sharply following the 1980–84 birth cohort in parallel with a marked increase in the proportion of girls attaining this level of education. We noted a parallel pattern in Central Africa and countries such as Sierra Leone, Uganda and Zambia. Similarly, in Southern Africa, the reversals in age at marriage within specific education groups emerged before the sharp increase in the composition of women with secondary education (beginning with the 1980–84 cohort).

On the other hand, in countries such as Burkina Faso, Chad, Cote d'Ivoire, Comoros, Congo, Malawi, Mali, Nigeria, and Togo, the stalls or reversals in age at marriage for the specific education group (mainly secondary education) coincided with a substantial increase in girls' school participation, thus suggesting that such stalls are likely connected to conditions linked to female education expansion. Moreover, the West Africa region pattern in Fig. 1 provides evidence for such a possibility. The stalls and reversals in age at marriage for this region's primary and secondary education group occurred as female education sharply expanded (1980–84 to 1995–99 cohorts). Nonetheless, the overall MAFM increased despite these education-specific MAFM stalls. This pattern implies that the magnitude of female education expansion over these cohorts did not yield its anticipated maximum effect on reducing early marriages. Indeed, the effect component for the decomposition of marriage rates between the 1980–84 and 1990–94 cohorts is positive and offsets the composition component. This West African region pattern is apparent in several countries (see list under Table 3).

Furthermore, given that rural areas are generally more disadvantaged than urban areas in most socioeconomic developments, one would anticipate that the quality of education and employment opportunities might have been more compromised in rural areas than urban areas as female education expanded. Thus, the diminishing returns hypothesis implies that if stalls or reversals that occurred are connected to conditions associated with education expansion, then such stalls or reversals would be more dominant among women from rural areas than those from urban areas. It also suggests that the increase in the composition of women from rural areas constituting the primary or secondary education groups as female education expanded would explain stalls or reversals within these specific groups (since rural areas are generally selected for early marriages). We evaluate these possibilities

**Table 2** Classification of countries which experienced stalls or reversals in MAFM at the population level, according to whether they provide evidence for compatibility hypothesis, diminishing returns hypothesis or both

Compatibility hypothesis (H1)	Diminishing returns hypothesis (H2)	Both H1 and H2
Stalls or reversals emerged because education expansion dominated primary education	Stalls or reversals emerged because age at first marriage within primary or secondary education groups reversed	Stalls or reversals emerged from a combination of H1 and H2
Benin	Nigeria	Burundi
Liberia	Chad	Kenya
Niger	Congo	Madagascar
Sierra Leone	Comoros	Senegal
Congo (DRC)	Malawi	Rwanda
	Uganda	Cote d'Ivoire
	Zimbabwe	
	South Africa	

by considering countries where the MAFM for the primary or secondary education group stalled or reversed as girls' school participation increased (see list under Table 3).

Table 3 shows changes in teenage marriage rates and rural/urban composition between the 1975–79 and 1990–94 cohorts within each education group. Consistent with the diminishing returns hypothesis, we find that among women with primary education, the increase in the teenage marriage rate is 5.4 times higher for women in rural areas compared to their counterparts from urban areas. For women with secondary education, the teenage marriage rate increased among women from rural areas (by 0.2%). In comparison, it decreased among women from urban areas (by 11.1%). This pattern parallels region-specific trends (see online supplement); however, there is some heterogeneity in rural–urban differences across the regions. For example, we find that among women with primary education in West Africa, the increase in the teenage marriage rate is only 2 times higher for women in rural areas compared to their counterparts from urban areas. This estimate is 8.1 times higher in Central Africa and 8.7 times higher in East Africa. For the secondary education group, the teenage marriage

**Table 3** Changes in the teenage marriage rate and rural/urban composition, according to the level of education, comparing the 1975–79 and 1990–94 birth cohorts

	Teenage marriage rate change (per 1000 women)			Rural/urban composition change (per cent)		
	1975–79	1990–94	Change	1975–79	1990–94	Change
<b>No education</b>						
Total	102.8	107.1	4.3	–	–	–
Rural	108.7	116.3	7.7	77.2	76.4	–0.7
Urban	84.5	80.6	–3.9	22.8	23.6	0.7
<b>Primary</b>						
Total	72.7	79.7	7.1	–	–	–
Rural	81.2	91.7	10.6	62.8	63.1	0.2
Urban	59.2	61.1	2.0	37.2	36.9	–0.2
<b>Secondary</b>						
Total	40.1	38.2	–1.9	–	–	–
Rural	47.1	47.4	0.3	37.2	41.1	3.9
Urban	36.1	32.1	–4.0	62.8	58.9	–3.9

The analysis includes countries where MAFM within specific education groups stalled or reversed as the proportion of women attaining some schooling increased substantially following the 1975–79 birth cohort

Countries include Benin, Burkina Faso, Chad, Comoros, Congo, Cote d'Ivoire, Guinea, Kenya, Madagascar, Mali, Mozambique, Nigeria, Senegal, Sierra Leone, Tanzania, Togo, and Zimbabwe

Some of the countries included for this analysis support compatibility hypothesis; it only implies that the stalls or reversals at the population level occurred way before substantial female education expansion; and that MAFM within specific education groups stalled or reversed when female education expanded substantially but did not translate into stalls at the population level – i.e. the composition effect outweighed the behaviour effect. Similarly, some countries included in this analysis did not experience stalls or reversals at the population level. However, age at marriage stalled or reversed within specific education groups as girls' school participation increased substantially

rate increased among women from rural areas while it declined among women from urban areas in West Africa. It increased for both the rural and urban areas in Central Africa. However, the increase is 3.5 times higher for the rural compared with the urban population. In East Africa, the teenage marriage rate declined almost similarly in rural and urban areas. This indicates that returns to education indeed varied starkly between rural and urban areas and across the regions as education expanded, with diminishing returns to education observed primarily in rural areas.

