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# ESTIMATION OF FERTILITY RATES FOR BAYELSA STATE; USING BRASS P/F RATIO TECHNIQUE AND GOMPERTZ RELATIONAL MODEL

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## ABSTRACT

*The aim of this paper is to examine fertility rate in the study area. The estimates presented in this research were sampled from secondary data extracted from records of three general hospitals in the three eco zones of the State using the Brass and Gompertz methods. From the analysis, it was observed that the estimated mean parities rise steadily with age reaching the peak in both methods. This observation is in line with the international standards that "data on lifetime fertility by the ages of women from most developing countries show that it rise steadily with age, reaching a maximum in the 45-49 age groups." The estimated total fertility rates obtained from both methods in the state lies within the estimates reported for Nigeria. The study further show that fertility rate in the study area is high and varies relatively among the sampled zones. Since majority of the rural dwellers lack knowledge of family planning and with the absence of primary health care services, planners and policy makers in the health sector should formulate programs aimed at bringing these services closer to the people so as to dissuade them from child mortality. Furthermore, enlightenment campaigns should be put in place to educate them on the use of contraceptive and the importance of birth control.*
***Keywords: Brass, Gompertz, Fertility, Estimate, Children, Rate.***

## INTRODUCTION

One of the most important components of Demographic change is fertility, others being mortality and migration. Fertility is a term used to indicate the actual number of children born alive. It is the frequency of child bearing among the population. It is usually measured in relation to women because women rather than their male counterpart actually give birth to the babies. Fertility rate therefore refers to the relative frequency with which births actually occur within a given population (Kpedepo 1982).

In fertility study, the child bearing age is from the age of 15 years to 49 years. Sources of information concerning fertility can be obtained through population census, survey and birth registration (vital registration). Through the study of fertility data the current level, the trend and the pattern of fertility can be determined.

In Nigeria for instance, it has been statistically speculated from the result obtained from the 1984 demographic survey of the country that the average Nigerian women would have a family size of over 6 children, a gross reproduction rate estimated at over 2.7 and a total fertility rate of over 5.6, thus ranking among the highest in the world (Oyeka 1986).

Brass et al (1978) from the world fertility survey obtain the total fertility rate as 6.34 for Nigeria. The sentinel survey of the National population programmed base line report (2000) recorded that; Nigeria fertility survey in 1981 has a total fertility rate of 6.3 while the sentinel survey in 2000 has it as 5.1.

The Nigeria Demographic Health Survey (2009) report shows that fertility rate in Nigeria has remained at a high level over the last 17 years from 5.9 births per woman in 1991 to 5.7 births in 2008.

The data for this work was extracted from records of three general hospitals in the three zones of the study area from nine general hospitals. The hospital are Kolo I general Hospital (eastern zone), Okolobiri general hospital (central zone)and Sagbama general hospital (western zone).

## The procedure for the computation of the Brass p/f ratio techniques

In Brass P/F ratio technique and Gompertz relational model, the basic information (data) needed for estimating the age specific fertility rate (ASFR) is shown in table 1.

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The brass P/F ratio techniques are essentially base on comparison of average parity equivalent (F) and reported average parity (P). So this method adjust the level of observed age pattern of fertility to agree with the level of the fertility indicated by the average parities in the age lower than 30-35 which are assumed to be correct. Measures of average parity equivalent (F) comparable to reported average parity (P) are obtained from eriod fertility rate by cumulating and interpolating (these measures are effectively averages of the addition of fertility over age group) Measures of average parity (P) to the estimated parity equivalent (F) are calculated, age group by age group and an average of the ratio obtained for younger women is used as an adjustment factor by which all the observed period rate are multiplied.

The steps are as follows:

**STEP 1:** Calculation of reported parities (Ave. Parity Per woman or mean parity (P (i)). These values are obtained by dividing the entries in column 2 by column 1. In Table 1 under appendix.

**STEP 2:** Calculation of period fertility rate $f$(i)

These are computed by dividing the entries in column 3 by those in column 1 (table 1 under appendix).

