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Proximate determinants and decomposition of changes in fertility levels across Nigeria regions: Evidence from Nigeria Demographic Health Survey, 2003-2018

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Abstract

There is disparity in fertility level across the six geopolitical zones in Nigeria. Deeper uunderstanding about the drivers of fertility trends are necessary to prioritize zonal specific strategies for fertility reduction in Nigeria. Thus, this study examined the proximate determinants (PDs) of fertility and decomposed the change in its level across the six geo-political zones in Nigeria. Data from Nigeria Demographic and Health Surveys of 2003 and 2018 were analyzed. Fertility data were based on the report of full birth history from women of reproductive age. The Revised Bongaarts framework was used to estimate PDs and fertility levels. The contribution of each PDs to the observed changes in fertility levels was quantified using Das Gupta's five- factor decomposition method. The Total fertility rate (TFR) in 2003 and 2008 across the zones are South-South (5.04 vs 4.36), South-West (4.88 vs 4.26), North West (7.25 vs 6.85), North East (6.87 vs 6.54), North Central (5.72 vs 5.48), South East (5.06 vs 4.86), Nigeria (6.00 vs 5.59). Across the zones, there was a change in the fertility inhibiting effect of Contraception (Cc) between 2003 and 2018. The fertility inhibiting effect of Postpartum Infecundability (Ci) and Abortion was the highest and smallest respectively across the zones. Delayed sexual exposure (Cm) and contraceptive use (Cc) contributed the most to the change across the regions. The percentage contribution of Cm in South-South, South West, and South East was 87.04%, 52.89%, and 172.85% respectively. Furthermore, most of the fertility change observed in North Central was attributable to Cc. Abortion index was not an important inhibiting factor of fertility in Nigeria. Delayed sexual exposure and contraceptive use accounted for the largest change observed in fertility levels across the six geo-political zones in Nigeria between 2003 and 2018. Strategies that promote delayed sexual exposure, contraceptive use and breast feeding practices will enhance fertility transition in Nigeria. *(Afr J Reprod Health 2023; 27 [3]: 77-86).*

Keywords: Proximate determinants, change in fertility level, decomposition, Nigeria

Résumé

Il existe une disparité dans le niveau de fécondité entre les six zones géopolitiques du Nigeria. Une meilleure compréhension des moteurs des tendances de la fécondité est nécessaire pour donner la priorité aux stratégies spécifiques à chaque zone pour la réduction de la fécondité au Nigeria. Ainsi, cette étude a examiné les déterminants immédiats (PD) de la fécondité et décomposé l'évolution de son niveau dans les six zones géopolitiques du Nigéria. Les données des enquêtes démographiques et sanitaires du Nigeria de 2003 et 2018 ont été analysées. Les données sur la fécondité étaient basées sur le rapport de l'historique complet des naissances des femmes en âge de procréer. Le cadre Bongaarts révisé a été utilisé pour estimer les PD et les niveaux de fécondité. La contribution de chaque DP aux changements observés dans les niveaux de fécondité a été quantifiée à l'aide de la méthode de décomposition en cinq facteurs de Das Gupta. L'Indice synthétique de fécondité (ISF) en 2003 et 2008 à travers les zones sont Sud-Sud (5,04 contre 4,36), Sud-Ouest (4,88 contre 4,26), Nord-Ouest (7,25 contre 6,85), Nord-Est (6,87 contre 6,54), Nord Centre (5,72 contre 5,48), Sud-Est (5,06 contre 4,86), Nigéria (6,00 contre 5,59). Dans toutes les zones, il y a eu un changement dans l'effet inhibiteur de la fertilité de la contraception (Cc) entre 2003 et 2018. L'effet inhibiteur de la fertilité de l'infécondabilité post-partum (Ci) et de l'avortement était respectivement le plus élevé et le plus faible dans toutes les zones. L'exposition sexuelle retardée (Cm) et l'utilisation de contraceptifs (Cc) ont le plus contribué au changement dans les régions. La contribution en pourcentage de Cm dans les régions Sud-Sud, Sud-Ouest et Sud-Est était respectivement de 87,04 %, 52,89 % et 172,85 %. De plus, la plupart des changements de fécondité observés dans le centre-nord étaient attribuables au Cc. L'indice d'avortement n'était pas un important facteur inhibiteur de la fécondité au Nigeria. L'exposition sexuelle retardée et l'utilisation de contraceptifs ont représenté le plus grand changement observé dans les niveaux de fécondité dans les six zones géopolitiques du Nigéria entre 2003 et 2018. Les stratégies qui favorisent l'exposition sexuelle retardée, l'utilisation de contraceptifs et les pratiques d'allaitement amélioreront la transition de la fécondité au Nigéria. *(Afr J Reprod Health 2023; 27 [3]: 77-86).*

