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# The association between contraceptive use transition and fertility dynamics in Zambia

**Million Phiri[1,2]*, Clifford Odimegwu[1], and Tobias Chirwa[3]**

[1]Department of Demography and Population Studies, School of Social Sciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa

[2]Department of Demography, Population Sciences, Monitoring and Evaluation, School of Humanities and Social Sciences, University of Zambia, Lusaka, Zambia

[3]Department of Biostatistics, School of Public Health, University of the Witwatersrand, Johannesburg, Gauteng, South Africa

## Abstract

The Zambian government has recognized family planning (FP) as a key strategy to reduce high fertility and teenage pregnancy rates. Over the years, contraceptive use has been increasing steadily in the country; however, the effects of increased contraceptive use on fertility dynamics have rarely been explored in Zambia. In this study, we examined the relationship between contraceptive transition and fertility dynamics using the Zambia Demographic and Health Surveys conducted from 1992 to 2018. We applied a Blinder–Oaxaca multivariable decomposition analysis technique to quantify the contribution of contraceptive transition to the observed reduction in fertility and teenage pregnancy rates. About 69% of the reduction in total fertility rate and 64% of the decline in teenage pregnancy rate were due to shifts in women's sociodemographic characteristics. Specifically, the increase in contraceptive use rates from 14.2% to 45.0% accounted for 17.7% of the reduction in total fertility rate. Furthermore, 54.8% of teenage pregnancies were averted due to increased contraceptive use among teenagers in Zambia. The study establishes that contraceptive use significantly reduced fertility and teenage pregnancy rates. These trends can be predominantly attributed to an escalation in the proportion of females achieving secondary education, along with delays in age at first marriage and sexual initiation. This necessitates the enhancement of current sexual and reproductive health, and FP approaches to uphold the escalating levels of contraceptive utilization to further increase the impact on fertility dynamics in the country.

***Keywords:*** Women's health; Contraceptive behavior; Fertility; Reproductive health; Zambia

***Corresponding author:**
Million Phiri
(million.phiri@unza.ac.zm)

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## 1. Introduction

The average total fertility rate in Sub-Saharan Africa (SSA) continues to exceed the average total fertility rate observed across all developing nations (Bongaarts, 2017; Mback, 2017; Zulu *et al.*, 2025). This may suggest the need for better integrated sexual and reproductive health (SRH) policies and programs to strengthen family planning (FP) access and utilization. Governments in SSA countries recognize that promoting FP is crucial for accelerating the reduction of fertility rates, as well as teenage pregnancy and maternal deaths. Many governments are making significant efforts to promote

and legitimize the provision and utilization of FP and reproductive healthcare services, which aim to enhance the adoption of various contraceptive modalities, including oral contraceptives, implants, injectables, intrauterine devices, and condoms (Karra *et al.*, 2017; Lenze & Klasen, 2017; Odimegwu *et al.*, 2023).

In the context of SSA, the implications of fertility patterns on developmental processes and the strategic decisions concerning interventions to counter adverse population trends have consistently garnered significant attention within the realm of demographic scholarship (Mberu & Ezeh, 2017). Hence, there has been a notable focus on SRH policies and initiatives to bolster FP efforts in SSA. An exemplary instance of this is the endorsement of the 2006 Maputo Program of Action by 48 member states of the African Union. This strategic framework aimed to advance the widespread availability of reproductive health services across African nations by 2015.

The 2006 Maputo Program of Action introduced a range of measures aimed at improving SRH across Africa, including expanding access to FP services, reducing maternal and child mortality, and addressing unsafe abortions. These measures focused on strengthening each country's healthcare systems through increasing funding for reproductive health programs and fostering partnerships among governments, civil society, and international organizations. The intended impacts of such interventions were to enhance health outcomes, promote gender equality, and accelerate progress toward achieving the Millennium Development Goals related to health and development in the region (The African Union Commission, 2016; United Nations, 2022).

Existing studies show that contraceptive transition, which is defined as changes in the prevalence of contraceptive methods used among women over time, has occurred in most countries in SSA (Beguy *et al.*, 2017; Kalinda *et al.*, 2022; Phiri *et al.*, 2024; Yussuf *et al.*, 2020). Furthermore, studies have documented the effect of contraceptive transition on fertility decline in SSA and elsewhere, revealing that increased contraceptive use has positively contributed to fertility reduction (Ariho & Kabagenyi, 2020; Bongaarts, 2017; Bongaarts, 2020; Garenne, 2018; May, 2017; Sarnak *et al.*, 2021). Literature suggests that women who have access to and utilize contraception have more control over their reproductive options. Contraceptives have made it easy for women or couples to delay or plan their pregnancies to reduce family sizes by preventing unplanned pregnancies (Bongaarts, 2017; Masiano *et al.*, 2019; Nanvubya *et al.*, 2022). Contraceptives have also given women more freedom by enabling them to further their education, enter the workforce, and make educated choices regarding their reproductive health rights (Ahmed *et al.*, 2019; Anderson & Leah, 2019).

To mitigate the negative effects of rapid population increase, the government of Zambia and many other governments in SSA and international organizations have been actively supporting and pushing FP interventions to increase access to and utilization among women (Ahmed *et al.*, 2019; Ministry of National Development Planning, 2019). Various efforts have been made to implement FP programs. These include major public campaigns to promote FP, improve service quality, and increase access to FP services. Population growth rates that have been declining in most SSA counties over the past few decades (Mberu & Ezeh, 2017) could be attributed to the successful investment in FP programs, which contributed to improved access to contraceptive services, hence reducing total fertility rates.

Between 1992 and 2018, Zambia consistently recorded a steady increase in contraceptive usage, surging from 14.2% to 49.6% (Zambia Statistics Agency *et al.*, 2019). Concurrently, there was a decrease in the total fertility rate from 6.2 offspring per female to 4.7 offspring per female of reproductive age (Zambia Statistics Agency *et al.*, 2019). Furthermore, teenage pregnancy rates declined from 33.8% in 1992 to 29.2% in 2018 (Phiri *et al.*, 2023; Zambia Statistics Agency *et al.*, 2019).

Despite this evidence, studies of fertility in Zambia have paid less attention to examining the contribution of contraceptive use to fertility dynamics. This is in contrast to empirical evidence from other SSA countries and beyond, where increased contraceptive use has been shown to significantly contribute to fertility decline. Our study, therefore, examined the association between contraceptive transition and fertility dynamics in Zambia. The results of this study provide insights that can guide the development of reproductive health initiatives and interventions for sustainable management of the country's population and contribute to ongoing efforts to address high fertility rates in SSA countries.

