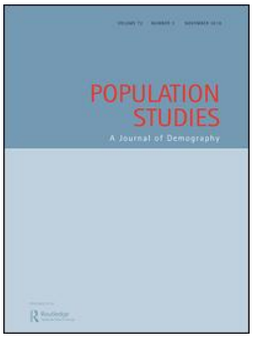

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Population Studies
A Journal of Demography

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rpst20

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To cite this article: Endale Kebede, Erich Striessnig & Anne Goujon (2021): The relative importance of women's education on fertility desires in sub-Saharan Africa: A multilevel analysis, Population Studies, DOI: 10.1080/00324728.2021.1892170

To link to this article: https://doi.org/10.1080/00324728.2021.1892170

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Population Studies, 2021
https://doi.org/10.1080/00324728.2021.1892170

The relative importance of women's education on fertility desires in sub-Saharan Africa: A multilevel analysis

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Lowering desired family size is a necessary precondition for fertility declines in high-fertility settings. Although accumulated evidence links socio-economic developments to changing fertility desires, little research has disentangled the relative importance of key socio-economic determinants. Combining individual- and community-level data from Demographic and Health Surveys in 34 sub-Saharan African (SSA) countries, we compare the relative role of different socio-economic factors on fertility desires at the individual, community, and country levels. Results show that at the individual level, women's education has a stronger effect than household wealth and area of residence. The high levels of reported desired family size in rural parts of SSA are mainly a consequence of relatively lower levels of education. The relative impact of women's education is even stronger at the community level. Our findings are robust to alternative measures of fertility preferences and strengthen previous findings regarding the relationship between fertility and women's education.

Supplementary material for this article is available at: https://doi.org/10.1080/00324728.2021.1892170

Keywords: desired fertility; sub-Saharan Africa; women's education; multilevel analysis; community education; wealth; place of residence; fertility intentions; Demographic and Health Survey

[Submitted May 2020; Final version accepted December 2020]

Introduction

The secular decline in fertility that has been taking place in many parts of the world is one of the defining processes shaping the demographic and socio-economic landscape of our times. Following the end of the Second World War, Asia and Latin America underwent a remarkably fast fertility transition (a process that had taken the European pioneers more than a century). Fertility declines in these regions were possible initially due to high unwanted fertility, and gradually then to lower desired family size, facilitated by the availability of birth control methods and other family planning services (Feyisetan and Casterline 2000; Casterline 2009). In contrast, sub-Saharan Africa (SSA) showed little to no sign of fertility decline until the 1980s, and ongoing fertility declines are happening at a much slower pace compared with other regions, and sometimes even stalling (Bongaarts 2008; Ezeh et al. 2009; Kebede et al. 2019). More puzzling even, fertility in SSA has remained high despite the increase in the availability of birth control and other family planning services, as well as substantial improvements in child mortality.

The reasons put forward for this so-called 'African exceptionalism' (Bongaarts and Casterline 2013) are manifold. Sustained high fertility could be associated with the strong pronatalist attitudes prevalent in the region (Caldwell and Caldwell 1990). Vast empirical evidence has confirmed that differences in fertility preferences can explain much of the variation in fertility across countries (Hirschman 1994; Pritchett 1994; Bryant 2007). Despite the recent emergence of a changing mentality towards the adoption of family limitation in a number of African countries, the desired number of children at any given level of fertility in SSA is considerably higher than in

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other less developed regions (Bongaarts 2017; Casterline and Agyei-Mensah 2017). Comparisons between the two most recent Demographic and Health Surveys (DHSs) from the countries included in our study reveal a negligible decline (or even increase) in the mean ideal number of children over time (see Table A1 in the supplementary material). More strikingly even, in contrast to other less developed regions, where people had already started to desire smaller family sizes at the onset of the fertility transition, in SSA we observe only a very modest excess of actual over desired fertility at this stage. As indicated by the diagonal line in Figure 1, realized fertility in the region is close to desired fertility, and in a number of countries, ideal family size is even higher than actual fertility.

Despite the strong connection between desired family size and its later realization, few studies have looked at fertility desires in SSA from a quantitative, cross-national comparative perspective. One possible reason is that fertility preferences appear to be less stable in the less developed country context than in late transition societies. As Trinitapoli and Yeatman (2018) have pointed out, however, this should come as no surprise, given that young people's lives are even less predictable in less developed countries than they are in economically more stable nations. Rather, researchers should embrace the fluctuating nature of fertility behaviour in less developed countries as valid information about shifts in the broader societal conditions of fertility desires. According to classical demographic transition theory, high fertility results from the desire for large families in response to socio-economic demands, rather than a failure to achieve desired smaller family sizes (Notestein 1945; Easterlin 1975; Schultz 2001). By increasing the direct costs, as well as the opportunity costs, of children, changes in socio-economic settings can erode the economic basis for high desired fertility. According to Bongaarts (2017), differences in the pace of fertility decline between Africa and other less developed regions can be explained to a large extent through the slower pace of socio-economic development in Africa.

In the ongoing debate about persistent high fertility in SSA, this study aims to disentangle the relative effects of different socio-economic factors on fertility desires. Specifically, we are interested in the relative contribution of education compared with wealth and area of residence. Since the importance of different socio-economic factors can vary by level of spatial aggregation, and higher-level effects can mask combined individual-level effects or an independent effect at the national level, we apply a multilevel framework to differentiate effects on fertility preferences at the individual, community, and country levels using data from 34 SSA countries.

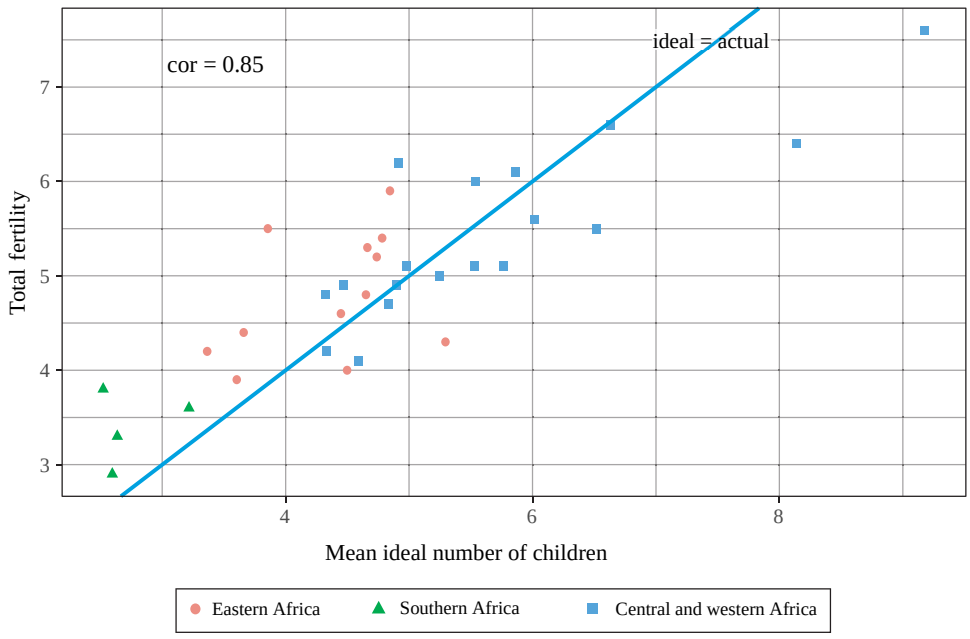

Figure 1 Mean ideal number of children vs total fertility: women aged 15–49 in 34 SSA countries
Note: The diagonal line shows where ideal (desired) fertility is equal to actual (realized) fertility.
Source: Authors' analysis of data from the most recent Demographic and Health Survey in each country, from the period 2006–07 to 2018.

This type of analysis is particularly promising for SSA, where fertility continues to be well above four children per woman in the majority of countries, and more than one-third of women aged 20–39 have no formal education (WIC 2018). The results of this study can, thus, advance our understanding of the link between education and fertility, and help us to assess the gains from future investments in education.

Education and fertility desires

Since the pioneering work of Cochrane (1979), various micro-level studies have emphasized the importance of education, particularly for females, in explaining fertility decline (Castro Martin 1995; Kravdal 2002; Bongaarts 2010). Education is generally associated with lower desired family size (Cleland 2002; Behrman 2015). Due to a strong economic paradigm in fertility research, however, the role of education is typically seen in conjunction with changes in income and other development indicators. In line with predictions from the neoclassical economic models of fertility, increases in women's education negatively affect their fertility preferences by increasing forgone income (Becker 1981). Similarly, unified growth theory explains that industrialization expands not only urbanization and income, but also the incentive to accumulate human capital, which subsequently leads to fertility decline (Galor 2011). This conflation of education with other development indicators becomes most obvious in the construction of the Human Development Index (HDI), which lumps indicators of human capital (mean of years of schooling for adults aged 25+ years and expected years of schooling for children of school entry age) together with per capita gross national income and life expectancy. Yet, recognizing and determining the importance of human capital relative to other driving forces of development has important policy implications—particularly in achieving the sustainable development goals (Lutz 2017)—which is why we look at them separately.