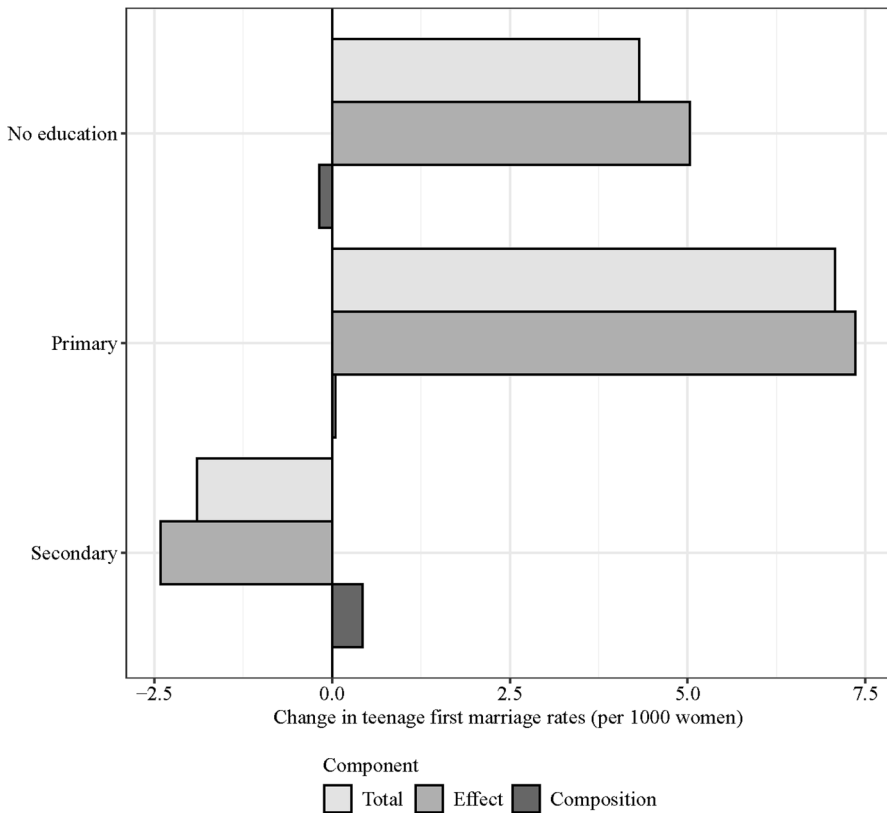
Concerning composition changes, we find marginal increases in the proportion of women from rural areas across all the education groups – the maximum is 3.9% for the secondary group. The area of residence in DHS data refers to residence status at the time of the survey. Thus, it does not fully capture the extent to which rural–urban representation changed within specific education groups because women who attended school in rural areas may migrate to urban areas to seek job opportunities or because of marriage (Mercandalli et al., 2019). Nevertheless, consistent with the diminishing returns hypothesis, we find that the changes in the rural–urban composition within each education group partly explain the observed stalls and reversals in age at marriage. Among women with secondary education, 17.8% of the reduction in teenage marriage rates due to changing marital timing behaviour (mainly among women in urban areas) was offset by the increase in the proportion of women from rural areas. The results in Table 3 and Fig. 3, thus, provide evidence that stalls or reversals in age at marriage that emerged as girls' school participation increased are linked to conditions associated with female education expansion.

## Discussion and Conclusion

This paper discusses the paradox of stalls and reversals in the timing of first marriages despite the expansion of female education in SSA. We performed a systematic investigation of this paradox in four broad SSA regions (West, Central, East and Southern Africa) and 33 individual countries using DHS data collected between 1986 and 2023. Our aim was twofold. First, to identify regions and countries that experienced stalls or reversals in age at first marriage and identify birth cohorts and ages over which such stalls or reversals occurred. Second, to describe how education expansion is linked to such stalls or reversals.

Concerning the first objective, we found that age at first marriage either stalled or reversed in 19 countries. At the regional level, age at first marriage stalled in Central and East Africa, and reversed in Southern Africa. These stalls and reversals dominated birth cohorts from 1965–69 to 1980–84. They occurred at different MAFM thresholds (15.6–31.1), which reflect the heterogeneity of marital timing behavior in SSA. Given the dominance of early marriages in this region, particularly in West, Central and East Africa, this observation implies that stalls and reversals in MAFM meant retardation of progress in efforts to alleviate early marriages. The decomposition results indeed revealed minimal decreases or increases in teenage marriage rates over cohorts for which MAFM stalled or reversed.

