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# Climate variability and fertility preferences in Zimbabwe: Examining the impact of environmental stress on the ideal number of children

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## ABSTRACT

Climate change variability is increasingly emerging as an important determinant of demographic behavior, particularly in Agrarian societies where livelihoods remain highly dependent on environmental stability. While fertility transition scholarship has traditionally emphasized socio-economic factors such as education, urbanization, and marital change, limited empirical attention has been given to how climate stress shapes fertility preferences in Sub-Saharan Africa. Guided by Risk Society Theory and Life Course Theory, this study examines the relationship between climate variability and the ideal number of children in Zimbabwe, conceptualizing fertility preferences as socially embedded and environmentally mediated decisions shaped by both structural transitions and ecological uncertainty. The study uses nationally representative georeferenced data from the 2015 Zimbabwe Demographic and Health Survey linked with high resolution datasets from WorldClim and NASA Earth observation sources. A quantitative cross-sectional design was employed, and Poisson regression was used to model the count nature of the dependent variable. The analytical sample consisted of 9910 respondents. The Findings show that Mean temperature is positively and significantly associated with ideal family size ($\beta=0.019$, $p<0.001$), suggesting that rising temperature may reinforce pronatalist preferences in climate vulnerable contexts. Annual precipitation showed a weak positive association ($\beta=0.002$, $p<0.093$), while other climatic indicators were not statistically significant. Among socio-demographic factors, higher educational attainment significantly reduced fertility preferences, with tertiary education showing strongest negative effect ($\beta=-0.435$, $p<0.001$). Urban residence was associated with lower ideal family size($\beta=-0.0122$, $p<0.001$), while marital union, age and household composition significantly increased fertility preferences. The findings suggest that fertility preferences in Zimbabwe are shaped not only by socio-economic transitions but also environmental uncertainty. The study contributes to climate demography by demonstrating that climate change climate change is becoming increasingly embedded in reproductive decision making and highlights the need to integrate reproductive health into climate adaptation policies.

**Key Words:** Climate Variability, Environmental Stress, Fertility Preferences, Ideal Number of Children, Reproductive Behavior, Zimbabwe

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## I. INTRODUCTION

The demographic transition has long been attributed to structural changes in education, employment, and urbanization. However, with the intensifying impact of climate change, scholars are increasingly considering how environmental stressors influence reproductive behavior (Barrett et al., 2020; Hunter & Sutton, 2018). This study seeks to contribute to this emerging field by examining the determinants of ideal number of children, with a specific focus on climate-related variables such as warming trends, land surface temperature changes, and drought exposure. We hypothesize that climatic stress may act both directly by altering economic stability and human mobility and indirectly by reshaping the social determinants of fertility.

Climate change poses one of the most formidable challenges to development in the 21st century, particularly in Africa, where it threatens to erode hard-won gains in health, food security, and socio-economic stability. While the entire globe is experiencing environmental disruption, Africa remains disproportionately vulnerable due to its historical marginalization, heavy dependence on climate-sensitive livelihoods, especially rain-fed agriculture and limited adaptive capacity. The continent is warming faster than the global average, and climate-related stressors such as droughts, floods, shifting rainfall patterns, and rising temperatures are becoming more frequent and intense (IPCC, 2024).

According to the Intergovernmental Panel on Climate Change (IPCC), these changes have already resulted in measurable impacts on agricultural productivity, water availability, and health outcomes across the continent. Rural communities where subsistence farming dominates have been particularly hard hit. The Food and Agriculture Organization (Nations., 2025) notes that erratic rainfall and higher temperatures have directly contributed to crop failures, rising food prices, and heightened levels of food insecurity. In many parts of Africa, the rain no longer follows predictable patterns, seasons are shorter or more intense, and dry spells arrive unexpectedly, undermining the stability of household livelihoods and threatening basic sustenance.

But beyond the obvious impacts on food and health systems, climate change also exerts subtler, yet equally consequential pressures on the social fabric reshaping behaviors, decisions, and aspirations, particularly around reproduction. In high-fertility regions of Sub-Saharan Africa, where socio-economic vulnerability intersects with environmental stress, fertility decisions are increasingly made in the shadow of climatic uncertainty. These are not merely private choices, but deeply contextual decisions influenced by perceptions of ecological risk, food security, resource availability, and future family survival.

Yet, despite the urgency of these dynamics, the relationship between climate change and fertility remains critically understudied. Much of the demographic literature on Africa continues to frame fertility behavior in terms of economic development, education, or cultural norms, paying little attention to the ecological context in which these decisions unfold. This oversight is problematic. In communities where climate disruptions jeopardize access to food, land, water, and income, the perceived ability to support a large family may diminish or conversely, the need for children as labor or social insurance may increase.

Zimbabwe presents a compelling case study for interrogating this intersection of environmental and demographic change. As a country highly dependent on agriculture with over 70% of the population engaged in subsistence farming it is acutely vulnerable to climate-induced shocks (Matsa, 2020). At the same time, Zimbabwe continues to experience high fertility rates, with limited declines despite decades of investment in reproductive health. The co-occurrence of persistent population growth and accelerating environmental stress raises important questions: How are Zimbabweans especially young adults reimagining their reproductive goals under conditions of growing ecological precarity? What role does climate play in shaping the ideal number of children, sex preferences, or age at first birth?

Despite growing evidence linking climate variability to fertility outcomes globally, limited empirical work has examined how environmental stress shapes the timing of first childbirth in Zimbabwe. Existing demographic studies in Zimbabwe have focused largely on fertility levels, contraceptives prevalence, and adolescents fertility, with little attention to reproductive timing as a climate sensitive process. This creates an important empirical and theoretical gap. By integrating geo-referenced climate indicators with demographic survey data, this study addresses this gap and extends current climate-demography scholarship.

### 1.1 Statement of the Problem

Zimbabwe has undergone a significant fertility transition over the past five decades, marked by a decline in the Total Fertility Rate (TFR) from 6.9 births per woman in 1980 to 3.9 in 2023-24 (ICF., 2024). This shift reflects broader demographic changes observed across sub-Saharan Africa, where social, economic, and cultural transformations have contributed to reduced fertility levels. Zimbabwe's fertility transition has been influenced by a combination of factors, notably increased access to education, improved availability and uptake of modern contraceptives, delayed marriage, and women's empowerment. The country's success in promoting reproductive health has often been attributed to a robust family planning program initiated in the 1980s. By 2015, the contraceptive prevalence rate among married women had reached 71%, and by 2023, over two million women were actively using family planning services ( Baschieri et al., 2024). Parallel to this, education levels among women have significantly improved, with the proportion of women with secondary education rising from 30% in 1988 to 66% in 2015, while those with no formal education declined from 14% to just 1% (ICF., 2024).