Women's education has also been shown to affect fertility desires through a number of non-economic pathways, such as increased knowledge and changing attitudes around fertility regulation (Cochrane 1979; Cleland and Wilson 1987), promotion of new norms (Caldwell 1976, 1980), social interactions (Bongaarts and Watkins 1996), enhanced autonomy of women (Jejeebhoy 1995), and improved child health (Pamuk et al. 2011). These pathways can be complex, and several studies have found the effects of women's education on desired number of children to be context dependent, varying across regions (Castro Martin 1995; Jejeebhoy 1995; Günther and Harttgen 2016; Casterline and Agyei-Mensah 2017), countries (Muhoza et al. 2014; Behrman 2015), and communities within countries (Kravdal 2002). Rather than being merely a function of individual socio-economic status (SES), women's fertility preferences are also influenced by the level of socio-economic development of the community and country in which they reside. The desired number of children among uneducated women from poorer and mostly illiterate communities differs markedly from the number of children desired by uneducated women living in richer, mostly literate communities, which is why we need to account for these different levels in assessing the relative importance of education.

Social scientists have long emphasized the impact of broader societal norms and institutions on individual family size preferences. Ryder (1973) showed that family size preferences are inherently sociological (rather than biological) and reflect the dominant paradigms of the time within a given society. More recently, Moultrie and Timæus (2014) argued that fertility trends are shaped by country-specific norms and institutions that can change over time and that regulate fertility. There are many possible explanations for context-dependent effects of SES on the desired number of children. First, individual norms and attitudes are acquired through social interactions, and depend on the stock of knowledge available in the vicinity, the level of urbanization (which regulates the speed at which new ideas circulate), and the economic resources at the community's disposal. Second, individuals tend to imitate the reproductive behaviours prevalent in their community, simply to gain acceptance and avoid criticism from others (Kravdal 2002). This effect is particularly strong in societies without developed welfare states, where informal support networks represent the main form of insurance, making individuals more likely to conform to values and attitudes shared by the community (Caldwell and Caldwell 1987). In addition to these community-level effects, socio-economic developments at the national level might affect individual fertility preferences. Overall educational attainment, for example, influences fertility-related content communicated through the mass media, as well as the image of women in society more broadly. Socio-economic development affects support for family planning efforts and national reproductive health campaigns aiming to improve health-related infrastructures while reducing the relative importance of child labour.

To date and to the best of our knowledge, no single study on SSA has systematically and simultaneously assessed the role of education relative to other socio-economic indicators at these three levels (individual, community, and country) in determining fertility intentions. Kravdal (2002) showed the independent effect of individual- and community-level education on actual fertility in 22 SSA countries. However, that study did not look at intentions, and since detailed information on household wealth was not available in DHSs before 2003, it could only disentangle the effect of education from that of area of residence. Hence, mediating factors that may be affected by women's education, such as household wealth, were disregarded. In contrast, by looking at women's ideal number of children at the three levels, we are able to study this important (perhaps the most important) determinant of actual fertility.

Our examination of fertility desires according to individual education, household wealth quintile, and area of residence for the 34 SSA countries reveals a pattern consistent with these arguments (Figure 2). First, mean ideal number of children declines with improvements in SES (education, wealth) and is lower in urban than rural settings. Despite possible issues of collinearity between the three indicators, women's educational status appears to be the strongest predictor of mean ideal number of children. Second, fertility desires by SES vary substantially across countries within SSA. This dispersion is particularly strong among poor, uneducated, and rural women compared with their wealthy, better educated, and urban counterparts.

Fertility preferences: Definitions and measurement issues

The terms used to denote fertility desires or ideal family size vary, as do the corresponding questions included in surveys (Thomson 2015). For this reason, we clarify here the terminology we use and the advantages and disadvantages of different ways of measuring fertility preferences. In addition, we present how we respond to the challenge of non-numeric responses (NNRs) to questions about fertility preferences and the possible preference for stating round numbers, such as ten children instead of nine or eleven.

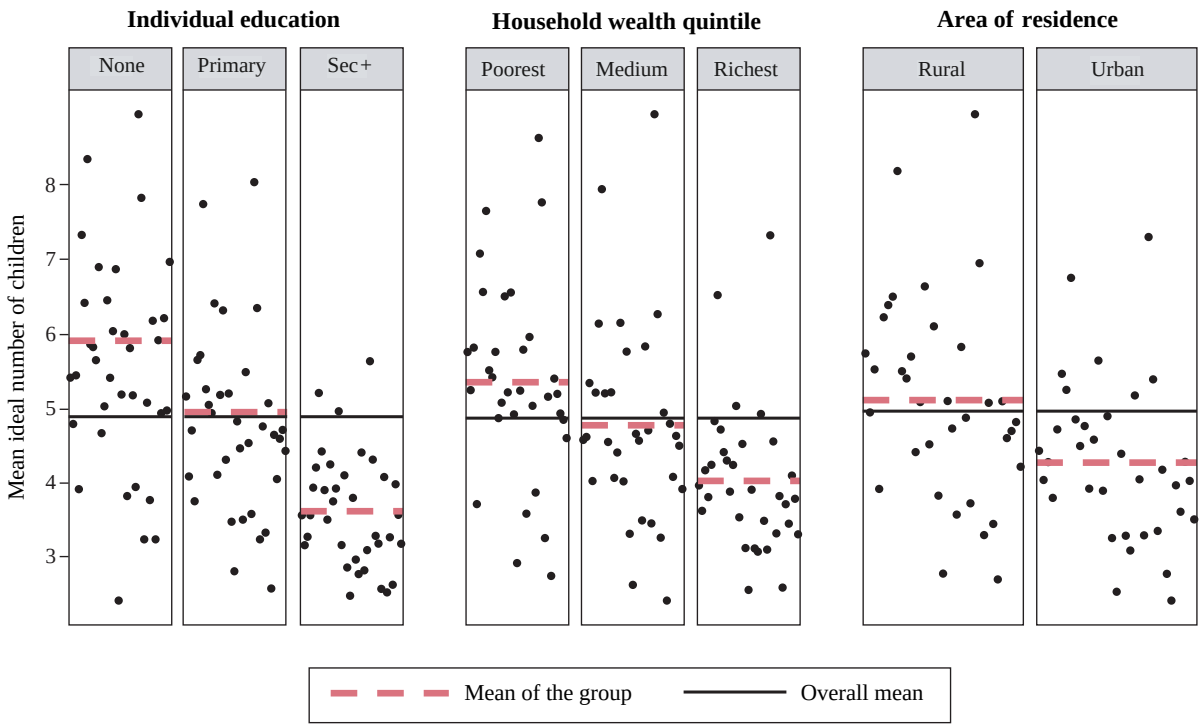

Figure 2 Mean ideal number of children by individual-level socio-economic status: women aged 15–49 in 34 SSA countries

Note: For individual education, the three categories shown are None (no formal education), Primary (completed primary education), and Sec+ (completed secondary education or more).

Source: As for Figure 1.

This study uses 'ideal number of children' and 'desired family size' interchangeably as measures of women's intentions. Desired family size is usually defined as the number of children a respondent would like to have based on their own assessment of the costs and benefits of childbearing, and 'if there were no subjective or economic problems involved in regulating fertility' (Easterlin 1975, p. 82). It was first consistently and internationally measured by the World Fertility Surveys (Lightbourne 1985). Later, DHSs employed a range of questions to collect detailed information on fertility desires and construct multiple indicators of family size preferences. These indicators have been used to measure unmet need for family planning, assess reproductive norms, and forecast future developments in actual fertility. The first type of question asks respondents about their fertility preferences prospectively. For parents, the question is: '*Would you like to have another child, or would you prefer not to have any more children?*' Related questions are also asked about desired waiting time, for those who want an additional child. In addition, the surveys include questions about the wantedness of recent births or pregnancies.

DHSs also provide more direct indicators of family size preferences based on the ideal number of children assessed retrospectively, using the following question: '*If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?*' For childless respondents, this question measures desires prospectively: '*If you could choose exactly the number of children to have in your whole life, how many would that be?*' The ideal number of children is the most used measure of fertility preference; however, it has several limitations (McClelland 1983; Bongaarts 1990; Casterline and El-Zeini 2007; Johnson-Hanks 2007).

