

Age-Specific Fertility Rate Projections in West Africa

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Abstract

Fertility has become the most important biological factor in predicting population growth due to significant improvements in reducing mortality. Fertility projections are important in predicting the demand for water, food, medical services and other basic social amenities. There are two main objectives in this study: 1) to examine past trends in age-specific fertility rate for West African countries; and 2) to predict future fertility rates there. Age-specific fertility data were retrieved from the United States Census Bureau; then simple linear regression models were fitted to forecast the fertility rates for seven age groups from 2016 to 2100. Results confirm that fertility rates in West Africa have been reducing very slowly as has been reported in other studies, but this examination reveals that few West African countries are likely to reach long-term fertility limits across all age groups due to the slow pace of reduction. This suggests that, current population control programs in most countries are not sufficient in achieving Sustainable Development Goals and policymakers need to consider additional measures to increase the pace of fertility reduction

Keywords

Age-specific fertility rates; long-term limits; projections

Introduction

Fertility and mortality are two main biological factors that determine population growth. For this reason, fertility and mortality trends have become important in predicting the demand for water, food, medical services and other basic social amenities. However, there has been a consistent decline in global mortality rates and a significant increase in life expectancy. Hence, a lot of attention has been focused on fertility as a tool for controlling population growth (Shelton, 2014; Weiss, 1972). According to the latest World Fertility Report, global patterns in fertility have changed over the last half-century, reaching unprecedented low rates (United Nations [UN], 2015)

The total fertility rate (TFR) of Africa stood at 5.1 births per woman between 2005 and 2010, which was relatively high compared to other continents. The United Nations (UN) projected that the continent's population could be 3.36 billion by the year 2100 (Nations, 2011). The TFR of Europe, Asia and Latin America is 1.6, 2.2 and 2.2 births per woman, respectively. However, Middle and West African countries still record TFRs higher than 5.5 births per woman (UN, 2015). As of the end of 2015, seven out of the 20 countries with the highest TFR were West African countries (Lesthaeghe, 2014). Such high fertility rates could be responsible for socioeconomic and environmental problems.

Fortunately, the World Fertility Pattern Report, published in 2015, indicated that Africa's TFR had reduced from 5.1 to 4.7 births per woman between 2010 and 2015. However, even with

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this reduction, the population of Africa was projected to be almost 4.5 billion by the end of the current century (UN, 2015; 2017). Thus, TFR of Africa remains the highest compared to other continents.

Age-specific fertility rate (ASFR) is a measure of the annual number of births by women of a specific age per 1,000 women. It is essential in demographic studies because chances of childbirth differ by mothers' age. The fertility rate for the adolescent age group (15-19) has been and remains the highest in Africa, and yet, a downward trend has been very slow (UN, 2015).

There has also been a reduction in ASFR for almost all countries in the Africa region. This reduction is attributed to different reasons. The most consistent reasons are the delay in marriage of young women, the effectiveness of family planning schemes, the pursuit of higher education and urbanization (Garenne, Tollman, Kahn, Collins & Ngwenya, 2001).

There is enough evidence to suggest a continuous decline in the TFRs of West African countries (Jain & Ross, 2012; Lesthaeghe, 2014). The question remains, though, as to whether the rate of decline in these countries will be enough to meet the Sustainable Developments Goals' target of reducing population growth (Abel, Barakat, Samir & Lutz, 2016). UN has projected the TFR of Africa to be 3.9 births per woman and 3.1 births per woman in 2030 and 2050, respectively. The ability of Africa to meet such targets will depend on the TFRs and ASFRs in West Africa.

However, the literature on ASFR projections is still lacking in various West African countries, partly due to the unavailability of credible data for analysis. As an effort to provide a glimpse of the future age-specific fertility behavior in the sub-region and also to contribute to existing literature, thereby influencing national decision-making and policy implementation, this study examines past trends in ASFR and forecasts fertility rates in West Africa from 2016 to 2100 using simple linear regression.