These developments have contributed to delayed marriages and a reduction in the number of women in reproductive unions, a key determinant of fertility decline. The percentage of women aged 15-19 who were married declined sharply from 43% in 1984 to 18% in 2015 (ICF., 2024). This delay in marriage and childbearing shortens the reproductive window, thus lowering overall fertility. Additionally, socio-cultural shifts associated with modernization have reshaped ideals about family size. Increasingly, Zimbabwean families prioritize the quality of children's lives over quantity, a trend supported by improved autonomy among women in making reproductive choices. Despite these gains, recent demographic surveys point to a plateau in fertility decline, especially among adolescents and women with limited education. Adolescent fertility remains a concern, with nearly one in ten girls aged 15-19 giving birth each year (Baschieri et al., 2024). Moreover, fertility rates remain significantly higher in rural areas (TFR of 4.6) compared to urban centers (TFR of 3.1), reflecting disparities in access to education, health services, and socio-economic opportunities (ICF., 2024).

While demographic and socio-economic factors are well-documented determinants of fertility transition, there is growing recognition that environmental factors, particularly those driven by climate change, may also play a role in shaping fertility behaviors. Zimbabwe is one of the countries most affected by climate variability in southern Africa, experiencing increasing frequency of droughts, erratic rainfall, and flooding. These environmental stressors affect agricultural productivity, food security, and livelihoods, particularly for rural, agrarian households who traditionally have higher fertility rates. Emerging literature suggests that climate-related stress can influence reproductive decision-making in various ways. Diminished agricultural income and household resources may lead to revised fertility ideals, especially as families reassess their ability to support large households. Environmental disruptions may also delay marriage, increase rural-to-urban migration, and limit access to reproductive health services, all of which could impact fertility outcomes. Yet, despite these plausible linkages, the intersection of climate change and fertility transition remains underexplored in Zimbabwean demographic research.

### 1.2 Research Objectives

i. To assess the impact of climate change particularly temperature trends and rainfall variability on the ideal number of children in Zimbabwe.
ii. To examine how socio-demographic factors (e.g., education, marital status) mediate the relationship between environmental stress and fertility preferences.
iii. To explore regional and residential (urban-rural) differences in how climate-related stressors influence reproductive timing

### 1.3 Research Questions

i. How do climate change indicators such as temperature, and rainfall variability influence the ideal number of children among Zimbabwean respondents?
ii. What roles do age, education, and marital status play in shaping fertility preferences in the context of climate-related stress?
iii. How does the impact of climate change on ideal family size vary across different ecological zones and between rural and urban areas in Zimbabwe?
iv. Literature Review

## II. LITERATURE REVIEW

### 2.1 Theoretical Review

This study draws on Life Course Theory and Risk Society Theory to explain the relationship between climate variability and reproductive timing. The Life Course Theory emphasizes that fertility transitions are shaped by the timing and sequencing of major life events such as marriage, education, and employment. Ideal number of children is therefore not merely a biological event, but a socially and economically structured transition (Elder Jr et al., 2003). On the other hand, the Risk Society theory as advanced by Ulrick Beck suggests that modern environmental risks increasingly shape household decision making under uncertainty (Beck, 1992). In climate vulnerable contexts, reproductive decision making may be delayed or accelerated depending on perceived livelihood insecurity (Chatsiwa, 2024; Chigavazira, 2019; IPCC, 2022; Ndiwa et al., 2025; Shah et al., 2023).

### 2.2 Empirical Review

#### 2.2.1 Climate Variability and fertility preference

Emerging empirical evidence suggests that climate variability influences fertility through multiple pathways, including food insecurity, income instability, migration and health vulnerabilities. Rather than affecting fertility directly, climate shocks such as rising temperatures, prolonged droughts, erratic rainfall, and declining agricultural productivity reshape household livelihood strategies, perceptions of economic security, and reproductive decision making (Casey et al., 2019; Grace & Nagle, 2025; Sellers & Gray, 2019; Sengupta & Dutta, 2025; Walsh et al., 2019). Studies conducted across Sub-Saharan Africa consistently show that environmental stress alters the perceived costs and benefits of childbearing, particularly in predominantly agrarian communities where household survival depends heavily on climate sensitive livelihoods (Zhao et al., 2024). In these settings, fertility preferences become adaptive responses to environmental uncertainty rather than purely cultural or biological outcomes (Grace, 2015; Grace et al., 2025; Sellers & Gray, 2019) Similarly, studies in Ethiopia and Zambia have found that environmental shock can disrupt marriage timing and accelerate or delay childbearing by increasing food insecurity, migration, and uncertainty regarding future household wellbeing and adaptive capacity (Ayele et al., 2024; Ayele et al., 2020; Ndhlovu, 2023; Zewdia et al., 2024). These findings suggest that climate stress is increasingly becoming part of the fertility decision making environment.

Several empirical studies provided evidence supporting these relationships. For example, Grace (2015); Organ et al. (2023) have shown that increasing drought exposure in Africa can alter fertility preferences and reproductive behavior in agrarian communities through declining agricultural productivity and heightened household vulnerability. Similarly, Tokat et al. (2023) and Walsh et al. (2019) reported that prolonged droughts and rainfall variability disrupted marriage formation and delayed childbearing by reducing household income and increasing livelihood insecurity. Likewise, Zewdia et al. (2024) observed that repeated environmental shocks increasingly become part of household fertility decision making, as couples reassess the timing and desired number of children under conditions of prolonged environmental stress. Collectively, these studies suggest that climate variability is to merely am environmental concern, but an emerging demographic determinant capable of reshaping fertility preferences through its influence on household resilience, economic security and perceptions of future wellbeing. However, much of this evidence remains concentrated in East and Southern Africa, highlighting the need for country specific investigations in Zimbabwe where prolonged climate variability continues to threaten livelihoods and population dynamics.

### 2.2.2 Socio economic Determinants of Ideal number of Children

Beyond environmental factors, education remains one of the most established determinants of the ideal number of children. Demographic theories particularly Bongaarts (1990, 2015) proximate determinants of fertility argue that fertility preferences evolve as households respond to changing educational opportunities, labor market participation, income expectations, and access to reproductive health services. Improvements in education and economic status generally increase the opportunity costs associated with childbearing, encouraging smaller desired family sizes. Conversely limited educational attainment, poverty and restricted access to family planning often sustain higher fertility preferences, especially in low income settings where children continue to contribute to household labor and economic security (Bongaarts, 2015; Easterlin & Richard, 1975). Urban residence similarly contributes to fertility decision making through improved access to reproductive health services, schooling and labor market opportunities (Mashaah et al., 2024; Stone, 1985).