First, indicators of ideal family size are subject to a social desirability bias in which responses may strongly reflect the society's overall ideal family size (Livi Bacci 2001). For example, the two-child family—one boy and one girl—has long been considered an ideal family composition in many western European countries. On the other hand, large household size is generally considered a societal ideal in many SSA countries.

Second, individual plans may change over the life course following changes in economic, social, health, and other prevailing conditions (Freedman et al. 1965; Hayford 2009; Iacovou and Tavares 2011). Experiences associated with childbirth or child loss, and changes in individuals' educational attainment or career trajectories, may contribute to changes in desired family size (Bongaarts 1990; Bankole and Westoff 1998; Morgan and Rackin 2010). Each birth experience provides new information that could change family size desires and expectations (Namboodiri 1983). Hence, fertility intentions should be examined at different parities (Yamaguchi and Ferguson 1995).

Third, rationalization or 'post facto revision' of family size preferences may lead respondents to adjust their ideal number of children upwards based on their actual number of living children. In our sample of 34 SSA countries, 75 per cent of women (aged 45–49) reported an ideal number of children higher than their number of living children, and about 8 per cent of sampled women stated the same number of children for both indicators.

Fourth, women's fertility intentions and expectations are heavily influenced by the fertility preferences of their husbands and/or other household members. Many empirical studies have presented women's fertility desires as the main indicator of fertility norms and decisions, which are determinant for their subsequent fertility. However, partners' divergent desired family sizes are the primary source of differences between women's fertility desires and their expectations (Miller and Pasta 1996; Thomson 1997). A study in Nigeria showed that when a husband and wife disagree on the desire for an additional child, the preferences of both are equally important for subsequent actual fertility (Bankole 1995). However, survey results in which both men and women were interviewed revealed that partners often share similar fertility desires (Rutstein and Rojas 2006; Testa 2006).

Fifth, in high-fertility settings, women who provide numeric answers to questions of ideal family size may not be able to state desires precisely, which might lead to 'number heaping': the tendency to round numbers, such as reporting ten children instead of nine or eleven (see Figure A1 in the supplementary material). In countries such as Chad and Niger, the vast majority of women state ten as an ideal number of children.

Despite these limitations and measurement issues, indicators of women's fertility desires can provide a quantitative base for assessing overall fertility norms and demands in the population, by looking at the granularity in the available data. For example, analysing the ideal number of children controlling for parity, as implemented in this study, can minimize biases associated with rationalization. Moreover, several studies have shown strong

connections between women's fertility desires and achieved fertility (Pritchett and Summers 1994; Günther and Harttgen 2016). As Van de Kaa (2001) explained, fertility preference indicators play a causal role in theories of fertility decline.

Non-numeric responses

In DHSs, a small but significant proportion of women who respond to questions about ideal family size do not give a numerical response, but instead provide NNRs, such as 'it is up to God', 'as many as possible', or 'I do not know'. Supplementary Table A2 presents the proportion of women who provided NNRs to the ideal family size question in 34 SSA countries by survey year. In earlier surveys, a substantial proportion of women provided NNRs. For example, in the first surveys in Nigeria (1990) and Burkina Faso (1993), about 61 and 25 per cent of women, respectively, provided NNRs. In recent surveys, however, the share of NNRs has declined significantly. In Burkina Faso's 2010 DHS, for example, only 3.5 per cent of women provided NNRs.

Although many researchers have taken such responses as missing values, studies have shown that NNRs are meaningful in understanding fertility transition theories (Hayford and Agadjanian 2011; Frye and Bachan 2017). In response to Coale's precondition for a lasting fertility decline, supposed to happen when childbearing is 'within the calculus of conscious choice' (Coale 1973, p. 65), demographers often associate NNRs with a 'pre-transitional mindset', under which women lack deliberate control over their fertility. On the other hand, a decline in NNRs to ideal family size questions is a precursor of fertility transitions (Caldwell 1976; Van de Walle 1992). Supplementary Figure A2 shows the prevalence of NNRs by mean ideal number of children across SSA countries. It reveals that NNRs are more prevalent in pre-/early transitional contexts where the mean ideal number of children (and thus total fertility) is higher.

Moreover, research has shown that the 'up to God' and 'I do not know' responses to the ideal family size question may reflect respondents' SES (e.g. educational attainment), as well as the uncertainty stemming from high child mortality (Riley et al. 1993; Sandberg 2005). A study in Malawi showed that better educated women tend to answer numerically, and report smaller ideal family sizes (Yeatman 2009). Supplementary Figure A3 displays the average proportion of NNRs in SSA by individual SES, in the most recent surveys. NNRs are generally higher among non-educated, poor, and rural women. The average proportion of NNRs among women with no formal education is about 7 per cent, while it is below 2 per cent among those with completed secondary education or higher. The prevalence of NNRs is also negatively associated with increasing community-level SES, particularly community-level education (Figure 3).

Due to their association with predictors of family size preferences, excluding NNRs from our sample data could cause severe selection bias. However, as shown in supplementary Table A2, the proportion of women providing NNRs to fertility preferences in SSA is declining over time. Thus, the bias associated with NNRs could be minimized by employing only the most recent DHS data, the approach used in this paper.

Data

This study is based primarily on DHS micro-level data from 18,520 clusters across 34 SSA countries. Within each country, the survey made use of a two-stage cluster sampling technique and standardized questionnaires to collect comparable, reliable, and nationally representative data on population health, living conditions, and demographic characteristics of households. Our data set pools information about 434,447 women aged 15–49 (see Table 1 and supplementary Table A3).

As discussed earlier, DHSs provide multiple indicators of women's preferences regarding family size. This study uses the most direct and easiest to interpret indicator, namely ideal number of children. In all 34 countries, women were asked: '*If you could go back to the time you didn't have any children and could choose exactly the number of children to have in your whole life, how many would that be?*' To minimize measurement limitations and associated biases of this indicator, our sample is limited to the most recent surveys, and the analyses conducted by parity.

To examine the effect of individual education on fertility desires, we categorize women's educational attainment into five levels: no formal education, incomplete primary education, completed primary education, some secondary education, and completed secondary education or more. Recognizing the possible independent effect of community-level education, we derive the mean years of schooling (MYS) of women in each sample cluster. To test whether less educated women could be affected by

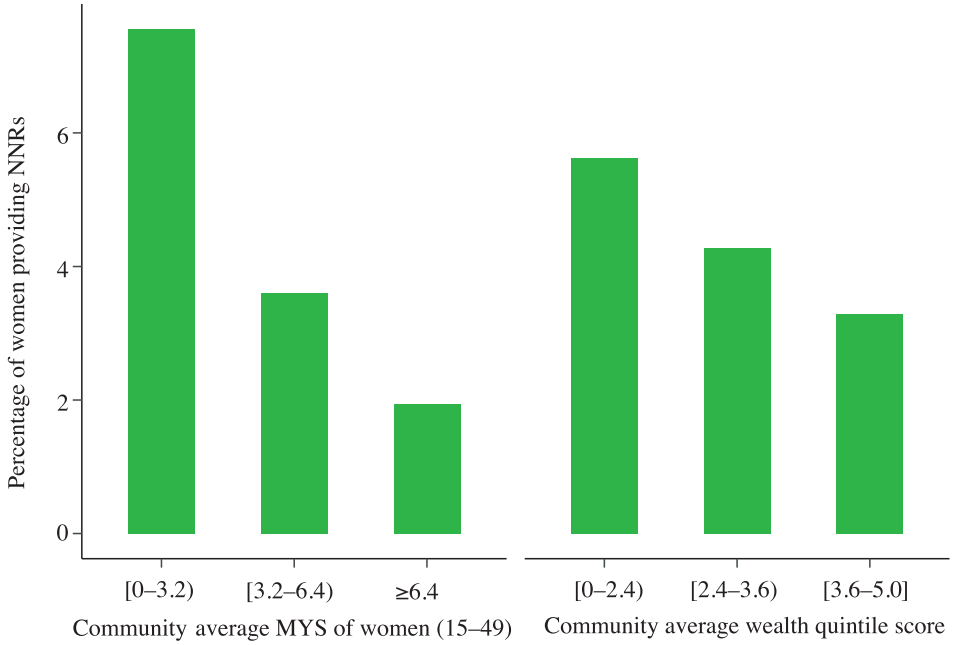

Figure 3 Percentage of women aged 15–49 providing non-numeric responses to ideal family size questions in 34 SSA countries, by community-level socio-economic status (education and wealth)
Note: MYS = mean years of schooling.
Source: As for Figure 1.

the reproductive behaviour of potentially influential women in the community (including better educated ones), we categorize the distribution of cluster-specific MYS approximately into thirds, with <3.2 MYS categorized as 'low', ≥3.2 but <6.4 years as 'medium', and ≥6.4 years as 'high'. To assess the impact of country-level education, in line with Pamuk et al. (2011), we include the logged proportion of working-age population (aged 20–64, both sexes combined) with lower secondary education or higher according to the Wittgenstein Centre's database (WIC 2018). The rationale given by Pamuk et al. (2011) for using this variable at the country level was that 'the presumed imitative effect whereby less educated mothers model the behaviour of their better educated counterparts would be less important at the national level than at the community level. On the other hand, a higher proportion of both men and women with at least a secondary school credential would not only provide a general indication of social and economic development, but would also indicate the availability of a more highly skilled work force' (Pamuk et al. 2011, p. 641). Results from sensitivity analyses using an alternative measure of national-level human capital are provided in the 'Sensitivity and robustness analysis' subsection.