### 1.1. Theoretical framework

In theory, the effect of contraceptive utilization transition on the dynamics of fertility can be comprehended through the theoretical foundations of the classical demographic transition theory and Easterlin's economic framework of fertility. These two theories provide valuable insights for understanding the intricate factors that influence fertility dynamics in SSA. The classical demographic transition theory was first put forth by Warren Thompson in 1929, and Frank W. Notestein later made improvements in

the mid-20th century (Szreter, 1993). This theory posits that as countries evolve economically and socially, they undergo a predictable series of demographic transitions (Bongaarts, 2009; Galor, 2012; Szreter, 1993). The central idea is that birth rates fall as societies become modern and experience economic growth (Bongaarts, 2009; Galor, 2012). Increased urbanization, greater education for women, wider contraception access, and shifts in cultural and social norms are often contributing factors (Akwara *et al.*, 2023; Götmark & Andersson, 2020).

The demographic transition model provides valuable insights into historical population changes and can help predict future demographic shifts in countries undergoing socioeconomic transformation. In Zambia, increasing contraceptive use can be seen as a driver of fertility decline, moving the country toward the later stages of the demographic transition. This theory posits that as access to FP improves and cultural attitudes shift, fertility rates decline, and families begin to prioritize quality of life over large family sizes, reflecting broader socioeconomic development.

Easterlin's economic framework of fertility is an economic theory that integrates economic and social factors to explain fertility decisions. It suggests that fertility levels are influenced by the balance between desired family size (based on sociocultural norms and economic conditions) and the costs of achieving that size, including the availability and use of contraception (Easterlin, 1975). In Zambia, the transition in contraceptive use reduces the costs (economic, health, and time related) associated with childbearing, leading to adjustments in fertility dynamics as individuals align their reproductive behavior with their socioeconomic aspirations. Both theories posit that social development factors, such as improved access to contraception, higher female educational attainment, and greater women's empowerment, play significant roles in shaping the fertility patterns of women in their reproductive years (Bongaarts, 2017; Dasgupta *et al.*, 2022; Macunovich, 1998). In accordance with the theoretical underpinning employed in this research, it is anticipated that when a country experiences a trend of increased contraceptive use over time, its fertility and teenage pregnancy rates are anticipated to decline. Therefore, examining the magnitude of the effect of contraceptive transition on fertility dynamics is key because such information provides critical insights for designing evidence-based reproductive health policies and programs aimed at achieving sustainable population growth.

## 2. Data and methods

### 2.1. Data sources

The study utilized data collected from six Zambia Demographic and Health Surveys (ZDHSs) conducted between 1992 and 2018. For the analysis, we used the women's datasets (IR recode) that contained data on reproductive-aged women (15 – 49 years old). The ZDHSs were surveys conducted nationwide and represented all regions. The DHS used a two-stage stratified cluster sampling approach to select households, dividing each region into rural and urban segments. The initial phase involved selecting enumeration areas based on proportional allocation to the region's size. During the second stage, household listing operations took place in all selected clusters. The DHS usually selects 20 – 25 households/cluster (Croft *et al.*, 2018; Zambia Statistics Agency *et al.*, 2019). The relevant variables for this study were extracted from the women's recode dataset. The study included six samples of sexually active, fecund women aged 15 – 49 years who were not pregnant. The analysis included 5,181 women in 1992, 5,938 in 1996, 5,844 in 2001, 5,347 in 2007, 12,653 in 2013, and 10,576 in 2018. The ZDHS report (Zambia Statistics Agency *et al.*, 2019) and other sources (Croft *et al.*, 2018) provided detailed explanations of the sampling procedures.

### 2.2. Data collection

The research utilized a cross-sectional approach to concurrently assess exposures and outcomes among participants at a distinct time juncture. Cross-sectional investigations are instrumental in ascertaining prevalence rates and exploring associations among diverse variables and outcomes through the analysis of either singular or longitudinal data. The ZDHS questionnaire was administered to all women aged 15 – 49 years who either spent a night in the household before the interview or were usual members in all selected households for the 1992 – 2018 DHSs. Questions about contraception, fertility, and reproductive health were asked of these women. Data were collected by well-trained enumerators who underwent intensive field training (Croft *et al.*, 2018; Zambia Statistics Agency *et al.*, 2019).

### 2.3. Variables and measurement

The outcome variables for this study are fertility rate and teenage pregnancy. The fertility rate was measured using the DHS variable, "children ever born to a woman at the time of the survey." This variable was collected as a count variable in the DHS. The second dependent variable is "teenage pregnancy." Experience of teenage pregnancy was measured as a binary outcome (yes/no). The variable was measured as a composite variable, which included teenage girls aged 15 – 19 years who were either currently pregnant or had ever been pregnant.

The study chose the independent variables based on their relevance in previous research as key determinants

of fertility dynamics in SSA (Ariho & Kabagenyi, 2020; Bietsch *et al.*, 2021; Phiri *et al.*, 2023; Wasswa *et al.*, 2021). The independent variables encompassed maternal age categories (15 – 24, 25 – 34, and 35 – 49 years old), adolescent ages (15 – 19 years old), residential setting classification (rural or urban), educational attainment levels (no formal education, primary education, secondary education, or tertiary education), and marital status classifications (single, married, or previously married), household wealth index (poor, moderate, or rich), religious denomination (Catholic, Protestant, or other), employment status (working or not working), age at first sexual debut (<15 years, 15 – 19 years, 20 or above), age at first marriage (<15 years, 15 – 19 years, 20 or above), ideal number of children (0 – 3, 4 – 5, 6+) and exposure to media FP messages (yes, no).

### 2.4. Statistical analysis

The analysis conducted in this research encompassed both descriptive and multivariable decomposition techniques to examine the shifting patterns in contraceptive utilization, fertility rates, and teenage pregnancies. The first stage analysis involved a trend analysis of contraceptive use, fertility rate, and teenage pregnancy rate for the six ZDHS datasets. This was performed to measure trend change for the three measures over time. The second level involved conducting a decomposition analysis to examine the effect of contraceptive transition and sociodemographic factors on fertility dynamics during the period 1992 – 2018.

The third level involved examining the effect of contraceptive transition and sociodemographic independent factors on the decline in teenage pregnancy rates. A two-component Blinder–Oaxaca multivariate decomposition analysis was employed to assess and quantify the impact of contraceptive transition on fertility dynamics in Zambia.

