Genus

Fertility transition in Rwanda: what does the trend in nuptiality reveal?

Dieudonne Ndaruhuye Muhoza[*]

*Correspondence:
dieumu_res@yahoo.fr
Department of Applied
Statistics, College of Business
and Economics, University
of Rwanda, Street, KK 737, P.
O. Box 4285, Kigali, Rwanda

Abstract

Recent literature on fertility trend in Rwanda indicates that the country is undergoing a fertility transition since fertility has declined from 6.1 births to 4.2 between 2005 and 2015. According to the fertility transition theory, the decline of fertility follows change in nuptiality. In Rwanda, the trend in nuptiality pattern over the period has however not yet been investigated. This research seeks to fill that gap by describing the trend in marriage timing between 2005 and 2015 and assess the effect of education and residence on that timing. Data come from the 2005, 2010 and 2015 Rwanda Demographic and Health Surveys, women files. The study population includes all women of reproductive age, 15–49 years. The outcome variables are the proportion of women never-married and the median age at first marriage. The key independent variables are period (year), education and residence type. The study used descriptive statistics and Cox proportional hazard regression. Results indicate that, over the 10 years of study, there have been a continuing increase of the proportions of women never-married and the median ages at first marriage. Education and urbanization have been found to have a delaying effect on marriage timing. The study concludes that the observed decline in fertility is associated with the rise in age at marriage. The combined effects of increasing number of women reaching the secondary education or higher and their low risks to marry at young age, with that of progress in contraceptive use among these educated women lead to expect a continuing fertility transition.

Keywords: Nuptiality, Marriage, Trend, Fertility transition, Rwanda

Introduction

Recent literature describing fertility trend in Rwanda concludes that the country is undergoing a fertility transition (Ndahindwa et al., 2014; Westoff, 2012). Between 2005 and 2015, fertility has declined by 1.9 births, from 6.1 births to 4.2 (National Institute of Statistics of Rwanda [NISR], 2015). According to Bongaarts' (2003)[1] classification of fertility in the fertility transitional process, such fertility level corresponds to mid-transitional period. Furthermore, the decline of fertility occurred concomitantly with important economic performances and social transformations leading to expect a subsequent long-term fertility decline. Over the same period, from 2005 to

---

[1] Pre-transition (7+), early (6–6.9), early–mid (5–5.9), mid (4–4.9), mid/late (3–3.9), late (2.1–2.9), post-transition (0–2.0).

2015, Rwanda has experienced an average annual economic growth of 8% (National Bank of Rwanda, 2017), while education was steadily increasing in quantity (number of enrolments) as well as in quality (levels attained). Enrolment rates at secondary and tertiary levels increased by 2.3 times and 2.4 times. Especially, females have massively undertaken secondary education and higher, with an increase of 2.7 times and 2.5 times (MINEDUC, 2016). In addition to education, the place and role of women in governmental decision-making positions have been considerably reinforced, whereby in 2018 women representing 50% of the ministerial cabinet members, 61% in parliament, 42% in Supreme Court, 27% of district Mayors (NISR, 2019).

According to the fertility transition theory, the sole fertility trend does not provide the full information on the process of reproductive change. Nuptiality is also an important component of this fertility transition process which may ensure its sustainability. Following Herdrich (2017), Harwood-Lejeune (2001) and Chesnais (1986), nuptiality transition is the first step of fertility transition and a prelude to deliberate birth control. Nuptiality affects fertility dynamic in various ways. First, age at first marriage affects the length of childbearing span by determining the time of entrance in marital life and so in childbearing process (Ikamari, 2005). In societies in which most births are born in wedlock and contraception is low, like the sub-Saharan Africa region, age at first marriage is inversely correlated to fertility, early marriage leading to high fertility and later marriage to lower. Second, age at first marriage is correlated with family stability where marriage at young ages has higher probability of dissolution than that concluded at high ages, which affects the reproductive period of a woman (Palamuleni, 2011). Third, age at first marriage is associated with mortality where early marriage is accompanied with high risks of both maternal and child mortality than the later one, which affects indirectly fertility attitude and span in various ways: replacement mechanism of lost children, remarriage or family dissolution. Through these mechanisms, age at first marriage has a strong significance with respect to future fertility of the couple, its stability and the health status of the mother and her children.

The advantages of a high age at marriage outstrip the sole slowing population growth and extend to socioeconomic gains. Rising age at marriage is often associated with several socioeconomic achievements including education rising and completion, building labour force skills and development of career interests (Letamo, 2014). These socioeconomic improvements shall accelerate themselves fertility transition by changing attitude and behaviour vis-à-vis to fertility. On the other side however, a long delay in marriage has adverse issues such as premarital sex, adolescent and unwanted pregnancy, abortion, STDs and HIV/AIDS (Palamuleni, 2010). All these multiple effects influence at various levels and in different ways the reproductive attitude and behaviour of populations.

Despite this important role in the determination of fertility change, the trend in nuptiality has not yet been investigated in Rwanda. Yet it is an important factor and an indicator of fertility change, and even of demographic dynamics. This research seeks to fill that gap by describing the trend in nuptiality in terms of marriage timing and assess the effects of education and residence, two important drivers of demographic change. The study does not however take into account the different forms of marriage; instead it focuses on marriage timing. Findings from this study will provide further evidence on the ongoing fertility transition in Rwanda and shed light on its sustainability. The research intends to answer the following questions:

How did age at first marriage evolve in Rwanda, between 2005 and 2015?

How did education and residence affect the marriage timing in Rwanda, between 2005 and 2015?

Nuptiality change and fertility transition: which theoretical link mechanisms?

The connections between nuptiality change and fertility transition has been largely documented since 1960s. The first writing on this link was presented by Davis (1963) who indicated that the postponement of marriage and a permanent celibacy are one of the responses to demographic pressure (United Nations, 1990). Later Chesnais (1986) subsequently developed the mechanism process of this theory and distinguished two steps in the fertility transition: a "*Malthusian transition*" in which fertility is lowered by the restriction of marriages; and, a "*neo-Malthusian transition*" in which fertility declines by a deliberate use of contraception. Based on this sequential process, Chesnais (1986) suggests that nuptiality transition could be considered as a first step in the fertility transition since control of marriages preceded births control. For him, the change in nuptiality is a prelude to deliberate birth control. Recognizing the inhibiting effect of nuptiality in the first stages of fertility transition, Bongaarts (1992) specifies however that as fertility transition progresses, the impact of contraception becomes dominant and much stronger.