Empirical studies consistently support these theoretical expectations. Research across Sub-Saharan Africa has shown that women’s educational attainment is one of the strongest determinants of fertility preference, with secondary and tertiary education being associated with significant lower desired family sizes due to increased labor market participation, delayed marriage, and improved reproductive autonomy (Bongaarts, 2015; Chandel et al., 2025; Easterlin & Richard, 1975).Urban residence has similarly been associated with lower fertility preference because urban households face higher living costs, greater access to education, and improved availability of reproductive health services (Jones et al., 2025; Mashaah et al., 2024; Stone, 1985). Household wealth also plays an important role, although influence varies across contexts. While wealthier households in many developing countries tend to prefer fewer children because of investments in child quality, poorer households often maintain larger desired family sizes as a strategy for labor provision and old age security. Marital status and age further shape reproductive intentions by influencing exposure to childbearing and household formation process. Together, this demonstrates that fertility preference emerges from the interaction between socio-economic circumstances and broader environmental conditions, reinforcing the importance of examining climate variability alongside traditional demographic determinants within the Zimbabwean context.

### 2.2.3 Regional and Residential Differences

Empirical evidence suggests that the influence of climate variability on fertility preferences differs across regions and between rural and urban populations because exposure and adaptive capacity vary considerably. Rural households, which depend largely on rain-fed agriculture, are generally more vulnerable to droughts, rainfall variability, and rising temperatures than urban households, making environmental stress a more important determinant of reproductive decision-making (Grace & Nagle, 2025; Sellers & Gray, 2019; World Bank, 2021). In contrast, urban households are less directly exposed to climate-related agricultural shocks and typically have greater access to diversified livelihoods, education, healthcare, and family planning services, all of which contribute to lower fertility preferences (Bongaarts, 2015; Mashaah et al., 2024).

Regional differences have also been observed within Sub-Saharan Africa, where variations in climate exposure, agricultural dependence, and socioeconomic conditions shape fertility responses differently across ecological zones (Grace, 2015; Casey et al., 2019; Walsh et al., 2019). Studies indicate that households in drought-prone regions are more likely to adjust their reproductive intentions in response to prolonged environmental uncertainty than those living in relatively stable environments (Organ et al., 2023; Zhao et al., 2024). However, despite increasing evidence from other African countries, little empirical research has examined whether climate variability influences fertility preferences differently across Zimbabwe's provinces or between rural and urban populations. This study addresses this gap by examining regional and residential heterogeneity in the relationship between climate variability and the ideal number of children in Zimbabwe.

### 2.2.3 Empirical Gap

Although previous studies have established associations between climate variability and fertility behaviour, three important gaps remain. First, relatively few studies have examined how temperature and rainfall variability influence the ideal number of children in Zimbabwe. Second, limited evidence exists on how socio-demographic characteristics mediate this relationship. Third, little empirical research has explored whether climate-related fertility preferences differ across regions and between rural and urban populations. This study addresses these gaps by examining the influence of climate variability on the ideal number of children while accounting for socio-demographic factors and regional and residential differences using nationally representative geo-referenced data from Zimbabwe.

## III. METHODOLOGY

### 3.1 Study Design

This study employs quantitative research design utilizing secondary data analysis. The primary data source is the Zimbabwe Demographic Health Survey (ZDHS) data from Zimbabwe, specifically focusing on the 2015 survey. This study aims to investigate the impact of climate change on age and first child bearing in Zimbabwe using secondary data from the Zimbabwe Demographic and Health Surveys (DHS) spanning 2015. The methodology involves a comprehensive approach, integrating climate change proxy variables, health, and socioeconomic data to understand the complex relationships between environmental changes and age at first child bearing as an outcome variable.

### 3.2 Data Sources

The primary data source for this study is the Zimbabwe DHS, which provides detailed information on ideal number of children, household characteristics, and health indicators across multiple survey rounds. GPS data from the 2015 Zimbabwe Demographic Health Survey, will be used to accurately link geographic locations with climate variables. Climate data will be sourced from global databases such as WorldClim and NASA's Earth data, encompassing variables such as annual precipitation, temperature (both day and night), aridity index, drought episodes, and enhanced vegetation index. Additionally, socioeconomic data on household income, education levels, healthcare access, and population density will be integrated to control confounding factors and provide a comprehensive analysis. Prior to analysis, the data underwent rigorous cleaning and preprocessing. This includes aligning the climate and DHS datasets temporally and spatially, addressing any missing data through imputation or augmentation methods, creating proxy variables to measure climate change and ensuring accurate spatial matching of GPS coordinates with climate data points.

### 3.3 Study Variables

The dependent variables in this study are the ideal number of children. The key explanatory variables include annual warming rate, land surface temperature, aridity Index, drought episodes, rainfall variability, vegetation productivity. Control variables include education years, employment status, marital status, age, place of residence, province and other selected household characteristics. These variables were selected based on extensive systematic literature review.

### 3.4 Statistical Analytical Approach

The analytical approach for this study involves a multi- stage approach. First descriptive statistics were computed to summarize the socio-demographic and environmental characteristics of the study population (Table 2 presents the socio-demographic characteristics of the study participants. The descriptive statistics provides an overview of the sample composition across age, marital status, place of residence, province, and educational attainment. Understanding these characteristics is important because they represent key demographic and socioeconomic factors that have consistently been associated with fertility preferences and are included as control variables in the regression models.

**Table 2** and Table 3). Measures such as mean, standard deviations and frequency distribution of key variables were used to describe the distribution of key variables and identify broad patterns in fertility preferences.

Second, multivariate regression analysis was employed to estimate the independent effects of climate variables on fertility preferences while controlling socio-demographic characteristics. Given that the dependent variable, ideal number of children is a count variable, Poisson regression model was used as the primary estimation strategy. Poisson regression is appropriate for modeling count outcomes because it estimates the expected frequency of an event while accounting for the discrete and non-negative nature of the dependent variable. The Poisson regression model is specified as:

$$\log(E[Y_i]) = \beta_0 + \beta_1 Climate_i + \beta_2 Demographici + \beta_3 Socioeconomici + \epsilon_i$$

Where $Y_i$ represents the ideal number of children represents for respondent$_i$, $Climate_i$ captures environmental indicators, $Demographic\ \ _i$ represents demographic characteristics and $Socioeconomic\ \ _i$captures socioeconomic variables and The error term is presented by $\epsilon_i$. Robust standard errors were used to account for heteroskedasticity and clustering effects, thereby improving the reliability of the estimates.