To examine the contribution of contraceptive transition to fertility rate reduction in Zambia, Poisson regression modeling was utilized. Fertility rate reduction was measured using trend reduction in children ever born between 1992 and 2018. Given that children ever born is a count variable and may exhibit some dependence, the single-level Poisson regression method was chosen as the primary analytical method. This model is typically utilized in situations in which the count data does not exhibit any dispersion, or when the mean value of the data is equivalent to the variance.

A multivariable decomposition analysis for the nonlinear outcome was used to decompose the effect of increased contraceptive use on teenage pregnancy decline, given that the outcome was a dichotomous variable. The change in fertility dynamics over time can be attributed to compositional differences between the surveys and varying effects of selected independent variables. Although trend analyses are often conducted from longitudinal studies, such studies are limited in many SSA countries. Decomposition methods have been developed to determine the contribution of factors to outcomes using cross-sectional data despite some limitations.

#### *2.4.1. Decomposition analysis*

The statistical tool, Blinder–Oaxaca decomposition analysis technique, was developed by Blinder Oaxaca in 1973 (Blinder, 1973) and was later generalized by Neumark in 1988 (Neumark, 1988). This approach allowed the outcome variables between the two groups to be broken down into components explained by observed characteristics and estimated coefficients while controlling for all confounding factors. The Blinder–Oaxaca decomposition technique has been utilized in multiple studies for the purpose of analyzing models with binary dependent variables (Sinning *et al.*, 2008). The decomposition formula to compute the mean difference in the binary outcome (Y) between two groups or periods was decomposed as in Equation I (Powers & Yoshioka, 2011).

$$\bar{Y}A - \bar{Y}B = (E\beta A(YiA|XiA) - E\beta B(YiB|XiB)) + (E\beta A(YiB|XiB) - E\beta B(YiB|XiB)) \quad (I)$$

In the decomposition formula, the recent ZDHS 2018 and reference ZDHS 1992 surveys are denoted by A and B, respectively. The component labeled "E" in the formula refers to the differential attributed to variations in endowments or characteristics of women, also known as the explained component or compositional characteristics effects. The "C" component represents the differential part related to coefficient or effect variations, commonly known as the unexplained component or coefficient effects. "A" denotes the time being compared, while "B" serves as the reference time. Therefore, "E" represented a hypothetical comparison of the outcome disparity from the viewpoint of the group "A." Group "B" viewed the outcomes of component "C" through a counterfactual comparison (de-Boer & Rodrigues, 2020; Powers & Yoshioka, 2011). The "mvdcmp" command in Stata software (version 17) was used to perform a multivariable decomposition analysis of trend change in fertility dynamics between the DHS data points in Zambia.

Blinder–Oaxaca decomposition analysis is unique in its ability to isolate and quantify the specific contribution of increased contraceptive use to changes in fertility dynamics, distinguishing it from other factors like socioeconomic or demographic influences. It allows the breakdown of fertility rate changes into direct and indirect effects, providing a

clearer understanding of the magnitude of contraceptive use alone in driving fertility decline. The method's advantages include its ability to identify contributing factors to inequality, providing detailed information for policymakers. However, the technique is limited by its reliance on linear assumptions, potential sensitivity to model specification, and inability to fully account for unobservable factors that may influence group differences (de-Boer & Rodrigues, 2020; Rahimi & Hashemi Nazari, 2021)

## 3. Results

### 3.1. Background characteristics of respondents

Table 1 presents the proportional distribution of demographic attributes within the sample population comprising individuals engaged in sexual activity across six DHSs. Most women surveyed from 1992 to 2018 fell within the age range of 25 – 34 years (34.4%, 33.3%, 33.7%, 36.5%, and 34.0%, respectively, across the 5 years). The distribution by place of residence shows that in all the survey years except for 1992, more women resided in rural than urban areas. When it comes to education level, the surveys consistently showed that most sampled women had a primary level of education, with percentages decreasing from 59.5% in 1992 to 43.3% in 2018. There was an apparent increase in women with tertiary education, from 2.1% in 1992 to 5.9% in 2018, and in secondary education, from 21.4% in 1992 to 40.5% in 2018.

In each of the survey years, more than 33% of the participants were from economically disadvantaged households, while the percentage of respondents from rich households rose from 44.1% in 1992 to 45.5% in 2018. With the exception of 1996, employed women outnumbered unemployed women in all the surveys. The proportion of women employed has varied from 50.0% in 1996 to 58.0% in 2001. Table 1 further reveals that the proportion of women who initiated their first sexual debut during the adolescence period increased from 41.6% in 1992 to 71.0% in 2018 but was stable, around 50%, between 1996 and 2013.

### 3.2. Trends in contraceptive use and fertility dynamics in Zambia

During the 26-year period, the country has recorded a steady and progressive rise in the contraceptive prevalence rate. The trend in utilization of contraceptive methods among sexually active, reproductive-aged women showed an increase from 14.2% in 1992 to 45.0% in 2018. A significant increase happened between 1992 and 2001 (14.2% – 31.6%) while the smallest increase occurred between 2013 and 2018 (44.8% – 45.0%) (Figure 1).

The results further show that although total fertility rates have been resilient in Zambia for a long period, a declining trend of almost two children was observed between 1992 and 2018 (from 6.5 children to 4.7 children/woman). Furthermore, the prevalence of teenage pregnancy in Zambia showed a reduction from 33.8% to 29.2% between 1992 and 2018 (Figure 1).

### 3.3. Changes in contraceptive use trends by sociodemographic characteristics

Contraceptive mutilation among sexually active women in Zambia showed different trends based on background from 1992 to 2018 (Table 2). The trend changes in contraceptive use occurred across all the DHS intervals. Overall, a change of 30.8% (14.2% – 45.0%) occurred among sexually active women during the analysis period. The largest change happened from 1992 to 1996 (12.3%), and the lowest was from 2013 to 2018 (0.2%). Contraceptive use increased by 7.8% between 2001 and 2007.

Zambia displayed regional differences in the transition of contraceptive use over time. Overall, rural areas recorded the largest increase (33.7%) compared to urban areas (28.1%) between 1992 and 2018. Urban areas recorded the largest increase (12.9%) between 1992 and 1996, and the lowest from 2013 to 2018 (−0.5%). Rural areas recorded the largest increase in prevalence of contraceptive use from 2001 to 2007 (10.8%), and the lowest was recorded from 2013 to 2018 (2.3%).