For the second objective, we observed that five countries that experienced stalls or reversals in MAFM did so because female education expansion dominated



**Fig. 3** Contribution of changes in rural/urban composition (composition component) and marital timing behaviour among women from rural and urban areas to the total change in teenage marriage rates, comparing 1975–79 vs 1990–94 birth cohorts, for each education group. Same notes as for Table 3. We pooled all eligible countries and performed a single decomposition analysis for each education group, comparing the 1975–79 cohort to the 1990–94 cohort. We consider these comparison cohorts because female education in SSA expanded sharply, mainly following the 1975–79 cohort (see Fig. 4a–d in the Appendix)

primary education. Hence, this finding offers support for our compatibility hypothesis. However, eight countries supported the diminishing returns hypothesis, and six countries revealed evidence supporting both the compatibility and diminishing returns hypotheses. At the regional level, West Africa revealed evidence in favor of the compatibility hypothesis; Southern Africa supported the diminishing returns hypothesis, while Central and East Africa supported both the compatibility and diminishing returns hypotheses. These results illustrate the diversity of the relationship between marital timing and female education expansion in this region, which is noteworthy for policies and programs aimed at reducing early marriages. It also indicates possible interaction effects between the level of educational attainment, prevailing cultural nuptiality regimes, and the pace and quality of education expansion that impact marital ages among girls and women.



Notwithstanding the evidence for the diminishing returns hypothesis, the findings suggested that the slow pace of progress for girls' participation in secondary schooling is the critical condition for stalls or reversals to emerge at the population level. At the regional level, this finding is more apparent in West Africa among women born after 1980–84. Age at marriage stalled for women with no formal schooling and those with secondary education and reversed among women with primary education. However, MAFM at the population level increased, primarily because the proportion of women who attended secondary education rose markedly, and the education gradient in age at marriage was huge (see Fig. 5 in the Appendix). In contrast, in East Africa, for example, marital timing for specific education groups stalled over the 1970–74 to 1980–84 cohorts, for which the composition of women attaining secondary education stagnated while those attending primary education increased. These findings confirm that changes in female education composition are critical in shaping trends in age at first marriage at the population level (Bongaarts et al., 2017). However, our results illustrate that the increase in the proportion of women with secondary education rather than primary education matters most.

Previous research argued that stalls or reversals in age at marriage in SSA could be linked to conditions associated with female education expansion –i.e. poor quality of education, changes in age patterns of school enrolment and completion, and loss of selectivity (Bongaarts et al., 2017; Grant, 2015). Our results reveal that not all stalls or reversals in SSA are attributable to female education expansion. In some regions, they emerged before girls' school participation had increased substantially; in others, they did not occur as girls' school participation expanded sharply. At the regional level, this pattern is apparent in Central and East Africa, where MAFM within education groups (particularly secondary education groups) rose sharply following the 1980–84 cohort as girls' school participation increased.

Women born after 1980–84 presumably benefitted the most from policies that promoted girls' school participation in the early 1990s. In extension, they probably experienced the most deterioration in education quality due to rapid school influxes (Bold et al., 2017; Evans & Mendez Acosta, 2021; Filmer et al., 2020), the most improvements in early school enrolment and grade progression rates (Grant, 2015; Lucas & Mbiti, 2012; Ndaruhutse, 2008; World Bank, 2020) and limited employment opportunities outside the family (Al-Samarrai & Bennell, 2007; Filmer & Fox, 2014). Thus, the pattern in Central and East Africa illustrates that even though rapid education expansion has downsides, it is not inevitably linked with stalls or reversals in marital age.

Nonetheless, where stalls or reversals coincided with substantial increases in girls' school participation, we found evidence suggesting that these two are connected. Within each education group, we observed more significant increases in teenage marriage rates among women from rural areas than their urban counterparts. This finding confirmed our anticipation that if reversals within education groups were indeed linked to female education expansion, then they were more likely steeper in rural than urban areas, noting that this urban–rural gradient was largest in Central and East Africa. Furthermore, we observed that the proportion of women from rural areas constituting each education group increased as girls' school

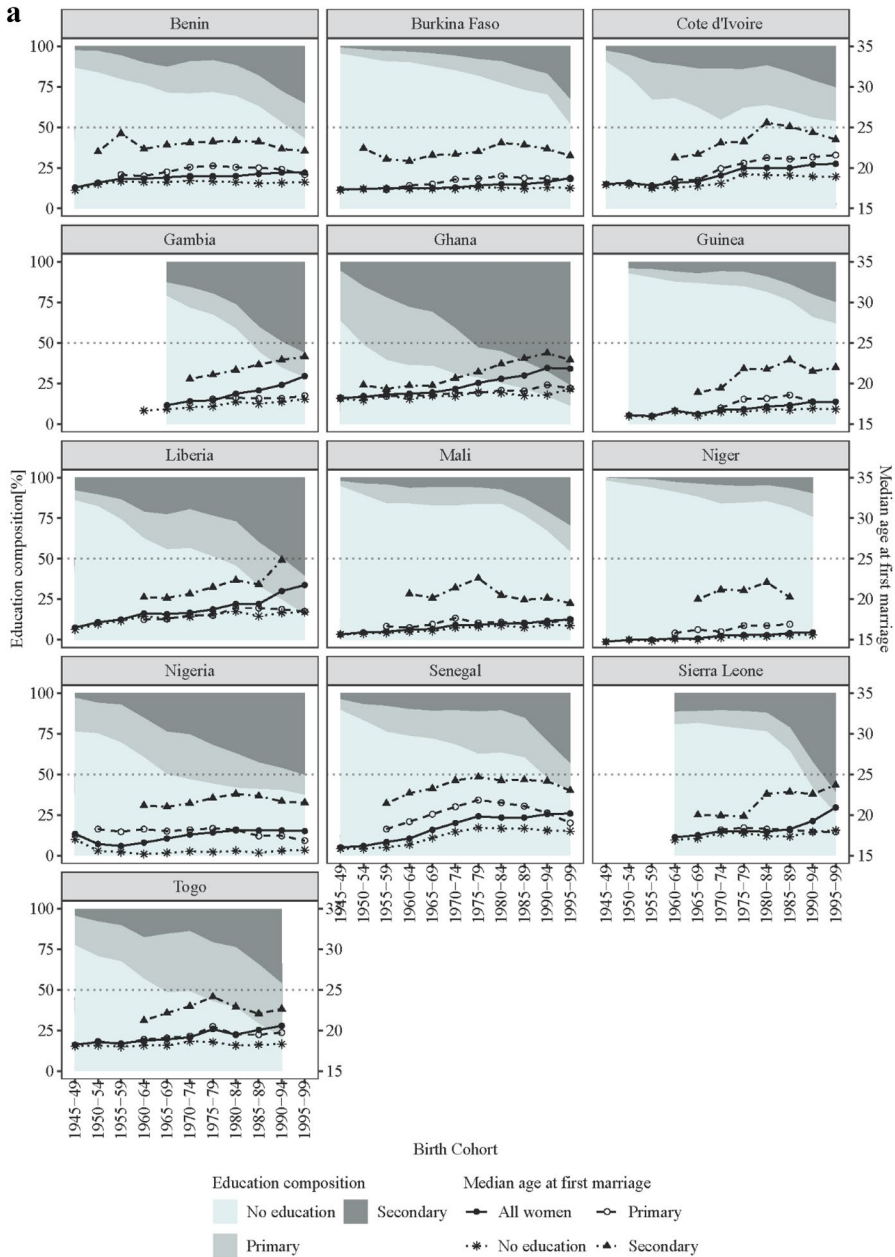
participation rose, and partially explained stalls and reversals in age at marriage within these groups, which is consistent with the diminishing returns hypothesis. This finding underscores that urban–rural differences in the return to girls’ schooling, especially in terms of women’s local labor market opportunities after they complete their schooling, deserve more attention going forward.