Mots-clés: Déterminants proches, changement du niveau de fécondité, décomposition, Nigeria

Introduction

Fertility level, often measured by the total fertility rate (TFR), indicates the reproductive behaviour of a woman if the prevailing age specific fertility rates (ASFR) is sustained throughout her reproductive years[1]. Fertility level of a country has an effect on its population size, structure and growth rate[2] and often used to determine replacement level which is attained when the TFR is on average of 2.1 children per woman. [3,4]. Globally, the level of fertility dropped from 5.3 children per woman in 1900 to about 2.5 children per woman in 2019[4]. The levels of fertility in developed regions of the world had been consistently less than two children per woman between 1990 and 2019[5,6]. The fertility rates have been found to be below replacement level in countries like Ireland (1.98), France (1.85), US (1.89), Australia (1.83), China (1.64), South Korea (1.33), Singapore (1.26) and Taiwan (1.22)[5].

A decline in fertility level was observed between 1990 and 2019 in Central and Southern Asia (4.3 to 2.4), Northern Africa (4.4 to 2.9), Latin America (3.3 to 2.2), and in Oceania (4.5 to 3.4). Over the same period, the level of fertility also decreased from above 6.3 children per woman to 4.6 children per woman in sub-Saharan Africa[6]. The world fertility level has been predicted to drop from 2.5 to 1.9 children per woman by 2100. African countries, especially those in the sub-Saharan region, have persistently recorded the highest level of fertility among the world sub-regions; and fertility decline to replacement level is not expected soon[7].

The current fertility level in some Africa countries such as Tunisia (2.1), Libya (2.2), Cape Verde (2.3), Seychelles (2.3), and South Africa (2.4) showed that fertility transition had begun[8]. Nonetheless, Nigeria (TFR=5.3), the most populous country in Africa with a population estimate of above 200 million[10], is among the top ten high fertility countries in the region[9]. In Nigeria, fertility level has been declining gradually from above six live births per woman in 1990 to above five live births in 2018[11-14]. A recent study showed a reducing but slow fertility decline in Nigeria[45]. According to the Nigeria Demographic Heath Survey (NDHS) reports, variation exists in fertility levels across the regions in Nigeria with the North West (6.6) having the highest and South West (3.9) the lowest. With this high fertility rates in Nigeria, the country is expected to lag behind in terms of achieving the replacement level in the years ahead.

In Nigeria, many factors such as ethnicity, religion, education, age at first birth have been identified as fertility predictors[43]. However, in practice, no single factor can explain the fertility behavior of a particular country[17]. Due to multifaceted- determinants of fertility, many theories have been proposed to describe fertility behavior. The approaches to fertility is not restricted to economical, socio-cultural, psychological, and biological and behavioral determinants[18]. This prompted Bongaarts to model fertility causative factors as proximate determinants (PDs) based on the natural fertility ideology. He proposed that the level of fertility in any population can be determined by the proportion of women of reproductive age that is married, the effective use of contraception, induced abortion, postpartum infecundability, the frequency of intercourse, the onset of permanent sterility, and spontaneous intrauterine mortality. He argued that the proposition that a woman may likely bear at least fifteen children during her lifetime could be reduced via modification of each of these factors[19,20]. Thus suggesting that a change in any of the PDs of fertility will directly affect fertility, even if others remain constant. Accordingly, fertility variations and trends can be attributed to changes in at least one of the PDs[21].