The impact of household economic resources on women's fertility desires is examined using quintiles of the household wealth distribution. This categorical variable is constructed using principal component analysis on information about assets and the availability of important household services, such as water supply, electricity, radio, and type of flooring (Filmer and Pritchett 2001). While this measure certainly has its limitations (Vyas and Kumaranayake 2006), it has been widely used, particularly in the absence of more detailed expenditure data. In addition, for the purpose of comparing the relative contributions of education and household wealth to the formation of fertility intentions, this asset-based measure is preferable to expenditure-based measures of household wealth. Not only would it be difficult to argue that a sudden increase in household consumption immediately led to a change in fertility intentions, it would also be difficult to compare a short-term measure with a stable long-term measure such as education.

At the community level, a categorical indicator of relative wealth (poor, medium, rich) is constructed from the mean of wealth quintile scores for all households within the cluster. At the national level the impact of economic resources is assessed using a country's per capita gross domestic product (GDP, purchasing power parity (PPP) in constant 2017 international dollars) around the time of the survey. These data are obtained from the World Development Indicators database (World Bank

Table 1 Number of women and DHS clusters, and selected country-level socio-economic characteristics: 34 SSA countries

Country	Survey year	Number of women (aged 15–49)	Number of clusters	GDP per capita (PPP in 2017 $)	Percentage of adults (aged 20–64) with lower secondary education or more	Percentage of population living in urban areas	Family planning effort index (FPEI)	Mean ideal number of children
Angola	2015–16	14,377	625	6,955	12.7	40.9	–	4.72
Burkina Faso	2010	16,526	573	1,350	11.6	23.0	45.6	5.07
Benin	2017–18	13,591	750	1,931	17.1	41.2	57.2	4.32
Burundi	2016–17	16,909	554	682	8.2	11.2	55.6	3.75
DR Congo	2013–14	3,955	153	760	43.3	40.0	40.2	5.95
Cameroon	2018	12,269	469	3,603	39.8	50.1	38.6	5.30
Chad	2015	13,550	624	2,073	10.3	22.1	45.5	7.76
Comoros	2012	4,740	252	1,396	32.8	27.9	–	5.15
Congo	2011	10,149	384	5,595	37.6	62.2	38.0	4.61
Cote d'Ivoire	2011	9,218	351	2,726	19.1	48.7	43.4	5.12
Ethiopia	2016	13,928	638	1,529	10.3	18.2	58.9	4.16
Gabon	2012	7,911	336	17,100	39.9	85.0	–	4.49
Gambia	2013	9,899	281	1,570	25.6	55.7	46.5	6.00
Ghana	2014	9,233	427	3,833	53.8	50.7	53.8	4.03
Guinea	2018	9,230	401	2,498	24.9	39.1	4.6	5.44
Kenya	2014	14,243	1,593	2,747	54.2	23.6	49.4	3.39
Lesotho	2014	6,608	399	2,672	27.0	24.8	42.2	2.53
Liberia	2013	8,817	322	770	28.4	47.5	45.6	4.53
Madagascar	2009	16,330	600	1,528	14.3	29.4	47.3	4.33
Malawi	2015	24,234	850	1,114	34.2	15.7	47.6	3.65
Mali	2018	9,455	379	2,283	11.6	34.7	50.9	5.79
Mozambique	2011	13,604	610	913	16.7	30.5	43.0	4.46
Namibia	2013	9,053	545	8,858	45.1	40.8	51.2	3.30
Niger	2012	10,201	480	807	4.7	17.3	49.8	8.56
Nigeria	2018	40,660	1400	5,155	42.2	42.8	40.7	6.11
Rwanda	2014	13,362	491	1,516	11.3	24.0	73.5	3.15
Sierra Leone	2013	15,864	434	1,570	21.2	38.0	41.1	4.67
South Africa	2016	8,485	750	12,393	71.2	54.5	60.8	2.87
Swaziland	2006–07	4,947	274	7,141	39.5	22.3	52.3	2.45
Tanzania	2015	12,631	606	2,421	14.8	28.8	46.6	4.56
Togo	2013–14	9,217	330	1,280	18.1	37.2	50.3	4.00
Uganda	2016	18,033	695	1,738	19.2	15.1	50.9	4.44
Zambia	2018	13,340	545	3,520	45.0	38.4	43.9	4.63
Zimbabwe	2015	19,878	399	1,709	68.0	33.0	58.7	3.81

Note: '–' indicates missing data.
Source: Authors' analysis of data from the most recent Demographic and Health Survey in each country, from the period 2006–07 to 2018.

2019) and included in our analysis as a logged continuous variable.

In addition, in our multilevel analysis we control for the impact of area of residence as defined and reported in DHSs (urban vs rural). Similarly, we control for region-specific differences in fertility desires within SSA by including dummy variables for central and western Africa (reference category), eastern Africa, and southern Africa.

Another major factor associated with lower fertility desires is availability and use of family planning services. Information on the intensity of family planning activities at the national level is available through the Family Planning Effort Index (FPEI) (Kuang and Brodsky 2016). The FPEI was intended to measure the strength and weakness of national family planning efforts in four main dimensions: policy context, service provision, monitoring and evaluation, and access to fertility control methods. The index was constructed based on the assessment of 10–15 experts from government, the private sector, academia, non-governmental organizations, and international agencies in each country, and is available periodically between 1972 and 2014 for a large number of countries. The national experts rated 36 items of their country's family planning

programmes on a scale from one (no effort) to ten. The FPEI was then calculated by taking the average of the 36 ratings as a percentage of the maximum possible score.

While the FPEI takes account of the input side of family planning, the output side (e.g. actual use of modern contraceptives) is excluded from our analysis for two main reasons. First, contraceptive use is to some extent a consequence of fertility preferences, not an explanatory factor. The desire for smaller families creates a demand for family planning services and, keeping all other factors constant, women with lower desired family sizes are more likely to use contraceptives than those with high fertility preferences. Second, women's contraceptive use is linked to their SES. Hence, including contraceptive use in the analysis would underestimate the total effect of the antecedent background factors, such as education and economic resources. Moreover, the study aims to compare the effects of the demand-side determinants of fertility preferences, setting aside the supply-side factors.

Descriptive country-specific sample statistics including the number of clusters, number of women sampled, and country-level socio-economic indicators included in the analysis are provided in Table 1. Mean ideal number of children varies substantially across SSA countries, ranging from 2.5 in Swaziland to 8.6 in Niger. Likewise, considerable heterogeneity is observed in socio-economic development. GDP per capita, for example, is as low as $682 in Burundi, while in Gabon it is as high as $17,000. The proportion of working-age adults with at least lower secondary education ranges from 4.7 per cent in Niger to 71.2 per cent in South Africa. In Gabon 85 per cent of the population is urban, compared with only 11 per cent in Burundi. Unlike the other socio-economic indicators, the FPEI index shows little variation between sample countries: at 49.8, the FPEI for Niger, the country with the highest ideal number of children, is not very different from the FPEI for Swaziland at the other end of the spectrum (52.3).