Results show that women aged 25 – 34 years recorded the highest improvement in contraceptive utilization between 1992 and 2018 (35.2%). The lowest increase in contraceptive use was recorded among adolescents aged 15 – 19 years (21.3%). The highest contraceptive use among women aged 25 – 34 years was recorded between 1992 and 1996 (10.9%), and the lowest from 2013 to 2018 (−0.3%). Among the women aged 35 – 49 years, the largest increase was recorded from 2007 to 2013 (9.7%).

In terms of marital status, women who were married recorded the highest improvement in utilization of contraceptives between 1992 and 2018 (39.4%). The highest increment was recorded between 1992 and 1996 (13.6%), and the lowest was recorded from 2013 to 2018 (0.5%). The lowest increase was recorded among women who were never married (16.7%). Among the women who were never married, the largest increase was recorded from 1992 to 1996 (8.2%), while the lowest was recorded from 2007 to 2013 (−0.1%) (Table 2).

### 3.4. Decomposition analysis of contraceptive transition on fertility rate

The results of the multivariable decomposition indicate that the fertility change in Zambian women from 1992 to 2018 can be attributed to changes in both women's compositional

**Table 1. Percent distribution of sociodemographic and sexual behavior characteristics of participating women**

| Background characteristics | DHS 1992 | DHS 1996 | DHS 2001 | DHS 2007 | DHS 2013 | DHS 2018 |
|---|---|---|---|---|---|---|
| | *n*=5,181 | *n*=5,938 | *n*=5,844 | *n*=5,347 | *n*=12,653 | *n*=10,576 |
| Age | | | | | | |
| 15 – 19 | 1,001 (19.4) | 975 (16.5) | 886 (15.2) | 627 (11.7) | 1,535 (12.2) | 1,280 (12.1) |
| 15 – 24 | 1,112 (21.5) | 1,428 (24.2) | 1,332 (22.8) | 1,071 (20.1) | 2,361 (18.8) | 2,168 (20.5) |
| 25 – 34 | 1,726 (34.4) | 1,967 (33.3) | 1,971 (33.7) | 2,047 (38.3) | 4,594 (36.5) | 3,594 (34.0) |
| 35 – 49 | 1,330 (25.7) | 1,542 (26.1) | 1,656 (28.4) | 1,595 (29.9) | 4,088 (32.5) | 3,524 (33.4) |
| Place of residence | | | | | | |
| Rural | 2,662 (51.5) | 2,627 (44.4) | 2,364 (40.4) | 2,193 (41.1) | 5,628 (44.7) | 4,853 (45.9) |
| Urban | 2,507 (48.5) | 3,285 (55.6) | 3,481 (59.6) | 3,147 (58.9) | 6,950 (55.3) | 5,713 (54.1) |
| Education level | | | | | | |
| No education | 882 (17.1) | 802 (13.6) | 752 (12.9) | 617 (11.6) | 1,153 (9.2) | 876 (8.3) |
| Primary | 3,074 (59.5) | 3,482 (58.9) | 3,414 (58.4) | 2,969 (55.6) | 6,088 (49.2) | 4,783 (45.3) |
| Secondary | 1,104 (21.4) | 1,439 (24.3) | 1,487 (25.4) | 1,443 (27.0) | 4,554 (36.2) | 4,281 (40.5) |
| Higher | 107 (2.1) | 188 (3.2) | 192 (3.3) | 310 (5.8) | 674 (5.4) | 627 (5.9) |
| Marital status | | | | | | |
| Never married | 869 (16.8) | 1,022 (17.3) | 916 (15.7) | 834 (15.6) | 2,216 (17.6) | 2,293 (21.7) |
| Married | 3,531 (68.3) | 3,916 (66.2) | 3,929 (67.2) | 3,680 (68.9) | 8,509 (67.6) | 6,629 (62.7) |
| Formerly married | 770 (14.9) | 973 (16.5) | 1,000 (17.1) | 826 (15.5) | 1,854 (14.7) | 1,643 (15.6) |
| Wealth index | | | | | | |
| Poor | – | 2,264 (38.3) | 2,136 (36.5) | 1,939 (36.3) | 4,566 (36.3) | 3,803 (36.0) |
| moderate | – | 1,040 (17.6) | 1,162 (19.9) | 966 (18.1) | 2,458 (19.5) | 1,951 (18.5) |
| Rich | – | 2,608 (44.1) | 2,546 (43.6) | 2,435 (45.6) | 5,554 (44.2) | 4,811 (45.5) |
| Religion | | | | | | |
| Catholic | 1,421 (27.5) | 1,420 (24.0) | 1,330 (22.7) | 1,087 (20.3) | 2,229 (17.7) | 1,817 (17.2) |
| Protestant | 3,578 (69.2) | 4,388 (74.2) | 4,393 (75.2) | 4,160 (77.9) | 10,166 (80.8) | 8,566 (81.2) |
| Other | 170 (3.3) | 104 (1.8) | 122 (2.1) | 93 (1.7) | 182 (1.4) | 183 (1.7) |
| Employment status | | | | | | |
| Unemployed | 2,434 (47.1) | 2,955 (50.0) | 2,452 (42.0) | 2,491 (46.7) | 5,636 (45.0) | 5,191 (49.1) |
| Employed | 2,734 (52.9) | 2,952 (50.0) | 3,389 (58.0) | 2,842 (53.3) | 6,889 (55.0) | 5,375 (50.9) |
| Age at first sex | | | | | | |
| <15 years | 925 (17.9) | 1,196 (20.2) | 961 (16.4) | 613 (11.5) | 1,207 (9.6) | 1,895 (17.9) |
| 15 – 19 years | 2,148 (41.6) | 2,684 (45.4) | 2,897 (49.6) | 2,599 (48.7) | 6,274 (49.8) | 7,500 (71.0) |
| 20+ years | 2,096 (40.6) | 2,031 (34.4) | 1,987 (34.0) | 2,128 (39.8) | 5,096 (40.5) | 1,171 (11.1) |
| Age at first marriage | | | | | | |
| <15 years | 738 (14.3) | 737 (12.5) | 663 (11.3) | 558 (10.4) | 1,030 (8.2) | 834 (7.9) |
| 15 – 19 years | 2,767 (53.5) | 3,104 (52.5) | 3,222 (55.1) | 2,804 (52.5) | 6,489 (51.6) | 4,788 (45.3) |
| 20+ years | 1,664 (32.2) | 2,070 (35.0) | 1,961 (33.5) | 1,979 (37.0) | 5,059 (40.2) | 4,944 (46.8) |