Several studies across the world have applied this Bongaart's framework in the analysis of fertility. Alene and Worku reported that the fertility-inhibiting effect of postpartum infecundability which was as a result of prolonged breastfeeding was the most important proximate determinant in Ethiopia[22]. A study conducted in Malaysia found that delay in marriage and uptake of contraceptive was the most important proximate determinants of fertility; while postpartum infecundability and abortion played a part in explaining ethnic fertility differentials[23]. To study the changes in fertility across sub-Saharan Africa, Madhavan analyzed the contributions of the proximate determinants of fertility to overall fertility decline by country and found increase in the proportions of unmarried women and contraceptive use as major factors responsible for fertility decline in sub-Saharan Africa (SSA)[24]. A Bangladesh study identified contraceptive use as a leading PDs in fertility change[25]. Across Asia countries, changing marriage pattern and induced abortion were key in reducing fertility among poor women[26]. Marriage and postpartum infecundabiliity were found to account for the highest inhibiting effect of natural fertility in Zambia[27]. Recently, programmes that would promote contraceptive use and breast feeding practices were recommended for rapid fertility decline among Ethiopia women[28].

In Nigeria, increased use of contraception and changes in marriage pattern were found to be associated with the fertility decline[17]. Another study concluded that the richest in Nigeria compared to the poorest were depending more on delayed marriage and contraception for fertility reduction[29,30]. Also fertility has been estimated at both national and across the six geopolitical zones in Nigeria by previous studies[12-16]. The studies focused mainly on the use of direct and indirect approaches to fertility estimation. However, estimating fertility level at sub-national regions will require appropriate consideration for PDs of fertility due to cultural diversities and socioeconomic differences in the six-geopolitical zones in Nigeria. Unfortunately, there is limited research evidence about which of the PDs has highest contribution to recent change in fertility level in each of these Nigerian geo-political zones. With several campaigns and programmes targeted at encouraging breastfeeding, increasing contraceptives use and female education, it is imperative to examine how these activities have contributed to the fertility transition in each of the six regions in Nigeria. A country of multi-ethnic nature like Nigeria where the level of fertility at the national level may be grossly inadequate to provide clear understanding about factors explaining fertility changes will require a sub-group analysis. The study's outcome will provide more insights into the drivers of fertility trends that are required to prioritize strategies for fertility reduction across the geopolitical zones in Nigeria. We, therefore, aimed to estimate the PDs and decompose the change in fertility level between 2003 and 2018 across the six geo-political zones of Nigeria.

Methods

Study design and data

The study utilized data from the 2003 and 2018 Demographic and Health Survey (NDHS). This was a cross- sectional and nationally representative survey of Nigerian households with a stratified representative sample that cut across all the six geopolitical zones. The 2003 survey used the sampling frame from the 1991 population census while the sampling frame from the 2006 population and housing census was employed for 2018 survey. The number of households interviewed in 2003 and 2018 was 7864 and 42000 respectively. The number of women aged 15-49 years interviewed for these surveys was 7620 and 41821 respectively[11,14]. Sample weights were applied to each case to adjust for differences in the probability of selection. Weighting is important in to increase the extent of representativeness in the sample and to reduce the errors associated with sample selection bias.

Data analysis

We used revised Bongaarts's proximate determinants (PDs) of fertility model and Das Gupta's five factor decomposition method to analyse the data. Bongaart framework estimated total fertility rate (TFR) as the product of four indices quantifying the fertility inhibiting effect and the total fecundity (TF) which is the average number of live births born to a woman, if she remains married throughout her reproductive years, in the absence of contraception, and no any induced abortion and if she does not breastfeed her children[20]. The four main PDs are marriage, contraception, abortion and postpartum infecundity. The indicator for each PDs ranges from 0 to 1 with smaller values showing greater effects and 1 indicating no inhibiting effect. The model assumes that the TF is almost the same for all women but the actual fertility is affected by the four main PDs. The TF to a Nigerian woman was estimated to be 14[21].

The revised Bongaart proximate determinants of fertility model

The analysis in this study was based on the revised Bongaart model[21]. The revision was made to the original model due to issues raised by Stover[31]. The revised model replaced the index of marriage or cohabitation with index of sexual exposure. The number of women who are exposed to the risk of childbearing was estimated by aggregating the number of married women (or in consensual unions) and unmarried women who are pregnant, report sex in the last month and use contraception or are postpartum infecundable. The index of contraception was revised by allowing variation in effectiveness by age and method. No revision was needed for Postpartum Infecundability Index. In this study, average duration of breastfeeding was used to estimate the postpartum infecundability. The abortion index was estimated using abortion rate produced by Sedgh and colleagues[32], because of a paucity of information on abortion in developing countries[21]. The estimates of TAR were calculated as 30 times the abortion rate per 1000 women aged 15-45 (divided by 1000). The abortion rate used in this study was obtained from the document of Sedgh and colleagues.