Method

In order to assess the relative impact of education on fertility desires, we employ multilevel Poisson regression models to account for the hierarchical nature of our data. Failure to control for the correlation resulting from the characteristics shared by women within the same DHS cluster and clusters within the same country could mask underlying unobserved heterogeneity and lead to biased estimates. Because of the small number of observations at the household level, we settle for a more parsimonious three-level model where women (level 1) are nested within clusters (level 2), which are again nested within 34 SSA countries (level 3). The base model is specified as follows:

$$\begin{aligned}\log(\mathrm{Y}^{N}_{i,\mathrm{k},c,t}) &= \alpha + \beta 1\mathrm{age}_{i,k,c,t} + \beta 2\mathrm{educ}_{i,k,c,t} \\ &+ \beta 3\mathrm{wealth}_{i,k,c,t} + \beta 4\mathrm{rural}_{i,k,c,t} \\ &+ X^{a}_{i,k,c,t} + X^{b}_{i,k,c,t} + U_K + U_c\end{aligned} \tag{1}$$

where individual i is nested in cluster k and clusters are grouped within country c. The subscript t represents the survey year, which varies among sample countries (see Table 1). Since the responses to questions on fertility ideals heavily depend on the number of children a woman already has (rationalization), equation (1) is estimated separately for subsamples of women at different parities, where $N =$ 0, 1–2, 3–4, and 5+. The outcome variable $Y_{i,k,c}$ measures the ideal number of children. The error terms U_K and U_c capture cluster- and country-specific deviation from the conditional mean (intercept), respectively. They are assumed to be normally distributed with constant variance. We control for women's age at time of survey ($\mathrm{age}_{i,k,c,t}$), as well as individual-level educational status ($\mathrm{educ}_{i,k,c,t}$), household wealth quintile ($\mathrm{wealth}_{i,k,c,t}$), and place of residence ($\mathrm{rural}_{i,k,c,t}$). Moreover, we implement controls at the community level ($X^{a}_{i,k,c,t}$), and country level ($X^{b}_{i,k,c,t}$): for the community, mean years of schooling of women of reproductive age, and mean wealth quintile score; at country level, proportion of adult population with at least lower secondary education, log GDP per capita, FPEI, and other geographical indicators. We develop eight models to test the relative impact of our indicators at multiple levels on the desired number of children.

Results

Education and household wealth

Table 2 reports the multilevel model estimates that compare the relative importance of education and economic resources in shaping women's fertility desires at the individual, community, and country levels. Model (1) shows the bivariate effect of selected individual-, community-, and country-level variables on desired number of children, adjusting for age of women and number of living children.

Table 2 Estimated rate ratios of ideal number of children from four models: women aged 15–49 in 34 SSA countries

	(1)		(2)		(3)		(4)	
	RR	95 per cent CI	RR	95 per cent CI	RR	95 per cent CI	RR	95 per cent CI
Individual level								
Woman's education								
None (reference)	1.00		1.00				1.00	
Incomplete primary	0.94	0.93–0.94	0.95	0.94–0.96	–		0.95	0.95–0.96
Completed primary	0.89	0.88–0.90	0.91	0.91–0.92	–		0.92	0.91–0.92
Incomplete secondary	0.84	0.83–0.84	0.87	0.87–0.88	–		0.88	0.87–0.88
Completed secondary or higher	0.77	0.76–0.77	0.81	0.80–0.81	–		0.82	0.81–0.83
Quintile of wealth index								
Poorest (q1) (reference)	1.00				1.00		1.00	
Poorer (q2)	0.96	0.96–0.97	–		0.97	0.97–0.98	0.98	0.97–0.98
Middle (q3)	0.93	0.92–0.93	–		0.96	0.95–0.96	0.97	0.97–0.98
Richer (q4)	0.89	0.88–0.89	–		0.94	0.93–0.94	0.96	0.96–0.97
Richest (q5)	0.81	0.80–0.81	–		0.88	0.87–0.89	0.94	0.93–0.95
Area of residence								
Urban (reference)	1.00							
Rural	1.21	1.20–1.22	–		–		–	
Community level								
MYS (women aged 15–49)								
[0–3.2) (reference)	1.00		1.00				1.00	
[3.2–6.4)	0.79	0.79–0.80	0.84	0.83–0.84	–		0.88	0.87–0.89
6.4 or more	0.65	0.64–0.65	0.72	0.71–0.73	–		0.79	0.78–0.80
Mean wealth index quintile score								
Poor [0–2.4) (reference)	1.00				1.00		1.00	
Medium [2.4–3.64)	0.86	0.85–0.87	–		0.88	0.88–0.89	0.94	0.93–0.95
Rich [3.64–5]	0.74	0.73–0.74	–		0.80	0.79–0.81	0.92	0.91–0.93
Country level								
Percentage of adult (aged 20–64) population with lower secondary education or more (natural log)	0.79	0.68–0.92	0.93	0.82–1.06	–		0.92	0.78–1.08
GDP per capita (PPP 2017 $) (natural log)	0.84	0.75–0.95	–		0.85	0.76–0.95	0.95	0.84–1.08
Family planning effort index (natural log)	0.99	0.77–1.26	–		–		–	
Subregion								
Central and western Africa (reference)	1.00							
Eastern Africa	0.78	0.69–0.88	–		–		–	
Southern Africa	0.49	0.41–0.59	–		–		–	
Random effects			MRR		MRR		MRR	
Level 3 (Country)	–		1.22		1.27		1.22	
Level 2 (Cluster)	–		1.15		1.17		1.15	
No. of countries	34		34		34		34	
No. of clusters	18,416		18,416		18,416		18,416	
No. of women	434,447		434,447		434,447		434,447	

Notes: RR = Rate Ratio; MRR = Median Rate Ratio; CI = confidence interval; MYS = mean years of schooling. Model (1) shows the bivariate effects of all variables; Model (2) shows the effects of education variables at all levels; Model (3) shows the effects of wealth variables at all levels; Model (4) includes both education and wealth variables. Age and number of living children are included as additional explanatory variables in all models.
Source: As for Table 1.

Older women tend to report higher desired numbers of children. Individual education and household economic resources both show strong and statistically significant relationships with fertility desires. Desired number of children is estimated to decrease with women's level of education. Relative to those with no education, estimated ideal number of children drops by 11 per cent for those with completed primary education, 16 per cent for those with incomplete secondary education, and 23 per cent for those with at least completed secondary education. Like education, the effect of household economic resources shows a negative bivariate association with desired number of children, where women from higher wealth quintiles desire fewer children. However, the difference in desired number of children between the lowest and highest wealth quintiles is smaller than the difference between having no education and having at least completed secondary education. Compared with women from the poorest households (q1), fertility desires among those from the middle wealth quintile (q3) are 7 per cent lower and among women from the wealthiest households (q5) are 19 per cent lower.

These associations between education, household wealth, and desired number of children are also apparent at the community level (Model (1)). For women residing in communities that are relatively highly educated (≥6.4 years of education on average), ideal number of children is about 35 per cent lower than for those in communities where the average educational attainment is ≤3.2 years. A higher mean wealth quintile score at the community level also appears to be associated with a lower ideal number of children, but the bivariate association is weaker than in the case of education. At the country level, the proportion of the working-age population with at least secondary education and per capita GDP both show considerable negative associations with desired number of children.

Model (2) focuses on the simultaneous adjustment of the effect of education at the individual, community, and country levels, controlling for age and number of living children. Increased education continues to be associated with a strong, statistically significant drop in fertility desires at all three levels. However, the adjusted effects are weaker than the unadjusted bivariate effects in Model (1). The estimated effect for the proportion of adults (20–64) with at least a lower secondary education at the country level appears substantially weaker and statistically insignificant, suggesting that the country-level effect of education no longer plays a significant role once individual- and community-level effects are controlled for. Similarly, in Model (3), the estimated coefficients of the effects of increased economic resources at all levels turn out to be much lower than in the bivariate Model (1). However, the effect of wealth continues to be statistically significant and of considerable size at all three levels.

Finally, Model (4) controls for both education and wealth at all levels simultaneously. Most notably, this leads to a reduction in the importance of economic resources at all levels, while the effect of education proves to be relatively robust to the inclusion of wealth. At the individual level, the effect of increased wealth remains statistically significant, but effect sizes are small: relative to women from the poorest wealth quintile (q1), desired fertility is estimated to be only 4–6 per cent lower among women in q4 and q5. At the community level, desired fertility for women from the richest neighbourhoods is estimated to be only 8 per cent lower than for women from the poorest neighbourhoods, while the difference in rate ratios for the richest and medium wealth neighbourhoods is no longer statistically significant. Similarly, at the country level, the effect of GDP per capita appears substantially weakened and insignificant.

On the other hand, the effect of women's education remains strong and statistically significant. The rate ratio for women with some secondary education is about 12 per cent lower than for those with no formal education. More strikingly even, at the community level, women from the most educated communities are estimated to report a 21 per cent lower desired number of children compared with women from the least educated communities. The effect of country-level education remains statistically insignificant. Results for the median rate ratio reported at the bottom of Table 2 indicate a relatively higher level of unobserved heterogeneity at the country level than the community level. This suggests that unobserved or unmeasured factors that are affecting women's fertility desires have a stronger impact at the country level than the community level. The stronger impact of women's education is also apparent for subsamples of women at different parities (see supplementary Table A4).