It is important to note that we were limited in the extent to which we could assess the contributions of specific mechanisms associated with the diminishing returns hypotheses (e.g. changes in age at school enrolment and completion, deterioration of education quality, limited economic opportunities, etc.). Much as such analyses could shed more insights into drivers of stalls or reversals in age at first marriage in this region, the available data in the DHS could not permit us to perform such analyses. Specifically, we lack information on, for example, age at first school enrolment, age at primary or secondary school exit, or clear measures of education quality or economic opportunities. Thus, further studies that extend the discussion of the paradox of education expansion and stalls or reversals in age at first marriage by considering these specific mechanisms could provide more insights into this topic. Such analyses may benefit from the application of regression-based decomposition approaches to accommodate as many specific mechanisms as possible. For our analyses, the graphical assessment and the difference-in-difference decomposition approaches sufficed since our empirical assessment focused on understanding the overall changes in education composition and marital timing within education groups and their contribution to changes in age at marriage at the population level.

The findings presented in this paper re-emphasize the need to expand female education beyond primary school to ensure meaningful reductions in early marriages in SSA. Thus, the dynamics of female education expansion we documented in West, Central and East Africa suggest different policy and programme needs for these regions. In West Africa, enrolment in primary school is a critical challenge. The primary-to-secondary progression ratio is relatively higher in this region, although there is room for improvement. On the other hand, enrolment in a primary school is now nearly universal in East Africa. Instead, getting girls beyond primary education is a significant challenge. The Central Africa pattern falls between that of West and East Africa. Policies that tailor primary and secondary school enrollment to the conditions and needs of each specific region will likely be more successful in facilitating the reduction of early marriages and, in turn, ensuring the advancement of females’ socioeconomic and reproductive health in SSA.

## Appendix

See (Figs. 4, 5, 6) and (Tables 4, 5, 6, 7).



**Fig. 4 a** Cohort changes in median age at first marriage (according to education level) and education composition (% with no education, % with primary education and % with secondary education) in West Africa. **b:** Cohort changes in median age at first marriage (according to education level) and education composition (% with no education, % with primary education and % with secondary education) in Central Africa. **c:** Cohort changes in median age at first marriage (according to education level) and education composition (% with no education, % with primary education and % with secondary education) in East Africa. **d** Cohort changes in median age at first marriage (according to education level) and education composition (% with no education, % with primary education and % with secondary education) in Southern Africa