In 1980s, with a wave of studies refining the framework of the proximate determinants of fertility, Bongaarts (1982, 1992) revised and simplified the original framework developed by Davis and Blake (1956) and Bongaarts (1978) and indicated that the nuptiality, in terms of proportion of married women, was one of the four variables which explain much of the variation in fertility levels across countries and over time. The three other determinants are contraception, abortion and post-partum infertility. Other factors remaining equal, delaying marriage is reducing the reproductive life spent in union. Fertility is therefore negatively correlated to age at marriage: the higher the median age at first marriage, the lower is the fertility. For Hertrich (2017), an average median age at marriage of 18 years is incompatible with a sustained fertility decrease.

More recently, empirical studies, especially on Asia (Jones, 2005; Therborn, 2004), have provided further evidence to the above theory that fertility decline starts with the delay in timing of marriage and the increase in the proportion of people remaining single. In the Asia–Pacific region, which experienced a rapid and strong fertility transition, Jones (2005) has noted that the decline of fertility has been strikingly linked to the delayed marriage and in many cases to the failure of many people to marry at all.

The link between nuptiality and fertility is exceptionally strong in sub-Saharan Africa region where undoubtedly high fertility is sustained by the traditional nuptiality system (Hertrich, 2017). As noted by Locoh (2006), Hertrich (2006) and Chojnocka (1995), in sub-Saharan Africa, nuptiality has been universal (for all people) and maximizing the span of a woman's reproductive life through early marriage and rapid remarriage in case of divorce or widowhood. According to UN (1986) and Bongaarts et al. (1984), the proportion of reproductive time spent out of union in sub-Saharan Africa is below 15%, and even below 10% in some populations. With these traditional marriage patterns, fertility transition cannot occur without a change. This seems to be a condition for fertility decline.

Moreover, the pathway through which nuptiality change influences fertility is not an isolated mechanism. Several other changes with also inhibiting effects on fertility occur together with nuptiality (Jones, 2005). The occurrence and social acceptance of premarital sexual activity due to the long period between puberty and later "legitimate" sexual activity has been common in the world (Mokomane, 2006; Therborn, 2004). For Jones (2007) this period takes a decade, two or three in length. Sexual activity out of wedlock should be understood, however, as both a cause and a consequence of delayed marriage because it results from the long waiting period, but at the same times it facilitates the delay by permitting informal sexual relationships which reduces the desirability of marriage. Of course, these relationships may result in births. Mokomane (2006) found in Botswana that the premarital childbearing was a prelude rather than an alternative to marriage and that the changing marriage patterns were associated with various changing social and economic conditions.

Furthermore, the delay in marriage has often also an intention to delay childbearing and other family obligations because the concerns are the same. In many developing regions to marry without the intention to have children is still considered as an aberrant behaviour. After marrying, young couples are subjected to considerable pressure, from families and to a lesser extent from friends, to have a baby. Therefore, the easiest way to avoid such pressure is to remain single. Although single people are pressured to marry, the pressure may be less than that exerted on married couples to have their first child. Getting marriage and having children are strongly correlated: age at marriage determines fertility and aspired fertility rationalizes age at marriage.

Data and variables

The study uses a pooled dataset from the 2005, 2010 and 2015 Rwanda Demographic and Health Surveys (RDHS), women files. These surveys are chosen as they are the most recent and cover a period of remarkable socio-demographic and economic change in Rwanda (NISR, 2016). Since the three surveys have used the same standard questionnaire and that samples are nationally representatives, the datasets are almost identical and thus allow a comparative analysis. The study population includes all women of reproductive age, 15–49 years.

The outcome variables are the proportion of women never-married and the median age at first marriage (Westoff, 2003). Age at first marriage, expressed in completed years, means the age at which a woman has started to cohabitate with her partner permanently. It includes both women legally married and those living together with their partners without formal marriage. The partner may be the current partner or not. The information on age at first marriage is obtained from the survey question: *How old were you when you first started living with him (first husband/partner).* Note that the median age at marriage is computed on women aged 25–49 years than 15–49 years. The two young age groups 15–19 and 20–24 years are excluded because half of the women had not yet entered in union at the time of survey and therefore the median age is not yet reached. In the dataset, individual ages at marriage range between 12 and 49 years. The median ages at first marriage have been computed arithmetically by linear interpolation from individual declaration on age at marriage expressed in completed years as done in DHSs

Reports (DHS).[2] The interpolation allows getting a median age on a continuous time scale needed for assessing change which may be less than a year. For the computation of the proportions of women never-married, however, all age groups will be considered in order to display the pattern of the whole reproductive period. The proportions of never-married women are derived from information on marital status in dataset.

The quality of data on age at marriage in Africa is subject to a number of criticisms. First, in many African countries, the concept of marriage is vague as termed by Harwood-Lejeune (2001). Many couples start their cohabitation with temporary or even occasional stay which may result in births. The permanent cohabitation or marriage came later when the couples feel economically or emotionally (full commitment) ready for formalization. This may lead to the variations in the declaration of marital status among respondents. Secondary, retrospective questions suffer from a fundamental weakness of imprecision in the recalling of age at marriage, especially among uneducated women who do not know even their age. How a woman who is unable to state her age could state her age at marriage? The incapacity to state their true age at marriage may lead to report the legal age for marriage in the country or the age at which girls are expected to marry in the society.

The key independent variables are *period* (year), *education* and *residence type.* Years are chosen to show the overtime trends. Education is chosen because of its strong effects on human behaviour including family formation. Riche literature (Mensch et al., 2005) points out education as the most factor that brings down traditional and societal norms, beliefs, and customs and introduces change in human behaviour and actions. Mensch (2005) went far and argued that increased schooling is the main force underlying the delay in first marriage among women. In RDHSs, information on education was collected using a direct question: *What is the highest level of school you attended?* Answers included none, primary, secondary and higher. In this analysis, the variable has been grouped in three categories: no education, primary, secondary or higher. Residential environment also impacts significantly individual's attitude and views on marriage and reproduction. While urbanization alters the community behaviour and brings new type of values and behaviour from other communities met or abroad, rural settings keep and remain attached to tradition which therefore affects the motivation and propensities for marriage. Singh and Samara (1996) explain the delaying effect of urbanization on marriage that women in urban areas are exposed to modern values encouraging later marriage and are less likely to be under the influence of kin who control the timing of marriage and choice of spouse.

Other independent variables included in the model equation of marriage timing, as controlling variables, are occupation, religion, region, age at first sex, family size of origin. Economic position as measured by the household wealth index commonly used in differentials analysis is not included since the current economic position of a woman is often an indicator of post-marriage situation (an effect from marriage/husband) than a position before marriage.