Figure 4 shows the predicted desired number of children for different combinations of education and economic resources, based on Model (4) in Table 2. Panel A shows the simulation of different combinations of assumptions for education at the individual and community levels for women from the lowest wealth quintile (q1), who are living in the poorest communities of a country with per capita GDP of only $1,000 and only 10 per cent of

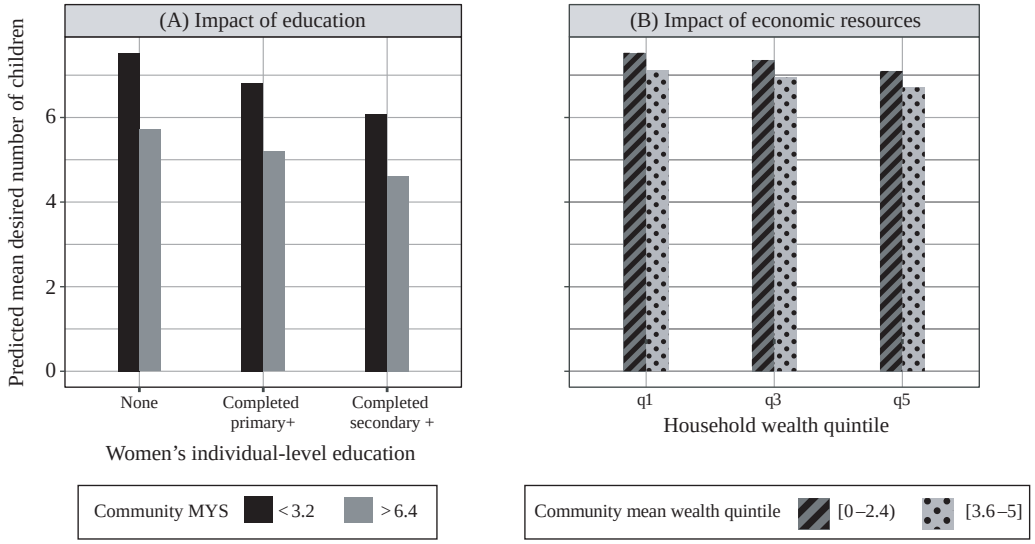

Figure 4 Simulations of desired fertility under different individual- and community-level education and economic resources scenarios

Notes: The simulations are run for a hypothetical country with GDP per capita (PPP) of $1,000, and with only 10 per cent of the adult population holding lower secondary education or higher. Panel (A) is calculated for the economically most disadvantaged women living in the poorest households (q1) within low economic resource communities. In contrast, panel (B) is calculated for women with no formal education who reside in a low-educated community. Predicted values are based on Model (4) in Table 2. MYS = mean years of schooling.

Source: As for Figure 1.

the population (aged 20–64) having lower secondary education or more. Under these circumstances, increasing education at the individual level leads to a sizable drop in desired number of children. In a community where women have on average ≤3.2 years of education, lifting a woman from no formal education to completed secondary education, keeping all else constant, would reduce her desired number of children by about 20 per cent (from 7.53 to 6.08 children per woman). In a highly educated community, where women's MYS is ≥6.4 on average, the same hypothetical experiment would reduce desired fertility from 5.71 to 4.62 children. However, the impact of higher economic resources on fertility desires of the most disadvantaged women is minimal. As displayed in panel B, for women with no formal education living in a poorly educated community, increasing household wealth from the poorest quintile (q1) to the highest (q5) would result in only a minor drop in the desired number of children, from 7.53 to 7.10.

The simulation results also reveal a relatively stronger impact of education compared with wealth at the community level. Moving a woman with no formal education from a low-educated community to a highly educated community would reduce her fertility preference by about 25 per cent (from 7.53 to 5.71). In contrast, panel B shows that being lifted from the poorest community wealth quintile to the richest would lead to only minor changes in desired number of children: from 7.53 to 7.11 for the poorest women (q1) and from 7.10 to 6.71 for the richest women (q5).

Effect of education by area of residence

Extensive evidence from less developed countries suggests that urban dwellers tend to aim for smaller family sizes than people living in rural areas (Eloundou-Enyegue and Giroux 2012). The main reasons are the higher financial cost of supporting a child in the city, lack of available living space, reduced demand for labour outside an agrarian context, and higher exposure of urban economies to negative consequences of economic downturns. However, the strength of the effect of area of residence, and whether it is linked to differences in other socio-economic developments (such as education and wealth), is less clear. Consistent with previous studies, we find a strong bivariate association between place of residence and fertility desires; relative to urban residents, the estimated ideal number of children for rural residents is about 21 per cent higher (Model (1), Table 2). But as shown in Model (5), Table 3, this effect disappears almost

Table 3 Estimated rate ratios of ideal number of children from four further models: women aged 15–49 in 34 SSA countries

	(5)		(6)		(7)		(8)	
	RR	95 per cent CI	RR	95 per cent CI	RR	95 per cent CI	RR	95 per cent CI
Individual level								
Woman's education								
None (reference)	1.00		1.00		1.00		1.00	
Incomplete primary	0.95	0.95–0.96	0.95	0.95–0.96	0.95	0.95–0.96	0.94	0.94–0.95
Completed primary	0.91	0.91–0.92	0.92	0.91–0.92	0.92	0.91–0.92	0.91	0.91–0.92
Incomplete secondary	0.87	0.87–0.88	0.88	0.87–0.88	0.88	0.87–0.88	0.87	0.87–0.88
Completed secondary or higher	0.81	0.81–0.83	0.82	0.81–0.83	0.82	0.81–0.83	0.82	0.81–0.83
Quintile of wealth index								
Poorest (q1) (reference)	–		1.00		1.00		1.00	
Poorer (q2)	–		0.98	0.97–0.98	0.98	0.98–0.99	0.98	0.98–0.99
Middle (q3)	–		0.97	0.97–0.98	0.97	0.97–0.98	0.97	0.97–0.98
Richer (q4)	–		0.96	0.96–0.96	0.96	0.96–0.97	0.96	0.96–0.97
Richest (q5)	–		0.94	0.93–0.95	0.94	0.93–0.95	0.94	0.93–0.95
Area of residence								
Urban (reference)	1.00		1.00		1.00		1.00	
Rural	1.05	1.04–1.06	1.00	0.99–1.01	1.00	0.99–1.01	1.00	0.99–1.01
Community level								
MYS (women aged 15–49)								
[0–3.2) (reference)	1.00		1.00		1.00		1.00	
[3.2–6.4)	0.85	0.84–0.85	0.88	0.87–0.89	0.88	0.87–0.89	0.88	0.87–0.89
6.4 or more	0.75	0.74–0.76	0.79	0.78–0.80	0.79	0.78–0.80	0.79	0.78–0.80
Mean wealth index quintile score								
Poor [0–2.4) (reference)	–		1.00		1.00		1.00	
Medium [2.4–3.64)	–		0.94	0.93–0.95	0.94	0.93–0.95	0.94	0.93–0.95
Rich [3.64–5]	–		0.92	0.91–0.93	0.92	0.91–0.93	0.92	0.91–0.93
Country level								
Percentage of adult (15–64) population with lower secondary education or more (natural log)	0.92	0.83–1.05	0.92	0.78–1.08	0.97	0.86–1.09	0.92	0.81–1.05
GDP per capita (PPP 2017 $) (natural log)	–		0.96	0.84–1.08	1.00	0.90–1.11	1.05	0.93–1.19
Family planning effort score (natural log)	–		–		–		0.91	0.79–1.04
Subregion								
Central and western Africa (reference)	–		–		1.00		1.00	
Eastern Africa	–		–		0.84	0.75–0.94	0.82	0.73–0.93
Southern Africa	–		–		0.59	0.49–0.71	0.58	0.48–0.73
Random effects	MRR		MRR		MRR		MRR	
Level 3 (Country)	1.22		1.22		1.16		1.15	
Level 2 (Cluster)	1.15		1.15		1.15		1.15	
No. of countries	34		34		34		30	
No. of clusters	18,416		18,416		18,416		16,803	
No. of women	434,447		434,447		434,447		398,389	

Notes: RR = Rate Ratio; MRR = Median Rate Ratio; CI = confidence interval; MYS = mean years of schooling. Model (5) shows the effects of urban/rural residence and education, while Model (6) adds wealth indicators; Models (7) and (8) build on Model (6) by adding subregion and FPEI, in turn. Age and number of living children are included as additional explanatory variables in all models.
Source: As for Table 1.

entirely once we control for the various effects of education. Model (6) extends Model (5) by adding wealth indicators, but the effect of education remains unchanged, whereas the coefficient for area of residence shows a small reduction, reflecting the lower economic resources of rural compared with urban residents. High levels of reported desired fertility in the rural parts of SSA are thus mainly a consequence of low levels of educational attainment among the people that live there.