### 3.5 Model Diagnostics

**Table 1**
*Model Fit and Significance*

| Statistic | Value |
|---|---|
| Number of observations | 9,910 |
| Wald $\chi^2$ (21) | 2463.93 |
| Probability > $\chi^2$ | <0.001 |
| Log pseudolikelihood | -18496.6 |
| Pseudo $R^2$ | 0.0448 |
| Iterations to convergence | 2 |

Table 1 shows diagnostic tests that were performed. The Poisson models converged successfully after two iterations, indicating computational stability. The model yielded a statistical significance overall fit Wald $\chi^2$=2463.93, p<1), confirming that the included predictors jointly explain variations in fertility preferences. The model's Pseudo $R^2$=0.0448, indicating that approximately 4.48% of the variations in ideal family size is explained by the predictors

## IV. FINDINGS & DISCUSSIONS

### 4.1 Findings

This section presents and discusses the empirical findings according to the three objectives of the study. These results are organized to systematically examine the influence of climate variability on fertility preferences, the mediating role of socio-demographic variables, and spatial variations in reproductive ideals across Zimbabwe. This objective driven structure strengthens the analytical flow and allows for clearer interpretation of how environmental and social factors interact in shaping fertility.

Table 2 presents the socio-demographic characteristics of the study participants. The descriptive statistics provides an overview of the sample composition across age, marital status, place of residence, province, and educational attainment. Understanding these characteristics is important because they represent key demographic and socioeconomic factors that have consistently been associated with fertility preferences and are included as control variables in the regression models.

**Table 2**
*Socio-demographic Characteristics of the Study Population (N=9110)*

| **Characteristic** | **Category** | **Percent (%)** |
|---|---|---|
| Age (years) | 15-19 | 20.3 |
| | 20-24 | 17 |
| | 25-29 | 15.3 |
| | 30-34 | 12 |
| | 35-39 | 13.6 |
| | 40-44 | 12.6 |
| | 45-49 | 9.3 |
| Marital status | Never married | 23.3 |
| | Married | 58.4 |
| | Living together | 3.2 |
| | Divorced/Separated | 11.7 |
| | Widowed | 3.3 |
| Residence | Urban | 45.4 |
| | Rural | 54.6 |
| Province | Bulawayo | 5.2 |
| | Manicaland | 12.8 |
| | Mashonaland Central | 8 |
| | Mashonaland East | 11.2 |
| | Mashonaland West | 13.7 |
| | Matabeleland North | 4.6 |
| | Matabeleland South | 4.7 |
| | Midlands | 12 |
| | Masvingo | 9.8 |
| | Harare | 18 |

| | | |
|---|---|---|
| Education | No education | 0.8 |
| | Primary | 20.3 |
| | Secondary | 70.1 |
| | More than secondary | 8.8 |

As shown in Table 2, the study population was relatively young, with the largest proportion of respondents aged 15-19 years (20.3%), followed by those aged 20-24 (17.0%) and 25-29 years (15.3%), reflecting Zimbabwe's youthful reproductive age population. The proportion of respondents gradually declined across older age groups, with women aged 45-49 years accounting for only 9.3% of the sample.

Regarding marital status, most respondents were married (58.4%), while 23.3% had never married, 11.7% were divorced or separated and relatively small proportions were living together (3.2%) or widowed (3.3%). In terms of residence 55.6% of respondents reside in Rural areas, compared with 54.4% residing in urban areas, reflecting the national population distribution during the survey period.

Geographically, respondents were distributed across all ten provinces, with Harare (18.0%), Mashonaland West (13.3%), Manicaland (12.8%) and Midlands (12.0%) contributing the largest shares of the sample. Education attainment was generally high with 70.1% of respondents having completed secondary education, 8.8% had education beyond secondary education, and only 0.8% reported no formal education. Overall, the sample exhibits substantial variation across demographic and socio-economic characteristics, providing an appropriate basis for examining differences in fertility preferences across population subgroups.

Table 3 summarizes the descriptive statistics for continuous variables included in the analysis. The statistics include the mean, standard deviation, minimum, quartiles, median and Maximum values providing an overview of the distribution and variability of fertility preferences and climate related variables prior to multivariable analysis.

**Table 3**

*Descriptive Statistics for Continuous Variables*

| Variable | Mean | SD | Min | P25 | Median | P75 | Max |
|---|---|---|---|---|---|---|---|
| Current age | 27.66 | 9.92 | 15 | 19 | 25 | 35 | 54 |
| Ideal number of children | 4.04 | 2.2 | 0 | 3 | 4 | 5 | 10 |
| Annual precipitation (2000) | 77.24 | 17.72 | 32.9 | 66.45 | 77.04 | 88.3 | 147 |
| Aridity index (1999) | 22.35 | 7.08 | 8.17 | 17.41 | 21.12 | 27.29 | 52.51 |
| Mean temperature (1999) | 20.68 | 1.38 | 18.07 | 19.46 | 20.48 | 21.44 | 25.38 |

Table 3 Shows that respondents reported an average age of 27.66 years (SD=9.92), indicating that the study population was concentrated within the prime reproductive ages. The mean ideal number of children was 4.4 (SD=2.20), suggesting that relatively large family size preferences remained common among Zimbabwean women. The interquartile range indicates that half of the respondents desired between three to five children, although preferences ranged from 0 to 10 children, demonstrating considerable variation in reproductive ideals.

Climatic factors similarly exhibited substantial geographical variation across survey clusters. Mean annual precipitation averaged 77.24 mm( SD=17.72) with values ranging from 39.9 mm to 147 mm reflecting differences in rainfall conditions across Zimbabwe. The mean aridity index was 22.35 (SD=7.08) while mean annual temperature averaged 20.68 degrees Celsius (SD=1.38). The observed variability in rainfall, aridity and temperature suggest sufficient environmental heterogeneity to examine how climatic conditions are associated with fertility preferences in subsequent regression analyses.

### 4.2 Regression Estimates for Ideal Number of Children

Table 4reports the results of multivariable negative Binomial regression analysis of factors associated with the ideal number of children in Zimbabwe. After adjusting for socio-demographic, household, regional and climate related characteristics, several variables were significantly associated with fertility preferences. The results demonstrate that both compositional factors, including age, education, marital status, residence and household composition and contextual environmental factors, particularly mean annual temperature, contribute to explaining variations in the ideal number of children.