We used the following notations:
TAR= Total abortion rate
TF = total fecundity rate
$f_f(a)$ = fecundity rate
$f_m(a)$ = fertility rate exposed women
$f_n(a)$ = natural exposed fertility,
m(a) = proportion married/union
x(a) = extramarital exposure
u(a) = contraception prevalence (exposed women)
o(a) = overlap with postpartum infecundability
e(a) = average effectiveness
r = fecundity adjustment
i(a) = average duration of postpartum infecundability (breastfeeding)
ar(a) = abortion rate, a = age

The first step was the calculation of proximate determinants of fertility for each time period (equations 1-12 below) as proposed by Bongaarts[21]:

$$TFR = C_m C_c C_i C_a TF \quad (1)$$

C_m is sexual exposure index

$$C_m = \sum C_m(a) W_m(a) \quad (2)$$

$$C_m(a) = m(a) + x(a) \quad (3)$$

$$W_m(a) = \frac{f_m(a)}{\sum f_m(a)} \quad (4)$$

$$f_m(a) = Cc(a) C_i(a) C_a(a) f_f(a) \quad (5)$$

C_c is contraception index

$$Cc = \sum Cc(a) Wc(a) \quad (6)$$

$$C_c(a) = 1 - r(a)(u(a) - o(a))e(a) \quad (7)$$

$$Wc(a) = \frac{f_n(a)}{\sum f_n(a)} \approx \frac{f_f(a)}{f_f(a)} \quad (8)$$

C_i is Postpartum Infecundability Index

$$C_i = \sum C_i(a) W_i(a) \quad (9)$$

$$C_i(a) = \frac{20}{18.5 + i(a)} \quad (10)$$

Abortion Index

$$C_a = \sum C_a(a) W_a(a) \approx \frac{TFR}{TFR + bTAR} \quad (11)$$

$$b = \frac{14}{18.5 + i(a)} \quad (12)$$

Direct method developed by Moultrie and colleagues was used to produce the total fertility rates (TFR). The mathematical exposition of this method has been published elsewhere[21]

Change in estimated TFR

The indices of the four major PDs were estimated for the 2003 and 2018 with assumption that TF was 14. Then, equation (1) was used to estimate TFR for both 2003 and 2018 in order to derive the change in Estimated TFR. Thereafter, we decomposed the change in estimated TFR between time periods to determine the contributions of each index to this change.

Decomposition of the change in estimated TFR

A five- factor decomposition method proposed by Das Gupta[33] was used to decompose the change in estimated TFR between 2003 and 2018. The description of the method is as follows:

If $T_1 = TFR_{2003}$ and a_1, b_1, c_1, d_1, & e_1 represent Cm, Cc, Ci, Ca & TF of 2003 respectively

$T_2 = TFR_{2018}$ and a_2, b_2, c_2, d_2, & e_2 represent Cm, Cc, Ci, Ca & TF of 2018 respectively

The change in TFR

$T_2 - T_1$ = a-effect + b-effect + c-effect + d-effect +e-effect (14)

a-effect = $Q(a_2 - a_1)$

Where Q is a function of b_1, c_1, d_1, e_1 b_2, c_2, d_2, e_2 given by:

$$Q = \frac{b_2c_2d_2e_2 + b_1c_1d_1e_1}{5} + \frac{b_2c_2d_2e_1 + b_2c_2d_1e_2 + b_2c_1d_2e_2 + b_1c_2d_2e_2 + b_1c_1d_2e_2 + b_1c_2d_1e_1 + b_2c_1d_1e_1}{20} + \frac{b_2c_2d_1e_1 + b_2c_1d_1e_1 + b_2c_1d_1e_2 + b_1c_1d_2e_2 + b_1c_1d_2e_2 + b_1c_2d_1e_2 + b_1c_2d_2e_1}{30} \quad (15)$$