In line with previous studies, our results from Model (7) confirm large variation in fertility desires across the larger subregions within SSA. Although this could derive partly from regional differences in socio-economic development, our multilevel results suggest that after controlling for education, wealth, and rural residence, fertility preferences are higher among women in central and western African countries (about 16 and 41 per cent higher, respectively) than women from eastern and southern African countries. This confirms the exceptionally high prevalence of pronatalist attitudes associated with cultural norms that support childbearing in central and western African countries (May 2012). The reduction in the country-level median rate ratio associated with the inclusion of subregional dummies also indicates the considerable impact of region-specific unobserved factors in determining fertility desires in SSA.

Bongaarts (2011) attributed the high levels of desired fertility in SSA to the relative weakness of family planning programmes in the region. The supposed channels through which family planning efforts determine differences across countries in the speed of fertility decline could correlate with education. Therefore, in Model (8), Table 3, we further control for country-level variation in the intensity of family planning efforts. Their effect, as measured by the FPEI, turns out to be insignificant, while the effects of education, at both the individual and community levels, remain strong and unchanged.

Sensitivity and robustness analysis

As described earlier, ideal number of children is not a perfect indicator of fertility preferences. DHSs provide information on a number of alternative measures, such as women's desire to have another child; the length of time a woman would like to wait before having another child (if she already has at least one); and whether the most recent birth was wanted or not. Casterline and El-Zeini (2007) suggested that 'desire for another child' is indeed the most valid and reliable indicator of fertility preferences. Although answers to the DHS question '*Would you like to have another child, or would you prefer not to have any more children?*' do not provide a quantitative measure of the intensity of women's fertility desires, tabulating them by parity can give an insight into women's desires to stop childbearing once a target number has been achieved (Casterline and Agyei-Mensah 2017).

Thus, in order to see if our results hold with an alternative indicator of fertility preferences, we respecify our original model (equation (1)) using desire for another child as the dependent variable. Since desire to have another child will depend heavily on the number of children a woman already has, we estimate this new specification described by equation (2) separately for subsamples of women at different parities, N. This also helps to avoid the potential bias induced through post facto rationalization with regard to ideal number of children.

$$\begin{aligned}\text{logit}(\text{Y}_{N,i,\text{k},c,t}) &= \alpha + \beta 1\text{age}_{i,k,c,t} + \beta 2\text{educ}_{i,k,c,t} \\ &+ \beta 3\text{wealth}_{i,k,c,t} + \beta 4\text{rural}_{i,k,c,t} \\ &+ X^{a}_{i,k,c,t} + X^{b}_{i,k,c,t} + \mu k + \mu c\end{aligned} \tag{2}$$

where $\mu k \sim N(0, \sigma 2)$; $\mu c \sim N(0, \sigma 2)$; Number of living children $N = 1, 2, 3, 4$.

The outcome variable $Y_{N,i,\text{k},c,t}$ measures whether a woman i with N surviving children at the time of the survey, t, wants an additional child or not. The explanatory variable $\text{age}_{i,k,c,t}$ is categorical in this model, using five-year age groups, whereas the individual education, household wealth quantile, and area of residence (urban/rural) variables are the same as in equation (1). The community- and country-level controls also remain unchanged.

Supplementary Table A5 reports the estimated odds ratios and associated 95 per cent confidence intervals for the likelihood of wanting another child, by women's parity, from the logistic regressions specified in equation (2). Consistent with the multilevel Poisson model results, the importance of area of residence in predicting fertility desires remains low in the logistic regression: irrespective of the number of living children, the odds of wanting another child among rural residents are not significantly different from those of their urban counterparts. At the country level, although insignificant, the proportion of adult population with lower secondary education or more is negatively associated with women's desire for an additional child at all

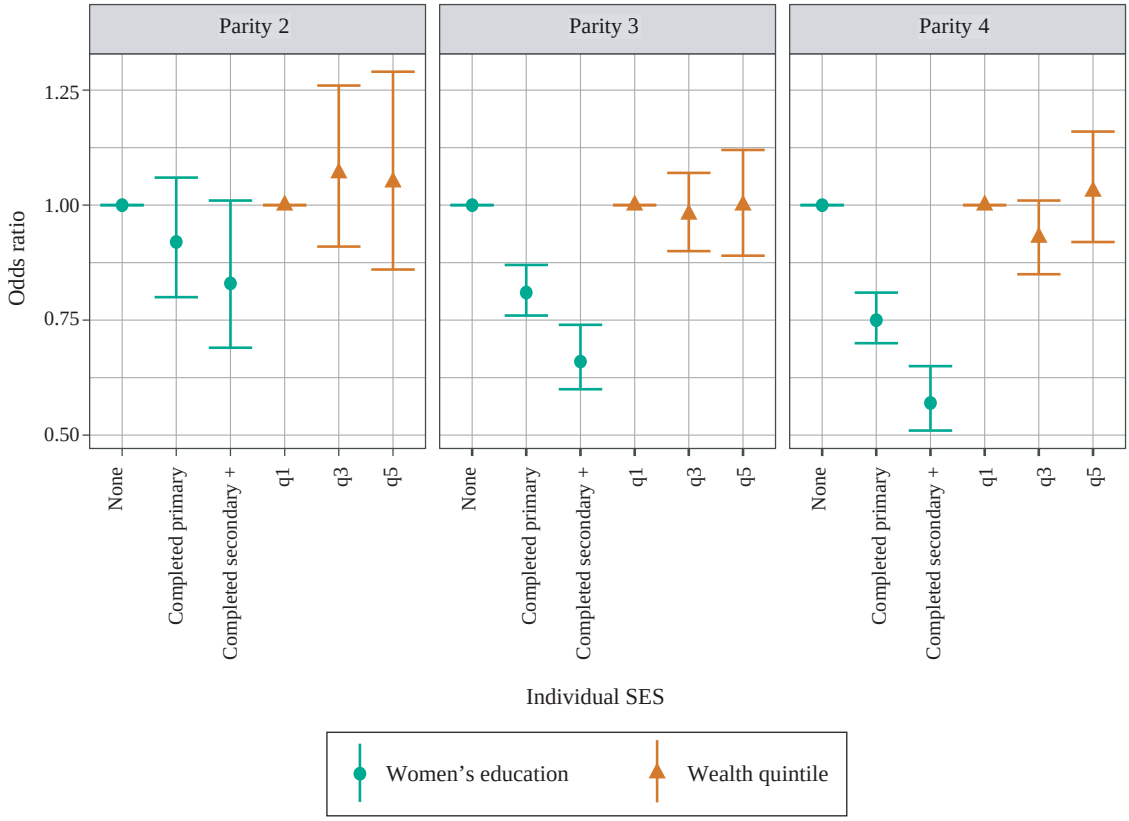

Figure 5 Estimated odds ratios for the likelihood of wanting an additional child, by parity, associated with increasing women's education and household wealth: women aged 15–49 in 34 SSA countries
Note: Vertical bars show 95 per cent confidence intervals.
Source: As for Figure 1.

parities, whereas per capita GDP is positively associated with the desire to have another child.

Figure 5 compares the effect of increased women's education and household wealth on fertility preferences for women with two, three, or four living children, estimated in three separate model runs. Irrespective of parity, the odds of wanting another child drop significantly with increasing education and the impact of women's education is estimated to be higher at higher parities. Relative to those women with no formal education, the likelihood of wanting another child for women with completed secondary education or more is lower by 17 per cent at parity two, by 34 per cent at parity three, and by 43 per cent at parity four. The larger drop in the odds of wanting another child for women with higher educational status could reflect a stronger family limitation mentality among better educated women. Household wealth quintiles, however, do not appear to be related to desires to have another child in any statistically significant way. Disregarding parity, preference for an additional child among women from the lowest wealth quintile (q1) is not significantly different from that of women in the highest (q5). These results confirm our conclusions drawn from the Poisson models, where women's education is found to be a stronger predictor of ideal number of children than household wealth.

The relative effects of community education vs community wealth are also examined (Figure 6). For women with only two living children, the odds of wanting another child for those residing in the least educated communities are about 20 per cent higher than among those from communities where the MYS of women of reproductive age is >3.2 but <6.4 years, and about 35 per cent higher than for those from (on average) highly educated communities (MYS ≥6.4 years). Moreover, the drop in odds associated with each higher level of community-level education markedly increases with parity, suggesting less desire for further children within better educated communities. Similarly, the odds of wanting another child drop substantially with the community mean wealth quintile at all parities. However, the decline in the odds ratio with higher levels of community wealth does not get stronger with the number of living children.