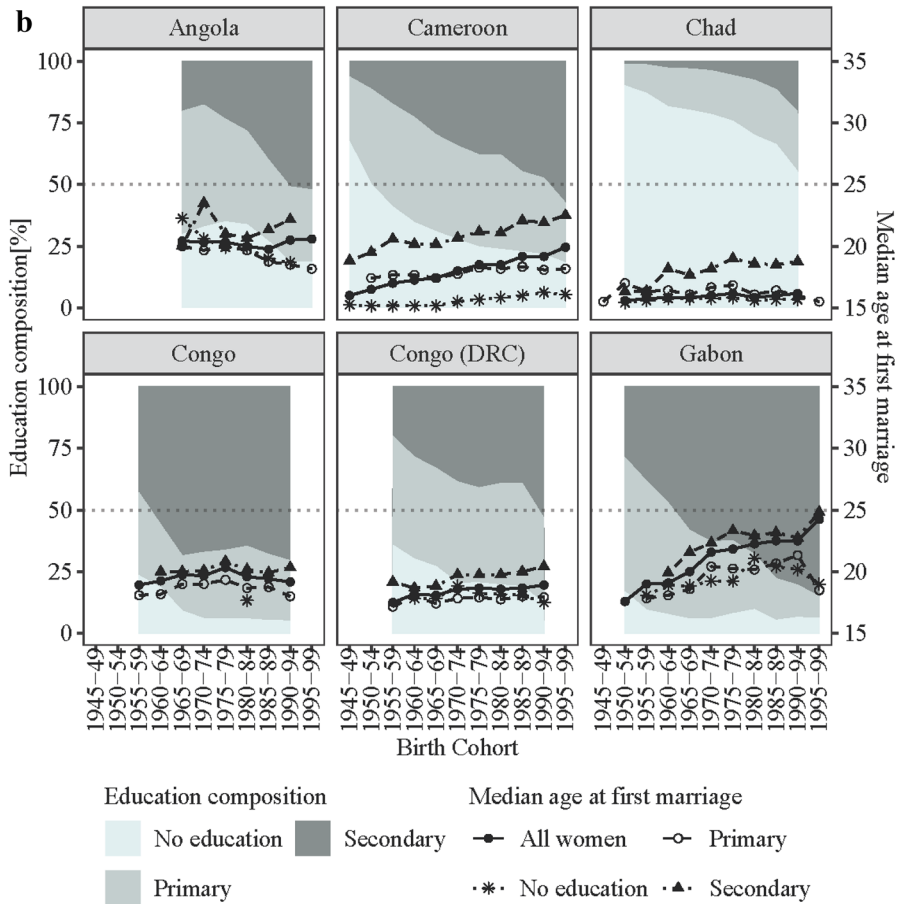


Fig. 4 (continued)