Notes: Data are presented as *n* (%); The symbol (–) signifies the absence of data pertaining to the variable in the corresponding DHS year.
Abbreviation: DHS: Demographic and Health Survey.

characteristics and fertility behavior. The results presented in Table 3 show that 68.98% of the reduction in fertility was due to changes in the characteristics of the women. However, the remaining 30.02% decline in fertility rate was linked to changes in women's fertility behavior caused by the change due to the effects of their characteristics. The

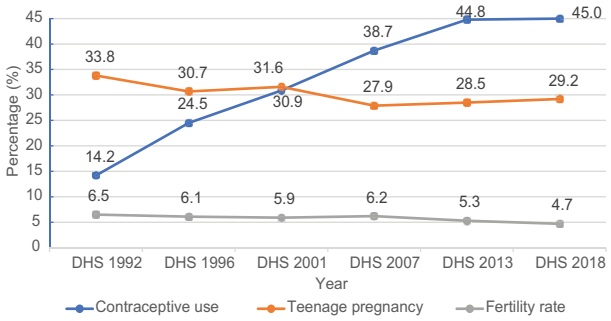


**Figure 1.** Trends in contraceptive use, fertility, and teenage pregnancy rates in Zambia in 1992 – 2018
Abbreviation: DHS: Demographic and health survey.

analysis shows that the observed increase in the utilization of contraceptive methods by women from 1992 to 2018 accounted for 17.67% of the reduction in the fertility rate in Zambia. In other words, the fertility rate would have increased by 17.67% if there had been no increase in the utilization of contraceptives.

Furthermore, an increase in the proportion of women with secondary education accounted for 33.80% of the observed reduction in fertility rate. This result indicates that the fertility rate would have increased by 33.80% if the proportion of women with a secondary level of education remained the same in 2018 as they were in 1992. Similarly, the rise in the proportion of women with tertiary education between 1992 and 2018 contributed 4.57% to the reduction in fertility. The reduction in the proportion of women who were married accounted for a reduction in the fertility rate by 15.95%.

In terms of fertility behavior, the coefficient shows that the positive fertility behavior of women with primary education contributed 22.43% to the reduction in the fertility rate in Zambia. The negative percentage indicates that the fertility rate would have been higher by 22.43% among women with primary-level education if the fertility behavior had not changed. Furthermore, changes in the fertility behavior of women who got married in the adolescent age group contributed to a 27.40% reduction in the country's fertility rate.

### 3.5. Decomposition analysis of contraceptive transition on teenage pregnancy rate

The results of the trend change in teenage pregnancy in Zambia between 1992 and 2018 are displayed in Table 4. The analysis presented examined the effect of contraceptive transition among teenagers and other predictors on the reduction of teenage pregnancy rates in Zambia. The results indicate that the decline in the incidence of adolescent pregnancy in Zambia can be primarily ascribed to shifts in the demographic attributes of adolescents rather than alterations in their reproductive practices. The results indicate that 64% of this variation is attributed to shifts in compositional elements, while the remaining 36% was linked to changes in reproductive behaviors.

In Zambia, the main factors that led to a decline in teenage pregnancy were secondary or tertiary level of education, contraceptive use, delayed age at first sexual encounter, and working status. Specifically, the increase in contraceptive use among teenagers significantly ($p$<0.001) contributed to the reduction in teenage pregnancy by 54.84%. The negative percentage indicates that if contraceptive use had not increased, the prevalence of teenage pregnancy would have been higher by 54.84%. The findings further indicate that the decrease in the incidence of adolescent pregnancy can be attributed to the shift in the percentage of adolescent girls achieving either secondary or tertiary educational attainment, which accounted for 87.15% of the variation observed. Similarly, the increase in the proportion of adolescents who were working significantly contributed 21.19% to the reduction in teenage pregnancy rates (Table 4). Furthermore, results show that teenage pregnancy among adolescents with primary education would have been higher by 25.67% if the proportion of adolescents who attained primary education had not changed between 1992 and 2018.

The increase in the percentage of teenagers who delayed the commencement of their sexual activity had a notable favorable impact of 30.08% on the decline in teenage pregnancies. Changes in the reproductive behavior of teenagers who were living in urban areas, had a primary level of education, and were exposed to mass-media FP messages positively contributed to the reduction in teenage pregnancies. In terms of percentage contributions, change in reproductive behavior among teenagers residing in urban areas contributed 21.44%, and those with primary education contributed 29.98% to the reduction in teenage pregnancy rates. Similarly, an increase in adolescents who received FP messages from the media contributed 7.69% (Table 4).

## 4. Discussion

The aim of this study was to examine the association between contraceptive transition and fertility dynamics in Zambia. Zambia, like many other countries in SSA, has undergone a fertility transition over the past four decades (1980 – 2020). The total fertility rate has exhibited a downward trend over the past decades, showing a reduction from an average of 7.2 children/woman in 1980 to an average of 4.7 children per woman in 2018 (Zambia Statistics Agency *et al.*, 2019). Additionally, teenage pregnancy rates reduced from 33.8% in 1992 to 29.2% in 2018 (Phiri *et al.*, 2023; Zambia Statistics

**Table 2. Distribution of contraceptive prevalence rate trend changes in sexually active women by background characteristics**