**Table 4**

*Negative Binomial Regression Estimates for Ideal Number of Children (Robust Standard Errors)*

| Variable | Coefficient (SE) | p-value | 95% CI |
|---|---|---|---|
| Age | 0.009 (0.001)*** | <0.001 | [0.007, 0.010] |
| Residence (Ref: Rural) | | | |

| | | | |
|---|---|---|---|
| Urban | -0.122 (0.010)*** | <0.001 | [-0.141, -0.104] |
| Marital Status (Ref: Never married) | | | |
| Married/Cohabiting | 0.065 (0.014)*** | <0.001 | [0.038, 0.092] |
| Widowed | 0.076 (0.025)*** | 0.002 | [0.028, 0.124] |
| Separated/Divorced | -0.008 (0.018) | 0.67 | [-0.043, 0.028] |
| Education (Ref: No education) | | | |
| Primary | -0.178 (0.047)*** | <0.001 | [-0.270, -0.087] |
| Secondary | -0.309 (0.047)*** | <0.001 | [-0.400, -0.217] |
| Tertiary | -0.435 (0.048)*** | <0.001 | [-0.529, -0.340] |
| Region (Ref: Bulawayo) | | | |
| Manicaland | 0.087 (0.023)*** | <0.001 | [0.042, 0.132] |
| Mashonaland Central | 0.075 (0.021)*** | <0.001 | [0.034, 0.116] |
| Mashonaland East | 0.045 (0.020)** | 0.024 | [0.006, 0.085] |
| Mashonaland West | 0.070 (0.020)*** | <0.001 | [0.031, 0.109] |
| Matabeleland North | -0.064 (0.024)*** | 0.008 | [-0.111, -0.017] |
| Matabeleland South | -0.118 (0.025)*** | <0.001 | [-0.167, -0.069] |
| Midlands | 0.011 (0.021) | 0.605 | [-0.030, 0.052] |
| Masvingo | 0.054 (0.021)*** | 0.009 | [0.014, 0.095] |
| Harare | 0.055 (0.018)*** | 0.003 | [0.019, 0.090] |
| Household Composition | | | |
| Daughters at home | 0.042 (0.005)*** | <0.001 | [0.032, 0.052] |
| Sons at home | 0.037 (0.006)*** | <0.001 | [0.027, 0.048] |
| Climate Variables | | | |
| Annual precipitation (2015) | 0.002 (0.001)* | 0.093 | [-0.0003, 0.004] |
| Mean temperature (2015) | 0.019 (0.004)*** | <0.001 | [0.012, 0.027] |
| Constant | 0.810 (0.112)*** | <0.001 | [0.590, 1.029] |

### 4.2.1 Assessing the impact of Climate Variability on the ideal number of children in Zimbabwe

Table 4reports the results of multivariable negative Binomial regression analysis of factors associated with the ideal number of children in Zimbabwe. After adjusting for socio-demographic, household, regional and climate related characteristics, several variables were significantly associated with fertility preferences. The results demonstrate that both compositional factors, including age, education, marital status, residence and household composition and contextual environmental factors, particularly mean annual temperature, contribute to explaining variations in the ideal number of children.

**Table 4** shows that climate conditions play a statistically significant role in shaping reproductive aspirations in Zimbabwe, although the effects vary across indicators. Among environmental variables examined, mean annual temperature emerged as the strongest and most statistically significant predictor of fertility preference (β=0.019), p<0.001). This suggests that one unit increase in mean temperature is associated with approximately 1.195% increase in the expected ideal number of children, holding all other things constant. This findings provide important evidence that rising temperatures may reinforce pronatalist preferences rather than suppress them.

Annual precipitation showed a weak positive association (β=0.002, p+0.093), indicating that rainfall variability may influence fertility preferences although the effect is less pronounced than temperature. This weak effect may reflect the unpredictability of rainfall patterns compared to more persistent and cumulative nature of temperature increase.

### 4.2.2 The role of Socio-demographic Factors in Shaping Fertility Preferences

Age was positively associated with the ideal family size (β=0.009, p<0.001), suggesting that older respondents continue to hold higher fertility preferences. This likely reflects generational differences in fertility socializations, where older cohorts were socialized under stronger pronatalist norms. Moreso, education emerged as one of the most influential predictors. Compared to respondents with no formal education, those with primary education reported significantly lower ideal fertility (β=-0.178, p<0.001), secondary education further reduced fertility preferences (β+-0.309,<0.001), and tertiary education showed the strongest negative effects (β=-0.435, p<0.001). These findings indicate a clear educational gradient; increased schooling systematically reduces desired family size.

Marital status also remained an important determinant of the ideal family size in Zimbabwe. Married or cohabiting respondents reported significantly higher ideal family sizes (β=0.076, p0.002). Thus, strengthening the institutional role of marriage in structuring fertility expectations. Urban residence was associated with lower ideal family size(β=-0.122, p<0.001), reflecting the continuity of urban fertility transition in Zimbabwe where urban contexts typically expose individuals to lower child mortality, greater female employment opportunities, better education, and easier access to family planning services, all of which contribute to smaller fertility ideals. Households composition was also significant as a determinant of the ideal number of children. Both daughters at home($\beta=0.042$, $p<0.01$) and sons at home ($\beta=0.037$, $p<0.001$) increased ideal family size, thus suggesting that fertility preferences may be shaped by cumulative childbearing experiences and family completion strategies.

#### 4.2.3 Regional and Residential Differences in Fertility Preferences Under Climate Variability

The findings revealed substantial regional heterogeneity, suggesting that place based environmental and soci0-economic conditions matter significantly. Relative to Bulawayo, respondents in Manicaland ($\beta=0.087$, $<0.001$), Mashonaland central ($\beta=0.075$, $p<0.001$), Mashonaland East ($\beta=0.045$, $p<0.024$), Mashonaland West ($\beta=0.070$, $p<0.001$), Masvingo ($\beta=0.054$, $p<0.009$), and Harare ($\beta=0.055$, $p=0.003$) reported significantly higher ideal family sizes. By contrast, respondents in Matabeleland North ($\beta=-0.064$, $p=0.008$) and Matabeleland South ($\beta=-0.118$, $<0.001$) reported lower fertility ideals. These spatial patterns likely reflect differences in ecological vulnerability, livelihood dependence on agriculture, access to social services, and cultural fertility norms. Provinces with higher agricultural dependence and climate vulnerability may maintain larger family ideals as a strategy for labor substitution and social insurance.

### 4.3 Discussion

This section interprets the empirical findings in relation to the study objectives, existing literature, and the guiding theoretical frameworks of Risk Society Theory and Life Course Theory. The discussion situates the findings within the broader climate demography scholarship and reflects on their implications for fertility transition in Zimbabwe.

#### 4.3.1 Climate Variability and fertility preferences in Zimbabwe

The findings demonstrated that climate variability, particularly temperature, has become an important contextual determinant of fertility preferences. Mean annual temperature emerged as the most significant climatic predictor, showing a positive association with ideal family size. This suggests that as environmental temperatures rise, respondents tend to express preferences for larger families. These findings complicate conventional demographic transition assumptions, which often predict that worsening socio-economic and environmental conditions will reduce fertility by increasing the costs of childbearing. Instead, the Zimbabwean evidence suggests that in agrarian and climate-vulnerable contexts, environmental stress may reinforce pronatalist preferences. This may be explained by the socio-economic utility f children in rural livelihoods, where they serve as labor, economic support and long-term social security.