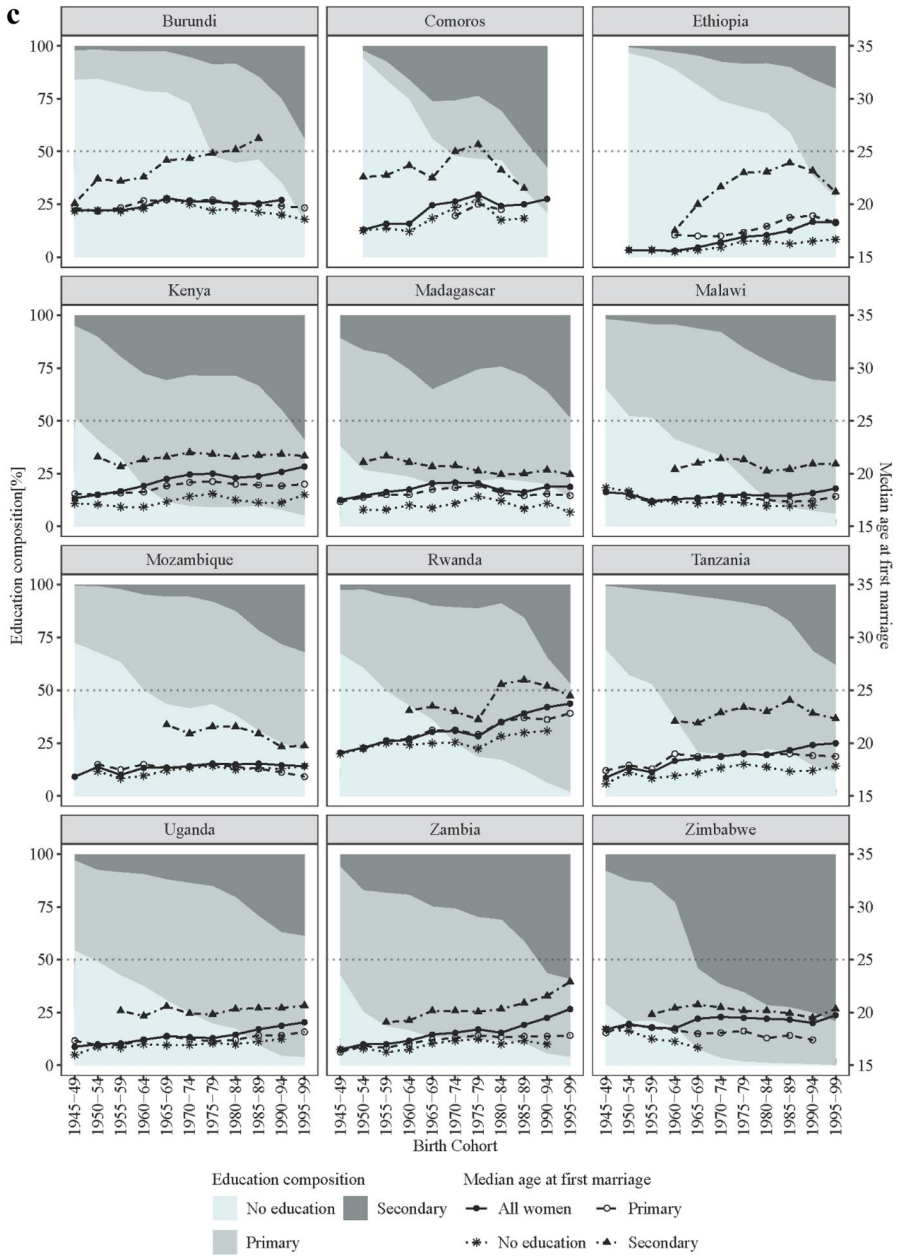


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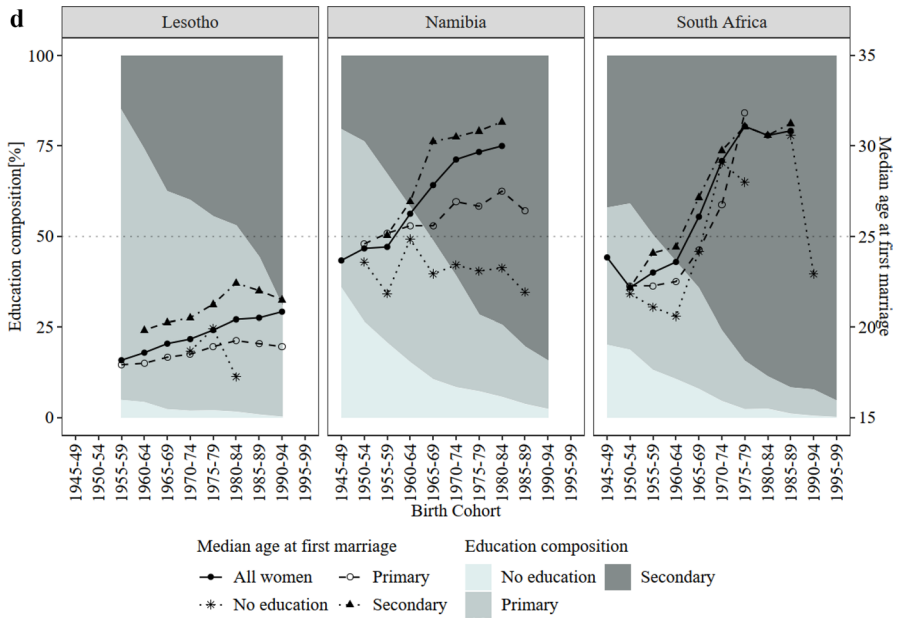
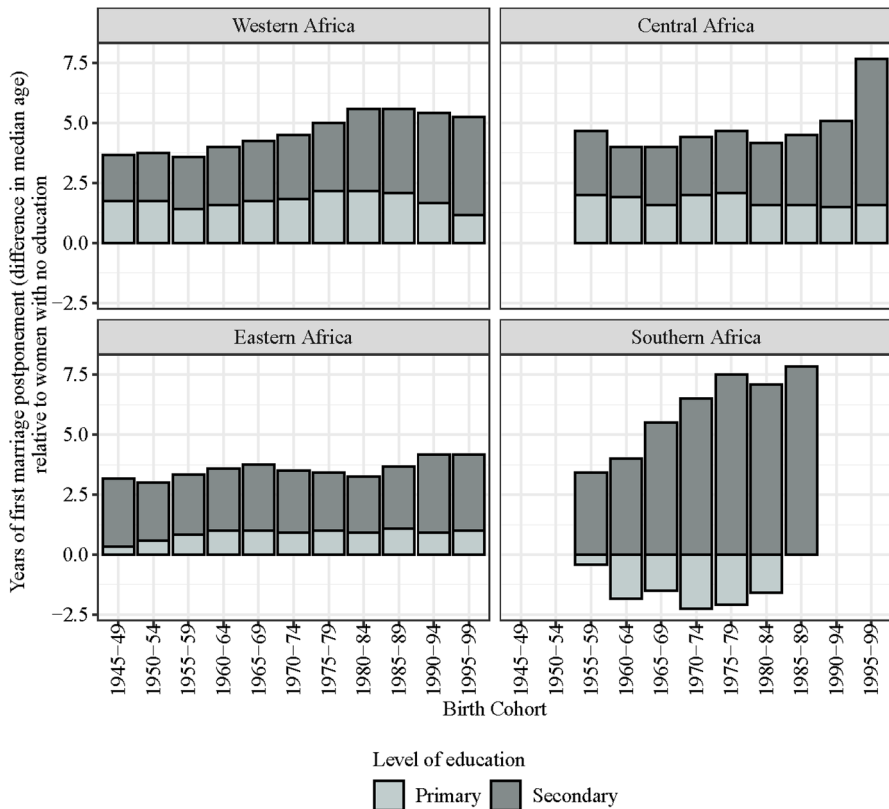
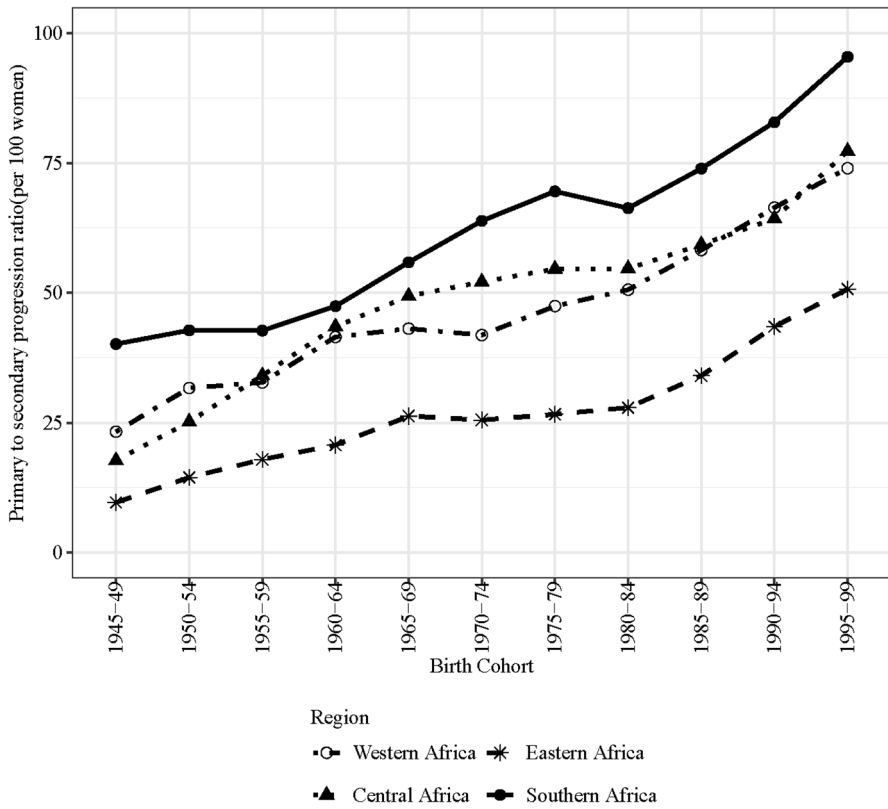