b-effect = $Q(b_2 - b_1)$

Where Q is a function of a_1, c_1, d_1, e_1, a_2, c_2, d_2, e_2 given by:

$$Q = \frac{a_2c_2d_2e_2 + a_1c_1d_1e_1}{5} + \frac{a_2c_2d_2e_1 + a_2c_2d_1e_2 + a_2c_1d_2e_2 + a_1c_2d_2e_2 + a_1c_1d_2e_2 + a_1c_2d_1e_1 + a_2c_1d_1e_1}{20} + \frac{a_2c_2d_1e_1 + a_2c_1d_1e_1 + a_2c_1d_1e_2 + a_1c_1d_2e_2 + a_1c_1d_2e_2 + a_1c_2d_1e_2 + a_1c_2d_2e_1}{30} \quad (16)$$

d-effect = $Q(d_2 - d_1)$

Where Q is a function of a_1, b_1, d_1, e_1, a_2, b_2, d_2, e_2 given by:

$$Q = \frac{a_2b_2c_2e_2 + a_1b_1c_1e_1}{5} + \frac{a_2b_2c_2e_1 + a_2b_2c_1e_2 + a_2b_1c_2e_2 + a_1b_2c_2e_2 + a_1b_1c_2e_2 + a_1b_2c_1e_1 + a_2b_1c_1e_1}{20} + \frac{a_2b_2c_1e_1 + a_2b_1c_1e_1 + a_2b_1c_1e_2 + a_1b_1c_2e_2 + a_1b_1c_2e_2 + a_1b_2c_1e_2 + a_1b_2c_2e_1}{30} \quad (17)$$

e-effect = $Q(e_2 - e_1)$

Where Q is a function of a_1, b_1, c_1, d_1, a_2, b_2, c_2, e_2 given by:

$$Q = \frac{a_2b_2c_2d_2 + a_1b_1c_1d_1}{5} + \frac{a_2b_2c_2d_1 + a_2b_2c_1d_2 + a_2b_1c_2d_2 + a_1b_2c_2d_2 + a_1b_1c_2d_2 + a_1b_2c_1d_1 + a_2b_1c_1d_1}{20} + \frac{a_2b_2c_1d_1 + a_2b_1c_1d_1 + a_2b_1c_1d_2 + a_1b_1c_2d_2 + a_1b_1c_2d_2 + a_1b_2c_1d_2 + a_1b_2c_2d_1}{30} \quad \mathbf{(18)}$$

Table 1: Original Bongaarts equation

Parameters of Bongaarts Framework	Equation	Variable
Marriage Index	$C_m = \frac{\sum m(a) f_m(a)}{\sum f_m(a)}$	m(a) = proportion married by age; $f_m(a)$ = age specific marital fertility rate; a = age
Contraception Index	$C_c = 1 - 1.08ue$	u = contraceptive prevalence (married women); e = average effectiveness
Postpartum Infecundability index	$C_i = \frac{20}{18.5 + i}$	i = average duration of postpartum infecundability
Abortion Index	$C_a = \frac{TFR}{TFR + bTAR}$ $b = 0.4(1+u)$	TFR = total fertility rate; TAR = total abortion rate; b = births averted per abortion
Total Fecundity (TF) TFR = C_m x C_c x C_i x C_a x TF		

Source: Bongaart (2015)

Results

Figure 1 illustrates the trends in total fertility rates resulting from the direct estimation method. The results, according to the figure, show a marginal decline in Nigeria; a persistence but slow decline in North Central. In South-East, it appears fertility rose between 2003 and 2008, but stalled between 2008 and 2018. Also, an accelerated fertility decline was observed in South-South compared to other regions. Inconsistences were observed in North West and South West. However, the level of fertility has been consistently lowest in the South West, and highest in the North West, except in 2003 where North East was highest and in 2013 where South-South was lowest.