**STEP 3:** Calculation of cumulative fertility rate Q(i).

$$Q(i) = 5\left(\sum_{i=1}^{7} f(i)\right) \quad \ldots\ldots 2.0.1$$

**STEP 4:** Calculation of Estimated Parity Equivalent F (i)

These values are calculated using the formula:

$$F(i) = Q(i-1) + a(i)f(i) + b(i)f(i+1) + c(i)Q7 \quad \ldots\ldots 2.0.2$$

Where the coefficients a (i), b (i) and c (i) are shown in table 7 under appendix

**STEP 5:** Calculation of P/F ratio

These values are obtain by dividing the entries in P (i) by those in F (i) in table 2 under appendix

**STEP 6:** Calculation of weighting factor w (i)

These values are calculated using the formula

$$W(i) = X(i) + \frac{Y(i)f(i)}{Q(7)} + \frac{Z(i)f(i+1)}{Q(7)} \quad \ldots\ldots 2.0.3$$

Where the coefficients X (i), Y (i) and Z (i) are shown in table 8 under appendix

**STEP 7:** Calculation of fertility rate for conventional age group $F^{+}$ (i)

These values are calculated using the formula

$F^{+}(i) = \{1 - w(i-1)\} f(i) + w(i) f(i+1)$ ……………………………2.0.4

**STEP 8:** Calculation of Adjusted fertility rate F* (i).

These values are obtained by using the formula:

$K F^{+}(i)$ ……………………………………………………………2.0.5

$$\text{Where } K = \frac{\frac{P(2)}{F(2)} + \frac{P(3)}{F(3)}}{2}$$

**The procedure for the computation of Gompertz Relational Model**

According to Zaba this provides a tool for adjusting and correcting fertility distribution derived from reports of births in the last year or children ever born (CEB).

The relation is given by

$$F(X)/F = A^{\beta^{X}} \quad \ldots\ldots 2.1.1$$

Where F(X) is cumulative age specific rates up to age x F is the total fertility were A and β are constants for a particular set of rates that lie between zero and one.

Brass suggested that taking double natural logarithm in succession on both sides of equation 6.1 can improved it.

Hence $\ln[-\ln(F(X)/F)] = \ln(\ln A) - X \ln\beta$ ……………………2.1.2

Thus the double logarithm transformation of the proportion of fertility achieved by age X becomes a linear function of X. This is expressed by:

$Y(X) = \alpha + \beta X$ ............................................................................2.1.3

Where $Y(X) = -\ln\{\ln(F(X)/F\}$

α and β are constants which vary for different schedules.

In the relational model

$Y(X) = \alpha + \beta Y_s(X)$ ..................................................................2.1.4

Where $Y_s(X)$ is a standard set of values derived from a standard fertility chosen to represent an average shape.

The problem is to estimate these parameters using age groups (15-19), (20-24), (25-29) and (35-39).

The simple procedure used is as follows:

Since $Y(X) = -\ln\{\ln(F(X)/F\}$ equation 2.1.3 becomes

$-\ln\{\ln(F(X)/F\} = \alpha + \beta X$ ......................................... 2.1.3 (1)

And $Y(X) = \alpha + \beta Y_s(X)$ .................................................2.1.4

where $Y_s(X)$ is as defined above

$F(X)$ is the cumulative fertility rate to exact age X

F is the approximate total fertility rate.

α and β are the parameter measuring location and dispersion of this distribution.

Using 2.1.3 (1) and 2.1.4, we can write

$$-\ln\{\ln(F(X)/F\} = \alpha + \beta Y_s(X) \quad \text{.......................................2.1.5}$$

Replacing $F(X)$ by $P_i$ we have

$$-\ln\{\ln(p_i/F\} = \alpha + \beta Y_s(i) \quad \text{...........................................2.1.6}$$

OR

$$\ln\left(\frac{p_i}{F}\right) = e^{-\alpha-\beta Y_s(i)}$$

OR

$$\ln p_i + \ln F = e^{-\alpha}.e^{-\beta Y_s(i)} \quad \text{............................................2.1.7}$$

Equation 2.1.7 has three unknown parameters F, α and β which can be estimated by taking three selected values of Pi (i=1, 2 ...7).

Let $P_1$, $P_2$ and $P_3$ be the mean parities for the age group 20-24, and 30-24

Respectively then equation 2.1.7 becomes

$$\ln p_1 + \ln F = e^{-\alpha}.e^{-\beta Y_s(1)} \quad \text{.................. (a)}$$

$$\ln p_2 + \ln F = e^{-\alpha}.e^{-\beta Y_s(2)} \quad \text{.................. (b)}$$

$$\ln p_3 + \ln F = e^{-\alpha}.e^{-\beta Y_s(3)} \quad \text{.................. (c)}$$