These findings align with earlier work by different scholars which show that climate variability alters reproductive behavior through livelihood uncertainty (Ayele et al., 2020; Grace, 2015; Grace et al., 2025; Sasson, 2017; Zenda, 2024). Similar findings have been established in studies conducted in Zambia and Ethiopia that reported that, drought exposure and environmental instability reshape fertility decisions by increasing household vulnerability (Ayele et al., 2024; Ayele et al., 2020; Ndhlovu, 2023; Zewdia et al., 2024). However, unlike studies that report fertility postponement under climatic stress, the findings in Zimbabwe suggests a pattern of adaptive pronatalism, where larger family size may be perceived as a coping mechanism against ecological uncertainty (Mashaah et al., 2024; Ngwenya, 2021; Thomas & Maluccio, 1996).

From a theoretical perspective, this supports Risk Society Theory, which argues that modern environmental risks increasingly shape household decision making (Beck, 1992; Kovačević & Kovačević, 2017). In this case, climate change is not merely an external ecological condition but has become internalized into reproductive logic. Fertility preferences may therefore function as a household adaptation response to environmental insecurity (Agarwal et al., 2022; IPCC, 2024).

The weak significance of precipitation suggests that temperature may be a more visible and sustained environmental stressor than rainfall variability. While rainfall remains central to agriculture production, rising temperatures may have a more direct cumulative effect on crop productivity, water scarcity, and labor conditions, making them more influential in shaping household reproductive aspirations.

#### 4.3.2 Socio economic Determinants of Ideal number of Children

The research confirmed that socio-demographic factors are significantly associated with fertility preferences while controlling for climate variables. Age remained positively associated with ideal family size, reflecting cohort differences in reproductive socialization. Older respondents were more likely to prefer larger families, which are likely to reflect historical pronatalist norms that were more prevalent in earlier generations. This is consistent with Zimbabwe's demographic history, were larger family sizes were culturally and economically advantageous, particularly in rural agricultural systems ( Ngwenya, 2021; Thomas & Maluccio, 1996).

Education has emerged as one of the strongest fertility reducing factors. The progressive decline in fertility preferences across educational systems confirms the role of education in fertility transition. This findings strongly aligns with demographic transition theory and extensive empirical literature that reports strong associations between education and its role in delaying marriages, raises opportunity costs of childbearing, and improve access to reproductive knowledge (Ayadi et al., 2025; Bongaarts, 2013; Mlema, 2024; Nguyen, 2025; Richie, 2022; Yang & Yang, 2025). This is particularly importance as it suggests that education remains a protective factor even under environmental stress. While climate uncertainty may reinforce pronatalist preferences, education appears to moderate this effects by shifting reproductive aspirations towards smaller family sizes. This supports the Life Course Theory, which emphasizes that education restructures life trajectories by delaying and sequencing major transitions such as marriage and childbearing (Penker & Kirbiš, 2025; Yu et al., 2025).

Marital status also remained a significant predictor of the ideal number of children. Married and cohabiting individuals reported higher fertility ideals than never married respondents, reflecting the institutional importance of marriage in organizing reproductive expectations (Bastianelli, 2025; Chiweshe, 2024; Molitoris, 2023; Shapiro & Gebreselassie, 2014). In Zimbabwe, marriage remains strongly linked to childbearing, and fertility often remains socially legitimized through formal or stable unions.

Urban residence was associated with lower ideal family sizes, reinforcing the continuing urban fertility transition. Urban residence often experiences higher cost of living, greater exposure to formal education, and increased access to family planning services, all of which reduce fertility preferences (Jones et al., 2025; Mashaah et al., 2024; Stone, 1985). This finding mirrors patterns observed across much of sub-Saharan Africa, where urbanization has been one of the strongest drivers of fertility decline.

Household composition also shaped fertility ideals. Respondents with more children already living at home reported higher fertility preferences, suggesting that reproductive aspirations are often cumulative and shaped by existing family building trajectories. This may also reflect sex composition balancing, where families continue childbearing in pursuit of a preferred gender (Mwageni & Ankomah, 2001; Sennott & Yeatman, 2012). Taken together, the findings reflect that, while climate variability introduces new pressures into reproductive decision making, socio-demographic structures remain central in shaping how those pressures are interpreted and responded to.

#### 4.3.3 Spatial variation in fertility preferences under climate stress

Significant provincial heterogeneity has been observed in this study signifying that fertility behavior remains spatially embedded. Provinces such as Manicaland, Mashonaland Central, Mashonaland East, Masvingo, and Harare reported significantly higher fertility preferences compared to Bulawayo, while Matabeleland North, Matabeleland South reported lower fertility ideals. These regional disparities likely reflect differences in ecological vulnerabilities, agricultural dependance, cultural norms, and access to reproductive services. Provinces with stronger reliance on rain-fed agriculture may maintain larger family ideals as a form of labor substitution and household resilience under climate uncertainty (Beck, 1992; Mugandani et al., 2012). In such settings, children remain economically functional and socially valuable. By contrast, provinces with lower fertility ideals may reflect stronger urbanization, different livelihoods systems, or greater access to education and health services (Evans & Gray, 2018; FAO, 2022; Zewdia et al., 2024).

These findings reinforce the importance of place-based fertility analysis, which recognizes that reproductive behavior is often shaped not only by individual characteristics but also by localized ecological and socio-economic conditions. Thus, climate vulnerability is not evenly distributed, and its consequences are similarly uneven. The rural-urban divide strengthens this argument with rural households remaining structurally more exposed to environmental stress due to dependence on agriculture, while urban households are relatively buffered through wage employment, infrastructure, and services access ((Agarwal et al., 2022; Sasson, 2017; Stone, 1985). Thus, differential exposure produces distinct fertility rationalities.

## V. CONCLUSION & RECOMMENDATIONS

### 5.1 Conclusion

This study contributes to emerging climate demography literature by providing evidence that climate variability, particularly rising temperatures, is significantly associated with fertility preferences in Zimbabwe. The findings challenge linear demographic transition assumptions by showing that environmental stress may reinforce, rather than suppress fertility aspirations in vulnerable agrarian contexts. This highlights the importance of understanding fertility aspirations not only as a function of modernization, but also as a strategic response to ecological uncertainty. At the same time, traditional determinants, such as education, urban residence, age, marital status, and regional contexts remain central to explaining fertility ideals. This confirms that climate effects are layered onto existing demographic structures rather than replacing them. For Zimbabwe, where climate shocks are intensifying and fertility decline remains uneven, understanding this intersection is essential for designing effective population, development and adaptation policies.