Data and Methods

Data on age-specific fertility rate (ASFR) estimates were retrieved from the website of the United States Census Bureau. The U.S. Census Bureau estimates fertility for countries with complete registration systems using demographic procedures. Such nations (most of which are developed) produce accurate and reliable data on a regular basis. In the case that birth registration is not available, the Bureau relies on fertility estimates from official government sources, which are published in statistical yearbooks. For countries with less efficient registration systems (especially developing countries), fertility rates were estimated using census and survey data (U.S. Census Bureau, 2011).

Registered births obtained from survey and census reports of countries with less reliable registration systems are evaluated by the U.S. Census Bureau to identify potential bias and sampling challenges before the information is used to estimate fertility rates. The Bureau ensures the quality of data on registered births by making sure that it has at least 90% completeness and reliability ratings. The ratings consider the source of data, sampling errors, the possibility of age heaping and age ratio. The data from survey and census reports is also consistently compared with data from other available sources (U.S. Census Bureau, 2013).

The data for this study contained ASFR of each of the 16 countries in West Africa over a 25-year period (1991-2015). Age-specific fertility data was obtained for the following countries: Benin, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. The female

reproductive ages considered are from 15 to 49 years, and this range is divided into seven groups: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49. Thus, the data contained ASFRs of seven age groups and 16 countries for 25 years, with 2,800 observations with no missing values.

Statistical analysis

Coale and Trusell (1996), de Beer (1989), Alkema et al. (2011), Fosdick and Raftery, (2014) and Shang (2012) have discussed different probabilistic methods of forecasting age-specific fertility. However, this study uses a simple linear regression model to forecast fertility rates due to the unique characteristics of the data. The data from 1991 to 2015 showed that fertility for almost all age groups in every country depicted a linear trend, especially after the year 2000 (Figure 2). The 44-49 age group in Cape Verde and Ghana seemed to be the only exception. However, a linear trend in those countries became visible after the year 2000. This linear characteristic of all age groups prompted the use of a simple linear regression model. This method was also applied due to its proven predictive abilities (Cattin, 1980).

Before fitting the regression model, the data were transformed using the ninth root transformation to ensure normality and constant variability. The root transformation was used instead of the log transformation because of the possibility of zero fertility rates.

For this study, the research team assumed that the current trends in fertility for each age group for every country would be stable and maintained. This assumption was based on the recent trends in ASFR in all countries. After exploring the age-specific fertility data from the 16 countries, it was observed that fertility in every country is following a linear trend. Thus, it is believed that the current age-specific fertility pattern could only change if there is a dramatic change in lifestyle as a response to one or more of the following: famine, conflicts, political instability, natural disasters, epidemics and population policy changes.

It was also believed that there is a long-term limiting fertility rate, below which fertility forecasts cannot go.

Long-term limits

Long-term minimum values were estimated based on the distribution of the data, with the assumption that recent fertility trends will continue until these limiting values are reached, then remain constant. The long-term limiting values of each age group was estimated by taking the average of the median and minimum current values of ASFR for the 16 countries in the sample.

These long-term limiting values were used to make sure that the fertility forecasts are not below a certain rate for all age groups. Figure 1 shows how these limits affect the fertility forecasts of Cape Verde.