Table 2 shows the estimated proximate determinants and total fertility rate by regions and

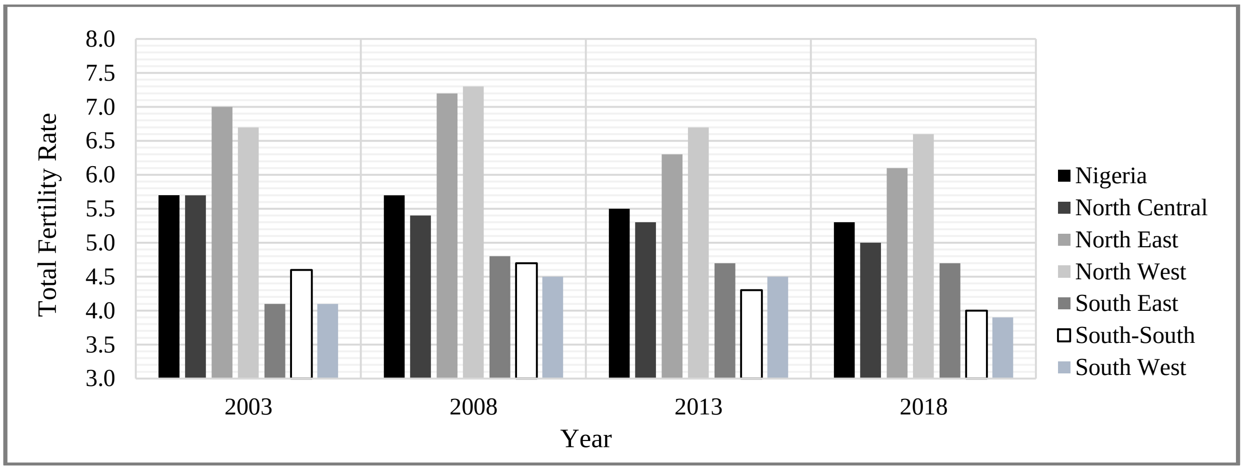

Figure 1: Trend in total fertility rates in Nigeria and Regions 2003- 2018

Table 2: Estimated proximate determinants and total fertility rate (TFR) for Region and Nigeria, 2003 & 2018

Regions by Survey years	**Sexual Exposure Index**	**Contraception Index**	**Postpartum Inf. index**	**Abortion Index**	**Total Fecundity**	**Estimated TFR**
Nigeria 2003	0.79	0.83	0.69	0.94	14	6.00
Nigeria 2018	0.77	0.79	0.70	0.93	14	5.59
North Central 2003	0.79	0.82	0.67	0.94	14	5.72
North Central 2018	0.78	0.78	0.69	0.92	14	5.48
North East 2003	0.83	0.91	0.68	0.95	14	6.87
North East 2018	0.86	0.84	0.68	0.94	14	6.54
North West 2003	0.89	0.90	0.68	0.95	14	7.25
North West 2018	0.88	0.85	0.69	0.94	14	6.85
South East 2003	0.70	0.77	0.72	0.93	14	5.06
South East 2018	0.66	0.77	0.76	0.91	14	4.86
South-South 2003	0.74	0.73	0.72	0.93	14	5.04
South-South 2018	0.65	0.73	0.73	0.90	14	4.36
South West 2003	0.73	0.70	0.73	0.93	14	4.88
South West 2018	0.68	0.68	0.73	0.90	14	4.26

Inf.: Infecundity

Table 3: Decomposition of change in TFR by Regions and Nigeria, 2003-2018

Regions by Survey years	Est. TFR	Change in Est. TFR	Sexual Exposure effect (% CB)	Contraception effect (% CB)	Postpartum Infecundability effect (% CB)	Abortion effect (% CB)	Residual (% CB)
Nigeria 2003	6.00	-0.41	-0.18	-0.26	0.12	-0.08	-0.009
Nigeria 2018	5.59		43.53	63.31	-28.06	18.86	2.35
North Central 2003	5.72	-0.24	-0.11	-0.22	0.21	-0.11	-0.002
North Central 2018	5.48		46.40	92.04	-85.37	46.05	0.89
North East 2003	6.87	-0.33	0.27	-0.55	0.05	-0.08	-0.03
North East 2018	6.54		-81.87	165.69	-15.77	24.05	7.90
North West 2003	7.25	-0.40	-0.04	-0.44	0.21	-0.12	-0.005
North West 2018	6.85		9.27	110.97	-52.56	31.08	1.24
South East 2003	5.06	-0.20	-0.34	-0.03	0.26	-0.08	-0.001
South East 2018	4.86		172.85	16.72	-132.74	42.56	0.58
South-South 2003	5.04	-0.68	-0.59	-0.04	0.08	-0.11	-0.01
South-South 2018	4.36		87.04	5.91	-11.43	16.80	1.67
South West 2003	4.88	-0.62	-0.33	-0.12	-0.04	-0.12	-0.02
South West 2018	4.26		52.89	18.56	6.40	19.64	2.51