Fig. 4 (continued)



**Fig. 5** Education gradient in the timing of first marriage in four sub-Saharan African regions across birth cohorts, comparing women with primary and secondary education relative to women with no education. *Note.* On average (across all birth cohorts), and relative to women with no education, attaining primary education increased the median age at first marriage by 1.7 years in West Africa, while secondary education increased it by 4.6 years. These estimates are 1.8 and 4.5 years for Central Africa, 0.9 and 3.6 years for East Africa and -1.6 and 4.1 years for Southern Africa





**Fig. 6** Primary to secondary progression ratio over birth cohorts in four sub-Saharan Africa regions, across birth cohorts

**Table 4** Distribution of Sample Size (women aged 20–49 with known information about marital status, education level and known date at first marriage among those who ever married) according to birth cohort, classified by region and country

Region and country	1945–49	1950–54	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	Total
Western Africa	6172	12,417	22,055	38,435	53,623	71,995	77,870	85,515	76,479	58,586	30,667	533,814
Benin	306	690	1799	3262	5149	7693	8747	9142	6790	4161	1946	49,685
Burkina Faso	493	1249	2491	4175	4960	6310	6886	6809	5540	3303	2860	45,076
Cote d'Ivoire	506	790	1018	1864	2564	3577	3045	3415	3892	3232	2269	26,172
Gambia	0	0	0	141	586	1521	2076	2990	3174	3470	1843	15,801
Ghana	839	1448	2334	3311	4174	4468	4783	4515	3793	3460	2158	35,283
Guinea	5	549	1176	1929	2905	4252	4481	3890	3165	2744	1291	26,387
Liberia	537	618	1284	1871	1840	2639	3035	3706	3092	2293	1339	22,254
Mali	462	1418	2736	4353	5925	7278	7463	6891	4580	3253	1520	45,879
Niger	491	1159	1800	3144	4283	4227	4086	3934	2821	1182	0	27,127
Nigeria	678	1096	2129	6047	8656	12,043	13,461	16,926	15,655	11,093	5106	92,890
Senegal	1039	1913	3336	5054	7588	11,716	12,827	15,883	16,969	14,484	7956	98,765
Sierra Leone	0	0	54	813	1902	3832	4602	5985	5395	4637	2379	29,599
Togo	453	1036	1309	1868	2816	2439	2378	1429	1613	1274	0	16,615
Central Africa	549	1535	4079	7346	12,996	17,025	20,093	20,852	18,857	14,885	4133	122,350
Angola	0	0	0	0	617	987	1561	1537	2355	2758	761	10,576
Cameroon	360	742	1725	2862	3839	4957	5340	5778	4436	3230	1708	34,977
Chad	189	542	1255	1375	3059	3608	3991	3508	3248	3034	178	23,987
Congo	0	0	325	1024	1656	2211	2627	3143	1980	740	0	13,706
Congo (DRC)	0	0	313	1068	2210	2836	3617	4447	4400	3069	0	21,960
Gabon	0	251	461	1017	1615	2426	2957	2439	2438	2054	1486	17,144
Eastern Africa	6745	14,225	24,501	41,013	54,517	71,490	76,855	76,036	63,729	46,927	21,790	497,828
Burundi	380	492	733	1314	1747	2409	2575	3795	4269	3655	1381	22,750
Comoros	113	216	310	462	705	1078	772	732	713	574	0	5675

**Table 4** (continued)

Region and country	1945–49	1950–54	1955–59	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	Total
Ethiopia	0	1086	2097	3323	4916	6956	8771	7431	5958	3547	936	45,021
Kenya	1300	2189	3245	4975	7357	8268	9598	9490	10,436	8460	4088	69,406
Madagascar	572	1259	2295	4033	4743	5995	6269	5883	4497	2735	3091	41,372
Malawi	376	1240	2187	4544	6044	8646	10,635	11,109	8150	5304	1179	59,414
Mozambique	274	831	1828	3030	3758	5105	6112	5572	3828	2634	2061	35,033
Rwanda	476	1226	2513	4199	5328	7373	7889	9060	7019	4967	2292	52,342
Tanzania	1044	1848	2714	4695	6240	7887	7500	6981	5712	4749	3087	52,457
Uganda	617	1202	2147	3650	4869	6114	5585	5261	4731	3722	1302	39,200
Zambia	807	1251	2201	3409	4863	6698	6383	6000	4903	4582	2062	43,159
Zimbabwe	786	1385	2231	3379	3947	4961	4766	4722	3513	1998	311	31,999
Southern Africa	625	1890	3305	5308	7383	8324	8472	7551	5817	3586	437	52,698
Lesotho	0	0	565	1310	1812	2033	2545	3352	2413	1196	2	15,228
Namibia	405	851	1479	2477	3506	3858	3706	3113	2205	1172	0	22,772
South Africa	220	1039	1261	1521	2065	2433	2221	1086	1199	1218	435	14,698