---

[2] Croft, Trevor N., Aileen M. J. Marshall, Courtney K. Allen, et al. 2018. Guide to DHS Statistics. Rockville, Maryland, USA: ICF, pp.63. https://dhsprogram.com/data/Guide-to-DHS-Statistics/index.cfm

Statistical analysis and modelling

The study starts with descriptive statistics on the trends in nuptiality using the two most used indicators: the proportion of never-married and the median ages at first marriage. The descriptive analysis investigates the differentials in marriage timing by year, education and residence. The descriptive analysis is followed with a Cox proportional hazard regression with interaction terms to perform the effects of selected independent variables including education and residence on the timing of first marriage.

The age at first marriage may be interpreted as a survival time from a single state to married state. Throughout this interval, women may either enter into marriage or be right censored at the time of the survey. In this case, women who were single at the time of the survey constitute censored cases. Censored cases require special treatment in estimating exposure time, and as such, ordinary regression procedures are not appropriate (Allison, 1995). I therefore use continuous time even history analysis techniques (Allison, 1984). In particular, the Cox proportional hazard model is used to assess the effect of independent variables on marriage timing. The model is generally described as:

$$h(t; x_1, \ldots, x_n) = h_0(t) \cdot \exp(b_1 \cdot x_1 + \cdots + b_n \cdot x_n),$$

where $h(t,_,)$ denotes the resultant hazard, given the values of the n covariates for the respective case $(x_1, x_2, \ldots, x_n)$ and the respective survival time (t). The term $h_0(t)$ is called the *baseline hazard*; it is the hazard for the respective individual when the values of all the covariates are equal to zero.

Results

General trends in nuptiality

As stated in the methodology section, two indicators are often used to assess changes in marriage timing: the proportion of women in reproductive ages never-married at various ages and the median ages at first marriage. The table below which summarizes these trends reveals two results: (1) a continuing postponement of marriage overtime, and (2) a steadily increase of the median ages at first marriage.

A continuing postponement of marriage overtime

Table 1 indicates that, on overall, over the 10 years of study, the proportions of women never-married were increasing at all age groups, except for women 15–19 years old who almost all are never-married (96% or 97%). For example, the proportion of never-married at age group 20–24 years increased from 54.4% in 2005, to 59.9% in 2010 and then to 60.7 in 2015 (an increase of 6.3 percentage points). More increase has been observed at age group 25–29 years with an increase of 8.3 percentage points. From there, the increase reduces as women become older. Even at 45–49 years considered as the end period of childbearing for women, the results display a continuing augmentation of the proportions of never-married although figures are small: 1.8% in 2005, 1.9% in 2010 and 4.1% in 2015. These changes translate the decline of the propensity for many girls to marry earlier. Instead, there is a continuing postponement of marriage as time passes.

Table 1 Trends in proportions of women never-married and median ages at selected ages, Rwanda 2005_2010_2015

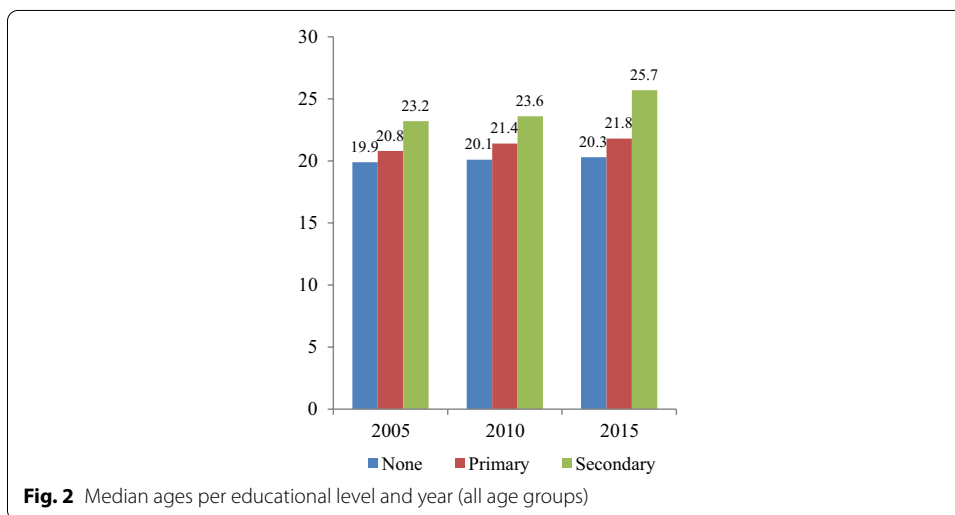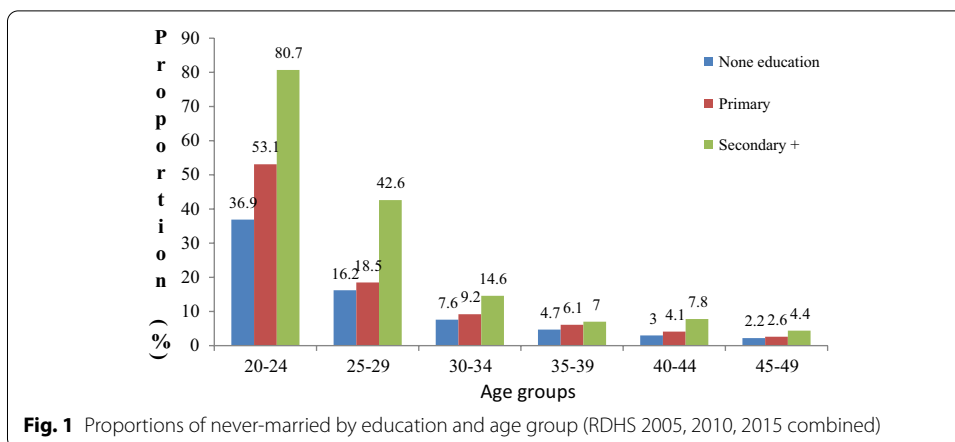| Age in years	Period			Change (2015–2005)
	2005	2010	2015	
Proportion of never-married				
15–19	97.2	96.6	96.3	− 0.9
20–24	54.4	59.9	60.7	6.3
25–29	16.9	22.6	25.2	8.3
30–34	8.6	8.8	11.1	2.5
35–39	4.9	5.4	7.1	2.2
40–44	2.7	5.4	4.2	1.5
45–49	1.8	1.9	4.1	2.3
Median age by age group				
All women (25–49)	*20.7*	*21.4*	*21.9*	*1.2*
25–29	20.6	22.3	22.8	2.2
30–34	21.1	20.9	22.4	1.3
35–39	21.0	20.9	21.0	0
40–44	20.4	21.4	21.1	0.7
45–49	20.3	20.6	21.5	1.2

Source Rwanda DHS 2005, 2010, and 2015

A steady increase of the median ages at first marriage

Table 1 shows that, all age groups combined (part 2, row All women 25–49 years), the median age at first marriage has increased by 1.2 years, from 20.7 years in 2005 to 21.4 years in 2010 and to 21.9 years in 2015, i.e. women were more and more pushing later the start of their families. The same table reveals that the rise of median age at first marriage was greater among younger women than among older ones (change in column 5). While the median age at first marriage has increased by 2.2 years among women aged 25–29 years and 1.3 years among the 30–34 years old, it remained the same for the three periods of surveys as 21.0 years among women aged 35–39 years and increased by only 0.7 years and 1.2 years among those aged 40–44 and 45–49 years, respectively.