| Background characteristics | ZDHS (1992 – 1996) | ZDHS 1996 – 2001 | ZDHS (2001 – 2007) | ZDHS (2007 – 2013) | ZDHS (2013 – 2018) | ZDHS (1992 – 2018) |
|---|---|---|---|---|---|---|
| Age | | | | | | |
| 15 – 19 | 8.1 | 5.7 | 3.6 | 0.6 | 3.3 | 21.3 |
| 15 – 24 | 10.7 | 5.4 | 8.8 | 0.7 | 2.3 | 27.9 |
| 25 – 34 | 10.9 | 11.0 | 5.2 | 8.4 | −0.3 | 35.2 |
| 35 – 49 | 8.8 | 1.9 | 8.2 | 9.7 | −0.3 | 27.5 |
| Residence | | | | | | |
| Urban | 12.9 | 6.7 | 3.5 | 7.5 | −2.5 | 28.1 |
| Rural | 9.1 | 6.8 | 10.8 | 4.7 | 2.3 | 33.7 |
| Education level | | | | | | |
| No education | 8.8 | 4.8 | 12.3 | 2.9 | −0.9 | 27.9 |
| Primary | 10.3 | 6.2 | 10.2 | 6.2 | 1.9 | 34.8 |
| Secondary | 7.9 | 8.4 | 1.4 | 5.9 | −0.7 | 22.9 |
| Higher | 6.4 | −4.6 | −7.1 | 8.1 | −9.1 | −6.3 |
| Marital Status | | | | | | |
| Never married | 8.2 | 1.5 | 3.8 | −0.1 | 3.3 | 16.7 |
| Married | 13.6 | 8.7 | 8.2 | 8.4 | 0.5 | 39.4 |
| Formerly married | 0.2 | 1.0 | 7.2 | 5.9 | 5.4 | 19.7 |
| Wealth status | | | | | | |
| Poor | – | 2.5 | 15.9 | 1.3 | 2.9 | 22.3 |
| Moderate | – | 10.1 | 3.4 | 14.3 | 1.1 | 28.9 |
| Rich | – | 8.1 | 2.7 | 6.8 | −2.6 | 15.0 |
| Employment status | | | | | | |
| Unemployed | 12.5 | 7.4 | 8.8 | 5.9 | −1.0 | 33.6 |
| Employed | 8.6 | 4.9 | 7.3 | 6.2 | 1.4 | 28.4 |
| Religion | | | | | | |
| Catholic | 10.1 | 6.3 | 7.8 | 5.2 | −1.0 | 28.4 |
| Protestant | 10.4 | 6.8 | 7.5 | 6.5 | 0.2 | 31.4 |
| Other | 9.3 | −3.7 | 19.2 | −5.3 | 14.2 | 33.7 |
| Age at first sex | | | | | | |
| <15 years | 9.0 | 5.6 | 8.0 | 4.8 | 6.0 | 33.4 |
| 15 – 19 years | 10.8 | 7.2 | 8.0 | 4.0 | 2.2 | 32.2 |
| 20 + years | 10.9 | 5.1 | 6.9 | 8.8 | −8.2 | 23.5 |
| Ideal number of children | | | | | | |
| 0 – 3 | 6.7 | 4.8 | 6.4 | 3.5 | −2.2 | 19.2 |
| 4 – 5 | 10.9 | 7.1 | 4.5 | 8.4 | 0.9 | 31.8 |
| 6+ | 9.6 | 5.0 | 12.8 | 4.6 | 0.7 | 32.7 |
| Age at first marriage | | | | | | |
| Below 15 | 10.0 | 2.6 | 12.8 | 9.3 | −1.1 | 33.6 |
| 15 – 19 | 10.2 | 9.0 | 8.3 | 7.9 | 2.7 | 38.1 |
| 20+ | 10.7 | 1.2 | 8.4 | 3.7 | −0.1 | 23.9 |
| Exposure to media family planning messages | | | | | | |
| No | 7.6 | 6.5 | 10.2 | 5.6 | 1.9 | 31.8 |
| Yes | 8.5 | 5.5 | 2.1 | 7.9 | −5.7 | 18.3 |
| Total | 12.3 | 6.4 | 7.8 | 6.1 | 0.2 | 30.8 |

Notes: Data are presented as %; The symbol (–) signifies the absence of data pertaining to the variable in the corresponding DHS year.
Abbreviation: ZDHS: Zambia's Demographic and Health Survey.

**Table 3. Contribution of explanatory variables to fertility rate changes in Zambia**

| Background characteristics | Due to differences in characteristics (E) | | Due to differences in coefficients (C) | |
|---|---|---|---|---|
| | Coefficients | Percent | Coefficients | Percent |
| Residence | | | | |
| Rural | Ref | | Ref | |
| Urban | 0.0036 (−0.0078, 0.0149) | 0.71 | 0.1199** (0.0487, 0.1912) | 18.37 |
| Contraceptive use | | | | |
| No | Ref | | Ref | |
| Yes | −0.1154** (−0.1985, −0.0323) | −17.67 | 0.1757*** (0.0555, 0.2407) | 22.68 |
| Woman's education level | | | | |
| None | Ref | | Ref | |
| Primary | −0.0706*** (−0.0885, −0.0527) | −10.82 | −0.1510** (−0.2622, −0.0438) | −23.43 |
| Secondary | 0.2206*** (0.1721, 0.2692) | 33.80 | 0.0191 (−0.0682, 0.1063) | 2.92 |
| Higher | 0.0299** (0.0117, 0.0480) | 4.57 | 0.0188 (−0.0051, 0.0426) | 2.87 |
| Marital status | | | | |
| Never married | Ref | | Ref | |
| Married | 0.1042*** (0.0854, 0.1230) | 15.95 | 0.5737*** (−0.2622, −0.0438) | 67.87 |
| Formerly married | −0.0607*** (−0.0737, −0.0476) | −9.29 | 0.1365** (−0.0682, 0.1063) | 20.91 |
| Age at first marriage | | | | |
| <15 years | Ref | | Ref | |
| 15 – 19 years | −0.1789** (−0.0499, −0.0254) | −5.76 | −0.1789** (−0.2962, −0.0616) | −27.40 |
| 20+ years | −0.1545** (0.1751, 0.2651) | 33.72 | −0.1546** (−0.2444, −0.0646) | −23.67 |
| Age at first sex | | | | |
| <15 years | Ref | | Ref | |
| 15 – 19 years | 0.1295* (0.0294, 0.2296) | −9.84 | 0.1208 (−0.6954, 0.9371) | 18.51 |
| 20+ years | 0.2553*** (0.1565, 0.3541) | 13.10 | −0.0825 (−0.6180, 0.4530) | −12.64 |
| Desired number of children | | | | |
| 0 – 3 | Ref | | Ref | |
| 4 – 5 | 0.0093 (−0.0608, 0.0795) | 1.43 | −0.0900 (−0.2756, 0.0405) | −18.01 |
| 6+ | 0.2817*** (0.1896, 0.3738) | 43.14 | −0.1512* (−0.3051, −0.0454) | −26.84 |
| Constant | | | 0.4851* (0.0798, 0.8905) | 74.31 |
| Total | 0.4452*** (0.3814, 0.5090) | 68.98 | 0.2077 *** (0.1197, 0.2956) | 30.02 |

Notes: Statistical significance determined at *$p$<0.05, **$p$<0.01, and ***$p$=0.001; Values in brackets represent confidence intervals.
Abbreviations: C: Coefficients; E: Endowments; Ref: Reference category.

Agency *et al.*, 2019). The shift in levels of fertility dynamics is typically associated with social, economic, reproductive health, and demographic changes that occurred in the country over the years (Ministry of National Development Planning, 2019; Munakampe *et al.*, 2021; Shumba *et al.*, 2024).