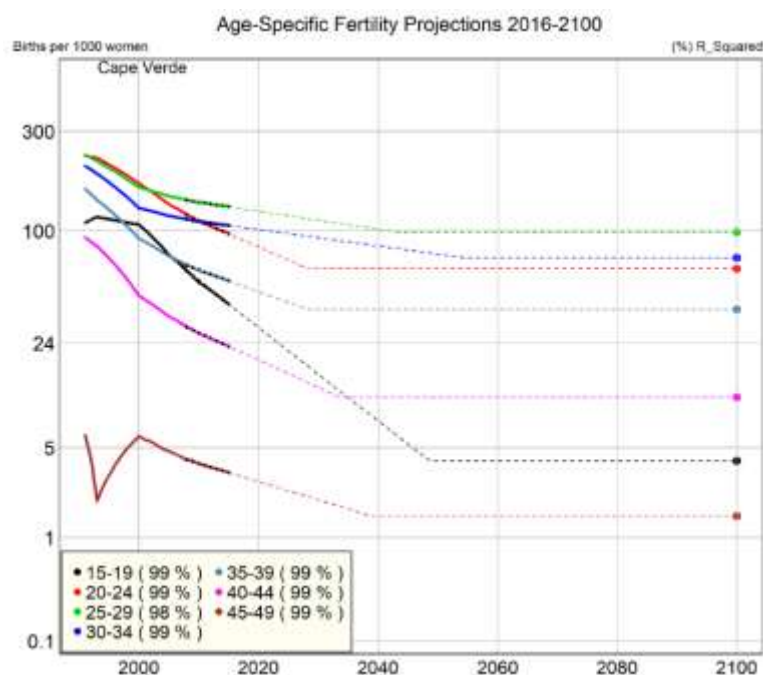


Figure 1: How long-term limits affect the fertility projections of Cape Verde

From the figure, the age-specific fertility projections follow the current trends of reduction until they reach long-term limits, then become constant. Thus, long-term limits prevent fertility projections of every age group from going below a certain threshold or reaching zero.

Simple linear regression models were fitted to the data to forecast the fertility rates of each age group for each country. The linear regression models were fitted for each age group in the data, which produced 112 models. The goodness of fit and accuracy of the regression models were measured by its R-squared. The ASFRs were forecasted from 2007, instead of 2016. The forecasted fertility rates from 2007 to 2015 were compared with the original rates from the data. The comparison was to ensure the accuracy of the forecasted fertility rates from 2016 to 2100. R programming software was used for all statistical analyses and graphical displays (R Development Core Team, 2013).

Results

ASFR Trends: 1991 to 2015

Preliminary analysis of data from the U.S. Census Bureau indicated that the ASFRs of all of the West African countries had been decreasing across all age groups. In Benin for instance, the fertility rates of 45-49 and 40-44 age groups began to maintain a steady decline after the year 2000, with all other age groups recording relatively insignificant reduction in fertility rates. However, it was very difficult to identify a significant reduction across all age groups in Burkina Faso from 1991 to 2015. Perhaps the most visible change was the 15-19 age group that reduced from 1.87 to 1.18 births per woman. Ivory Coast, The Gambia and Ghana also maintained a slow decline in their ASFRs from 1991 to 2015. A closer look at the fertility of the 45-49 age group in Ghana showed that there was a sharp increase in 1998, after which there was a steep decline until 2003, then the reduction became stable. Over the 25-year period,

Guinea, Guinea-Bissau, Mali, Mauritania and the remaining countries showed a relatively slow decline in ASFRs. However, Liberia seemed to be the exception. The fertility of that country increased in all age groups until 1997, when rates began to decline. Cape Verde achieved the highest reduction rate for all age groups from 1991-2015. A summary description of trends in the data is represented in alphabetical order in Figure 2.