Now, subtracting (a) from (b) we have

$$\ln p_1 \ln p_2 = e^{-\alpha}.e^{-\beta Y_s(2)} - e^{-\alpha}.e^{-\beta Y_s(1)} \quad \text{........................2.1.8}$$

$$\text{Or } \ln p_1 \ln p_2 = e^{-\alpha}\{e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)}\}$$

Similarly subtracting (c) from (b) we have

$$\ln p_3 \ln p_2 = e^{-\alpha}\{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}\} \quad \text{...............................2.1.9}$$

Dividing 2.1.9 by 2.1.8, we have

$$\frac{\ln p_3 \ln p_2}{\ln p_1 \ln p_2} = \frac{e^{-\alpha}\{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}\}}{e^{-\alpha}\{e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)}\}}$$

$$\frac{\ln p_3 \ln p_2}{\ln p_1 \ln p_2} = \frac{\{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}\}}{\{e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)}\}} \quad \text{..........................................2.1.10}$$

OR $\frac{\ln p3 - \ln p2}{\ln p1 - \ln p2} = \left(\frac{(e^{-Y_s(2)} - e^{-Y_s(3)})}{(e^{-Y_s(2)} - e^{-Y_s(1)})}\right)^{\beta}$

Let $\frac{\ln p3 - \ln p2}{\ln p1 - \ln p2} = K$

And $\frac{(e^{-Y_s(2)} - e^{-Y_s(3)})}{(e^{-Y_s(2)} - e^{-Y_s(1)})} = R$

*Then* $K = R^{\beta}$

$\ln K = \beta \ln R \Rightarrow \beta = \frac{\ln k}{\ln R}$

Since $P_1$, $P_2$, P3, $Y_s(2)$ and $Y_s(3)$ are known the value of $\beta$ can be determine from above.
Once $\beta$ is known, α can be determined too:
From equation 2.1.8,

$$\ln p1 - \ln p2 = e^{-\alpha}(e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)})$$

Also from equation 2.1.10,

$$\ln p1 - \ln p2 = \frac{(\ln p3 - \ln p2)(e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)})}{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}}$$

$$= e^{-\alpha}(e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)}) = \frac{(\ln p3 - \ln p2)(e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)})}{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}}$$

Hence $e^{-\alpha} = \frac{(\ln p3 - \ln p2)}{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}}$

$\alpha = -\ln\left(\frac{(\ln p3 - \ln p2)}{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}}\right)$ ........................................2.1.11

Finally F can be obtain from equation 2.1.7

i.e. $\ln F = e^{-(\alpha - \beta Y_s(i))} + \ln pi$

$F = \exp(e^{-(\alpha - \beta Y_s(i))} + \ln pi)$ ....................................2.1.12

Let i = 3: $F = \exp(e^{-(\alpha - \beta Y_s(3))} + \ln p3)$, the values of α and $\beta$ the values of $Y(X)$ i.e. $Y(X) = \alpha + \beta Y_s(X)$ ....................................................2.1.13

Then $Y(X)$ values can be converted into as follows:

$\frac{F(X)}{F} = \exp(-e^{-Y(X)})$

OR

$F(X) = F\exp(-e^{-Y(X)})$ ............................................................2.1.14

And then age-specific fertility rates (ASFR) are obtained as follows:

ASFR= $\frac{F(X) - F(X-1)}{n}$ .............................................................. 2.1.15

Where n is the length of the age interval which is generally 5 years.

## DATA ANALYSIS

Here, the computation of fertility rate will be examined using the two methods.

**Brass p/f ratio techniques for the Estimation of Fertility Rate**

The steps in 2.0 are applied to the data in table 1 below (for the state). An illustration in each step is shown below:

**STEP 1:** Calculation of reported parities (Ave. Parity Per woman or mean parity (P (i)). These values are obtained by dividing the entries in column 2 by column 1 in table 1.
e.g. P (3) = 255/104 = 2.4519.

**STEP 2:** Calculation of period fertility rate $f$(i)

These are computed by dividing the entries in column 3 by those in column 1 table 1. e.g. f (2) = 29/98 = 0.2959

**STEP 3:** Calculation of cumulative fertility rate Q (i).

$$Q(i) = 5\left(\sum_{i=1}^{7} f(i)\right) \quad \text{..........................................2.0.1}$$

E.g. Q (7) = (5x0.0952) + (5 x 0.2959) +(5 x 0.3173)+ (5x0.2987) + (5 x 0.1475 + (5x0.1020) + (5 x 0.0263) = 6.4145

**STEP 4:** Calculation of Estimated Parity Equivalent F (i)

These values are calculated using the formula:

$$F(i) = Q(i-1) + a(i)f(i) + b(i)f(i+1) + c(i)Q7 \quad \text{.......2.0.2}$$

Example,
F (4) = 3.5420+ (3.442 x 0.2989) + (-0.563 x -1475) + (0.0029 x 6.4145)
= 4.5057

Where the coefficients a (i), b (i) and c (i) are shown in table 1 under appendix.