The period 1992 – 2018 presents a phase of nearly three decades in which Zambia's fertility has changed in observable ways, making it appropriate for analysis of fertility dynamics. This allowed the study to observe the changes in contraceptive use behavior and the population's demographic composition by examining fertility changes. The timeframe spanning from 1992 to 2018 witnessed significant alterations in population policy and FP programs in Zambia, which potentially influenced demographic transformations in the region. This era saw the evolution of Zambia's population policy, initially established in 1989 and subsequently revised in 2007. The updated population policy of 2019 underscored the critical need to enhance the provision of FP, sexual, and reproductive health services as a strategy to combat the enduringly high fertility rates in Zambia (Ministry of National Development Planning, 2019). These changes may have had some effects on the country's fertility dynamics.

The results of our study have shown that, in Zambia, the utilization of contraceptives among women engaging

**Table 4. Contribution of explanatory variables to the difference in prevalence of teenage pregnancy among adolescent girls**

| Background characteristics | Due to differences in characteristics (E) | | Due to differences in coefficients (C) | |
|---|---|---|---|---|
| | Coefficients | Percent | Coefficients | Percent |
| Contraceptive use | | | | |
| No | Ref | | Ref | |
| Yes | 0.0248*** | −54.84 | 0.0031 | −6.83 |
| Residence | | | | |
| Rural | Ref | | Ref | |
| Urban | 0.0049** | −10.71 | −0.0097 | 21.44 |
| Region | | | | |
| Lusaka | Ref | | Ref | |
| Central | 0.0018* | −3.91 | 0.0034 | −7.39 |
| Copperbelt | −0.0075* | 16.56 | 0.0139 | −30.75 |
| Eastern | 0.0010* | −2.29 | 0.0034 | −7.60 |
| Luapula | 0.0009 | −1.92 | 0.0010 | −2.14 |
| Northern | 0.0025* | −5.52 | 0.0062 | −13.59 |
| North-western | 0.0027* | −6.01 | 0.0017 | −3.79 |
| Southern | −0.0062** | 13.71 | 0.0159* | −35.15 |
| Western | 0.0023*** | −5.12 | 0.0057 | −12.52 |
| Religion | | | | |
| Catholic | Ref | | Ref | |
| Protestant | −0.0005 | 1.00 | −0.0057 | 12.48 |
| Other | −0.0001 | 0.02 | −0.0005 | 1.04 |
| Early sexual debut | | | | |
| No | Ref | | Ref | |
| Yes | −0.0136*** | 30.08 | −0.0123 | 27.12 |
| Woman's education level | | | | |
| None | Ref | | Ref | |
| Primary | 0.0116 | −25.67 | −0.0136 | 29.98 |
| Secondary/higher | −0.0395** | 87.15 | −0.0040 | 8.72 |
| Employment status | | | | |
| Not working | Ref | | Ref | |
| Working | −0.0096*** | 21.19 | 0.0031 | −6.74 |
| Ideal number of children | | | | |
| 0 – 3 | Ref | | Ref | |
| 4 – 5 | 0.00000 | 0.00 | 0.0007 | −1.57 |
| 6+ | −0.00121 | 2.67 | 0.0077 | −16.90 |
| Exposure to media family planning messages | | | | |
| No | Ref | | Ref | |
| Yes | −0.00346* | 7.65 | −0.0035 | 7.69 |
| Constant | | | −0.0328 | 72.46 |
| Total | −0.0290* | 64.04 | −0.0163 | 35.96 |

Note: Statistical significance determined at *$p$<0.05, **$p$<0.01, and ***$p$=0.001.
Abbreviations: C: Coefficients; E: Endowments; Ref: Reference category.

in sexual activity has experienced a notable rise during the analysis period. The observed increase in contraceptive use has resulted in a significant reduction in fertility and teenage pregnancy rates in Zambia. Several studies have documented a positive relationship between increased contraceptive use and fertility reduction in SSA countries (Ariho & Kabagenyi, 2020; Dasgupta *et al.*, 2022; Orwa *et al.*, 2023; Tetteh *et al.*, 2022). This is because contraceptive use directly enables women to manage the timing and number of their pregnancies. By offering reliable methods to prevent unintended pregnancies, space births, and limit family size, contraceptives support women in achieving their personal or FP objectives (Bietsch *et al.*, 2021; Bongaarts, 2017; Shasha *et al.*, 2023; Sikaluzwe *et al.*, 2024). This control over reproductive choices leads to a reduction in the overall number of births a woman is likely to have throughout her reproductive years. This implies that improving access to and utilization of contraceptive methods among reproductive-aged women has the potential to further reduce fertility levels in SSA countries.

Prior studies conducted in other countries have affirmed that increased contraceptive use among fecund women has a negative effect on fertility rate (Bongaarts, 2017; Garenne, 2018; Schoumaker, 2019). This study's findings corroborate previous findings on the positive effect of increased contraceptive use on fertility rate changes (Ariho & Kabagenyi, 2020; Garenne, 2018; Schoumaker, 2019). A study in Uganda found that increased contraceptive use contributed to an 8.2% reduction in fertility rate in 2006 – 2016 (Ariho & Kabagenyi, 2020). Another study in Ethiopia reported that an 18.6% increase in contraception use recorded in 2000 – 2011 contributed 30% to the decline in fertility rate during the same period (Wondimagegenhu, 2012). The finding of this current study implies that increasing contraceptive use further among Zambian women is key to the country's population policy's goal of fertility reduction.

Furthermore, prior studies have highlighted the significance of contraceptive use in reducing teenage pregnancy rates. A study conducted in Ghana by Tetteh *et al.* (2022) reported that not using contraceptives consistently and correctly, especially among adolescents, significantly increased the risk of pregnancy. Manlove (2015) found that changes in contraceptive methods, particularly an increase in condom use, contributed to a 48% decline in teen pregnancy rates between 2002 and 2010 in the United States of America. These findings suggest that proper and consistent contraceptive use among adolescents is crucial in reducing the risk of teenage pregnancies, indicating a direct link between increased contraceptive use and fertility reduction. This implies that addressing contraceptive behaviors among adolescents can play a significant role in reducing fertility rates and preventing unintended pregnancies.

To address reproductive health challenges relating to unintended pregnancies, SRH programs, such as comprehensive sexuality education, should be prioritized. Comprehensive sexuality education linked with accessible SRH services has shown promise in reducing early and unplanned pregnancies among adolescent girls who are still in school (Mbizvo *et al.*, 2023). These interventions should target multiple levels, including individual factors like contraceptive use and knowledge, interpersonal influences such as peer pressure and family dynamics, community-level socio-cultural norms, and policy environments affecting access to SRH information and services (Malunga *et al.*, 2023). Furthermore, improving access to FP services, particularly for women with low education levels, is crucial to further reduce unintended pregnancies in Zambia (Sikaluzwe *et al.*, 2024).