Est.: Estimated; TFR: Total Fertility Rate; CB: Contribution; Est.: Estimated

Nigeria, 2003 & 2018. As indicated in the table, the Estimated TFR based on estimated proximate determinants for Nigeria and regions are as follows: Nigeria 2003 (6.0), Nigeria 2018 (5.59), North Central 2003 (5.72), North Central 2018 (5.48), North East 2003 (6.87), North East 2018 (6.54), North West 2003 (7.25), North West 2018 (6.85), South East 2003 (5.06), South East 2018 (4.86), South-South 2003(5.04), South-South 2018 (4.36), South West 2003 (4.88), South West 2018 (4.26). In 2003, fertility inhibiting effect of Postpartum Infecundity was the greatest in Nigeria (0.69); North Central (0.67), North East (0.68), North West (0.68) and South-South (0.72). However, in the South East, it was a delay in sexual exposure (0.70); and it was contraceptive use in South West (0.70). In 2018, the pattern remained nearly the same in the Northern region and South-East; but it was a delay in sexual exposure that has highest inhibiting effects on fertility in South West (0.68) and South-South (0.65). Notably, the abortion rate has the smallest fertility inhibiting effect across the regions.

Table 3 shows the decomposition of changes in estimated TFR for Regions and Nigeria, 2003-2018. According to the result, change in TFR between 2003 and 2018 across the regions are given as follows from highest to the lowest: South-South (-0.68), South West (-0.62), North West (-0.40), North West (-0.33), North Central (-0.24) and South East (-0.20) as well as Nigeria (-0.41). Sexual exposure index and contraceptive use contributed the most to the change across the regions. For instance, the percentage contribution of sexual exposure in South-South, South West, South East, and Nigeria were 87.04%, 52.89%, 172.85% and 43.53% respectively. However, it is worthy of note that the contraceptive use reduced between 2003 and 2018 in North West. Furthermore, most of the change observed in North central (92.04%) and Nigeria (63.31%) was attributable to contraceptive use.

Discussion

Our study estimated the proximate determinants of fertility and fertility level as well as decomposed the changes in fertility levels across the six geopolitical zones of Nigeria between 2003 and 2018. The estimated TFRs for Nigeria in 2003 (6.0) and 2018 (5.6) were inconsistent with that of NDHS reports; this may be due to different method employed in this study. However, the change of 0.4 observed was the same with the change documented in the NDHS 2018 report[14]. The estimates across the regions as indicated in the study- North Central 2003 (5.7), North Central 2018 (5.5), North East 2003 (6.9), North East 2018 (6.5), North West 2003 (7.3), North West 2018 (6.9), South East 2003 (5.1), South East 2018 (4.9), South-South 2003(5.0), South-South 2018 (4.4), South West 2003 (4.9), South West 2018 (4.3)- are plausible estimates because they fell within the range of other reports[23]. The level of fertility was highest in the North West and lowest in South West, and this pattern was consistent in 2003 and 2018. This finding is in line with earlier studies conducted in Nigeria[14,15]. The northern region dominated by people of Hausa/Fulani origin who have lower literacy level, and are predominantly Muslim[14]. These groups have been marked as fertility drivers in Nigeria[15].

The findings of this study identified three proximate determinants of fertility that have played important roles in Nigeria's fertility level in 2003 and 2018. In both 2003 and 2018, fertility inhibiting effect of Postpartum Infecundity was the greatest in Nigeria, North Central, North West and North East. While, in South East, South-South and South West it was delayed sexual exposure and contraception use that were greatest inhibitor of natural fertility. This indicates that postpartum infecundability (breastfeeding), delayed sexual exposure, and contraception are important predicators of fertility outcome in Nigeria. These results were similar to findings in Malaysia, Bangladesh, Ghana, Zambia, Namibia, and Ethiopia[23,25,27,28,34,35]. The fertility-inhibiting effects of contraceptive use and sexual exposure increased in Nigeria between 2003 and 2018. In 2003, C_c was 0.8324 but decreased to 0.7850 in 2018; while a minimal changed was observed in C_m between 2003 (0.7938) and 2018 (0.7691). The change in C_c reflected an increase in contraceptive use prevalent rate among Nigeria reproductive women as documented in NDHS reports[14].