The higher magnitude of delaying marriage among young women shall be due to the arrival of new flows of girls predominated by those who have some education and therefore who delayed their marriage because of schooling and the desire to get a job before engaging in marriage. RDHS reports show that the share of women with secondary education or above in the sampled populations increased from 9.6% in 2005 to 16.2% in 2010 and to 23.4% in 2015.

Educational differentials

Because education is being generalized within the Rwandan population nowadays, the effect of education is estimated by age group of 5 years to capture the potential differences between women at different ages. Table A (appendix) provides a disaggregated analysis of nuptiality by age group, education, and periods. From this table, two interesting trends can be analysed: (1) the variations of marriage timing with education during the same period and (2) the change over time of marriage timing between women of the same educational level.

Fig. 1 Proportions of never-married by education and age group (RDHS 2005, 2010, 2015 combined)

Fig. 2 Median ages per educational level and year (all age groups)

Delaying effect of education on marriage

As expected, the results from Fig. 1 (and Table A appendix) show that education plays an important role in delaying marriage. At all age groups, with exception of 15–19 years, the proportions of women never-married increase with the rise of education. For example, among women aged 20–24 years, the proportion of never-married, all three periods combined, exceeds a bit the third (36.9%) among women with no education, surpasses half (53.1%) among those with a primary education and is still high as 80.7% among those with secondary education or higher. Similarly, among women aged 30–34 years (10 years older), the proportion of never-married is 7.6% among women with no education, 9.2% for those with primary and 14.6% among those with secondary or higher. This pattern is observable irrespective of the period considered (Table A appendix).

The trends in the proportions of women never-married translate in the median ages at marriage of different age groups and at different periods (Table A appendix). Whatever the period (Fig. 2), the median age at marriage increases with education. In 2015 for example, while women with no education married at 20.3 years, those with primary married at 21.8 years, and those with secondary level or higher at 25.7 years. Equivalent trends can be observed in 2005 and 2010.

Fig. 3 Median ages per education and age group, (RDHS 2010)

Fig. 4 Proportions never-married among women with no education
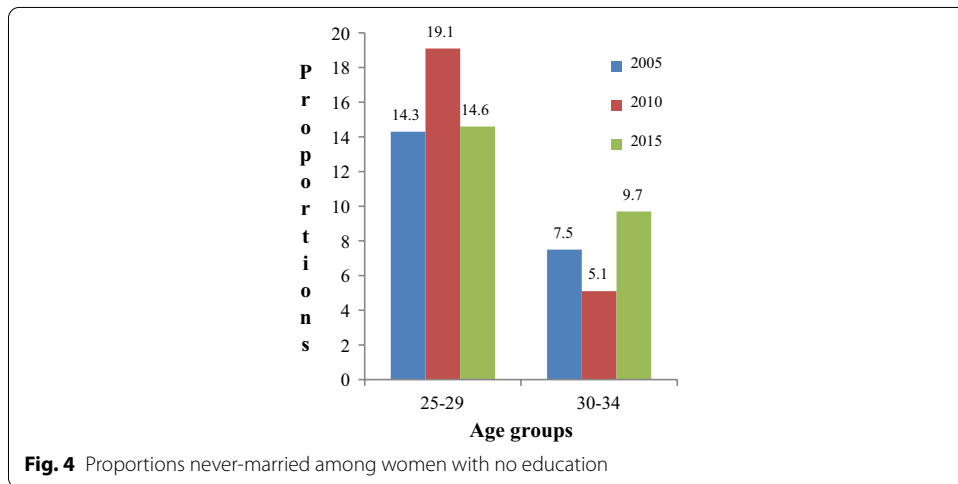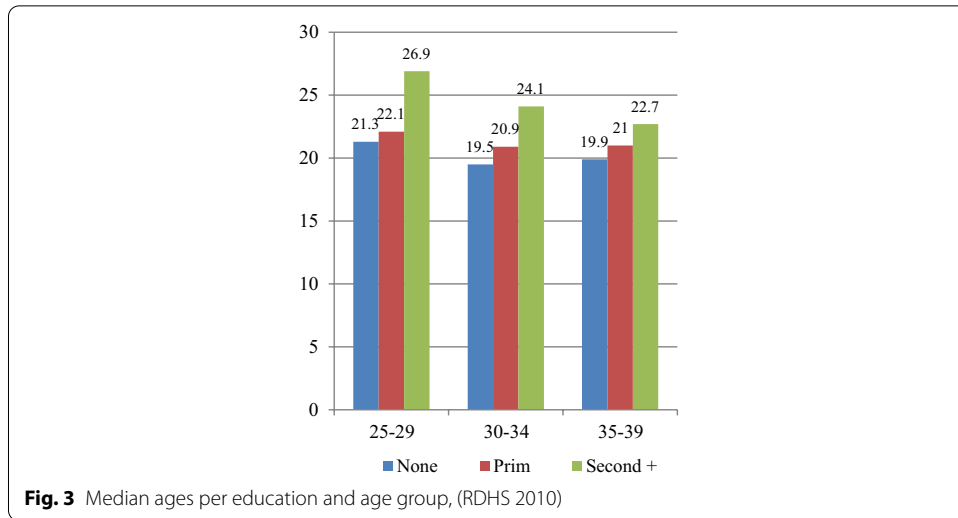
The increase is exceptionally higher from the primary education to the secondary or higher where the median ages rise significantly (Figs. 1, 2). This pattern highlights the desire of women with secondary level or higher to achieve a certain level of school and may be to consolidate an employment before starting a family. These results indicate that raising the educational level increases the proportion of women delaying their marriage (Fig. 3).