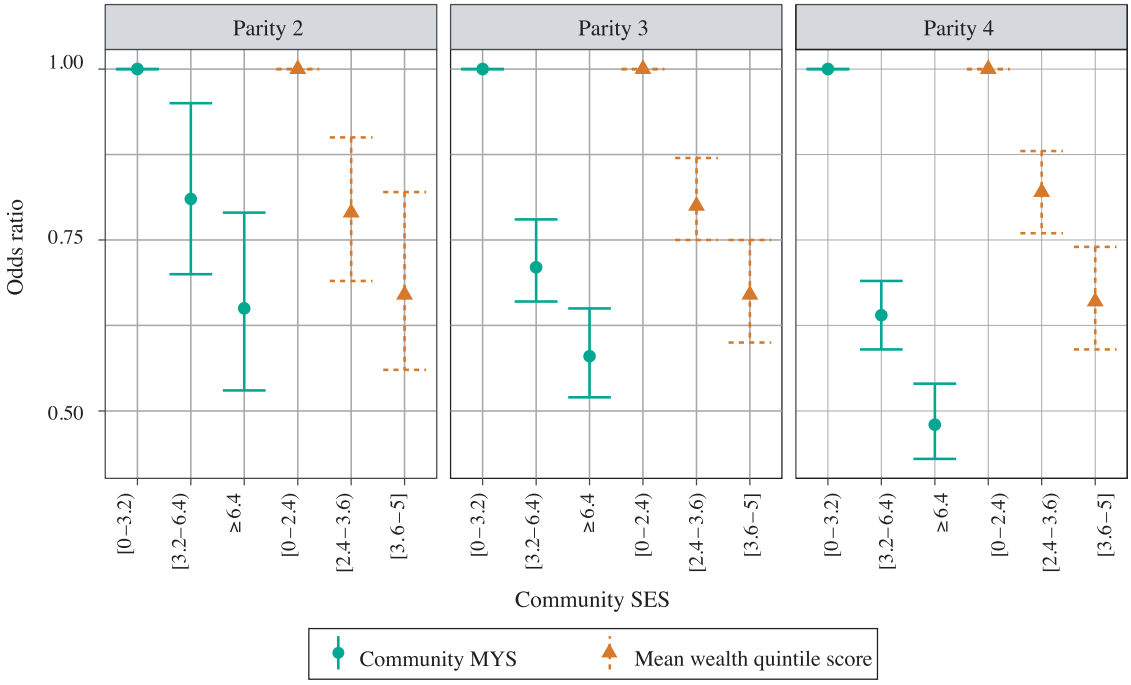

Figure 6 Estimated odds ratios for the likelihood of wanting an additional child, by parity, associated with increasing community MYS and community wealth quintile: women aged 15–49 in 34 SSA countries
Note: Vertical bars show 95 per cent confidence intervals. MYS = mean years of schooling.
Source: As for Figure 1.

As a last step, we check the robustness of our results to using several alternative key variables. Supplementary Table A6 shows the relative effects of education vs wealth, differentiating between two measures of education at country level, which confirms that the findings are robust. Furthermore, whereas we consider all women of reproductive age in the main analysis, supplementary Tables A7 and A8 present alternative regressions by marital status, for 'never in union' vs ever-married women. The results confirm the robust and relatively stronger effect of education (vs wealth) in both subsamples, even after controlling for spousal education.

Discussion and conclusion

The originality of this research lies in its analysis of the relative effects of education and economic resources on women's fertility desires at individual, community, and country levels. Using DHS data for 34 SSA countries, we show that both individual and community educational levels have a significant dampening impact on women's fertility desires. Thus, our results confirm the findings of Kravdal (2002), as well as Colleran and Snopkowski (2018), with regard to actual fertility. Comparing the relative effects of education and wealth, we find that education has a stronger effect than wealth at all three levels, the effects of both being statistically significant at the individual and community levels. However, when we include both variables at all levels in one model, the importance of wealth is reduced, particularly at the community level. At the same time, the effect of education proves to be robust, even when controlling for place of residence and marital status, or using alternative parity-specific measures of fertility intentions. This result confirms what has been shown by a broad literature looking into the relationship and causal links between women's educational attainment and fertility (Jejeebhoy 1995; Gustafsson 2001; Kravdal 2002; Bongaarts 2010). It also provides several key findings. It proves at the continental level (sub-Saharan Africa) that wealth and place of residence fall short of explaining the relationship between women's education and fertility intentions. This, in turn, is a clear indication that education does not only impact fertility intentions through the economic endowment channelled by education, as hinted at, for instance, by Cleland and Wilson (1987). Still, the reasons for education being more influential in determining fertility intentions than other contextual parameters, such as wealth and place of residence, remain under-researched in the SSA context. Several studies have shown that the association between wealth

and fertility (realization in most cases) appears to be heavily context-dependent, but is usually positive at very high levels of fertility (Skirbekk 2008; Colleran and Snopkowski 2018). Pointing at evidence from small-scale, pre-transitional economies and arguing from an evolutionary perspective, Kaplan (1996) concluded that resource abundance leads to higher fertility. However, this would mean that high-income countries would experience the highest fertility of all, which is not the case. Obviously, there is a turning point at which the effect of wealth on fertility becomes negative.

To explain our results on household wealth, it is worth revisiting Caldwell's wealth flows theory (Caldwell 1976); this can be related back to the early work on the demographic transition by Notestein (1945), whose hypothesis was that social and economic development would bring fertility down by changing parents' aspirations and the role of children. Caldwell argued that in traditional pre-transitional societies, the intergenerational net flow of resources goes from children to parents. Only later, in transitional societies, does the direction of the net flow reverse, leading to greater parental investments in children, accompanied by a smaller number of children. While this theory has been widely disputed, for instance with regard to the measurement of flows (Kaplan 1994), Caldwell's emphasis on social changes that lead to changing demand for children, while simultaneously concentrating greater family concern on the children, has not been disproven empirically.

These potential explanations are important in the context of our work. Most of the SSA countries in our sample are transitional societies, undergoing profound social changes—such as the spread of mass education—which influence cultural norms and modes of behaviour, but also numeracy about family size. As Etienne van de Walle put it in his 1992 Presidential Address to the Population Association of America (Van de Walle 1992), 'the perception of a particular family size as a goal in a long-term strategy of couples may be a cultural trait present in some places and times but not in others'. Our results lend support to a cognition-driven theory of demographic transition, where changes in the educational attainment of some women create a vanguard of change in terms of fertility intentions and subsequent actual fertility. The newly adopted norms are then shared and transmitted within communities to those less exposed to education.

What we demonstrate here as well—paraphrasing Kravdal (2002)—is that education at the community level has an effect on a woman's fertility intentions above and beyond that of her own education. The predominant effect of community-level average education, compared with community-level average wealth and place of residence, could be explained by social spillover effects which, for instance, would lead uneducated women living in an educated community to pursue a different fertility career compared with uneducated women living in an uneducated community. However, our results also imply that neighbouring populations are more homogenous in terms of wealth than in terms of education.

From a policy point of view, the fact that education is more determinant for the reduction in fertility intentions than wealth is rather good news, because education is usually a direct public investment, whereas wealth accumulation is the outcome of a more complex process, involving many factors that cannot easily be influenced by policy.

Education as a dominant factor in desired fertility and, in turn, actual fertility in SSA has clear implications: improvements in women's education on the subcontinent will be important in accelerating the fertility transition. The speed of these changes will strongly influence population growth in the mid to long term. While population momentum guarantees further population growth at least until the middle of the century, SSA could show very different fertility patterns thereafter, depending on the educational investments made in future. Furthermore, and as shown by Bongaarts (2020), combined with increasing education, the availability of family planning programmes could reduce wanted (as well as unwanted) fertility.

This paper has some limitations that are in part inherent to the data used. The indicator chosen to evaluate family planning services, the FPEI index, does not show much variation across countries and was chosen mainly because of the lack of other international supply-side indicators. A second limitation is that we used cross-sectional data and cannot infer a causal relationship between a change in any of the independent variables and the desired number of children. In order not to complicate the analysis, we limited the number of variables to those essential for our research question. As a result, we may have missed some variables that could be of importance, such as women's labour force participation and level of autonomy, or the survival of children born prior to survey date. Adding such further potential determinants of fertility intentions could be the task for further work, alongside monitoring how the relationship between education and fertility will evolve in the SSA context as these countries move to the later stages of the demographic transition.

Notes and acknowledgements

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2 Endale Kebede and Erich Striessnig are based at the Wittgenstein Centre for Demography and Global Human Capital, which is a collaboration between the World Population Program at IIASA, the Vienna Institute of Demography (VID) of the Austrian Academy of Sciences (ÖAW), and the University of Vienna. Anne Goujon has undertaken this work while at the Wittgenstein Centre for Demography and Global Human Capital, and finalized it at the European Commission Joint Research Centre.

3 The authors gratefully acknowledge the comments and suggestions of Professor Wolfgang Lutz.

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