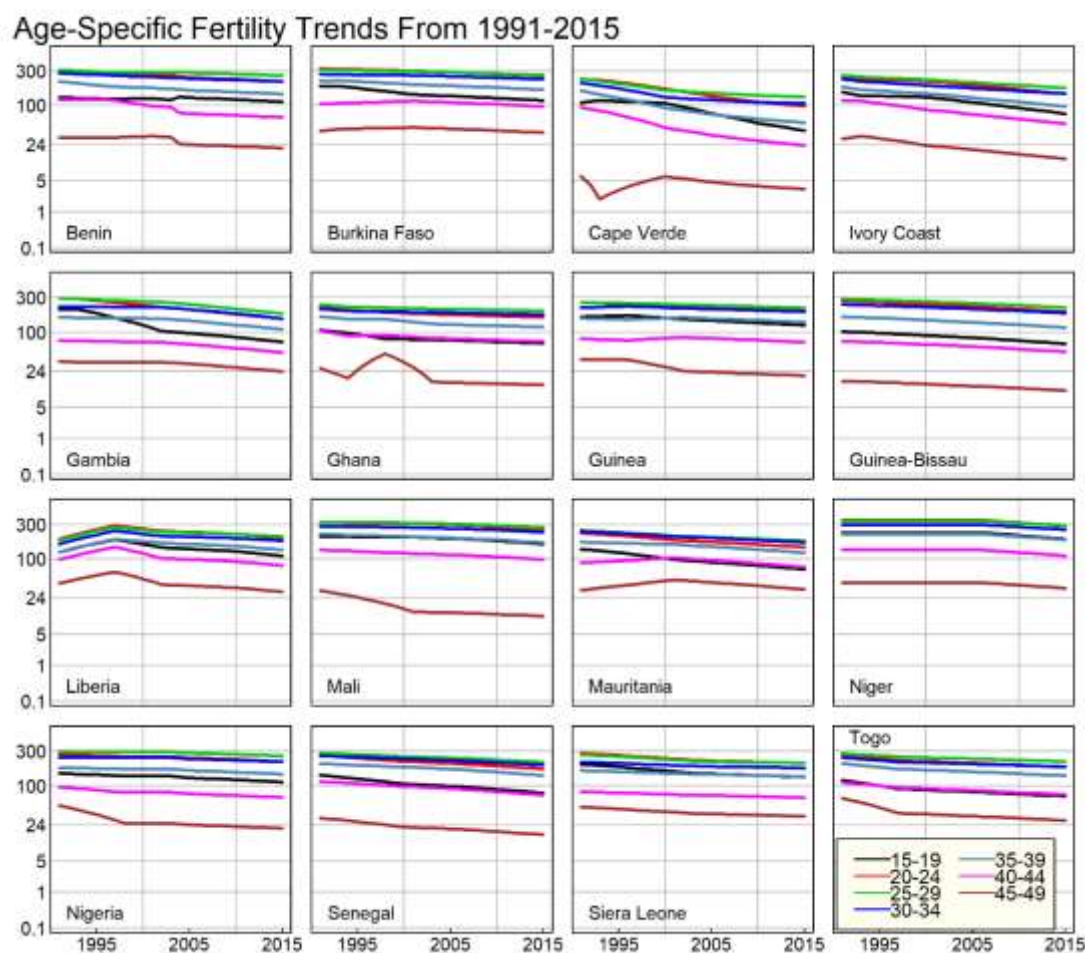


Figure 2: Age-specific fertility trends of each country in West Africa from 1991 to 2015

According to the forecasts from the linear regression models, only three countries are affected by long-term limits of fertility across all age groups. These countries are likely to achieve these limiting values before the year 2100; thus, their age-specific fertility rates are expected to remain constant before 2100. These countries are Cape Verde, Ivory Coast and The Gambia. The forecasts show that before the year 2060, Cape Verde will reach the long-term limits for all age groups. In Ivory Coast, the 15-19 age group will be the last to reach the limits in 2080, while all other age groups will reach their limits a decade before. The 15-19 and 45-49 age groups in The Gambia are expected to reach long-term limits by the years 2098 and 2095, respectively. Different age groups in some of the countries are likely to reach long-term limits before the year 2100. For example, in Liberia and Mauritania, all the age groups except 15-19 and 45-49 are likely to reach the limits before 2100. At the current rate of reduction in ASFR, countries like Benin, Burkina Faso, Ghana, Guinea, Mali, Nigeria, Sierra Leone and Togo might not achieve enough reduction to meet long-term limits by 2100. (Figure 3a and 3b).