Time varying of educational effects on marriage

Figures 4 and 5 and Table in Appendix indicate that, for women from the same age group and the same educational level, the proportions of never-married are increasing with time. The increasing pattern varies, however, with the educational level. While it is less clear among women with no education or those with a primary level, the increase of never-married is consistent among those having the secondary education. Thus, the proportion of never-married among women aged 25–29 years with no

Fig. 5 Proportions never-married among women with secondary education +

Fig. 6 Trend in median ages among women with no education
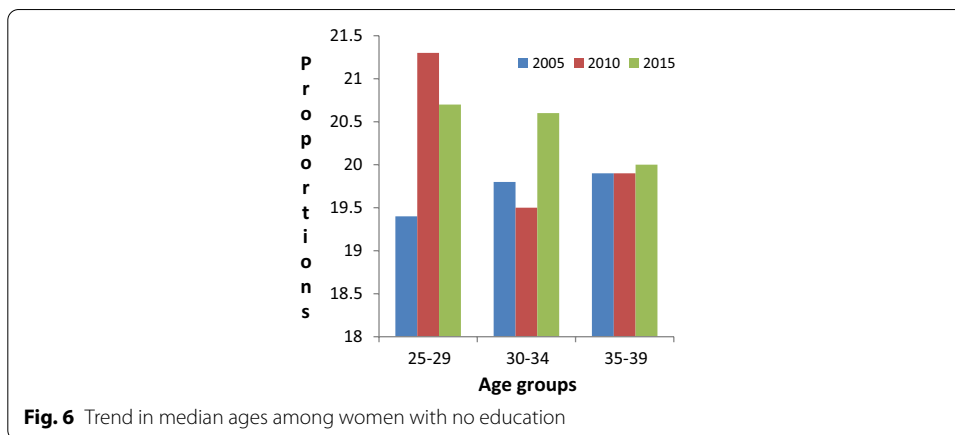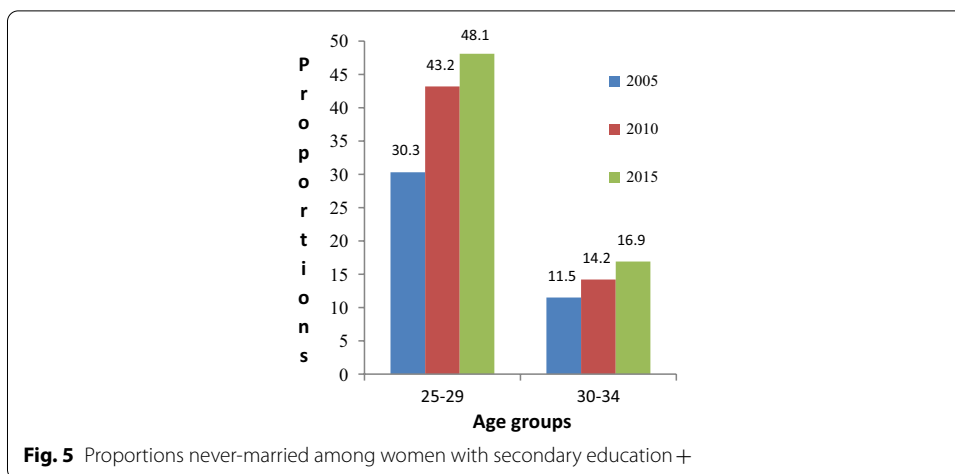
education for instance, increased from 14.3% in 2005 to 19.2% in 2010, but decreased again to 15.0% in 2015 (Fig. 4). However, among women who have reached some secondary school or more, the educational increasing effect is clearly consistent. Exception of the young women aged 15–19 and 20–24 years whose the large majority are still single, the proportions of never-married rise with time: 30.3% in 2005, 43.2% in 2010 and 48.1% in 2015 among 25–29 old women; 11.5%, 14.2% and 16.9%, respectively, at ages 30–34; and 6.4%, 8.2%, 8.5% among those aged 40–44 years. The small or absence of change in the proportions of never-married among women with low education shall be due to the fact that the delaying mechanisms of education (years spent at school and job seeking period) do not yet apply at this level.

Figures 6 and 7 (and Table A in appendix, part 2) describe the educational differentials in median ages at first marriage. Over the 10 studied years, the overall median age at marriage has increased by 1.2 years from 20.8 years to 22.0 years. However, the increase augments with education, from only 0.4 year for women with no education, to 1.0 year for those with primary and 2.4 years for those with secondary education. In addition, whatever the educational group, the increase is exclusively observed among young women 25–29 and 30–34 years. Among young women aged 25–29, it
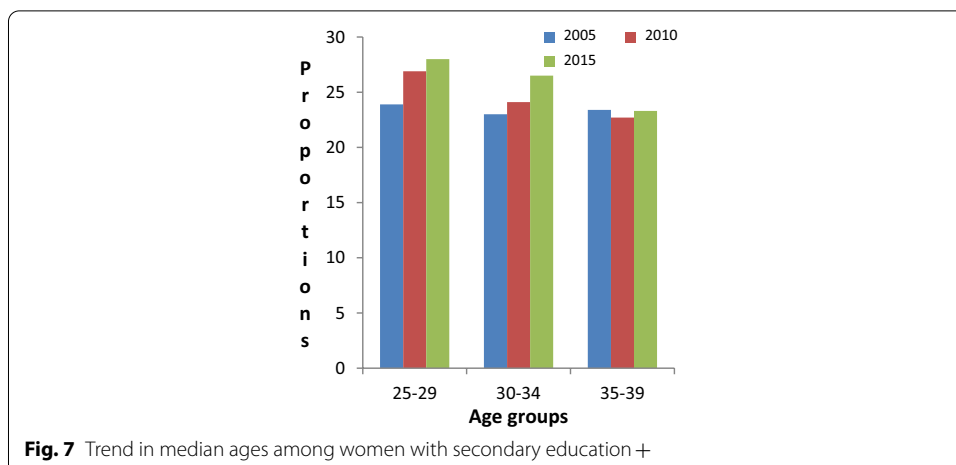
Fig. 7 Trend in median ages among women with secondary education +

Table 2 Proportions (%) of women never-married of different age groups by year and residence, and median age at first marriage, Rwanda 2005, 2010 and 2015

Age group	2005		2010		2015	
	Urban	Rural	Urban	Rural	Urban	Rural
15–19	98.6	96.8	97.3	96.5	96.7	96.1/2
20–24	68.6	49.7	64.9	58.7	69.5	57.2
25–29	26.0	14.0	32.4	20.4	34.5	21.7
30–34	13.6	7.1	12.2	8.1	12.6	10.6
35–39	7.6	4.1	6.3	5.2	7.6	6.9
40–44	3.2	2.7	7.9	5.1	4.2	4.2
45–49	2.8	1.6	1.4	2.0	6.5	3.6
Median age	21.5	20.6	23.0	21.2	23.2	21.7

is 1.3 years among no educated, 1.7 years among those with primary and 4.1 among those with secondary or more.