**Table 5** Proportion married by age according to birth cohort

Birth cohort	Proportion married by age					
	20	25	30	35	40	45
1945–49	74.1	91.9	96.3	97.8	98.4	98.7
1950–54	72.0	90.5	95.6	97.1	97.8	98.3
1955–59	72.1	90.7	95.5	97.1	97.9	98.3
1960–64	69.2	88.6	94.6	96.7	97.6	98.1
1965–69	65.5	86.2	93.1	95.7	96.8	97.4
1970–74	62.6	84.6	92.7	95.4	96.8	97.5
1975–79	61.1	84.4	92.0	95.1	96.6	97.6
1980–84	60.8	83.5	92.1	95.5	97.3	
1985–89	58.3	82.6	91.7	95.4		
1990–94	54.8	80.2	91.0			
1995–99	51.5	78.9				

**Table 6** Changes in education composition (% with no education, % with primary and % with secondary education) between comparison cohorts in four sub-Saharan Africa regions

	First decomposition			Second decomposition			Third decomposition		
	1955–59	1970–74	Change	1970–74	1980–84	Change	1980–84	1990–94	Change
West Africa									
No education	75.9	66.5	–9.5	66.5	61.8	–4.6	61.8	46.2	–15.6
Primary	16.2	19.5	3.3	19.5	18.9	–0.6	18.9	18.1	–0.8
Secondary	7.9	14.0	6.2	14.0	19.3	5.3	19.3	35.7	16.4
Central Africa									
No education	49.8	32.2	–17.6	32.2	27.1	–5.1	27.1	23.2	–3.9
Primary	33.1	32.5	–0.6	32.5	33.1	0.6	33.1	27.4	–5.6
Secondary	17.1	35.3	18.2	35.3	39.8	4.5	39.8	49.3	9.5
East Africa									
No education	46.2	28.2	–18.0	28.2	23.0	–5.2	23.0	13.7	–9.4
Primary	44.2	53.5	9.3	53.5	55.5	2.1	55.5	48.8	–6.7
Secondary	9.7	18.3	8.7	18.3	21.4	3.1	21.4	37.5	16.1
Southern Africa									
No education	15.1	5.6	–9.4	5.6	3.4	–2.3	3.4	1.0	–2.4
Primary	48.7	34.1	–14.6	34.1	32.6	–1.5	32.6	17.0	–15.6
Secondary	36.3	60.2	24.0	60.2	64.1	3.8	64.1	82.0	18.0

**Table 7** Changes in teenage marriage rates (per 1000 women) between comparison cohorts according to the level of education in four sub-Saharan Africa regions

	First decomposition			Second decomposition			Third decomposition		
	1955–59	1970–74	Change	1970–74	1980–84	Change	1980–84	1990–94	Change
<b>West Africa</b>									
<i>All women</i>	110.6	89.2	– 21.4	89.2	81.1	– 8.1	81.1	70.7	– 10.4
No education	121.9	106.3	– 15.7	106.3	104.2	– 2.0	104.2	105.6	1.4
Primary	93.4	73.8	– 19.6	73.8	66.9	– 6.9	66.9	73.2	6.3
Secondary	56.9	44.1	– 12.8	44.1	35.3	– 8.8	35.3	34.4	– 0.9
<b>Central Africa</b>									
<i>All women</i>	108.7	82.2	– 26.5	82.2	79.1	– 3.1	79.1	72.2	– 6.9
No education	140.2	121.5	– 18.8	121.5	119.4	– 2.1	119.4	121.9	2.5
Primary	101.6	85.3	– 16.2	85.3	88.1	2.8	88.1	92.5	4.3
Secondary	55.8	52.6	– 3.2	52.6	51.6	– 1.0	51.6	45.3	– 6.3
<b>East Africa</b>									
<i>All women</i>	95.9	77.9	– 18.0	77.9	75.7	– 2.2	75.7	64.0	– 11.6
No education	108.8	97.9	– 11.0	97.9	98.8	0.9	98.8	98.3	– 0.5
Primary	94.9	82.0	– 12.9	82.0	80.0	– 2.0	80.0	79.9	– 0.1
Secondary	51.3	42.7	– 8.6	42.7	45.8	3.0	45.8	36.2	– 9.6
<b>Southern Africa</b>									
<i>All women</i>	41.9	29.4	– 12.5	29.4	32.3	2.9	32.3	24.0	– 8.3
No education	51.5	38.6	– 12.9	38.6	51.6	12.9	51.6	26.5	– 25.1
Primary	52.7	48.3	– 4.4	48.3	56.3	8.1	56.3	60.8	4.5
Secondary	25.3	18.8	– 6.5	18.8	20.4	1.6	20.4	17.3	– 3.0

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**Data availability** All data used for this analysis is publicly available and can be accessed on request at [https://dhsprogram.com/data/dataset\\_admin/login\\_main.cfm](https://dhsprogram.com/data/dataset_admin/login_main.cfm).

## Declarations

**Conflict of interest** The authors have no relevant financial or non-financial interests to disclose.

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