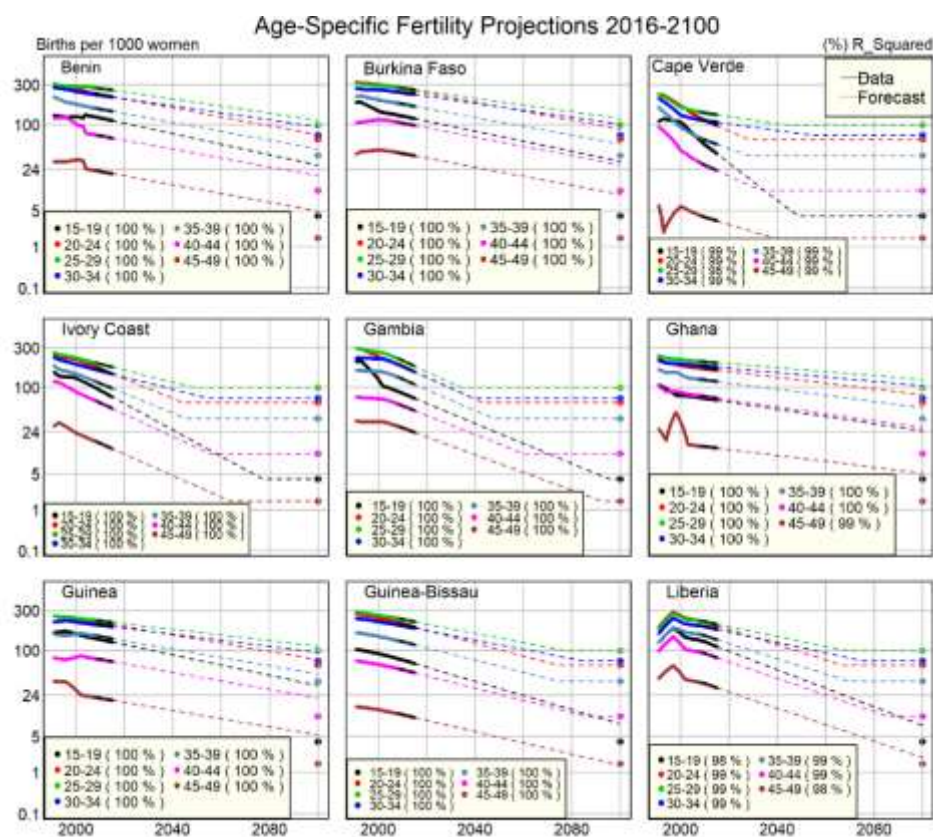


Figure 3a: Age-specific fertility forecasts for West African countries from 2016 to 2100

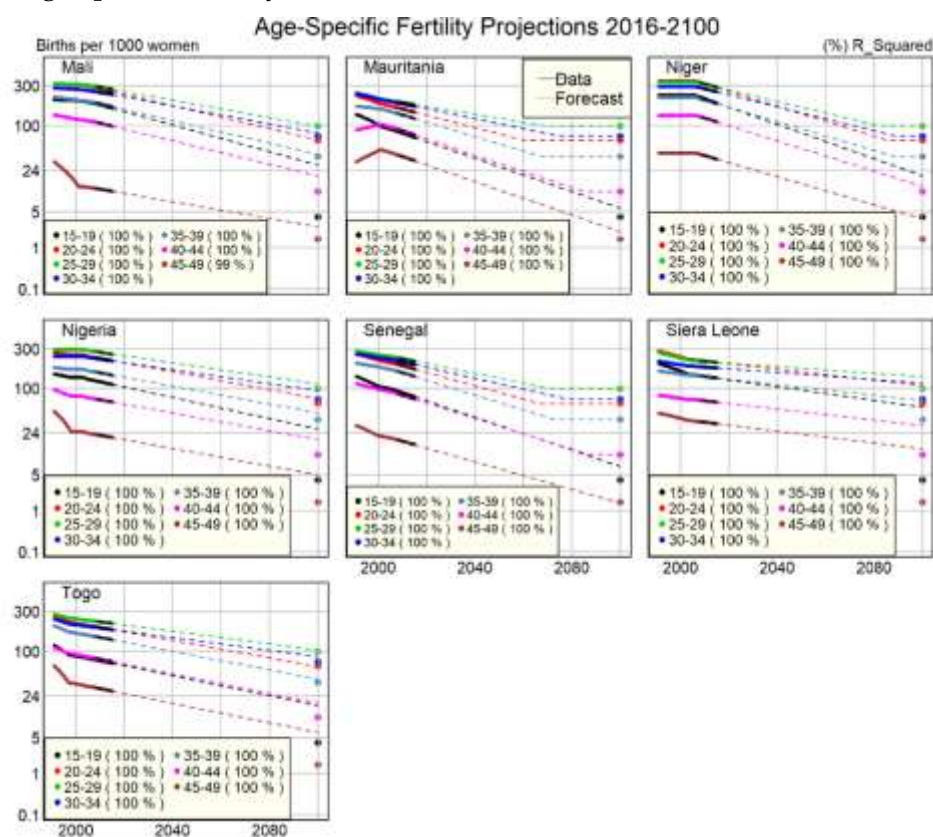


Figure 3b: Age-specific fertility forecasts for West African countries from 2016 to 2100