These trends show an increasing educational gap in the timing of marriage in Rwanda resulting from an increasing delay of marriage among educated women.

Differentials by residence

Table 2 presents the proportions of women never-married and the median ages at first marriage of women of different age groups by period and residence. For all age groups, with few exceptions at old ages, the proportions of never-married women are higher in urban than in rural areas. For instance, among women aged 25–29 years in 2005, these proportions are 26% in urban and only 14% in rural; the corresponding figures are 32% and 20% in 2010, 35% and 22% in 2015. This pattern would mean that women get married later in cities than in rural areas.

Looking at the variations over periods, globally, the proportions of never-married exhibit a tendency to the increase with time in both residential areas. Thus, among the 25–29 years old women residing in urban, the proportions of never-married increase from 26% in 2005 to 32.4% in 2010 and 34.5% in 2015. In rural areas, the corresponding figures are 14.0% in 2005, 20.4% in 2010 and 21.7% in 2015.

The differentials by residence are also illustrated by the median ages. Whatever the period, the median age at first marriage is higher in cities than in rural and is increasing with time in both residential areas. Further, the gap between the two areas is enlarging with time from 0.9 years in 2005, 1.8 years in 2010 and 1.5 years in 2015, especially because of much increase in urban areas.

Socioeconomic predictors of first marriage timing

Table 3 provides the multivariate Cox proportional hazard regression results of selected predictors of marriage timing of the pooled periods in two models: model 1 with all selected predictors and model 2 which adds to model 1 interaction terms. Overtime, the hazard ratios of getting married have decreased progressively, from 1.00 in 2005 (ref. category) to 0.90 in 2010 and to 0.78 in 2015. This trend indicates a decline of 10% (10 = 1.00–0.90) in 2010 and 22% (1.00–0.78) in 2015. This result is statistically significant at 99%. The pattern of decline varies however across socioeconomic groups.

With regard to the educational attainment the propensities to get married decrease with education, from a hazard ratio of 1.00 among women with no education (ref. category) to 0.71 among those with a secondary education or higher. Other factors held constant, women working in the sector of services display lower hazard ratio (HR 0.85) to marry than those employed in agriculture (HR 1.00) while those working in jobs requiring manual skills (HR 1.05) or not working (HR 0.97) behave as cultivators. Controlling for the other factors, Protestants tend to marry early than members of other religions.

Results display also significant variations in timing of marriage between urban women and those living in rural areas and between provinces. Women residing in rural are more likely to marry early (HR 1.15) than their sisters living in urban (HR 1.00). Women from the Western province (HR 1.25), Northern (HR 1.40), and Eastern (HR 1.29) exhibit higher hazard ratios for marriage than those from the southern province (HR 1.00) or the City of Kigali (HR 0.966).

In addition to socioeconomic and regional factors, the timing of marriage is influenced by demographic and behavioural factors, of which age at first sexual experience. Compared to women who had their first intercourse at youngest age as less than 16 years HR 1.00), the propensity to marry earlier declines by 51% (1.00–0.49) when the first intercourse occurred at 19–21 years and by 85% (1.00–0.15 when it happened at 22 years and more. The number of siblings does not show any effect on marriage timing.

The model 2 does not add important things. Except women with the primary education in 2010 who reduce significantly the hazard ratio compared to 2005, all other interaction effects are not statistically significant, indicating globally all educational groups or residents of both urban and rural areas are changing their nuptiality pattern in the same way.

Discussion and conclusion

This research aimed at investigating whether the recent ongoing fertility transition in Rwanda as described by the trends in fertility is sustained by the nuptiality pattern. The rationale of the research is based on the fact that in the process of fertility transition nuptiality change precedes fertility decline and expresses change in various dimensions of reproductive life.

Table 3 Multivariate Cox regression in hazard ratio of selected factors on timing of first marriage

Variable and categories	Model 1		Model 2	
	Hazard ratio	±95 CI	Hazard ratio	±95 CI
Year				
2005	1.000			
2010	0.900***	0.868–0.933		
2015	0.781***	0.753–0.811		
Education				
None	1.000			
Primary	0.904***	0.872–0.938		
Secondary+	0.715***	0.674–0.759		
Residence				
Urban	1.000			
Rural	1.149***	1.096–1.204		
Occupation				
Agriculture	1.000			
Not skilled	1.050*	0.993–1.110		
Services	0.852***	0.793–0.915		
Not working	0.967	0.921–1.016		
Religion				
Catholic	1.000			
Protestant	1.045***	1.014–1.076		
Muslim	1.011	0.909–1.124		
Others	0.993	0.892–1.104		
Province				
South	1.000			
Kigali	0.966	0.908–1.027		
West	1.250***	1.200–1.303		
North	1.402***	1.340–1.467		
East	1.288***	1.236–1.343		
No sibling				
0–3	1.000			
4–7	0.976	0.934–1.021		
8+	0.973	0.928–1.020		
Missing	0.888	0.698–1.130		
Age first sex				
<16	1.000			
16–18	1.027	0.963–1.094		
19–21	0.494***	0.464–0.526		
22+	0.148***	0.139–0.158		
Unclear	0.255***	0.228–0.285		
Interaction terms				
Education*year				
Primary in 2010			0.858***	0.787–0.935
Second+ in 2010			0.969	0.844–1.112
Primary in 2015			0.982	0.898–1.074
Second+ in 2015			1.094	0.955–1.253
Residence *year				
Rural in 2010			1.032	0.933–1.140
Rural in 2015			1.000	0.912–1.098

*Significant at 10%

** Significant at 5%

*** Significant at 1%

Results from analysis have indicated that over the 10 study years, nuptiality pattern has been changing. The proportions of never-married women at different ages have increased over time showing that more women have been postponing the timing of their marriage and so getting married later. Subsequently, the median ages at first marriage have been also rising. The later marriage has led to the emergence of permanent celibates, which results in the reduction of the share of married women in the total population and hence alters the African universal marriage pattern. In addition, the increase of age at marriage was clearly observed among young women than among the old ones assuming the effects of arrival of new flows of women with some education and who approve and adopt modern and western values and behaviours. The change from the traditional nuptiality pattern characterized by an early and universal marriage expresses the decline of the propensity for many girls to marry early as per the past; instead, there is a continuing postponement of marriage as time passes. The rise of the age at first marriage is not a particular phenomenon of Rwanda. It has been observed over the recent last decades in many other developing countries undergoing demographic change. Using demographic and health surveys data of many developing countries, Westoff (2003) noted the emerging of later marriage in most of these countries, among urbanites as well as among rural residents, among better educated as among less educated. The generalization of emergence of later marriage associated with fertility decline confirms the theoretical link between nuptiality change and fertility transition.