**STEP 5:** Calculation of P/F ratio

These values are obtain by dividing the entries in P (i) by those in F (i) in table 2.
E.g. P (5)/F (5) = 4.6885/5.4804 = 0.8555

**STEP 6:** Calculation of weighting factor w (i)

These values are calculated using the formula

$$W(i) = X(i) + \frac{Y(i)f(i)}{Q(7)} + \frac{Z(i)f(i+1)}{Q(7)} \quad \text{......................2.0.3}$$

E.g. w (2) = 0.068 + (0.999 x 0.2959/6.4145) + (-0.233 x 0.3173/6.4145) = 0.1088

Where the coefficients X (i), Y (i) and Z (i) are shown in table 2 under appendix.

**STEP 7:** Calculation of fertility rate for conventional age group $F^{+}$ (i)

These values are calculated using the formula

$F^{+}$ (i) = {(1 – w (i-1)} f (i) + w (i) $f$(i+1)..........................2.0.4

E.g. $F^{+}$ (2) = {(1-0.0702) x 0.2059} + (0.1026 x 3173) = 0.3077

**STEP 8:** Calculation of Adjusted fertility rate F* (i).

These values are obtained by using the formula K $F^{+}$ (i).........2.0.5

$$\text{Where } K = \frac{\frac{P(2)}{F(2)} + \frac{P(3)}{F(3)}}{2}$$

$$\text{e.g.} \quad K = \frac{1.0106 + 0.8463}{2} = 0.9285$$

Hence KF* (2) = 0.9285 x 0.3077 = 0.2857

The result of the computations is shown in table 2 below. In the same way, the results of the Estimates of Bayelsa central and Bayelsa west were obtained. The result of the adjusted ASFR for the three zones and the state are shown in table 3.

Table 1:
Children Ever Born from 2005-2009 and Births During the Past year by Age group of Mothers in Bayelsa State

| | BAYELSA EAST | | | BAYELSA CENTRAL | | | BAYELSA WEST | | | BAYELSA STATE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age Group | No. of Women 1 | CEB 2 | Birth in Past 3 | No. of Women 4 | CEB 5 | Birth in Past year 6 | No. of Women 7 | CEB 8 | Birth in Past Year 9 | No. of Women 10 | CEB 11 | Birth in Past Year 12 |
| 15-19 | 105 | 56 | 10 | 151 | 75 | 17 | 326 | 163 | 33 | 582 | 294 | 60 |
| 20-24 | 92 | 131 | 29 | 135 | 179 | 36 | 291 | 386 | 86 | 524 | 696 | 151 |
| 25-29 | 104 | 255 | 33 | 127 | 352 | 46 | 273 | 759 | 99 | 504 | 1366 | 178 |
| 30-34 | 77 | 283 | 23 | 107 | 399 | 31 | 228 | 913 | 65 | 412 | 1595 | 119 |
| 40-44 | 61 | 286 | 9 | 85 | 398 | 13 | 181 | 853 | 27 | 327 | 1537 | 49 |
| 45-49 | 49 | 247 | 5 | 69 | 342 | 7 | 144 | 736 | 16 | 262 | 1325 | 28 |
| 45-49 | 38 | 202 | 1 | 55 | 280 | 4 | 116 | 601 | 5 | 209 | 1083 | 10 |
| TOTAL | 532 | 1,460 | 110 | 729 | 2,025 | 154 | 1,559 | 4,411 | 331 | 2,820 | 7896 | 595 |

Source: General Hospital Kolo1, Genral Hospital Okolobiri and General Hospital Sagbama