### 5.2 Recommendations

National adaptation frameworks should integrate fertility and reproductive health planning as part of climate resilience. Given the higher fertility preferences in rural areas. Climate adaptation programs must prioritize agricultural stabilization, irrigation and food security. The strongest fertility reducing effect came from education. Expanding educational attainment remains central to long term demographic resilience. Provincial fertility differences require localized policy interventions rather than national uniformity. Reducing dependence on children as insurance requires stronger pension systems, agricultural subsidies and rural welfare mechanisms.

### Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## REFERENCES

Agarwal, T., Goel, P. A., Gartaula, H., Rai, M., Bijarniya, D., Rahut, D. B., & Jat, M. L. (2022). Gendered impacts of climate-smart agriculture on household food security and labor migration: Insights from Bihar, India. *International Journal of Climate Change Strategies and Management, 14*(1), 1–19.

Ayadi, M. F., Onodipe, G., & Adepoju, O. E. (2025). Adolescent fertility and its impact on educational attainment in Nigeria: A propensity score matching approach. *International Journal of Healthcare Management, 18*(2), 318–326. https://doi.org/10.1080/20479700.2023.2295113

Ayele, E., Temesgen, D., Lemma, T., & Wordofa, M. G. (2024). Gender dimensions of determinants of adaptation strategies to climate change among smallholder farmers in Northeast Ethiopia. *Global Social Welfare*. https://doi.org/10.1007/s40609-024-00364-4

Ayele, T., Dedecha, D., & Duba, D. (2020). The impact of climate change on pastoralist livelihoods in Ethiopia: A review. *Journal of Resources Development and Management, 63*, 1–14. https://doi.org/10.7176/JRDM/63-02

Bastianelli, E. (2025). Climate change worries and fertility intentions: Insights from three EU countries. *Journal of Marriage and Family, 87*(2), 659–675. https://doi.org/10.1111/jomf.13048

Beck, U. (1992). *Risk society: Towards a new modernity*. Sage.

Bongaarts, J. (2013). The causes of educational differences in fertility in sub-Saharan Africa. *Vienna Yearbook of Population Research, 11*, 21–50.

Bongaarts, J. (1990). The measurement of wanted fertility. *Population and Development Review, 16*(3), 487–506. https://doi.org/10.2307/1972833

Bongaarts, J. (2015). Modeling the fertility impact of the proximate determinants: Time for a tune-up. *Demographic Research, 33*, 535–560. https://doi.org/10.4054/DemRes.2015.33.19

Caldwell, J. C. (1987). The cultural context of high fertility in Sub-Saharan Africa. *Population and Development Review, 13*(3), 409–437. https://doi.org/10.2307/1973133

Caldwell, J. C. (1987). The cultural context of high fertility in Sub-Saharan Africa. *Population and Development Review, 13*(3), 409–437. https://doi.org/10.2307/1973133

Casey, G., Shayegh, S., Moreno-Cruz, J., Bunzl, M., Galor, O., & Caldeira, K. (2019). The impact of climate change on fertility. *Environmental Research Letters, 14*(5), Article 054007. https://doi.org/10.1088/1748-9326/ab0843

Chandel, A., Yadav, M., & Hung, T. H. (2025). Social and economic consequences of early marriage on women's education and workforce participation. In *Social, political, and health implications of early marriage* (pp. 261–290). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3394-5.ch011

Chatsiwa, J. (2024). Vulnerability to climate variability of smallholder farmers in Gutu District, Zimbabwe: A pro-poor asset adaptation approach. *Journal of Asian and African Studies*. Advance online publication. https://doi.org/10.1177/00219096241284738

Chigavazira, T. (2019). *The vulnerability of women to droughts in Mudzi District, Zimbabwe: The complexities of livelihood strategies and responses* (Master's thesis, University of the Witwatersrand).

Chiweshe, M. K. (2024). *Marriage in contemporary Zimbabwe: Identity, community, and change*. Routledge. https://doi.org/10.4324/9781003542339

Dasgupta, P. (2022). Contraceptive use and fertility transitions: The distinctive experience of sub-Saharan Africa. *Demographic Research, 46*, 97–130. https://doi.org/10.4054/DemRes.2022.46.4

de Haas, B., Kabagenyi, A., & Diennabila, S. (2025). Reproductive autonomy in fertility research in Sub-Saharan Africa: A scoping review. *Studies in Family Planning, 56*(2), 243–273. https://doi.org/10.1111/sifp.70012

Easterlin, R. A. (1975). An economic framework for fertility analysis. *Studies in Family Planning, 6*(3), 54–63.

Elder, G. H., Jr., Johnson, M. K., & Crosnoe, R. (2003). The emergence and development of life course theory. In J. T. Mortimer & M. J. Shanahan (Eds.), *Handbook of the life course* (pp. 3–19). Springer. https://doi.org/10.1007/978-0-306-48247-2_1

Food and Agriculture Organization of the United Nations. (2022). *FAO's global information system on water and agriculture (AQUASTAT).*

Garenne, M. (2018). Family planning and fertility decline in Africa: From 1950 to 2010. In *Family planning*. IntechOpen. https://doi.org/10.5772/intechopen.71029

Grace, K., & Nagle, N. N. (2015). Using high-resolution remotely sensed data to examine the relationship between agriculture and fertility in Mali. *The Professional Geographer, 67*(4), 641–654.

Grace, K., Merchant, E. K., & Nagle, N. (2025). Population and climate change: Considering climate change demography's past and future. *Population and Development Review, 51*(1), 361–388. https://doi.org/10.1111/padr.12722

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Intergovernmental Panel on Climate Change. (2024). *Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC.

Jones, L., Anderson, S., Læssøe, J., Banzhaf, E., Jensen, A., Tubadji, A., Hutchins, M., Yang, J., Taylor, T., & Wheeler, B. W. (2025). Re-thinking people and nature interactions in urban nature-based solutions. *Sustainability, 17*(7), Article 3043. https://doi.org/10.3390/su17073043

Kabagenyi, A., Kayemba, V., Ariho, P., Rusatira, J. C., & Rutaremwa, G. (2025). East Africa's fertility and contraceptive use: Analysis of 1950–2100 to inform the demographic dividend processes. In *Advancing population and development in Uganda and beyond: Present and future considerations in honour of Dr. Jotham Musinguzi* (p. 25). Fountain Publishers.

Kovačević, B., & Kovačević, I. (2017). *Sociology of global risk society: Anthony Giddens and Ulrich Beck*. European Defendology Center.

Evans, A., & Gray, E. (2018). Modelling variation in fertility rates using geographically weighted regression. *Spatial Demography, 6*(2), 121–140.

Mashaah, T., Gomo, E., Maradzika, J. C., Madziyire, M. G., & January, J. (2024). Psychological, sociocultural, and coping experiences of women with infertility using traditional healthcare services in Harare urban, Zimbabwe: A qualitative study. *African Journal of Reproductive Health, 28*(6), 25–38.