The projections from the linear regression model also confirm the assumption that current trends in the ASFR of each country will remain. After 2015, fertility rates of each age group have been projected to follow a linear trend until 2100. These projections are highly possible, especially considering trends in the decade before 2015. Within this period, the trend in fertility has been linearized, and unless there is a very significant change in reproductive behavior, the trends in ASFR are likely not to change. Toward the latter part of the century, (2090-2100), the ASFRs of most countries are likely to become constant, as they would have reached lower limits.

ASFR projections from 2007 to 2015 based on the linear regression models overlap with the projections from the data. The overlap is represented in black color for each age group. The overlap implies that the projections from the linear regression models are almost the same as the projections from the U.S. Census Bureau.

Discussion

This study confirms the downward trends in ASFR across West Africa as documented by Pantazis (2016). Additionally, this study sparks an interesting revelation. Long-term fertility limits were estimated for every age group. These limits serve as lower bounds for fertility rates. The long-term fertility limits are different from the fertility replacement level described by Craig (1994). Replacement level fertility is estimated using the TFR index, while long-term fertility limits are estimated from ASFRs. The fertility rates that are likely to reach lower limits before the year 2100 are expected to remain constant.

The linear regression model was used to forecast age-specific fertility rates in West Africa, with R-squared used as a goodness-of-fit measure for the model. The R-squared from the regression models demonstrates that the models provide a good fit for the forecasts. For instance, in the case of Cape Verde, an R-squared of 99% means that the regression model provides a 99% accurate fit to the data (thus, the margin of error is 1%). According to the results from the linear regression model, if current trends in fertility remain constant, as per the assumption of the study, then all of the countries in West Africa are likely to record reductions in age-specific fertility rates by 2100, although almost all of the countries will still have high fertility rates.

Fertility can be considered as a major determinant of population growth; hence, trends in fertility (especially ASFR) have a direct impact on population growth rate. Based on this study, the ASFRs in most countries in West Africa will reach long-term limits late in the century, and they are expected to remain high even by the second half of the 21st century. These high fertility rates may be a significant hindrance to achieving Sustainable Development Goals (SDGs) and might even result in higher population sizes in Africa than projected by the UN (UN, 2017).

By the end of the 20th century, almost all countries in West Africa had adopted policies to control population growth by reducing fertility rates (Sullivan, 2007). This study suggests that declines in ASFR in most countries started a few years before or after the year 2000. After that, there has not been any significant change in the rate and trend of reduction. The consistent pattern implies that different measures adopted by the countries have ensured a consistently smooth, but slow, reduction in fertility. These findings suggest that unless there is a significant policy change in these countries, this gradual reduction will be maintained. Pantazis (2016), Gaisie (2013), Ekane (2013) and Fayisetan and Bankole (2002) have discussed some of the measures that were adopted.

Conclusion and Recommendations

The present study has presented a relatively simple method (linear regression) for estimating the trends of age-specific fertility and projecting ASFR in West Africa. This approach confirms and validates traditional demographic methods of assessing trends in fertility. It may add validity to the forecasts if the regression models are compared with forecasts from other methods over the same period, to confirm the predictive accuracy of the regression model.

This study forecasted the ASFRs of 16 West African countries from 2016 to the end of the current century. The results reveal that age-specific fertility will see a consistent but slow trend of reduction. This slow trend suggests that current population control policies in West African countries are not enough to reduce fertility, and subsequently, population growth rate, to achieve SDGs by 2030 (Abel, Barakat, Samir & Lutz, 2016). Economic policymakers, government population control agencies and other organizations must introduce additional measures – or ensure strict compliance with current measures – that will increase the pace of reduction of age-specific fertility. These additional measures may help these countries achieve SDGs on population growth by 2030.

Acknowledgements

This work was supported by the Higher Education Research Promotion and Thailand's Education Hub for Southern Region of ASEAN Countries Project Office of the Higher Education Commission.

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