Based on the result of this model the highest change was observed in South-South (-0.68) and lowest in South East (-0.20). The huge change observed in South-South compares to other regions may not be unconnected with literacy level (ability to read and write) which was the highest in the region[14] and decline of under-five mortality was more rapid in the region compared to other regions[37]. However, meagre change noticed in South East remains a puzzle that needs a second look because reproductive women of South-South and South East have similar characteristics.

The results of the decomposition presented in this study show that the change observed in the level of fertility was majorly caused by delayed sexual exposure and contraception use. This finding corroborates the studies that have established the importance of contraceptive use and age at first sexual debut in facilitating fertility reduction[27,38,39]. The contribution of sexual exposure to change observed in TFRs of Southern regions between 2003 and 2018 reflects postponement in the age of first marriage. This is not surprising in Southern region of Nigeria because of women with a higher level of education[14]. Women's education affects fertility via postponement of the onset of childbearing and contraceptive use[40]. Furthermore, the results of this study also revealed that the little change observed in the Northern region was majorly due to a marginal increase in the prevalent of Contraceptive use in the regions[14]. Given the relatively early marriage that persists in the North West and North East[15], the fertility level remains above six.

Implications for policy and future research

Nigeria, with a population estimate of above 200 million and growth rate of about 2.5%, is among the ten topmost fertility level in the world. The unrestraint population growth of Nigeria may have harmful implication for the country's health, environment, and infrastructural development. The consequences of the population growth in Nigeria and most low income country are compounded by the prevailing economic, political and cultural situation[2]. Analysis of fertility across sub-national in a heterogeneous country like Nigeria is necessary considering its importance on accomplishment of sustainable development goals. The different drivers of fertility found in this study are necessary to prioritize strategies for fertility reduction across the zones of Nigeria. In the quest to facilitate a rapid reduction in Nigeria fertility level, researches that will focus on the needed change in each of the PDs for drastic decline in fertility level across the zones of Nigeria will be a welcome development.

Limitation

Theoretically, Bongaarts PDs framework is strong; however, it is limited by paucity of data on some of the PDs such as sexual activities, the effectiveness of contraceptive use, and abortion rate. Estimating these PDs accurately has remained hard. Also, the study was based on cross-sectional study design; and high rates of error particularly non-sampling errors are associated with this type of study design. More so that the information collected were self-reported, some cultural beliefs and practices might affect the information on fertility behavior. There are tendencies of underreporting of births due to omission and displacement which could lead to under-estimation of fertility. Also, the inability to assess other distant variable that may better explain the driver of fertility is a limitation

Conclusion

Out of the four proximate determinants of fertility, only abortion index appears to be an unimportant inhibiting factor of fertility across the six geo-political zones of Nigeria. This study has also revealed that fertility levels are still high in Nigeria. There were regional differentials in fertility levels and trends. The driver of fertility level in Nigeria remain North West and North East. Notably, Southern regions are moving to the point of transiting to the second phase of transition that is where TFR equals 4.0; while, fertility levels are above 6 children per woman in North West and North East. The decomposition analysis revealed that delayed sexual exposure and contraceptive use contributed the largest chunk of the change observed in fertility level in Nigeria between 2003 and 2018. Strategies that will promote delayed sexual exposure, contraceptive use and breast feeding practices among the reproductive women are imperative to accelerate fertility transition in Nigeria. Programmes that focus on increasing educational opportunities for girls should be organized. Also, increasing access to family planning services for women of reproductive age, and encouraging the use of contraceptive should be considered as a matter of necessity in the country.

Ethical approval and consent to participate

The study was based on the secondary data which were assessed on the web platform of the data originators. The data originators sought informed consents from the respondents and they were assured of confidentiality and anonymity of the information they provide. There was no identifier in the raw data that can be used to link a particular respondent to the information she provides. Proper approval to download and use NDHS data was obtained from ORC Macro International, the agency responsible for Demographic and Health survey globally.

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