Matsa, M. (2020). *Climate change and agriculture in Zimbabwe: Sustainability in minority farming communities*. Springer. https://doi.org/10.1007/978-3-030-51346-7

Mlema, C. F. (2024). *Impact of women's education on maternal health in Zimbabwe* (Master's thesis, Seoul National University).

Molitoris, P. (2023). Early childbearing and child marriage: An update. *Studies in Family Planning, 54*(3), 503–521. https://doi.org/10.1111/sifp.12243

Mugandani, R., Wuta, M., Makarau, A., & Chipindu, B. (2012). Re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change. *African Crop Science Journal, 20*(Suppl. 2), 361–369. https://doi.org/10.4314/acsj.v20i2

Mwageni, E. A., & Ankomah, A. (2001). Sex preference and contraceptive behaviour among men in Mbeya Region, Tanzania. *Journal of Family Planning and Reproductive Health Care, 27*(2), 85–89.

Ndhlovu, O. (2023). *Climate change adaptation among smallholder farmers in Zambia* (Master's thesis, University of Cape Town).

Ndiwa, A. M., Mburu, J., Mulwa, R., & Chumo, C. (2025). Determinants of climate change vulnerability across different agricultural enterprises in Kenya: An ordered probit analysis. *Climate Services, 38*, Article 100578. https://doi.org/10.1016/j.cliser.2025.100578

Nguyen, M. (2025). Education and reproductive empowerment: How schooling shapes women's contraceptive use and fertility intention in low- and middle-income countries. *International Journal of Educational Development, 115*, Article 103287. https://doi.org/10.1016/j.ijedudev.2025.103287

Ngwenya, C. L. (2021). *An investigation into the progression of premarital fertility since the onset of Zimbabwe's fertility transition* (Master's dissertation, University of Cape Town). University of Cape Town OpenUCT Repository. http://hdl.handle.net/11427/36110

Organ, J., Dixon, D., & Villa, K. (2023). Climate change, fertility and Sahelian demographics. *Journal of Sustainable Development, 16*(1), 1–16. https://doi.org/10.5539/jsd.v16n1p1

Penker, M., & Kirbiš, A. (2025). Education for future? Investigating the role of education in explaining active green engagement: A multilevel moderated mediation analysis. *Sustainable Futures*, *9*, Article 100608. https://doi.org/10.1016/j.sftr.2025.100608

Richie, C. (2022). Climate change and health care education. In M. W. M. (Ed.), *Applied philosophy for health professions education: A journey towards mutual understanding* (pp. 233–250). Springer. https://doi.org/10.1007/978-981-19-1512-3_16

Sasson, W. (2017). Land cover change and fertility in West-Central Africa: Rural livelihoods and the vicious circle model. *Population and Environment, 38*(4), 345–368. https://doi.org/10.1007/s11111-017-0279-x

Sellers, S., & Gray, C. (2019). Climate shocks constrain human fertility in Indonesia. *World Development*, *117*, 357–369. https://doi.org/10.1016/j.worlddev.2019.02.003

Sengupta, P., & Dutta, S. (2025). Eco-fertility: Examining the climate change–total fertility rate nexus in the context of sustainable development goals: A systematic review. *Medical Review, 5*(1), 35–43. https://doi.org/10.1515/mr-2024-0024

Sennott, C., & Yeatman, S. (2012). Stability and change in fertility preferences among young women in Malawi. *International Perspectives on Sexual and Reproductive Health, 38*(1), 34–42. https://doi.org/10.1363/3803412

Shah, M. I., Shuaibu, M. S., AbdulKareem, H. K., Khan, Z., & Abbas, S. (2023). Inequality consequences of natural resources, environmental vulnerability, and monetary-fiscal stability: Global evidence. *Environmental Science and Pollution Research, 30*(4), 10329–10345. https://doi.org/10.1007/s11356-022-22788-1

Shapiro, D., & Gebreselassie, T. (2014). Marriage in Sub-Saharan Africa: Trends, determinants, and consequences. *Population Research and Policy Review, 33*(2), 229–255. https://doi.org/10.1007/s11113-013-9287-4

Stone, L. (1985). Urban-rural fertility differences and their determinants in Africa. *Population and Environment*, *8*(3–4), 187–208. https://doi.org/10.1007/BF01258420

Thomas, D., & Maluccio, J. A. (1996). Fertility, contraceptive choice, and public policy in Zimbabwe. *The World Bank Economic Review*, *10*(1), 189–222. https://doi.org/10.1093/wber/10.1.189

Tokat, M. A., Bilgiç, D., Yağcan, H., & Demirdağ, C. (2023). A factor whose effects on fertility are overlooked: Climate change and its consequences. *Reproductive BioMedicine Online, 47,* Article 103551. https://doi.org/10.1016/j.rbmo.2023.103551

United Nations Population Fund. (2024). *Navigating megatrends: The ICPD Programme of Action for a sustainable future: ICPD30 think piece—The ICPD and climate action*. UNFPA.

Walsh, B. S., Parratt, S. R., Hoffmann, A. A., Atkinson, D., Snook, R. R., Bretman, A., & Price, T. A. R. (2019). The impact of climate change on fertility. *Trends in Ecology & Evolution, 34*(3), 249–259. https://doi.org/10.1016/j.tree.2018.12.002

Yang, J., & Yang, Z. (2025). The impact of intergenerational educational mobility on fertility intentions: Evidence from China. *Applied Economics*, 1–15. https://doi.org/10.1080/00036846.2025.2479158

Yu, Y., Nguyen-Phung, H. T., & Le, H. (2025). Women's empowerment in Zimbabwe: Examining the role of educational reform. *Social Indicators Research, 177*(2), 489–531. https://doi.org/10.1007/s11205-024-03515-4

Zenda, M. (2024). A systematic literature review on the impact of climate change on the livelihoods of smallholder farmers in South Africa. *Heliyon, 10*(18), Article e14193.

Zewdia, W. F., Asmelash, D., & Asmelash, Y. (2024). Geo-spatial analysis of high-risk fertility behaviors and child stunting in Ethiopia. *Frontiers in Public Health, 12,* Article 1449689. https://doi.org/10.3389/fpubh.2024.1449689

Zhao, J., Qi, W., Cheng, Y., Hao, R., Yuan, M., Jin, H., Wang, Y., Lv, H., Wu, Y., & Hu, J. (2024). Influence of perceived stress on fertility intention among women of childbearing age without children: Multiple mediating effects of anxiety, family communication, and subjective well-being. *Reproductive Health, 21*(1), Article 135. https://doi.org/10.1186/s12978-024-01855-5