This study also highlights the importance of women's education, age at first marriage, and age at first sexual encounter in determining fertility reduction. The findings show that an increase in the proportion of women who attained secondary or tertiary education in Zambia significantly contributed to a reduction in fertility and teenage pregnancy rates. Existing literature shows that there is an association between women's education status and fertility dynamics (Alazbih *et al.*, 2021; Ariho & Kabagenyi, 2020; Olowolafe *et al.*, 2023; Tetteh *et al.*, 2022; Wasswa *et al.*, 2021), suggesting that increasing education levels lead to increased contraceptive use, delayed marriage, and a smaller family size desire. Women who have attained secondary or higher level education are more likely to delay marriage and desire small families (Bongaarts, 2020; Mapoma *et al.*, 2018; Okoli *et al.*, 2022). This signifies how education influences the reproductive behavior of women. Furthermore, scholarly investigations demonstrate a notable decrease in the occurrence of adolescent pregnancies among teenagers with elevated levels of educational attainment. This implies that education plays a crucial role in equipping young women with the knowledge to make well-informed choices regarding their reproductive health decisions. Therefore, increasing access to education can further contribute to reducing early pregnancy risk among teenagers.

Our study has also shown that age at first sexual experience and age at first marriage are key factors in determining fertility and teenage pregnancy rates. Hertrich (2017) and Casterline *et al.* (2017) examined the relationship between the age at first marriage and the beginning of the fertility transition and claim that the fertility transition is extremely improbable when women experience sexual debut or enter their first partnerships at very young ages. According to these scholars' findings, a change in the age at first marriage has served as a more significant indicator of early fertility decline than changes in contraceptive use across many countries in SSA (Casterline *et al.*, 2017; Hertrich, 2017).

This conclusion is supported by the findings of this current study, which has shown that an increase in the proportion of women who were married at the age of 20 years or later was one of the major contributors to fertility decline in Zambia. This trend was accompanied by an increase in the proportion of women attaining secondary education or an increase in those who initiated sexual debut at the age of 20 years or later. Furthermore, our study shows that a reduction in the proportion of women who desired six or more children had a significant effect in reducing the fertility rate in the country. This suggests that SRH interventions aimed at reducing fertility should also target women with high fertility preferences to create a greater impact.

The study has provided evidence that contraceptive transition among women of reproductive age has occurred in Zambia. Although the observed increase in contraceptive use has positively contributed to changing fertility dynamics, fertility and teenage pregnancy rates are still high compared to other countries in the region (Kalinda *et al.*, 2022; Yussuf *et al.*, 2020). This calls for actions to increase resources to FP programs in the country to enhance the benefits of contraceptive use. There is also a need for further research to critically examine other drivers of fertility dynamics in Zambia to design interventions that could help address high fertility. For sustained fertility decline, couples must be "ready, willing, and able" to use modern contraception, with readiness, willingness, and ability measured by a desire to limit births, approval of FP, and knowledge of contraceptive methods, respectively (Biney *et al.*, 2021; Muhoza *et al.*, 2018).

Our study results underscore the need for public health and FP policies to prioritize educational opportunities for girls and promote adolescent SRH initiatives such as comprehensive sexuality education that encourages delayed marriage and early sexual activity. Such measures can lead to more sustainable reductions in fertility and teenage pregnancy rates, ultimately improving health outcomes and socioeconomic development. Moreover, this research offers significant findings regarding how contraceptive transition has contributed to significant changes in fertility dynamics in Zambia. By demonstrating that the observed contraceptive transition accounted for a substantial reduction in the total fertility rate and prevented over half of teenage pregnancies, the findings underscore the need for health policymakers to lobby for increased financial investment in FP programs, especially adolescent reproductive health programs. This will help address the country's population growth challenges and high teenage pregnancies.

### 4.1. Strengths and limitations

The results of this analysis can be generalized to the total population of married women in Zambia, as it included a nationally representative sample of sexually active women of reproductive age in Zambia. The availability of multiple DHS datasets made it possible to investigate the long-term trends in contraceptive use and fertility dynamics. Furthermore, it was possible to examine the effects of contraceptive use on fertility dynamics in Zambia. However, causality cannot be inferred in this study due to the cross-sectional study design employed by the DHS.

## 5. Conclusion

This study found that although fertility rates remain high, contraceptive use significantly contributed to the shift in fertility dynamics in Zambia. Furthermore, there is evidence that contraceptive transition among adolescent girls has helped avert teenage pregnancies over time. This study also revealed that an increase in the proportion of women who attained secondary or tertiary education, delayed initiation of sexual debut, and delayed age at first marriage are the main drivers of changes in fertility dynamics in Zambia. There is a need to enhance access to education and contraceptive methods, especially among adolescent girls. Additionally, comprehensive sexuality education that promotes delay in initiating sexual debut and discourages early marriage should be promoted and prioritized, especially for adolescents and young women. Such health interventions have the potential to equip young women with accurate information about SRH.

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## Conflict of interest

The authors declare that they have no competing interests.

## Author contributions

*Conceptualization:* Million Phiri, Clifford Odimegwu
*Formal analysis:* Million Phiri
*Investigation:* Million Phiri
*Methodology:* Million Phiri, Tobias Chirwa
*Writing – original draft:* Million Phiri
*Writing – review & editing:* All authors

## Ethics approval and consent to participate

In the study, secondary data sources were used. Permission to use DHS datasets was given by the DHS program. The DHS data does not contain any personal identification of survey

respondents. The Research Ethics Review Boards of The Tropical Disease and Research Centre (TDRC) in Zambia and the Centers for Disease Control and Prevention approved the 1992 – 2018 DHS Biomarker and survey protocols for Zambia. Therefore, all techniques used for gathering data were compliant with applicable guidelines and ethical standards. In accordance with the regulations of the DHS, all individuals participating in the survey who were above 18 years of age were required to provide explicit informed consent during the enumeration process. Additionally, prior to seeking assent from minors under the age of 18, informed consent was obtained from the parents or legal guardians of participants aged between 15 and 17 years.

## Consent for publication

Not applicable.

## Availability of data

The data utilized in this study can be accessed publicly through the IPUMS DHS or DHS Program websites: https://www.idhsdata.org/idhs/, https://dhsprogram.com

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