The finding of marriage postponement in Rwanda in the context of fertility decline is consistent with the fertility transition theory according to which the decline of fertility is associated with the change in nuptiality pattern, mainly the increase in age at marriage (Antoine, 2006; Chojnacka, 1995; Harwood-Lejeune, 2001; Letamo, 2014; Shapiro, 2014; Soler-Hampejsek et al., 2009; Westoff, 2003). In Rwanda, data from the 2014/2015 DHS indicate that the increase in age at marriage was correlated with the decline of fertility from 6.1 births in 2005, 4.6 in 2010 and 4.2 births in 2015, although several other factors such as contraceptive use contributed to this decline (NISR, 2016). Studying the role of nuptiality in fertility transition, Chojnacka (1995) has demonstrated and argued that prior to the onset of the fertility transition, there is change in nuptiality even when fertility may remain high or continue to increasing for decades. Mensch (2005) and Palamuleni (2010)**,** investigating the causes of change in marriage, have found that this change was due to the change of socioeconomic conditions such as increasing levels of education, female participation in the labour force, urbanization, modernization and westernization, as well as the decline of arranged marriages, the costs of marriage, and change of laws and norms relative to marriage. Particularly for education, Westoff (1992) has developed the mechanisms of delaying marriage that school attendance takes girls out of the domestic environment and offers literacy and exposure to ideas and values that compete with traditional customs leading to early marriage. The general educational effect on marriage timing may however be upset by strong historical and local contexts. In Israel for example, despite notable demographic and socioeconomic changes, Sabbah-Karkaby (2017)

found that traditional norms and structural conditions together were still shaping the time of marriage among the Palestinian population.

The results of this research are also consistent with the educational and residential differentials in marriage timing which characterize the transitional phase of the demographic transition theory. Indeed, according to the theory, the higher segments of the populations are the first to experience change, either of the nuptiality or the fertility, before the other categories to follow later through the diffusion mechanism (National Research Council, 1999). Results from Rwanda have clearly shown that better educated women or those living in urban areas marry later than the others. However, they did not provide enough evidence on the increase of delaying effect of education and residence only observed on descriptive statistics. Instead, the postponement of marriage would be noticeable in all socioeconomic groups. The delaying effect of education and urbanization was observed in several settings. In southern Malawi, a study on adolescents found that school attendance was significantly reducing the risk of first marriage at an early age (Soler-Hampejsek et al., 2009) while in Kinshasa Shapiro and Tambashe (2003) showed that enrolment in school was associated with a significantly lower likelihood of not only starting a marriage but also initiating sexual activity. Outside Africa, in Israel, Sabbah-Karkaby (2017), exploring the link between education and first marriage on the Palestinian population, demonstrated that a long stay at school was delaying marriage. For Mensch (2005) and Garenne (2004), education is the main force and leading mechanism underlying the delay in first marriage among women. Talking about urbanization, Singh and Samara (1996) argue that urban women delay their marriage because they are exposed to modern values that encourage later marriage and are less likely to be under the influence of kin who control the timing of marriage and choice of spouses. The amplitude of educational and residential effect may depend however on the accuracy of the information related to age at marriage. The presence of many women illiterate (not educated) in African population who do not know with accuracy their age at marriage may affect that effect. The most error, especially for uneducated women, would be to declare higher age than the reality by tendency of complying with the current legislation or social norm; this will reduce the difference between different educational groups.

This study provides evidence that nuptiality in terms of age at marriage is changing in Rwanda. In all socioeconomic groups of the population, age at marriage is increasing; but it remains significantly higher among educated women. The combined effects of increasing number of women reaching the secondary education or higher and their low risks to marry at young age, with that of progress in contraceptive use among these educated women (NISR, 2016) lead to expect a continuing fertility decline and so an irreversible fertility transition, which shall contribute to a sustained decline of population growth in Rwanda.

Appendix

See Table 4.

Table 4 Proportions (%) of women never-married of different age groups by education and year

	No education				Primary				Secondary and above			
Proportion of never-married												
Age group	2005	2010	2015	All	2005	2010	2015	All	2005	2010	2015	All
15–19	93.2	82.8	84.4	**89.7**	97.5	96.6	95.0	**96.5**	99.0	98.4	98.4	**98.5**
20–24	35.1	40.5	35.3	**36.9**	54.6	55.1	48.5	**53.1**	80.3	81.5	80.4	**80.7**
25–29	14.3	19.1	14.6	**16.2**	14.9	20.0	19.5	**18.5**	30.3	43.2	48.1	**42.6**
30–34	7.5	5.1	9.7	**7.6**	8.3	8.7	10.3	**9.2**	11.5	14.2	16.9	**14.6**
35–39	3.9	4.3	6.2	**4.7**	5.3	5.5	7.1	**6.1**	6.1	6.6	8.0	**7.0**
40–44	2.1	4.9	2.1	**3.0**	2.7	5.2	4.2	**4.1**	6.4	8.2	8.5	**7.8**
45–49	2.2	1.6	3.0	**2.2**	1.2	2.2	4.0	**2.6**	2.4	1.2	9.3	**4.4**
Median age at first union												
Age group	2005	2010	2015	Increase	2005	2010	2015	Increase	2005	2010	2015	Increase
All	*19.9*	*20.1*	*20.3*	0.4	*20.8*	*21.4*	*21.8*	1.0	*23.2*	*23.6*	*25.7*	*2.5*
25–29	19.4	21.3	20.7	1.3	20.5	22.1	22.2	1.7	23.9	26.9	28.0	4.1
30–34	19.8	19.5	20.6	0.8	21.2	20.9	22.2	1.0	23.0	24.1	26.5	3.5
35–39	19.9	19.9	20.0	0.1	21.2	21.0	21.1	− 0.1	23.4	22.7	23.3	− 0.1
40–44	19.8	20.3	19.9	0.1	20.4	21.6	21.2	0.8	22.1	23.2	24.1	2.0
45–49	20.3	20.0	20.3	0.0	20.3	20.6	21.7	0.4	20.1	23.1	24.8	4.7

References

Allison, P. (1984). *Event history analysis: Regression for longitudinal data*. Sage.

Allison, P. D. (1995). *Survival analysis using the SAS system: A practical guide*. SAS Institute Inc.

Antoine, P. (2006). Analyse biographique de la transformation des modèles matrimoniaux dans quatre capitales africaines: Antananarivo, Dakar, Lome´ et Yaounde´. *Cahiers Québécois De Démographie, 35*(2), 5–38.

Bongaarts, J. (1978). A framework for analyzing the proximate determinants of fertility. *Population and Development Review, 4*(1), 105–132.

Bongaarts, J. (1982). The fertility-inhibiting effects of the intermediate fertility variables. *Studies in Family Planning, 13*(6–7), 179–189.

Bongaarts, J. (1992). The fertility-inhibiting effects of the intermediate fertility variables. In A. G. Hill & W. Brass (Eds.), *The analysis of maternity histories.* Editions Derouaux-Ordina.

Bongaarts, J. (2003). Completing the fertility transition in the developing world: The role of educational differences and fertility preferences. *Population Studies, 57*(3), 321–335.

Bongaarts, J., Frank, O., & Lesthaeghe, R. (1984). The proximate determinants of fertility in sub-Saharan Africa. *Population and Development Review, 10*, 511–537.

Chesnais, J.-C. (1986). La transition démographique. Etapes, formes, implications économiques. Etude de séries temporelles (1720–1984) relatives à 67 pays. *Population (french Edition), 41*, 1059–1070.

Chojnacka, H. (1995). The role of nuptiality in the demographic transition. The case of Africa: A conceptual essay. *Genus, 51*(3–4), 117–150.

Davis, K. (1963). The theory of change and response in modern demographic history. *Population Index, 29*(4), 345–366.

Davis, K., & Blake, J. (1956). Social structure and fertility: An analytic framework. *Economic Development and Cultural Change, 4*(3), 211–235.

Garenne, M. (2004). Age at marriage and modernisation in sub-Saharan Africa. *Southern African Journal of Demography, 9*(2), 59–79.

Harwood-Lejeune, A. (2001). Rising age at marriage and fertility in Southern and Eastern Africa. *European Journal of Population, 17*, 261–280.

Hertrich, V. (2006). La polygamie: Persistance ou recomposition? Le cas d'une population rurale du Mali. *Cahiers Québecois De Démographie, 35*(2), 39–70.

Hertrich, V. (2017). Trends in age at marriage and the onset of fertility transition in sub-Saharan Africa. *Population and Development Review, 43*(2017), 112–137.

Ikamari, L. D. E. (2005). The effect of education on the timing of marriage in Kenya. *Demographic Research, 12*(1), 1–28.

Jones, W. G. (2005). The 'flight from marriage' in South-East and East Asia. *Journal of Comparative Family Studies, 36*(1), 93–119.

Jones, W. G. (2007). Delayed marriage and very low fertility in Pacific Asia. *Population and Development Review, 33*(3), 453–478.

Letamo, G., Bainame, K., & Motsholathebe, B. (2014). Nuptiality Levels and trends in Botswana. *Botswana Notes and Records, 46*, 46–57.

Locoh, T. (2006). Factors in couple formation. In G. Caselli, J. Vallin, & G. Wunsch (Eds.), *Demography: Analysis and synthesis* (Vol. 1, pp. 373–396). Elsevier.

Mensch, B., Singh S., & Casterline J. B. (2005). Trends in the timing of first marriage among men and women in the developing world. Policy Research Division Working Paper no. 202. New York: Population Council. Version of record: https://doi.org/10.17226/11524

Ministry of Education (MINEDUC) Rwanda. (2016). 2016 Education Statistical Yearbook. Kigali.

Mokomane, Z. (2006). Cohabiting unions in sub-Saharan Africa: Explaining Botswana's exceptionality. *Journal of Comparative Family Studies, 37*(1), 25–42.

National Bank of Rwanda. (2017). Annual Report 2017. Kigali.

National Institute of Statistics of Rwanda. (2019). National Gender Statistics 2019. Kigali, Rwanda. Retrieved from https://statistics.gov.rw/publication/national-gender-statistics-report-2019

National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health [Rwanda], and ICF International. (2015). Rwanda Demographic and Health Survey 2014–15. Rockville, Maryland, USA: NISR, MOH, and ICF International.

National Research Council. (1999). *The Role of diffusion processes in fertility Change in Developing Countries.* The National Academies Press.

Ndahindwa, V., Kamanzi, C., Semakula, M., Abalikumwe, F., Hedt-Gauthier, B., & Thomson, D. R. (2014). Determinants of fertility in Rwanda in the context of a fertility transition: A secondary analysis of the 2010 Demographic and Health Survey. *Reproductive Health, 11*(87), 3–9. https://doi.org/10.1186/1742-4755-11-87

Palamuleni, M. E. (2010). Recent marriage patterns in South Africa 1996–2007. *Bangladesh e-Journal of Sociology, 7*, 1.

Palamuleni, M. E. (2011). Socioeconomic determinants of age at marriage in Malawi. *International Journal of Sociology and Anthropology, 3*(7), 224–235.

Sabbah-Karkaby, M., & Haya, S. (2017). Links between education and age at marriage among Palestinian women in Israel: Changes over time. *Studies in Family Planning, 48*(1), 23–38.

Shapiro, D., & Tambashe, B. O. (2003). *Kinshasa in transition: Women's education, employment, and fertility*. University of Chicago Press.

Shapiro, D., & Tesfayi, G. (2014). Marriage in sub-Saharan Africa: Trends, determinants, and consequences. *Population Research Policy Review, 2014*(33), 229–255. https://doi.org/10.1007/s11113-013-9287-4

Singh, S., & Samara, R. (1996). Early marriage among women in developing countries. *International Family Planning Perspectives, 22*, 148–175.

Soler-Hampejsek, E., Mensch, B. S., & Hewett C. P. (2009). Education and timing of sexual initiation and marriage: The effect of school attendance, attainment and repetition in rural Malawi. Poster presentation at the XXVI IUSSP International Population Conference, Marrakech, 27 Sept–2 Oct. Retrieved from http://www.popcouncil.org/pdfs/events/2009IUSSP_Soler.pd

Therborn, G. (2004). *Between sex and power: Family in the World, 1900–2000*. Routledge.

United Nations. (1986). Nuptiality: selected findings from the World Fertility Survey data. Department of International Economic and Social Affairs of the United Nations Secretariat, New York.

United Nations. (1990). Patterns of first marriage: Timing and prevalence. Department of International Economic and Social Affairs of the United Nations Secretariat

Westoff, C. F. (1992). Age at Marriage, Age at first Birth and Fertility in Africa. World Bank Technical Paper 169. Washington D.C: The World Bank.

Westoff, C. F. (2003). Trends in Marriage and Early Childbearing in Developing Countries. DHS Comparative Reports No. 5. Calverton, Maryland: ORC Macro.

Westoff, C. F. (2012). The recent fertility transition in Rwanda. *Population and Development Review, 38*, 169–178.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.