Table 2:
Result of the Computation of Brass/F Method for Estimating Fertility Rate in Bayelstate

| AGE GROUP | Index (i) | Average Parity per Women P (i) | Period fertility rate f (i) | Cumulative fertility rate Q (i) = $5(\sum_{i=1}^{7} f(i))$ | Estimated Parity equivalent F (i) | P/F ratio p(i)/F (i) | Weight Factor W(i) | Fertility rate for conventional age group F'(i) | Adjusted fertility rate F* (i) = KF' (i) K = 0.9285 |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.5333 | 0.0952 | 0.4760 | 0.2007 | 2.6572 | 0.0702 | 0.1160 | 0.1077 |
| 20-24 | 2 | 1.3367 | 0.2959 | 1.9555 | 1.3227 | 1.0106 | 0.1026 | 0.3077 | 0.2857 |
| 25-29 | 3 | 2.4519 | 0.3173 | 3.5420 | 2.8972 | 0.8463 | 0.1088 | 0.3172 | 0.2945 |
| 30-34 | 4 | 3.6753 | 0.2987 | 5.0355 | 4.5057 | 0.8157 | 0.1378 | 0.2865 | 0.2660 |
| 35-39 | 5 | 4.6885 | 0.1475 | 5.7730 | 5.4804 | 0.8555 | 0.1449 | 0.1420 | 0.1318 |
| 40-44 | 6 | 5.0408 | 0.1020 | 6.2830 | 6.1010 | 0.8262 | 0.2368 | 0.0934 | 0.0867 |
| 45-49 | 7 | 5.3159 | 0.0263 | 6.4145 | 6.3808 | 0.83310 | - | 0.0201 | 0.0187 |
| TOTAL | | | 1.2829 | | | | | 1.2829 | 1.1911 |
| TFR | | | 6.4145 | | | | | 6.4145 | 5.9555 |

The TFR is 5 x 1.1911 = 5.955 births per woman

This implies that should each woman experience this adjusted age specific fertility rate (ASFR) throughout her childbearing years, she would give birth to about 6 children by the age of 50, which is approximately the same with the period or observed rate.

Table 3:
Result of Adjusted ASFR for the three zones and the State using the Application of Brass P/F Ratio Techniques (Method)

| | | Observed Average (mean) Children ever born (mean parity) | | | | Estimated Average (mean) CEB (Parity) | | | | Adjusted ASFR | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age Group | Index | Bayelsa East | Bayelsa Central | Bayelsa West | Bayelsa State | Bayelsa East | Bayelsa Central | Bayelsa West | Bayelsa State | Bayelsa East | Bayelsa Central | Bayelsa West | Bayelsa State |
| 15-19 | 1 | 0.5333 | 0.4967 | 0.5000 | 0.5052 | 0.2007 | 0.2511 | 0.2168 | 0.2228 | 0.1077 | 0.1294 | 0.1161 | 0.1178 |
| 20-24 | 2 | 1.3367 | 1.3259 | 1.3265 | 1.3282 | 1.3227 | 1.2849 | 1.3225 | 1.3140 | 0.2857 | 0.2755 | 0.2958 | 0.2884 |
| 25-29 | 3 | 2.4519 | 2.7717 | 2.7802 | 2.7103 | 2.8972 | 2.9959 | 3.0863 | 3.0256 | 0.2945 | 0.3541 | 0.3430 | 0.3355 |
| 30-34 | 4 | 3.6753 | 3.7290 | 4.0044 | 3.8714 | 4.5057 | 4.6383 | 4.7134 | 4.6516 | 0.2660 | 0.2703 | 0.2583 | 0.2625 |
| 35-39 | 5 | 4.6885 | 4.6824 | 4.7127 | 4.7003 | 5.4804 | 5.6206 | 5.6662 | 5.6159 | 0.1318 | 0.1442 | 0.1379 | 0.1381 |
| 40-44 | 6 | 5.0408 | 4.9565 | 5.1111 | 5.0573 | 6.1010 | 6.1311 | 6.2895 | 6.2091 | 0.0867 | 0.0911 | 0.0986 | 0.0951 |
| 45-49 | 7 | 5.3159 | 5.0909 | 5.1810 | 5.1818 | 6.3808 | 6.7028 | 6.6854 | 6.6300 | 0.0187 | 0.0647 | 0.0332 | 0.0378 |
| | | | | | | | | | Total | 1.1911 | 1.3293 | 1.2829 | 1.2752 |
| | | | | | | | | | TFR | 5.9555 | 6.6465 | 6.4145 | 6.376 |

**Gompertz Relational Model for The Estimation of Fertility Rate.**

The equation 2.1.10 to 2.1.15 are applied to estimates the parameters and other estimates of the model. The parameters are estimated by assuming $P_1$, $P_2$ and $P_3$ to be the mean parities for the age group 20-24, 25-29 and 30-34. Furthermore, in using the $Y_s$ (x) values to fit the model to observed mean parities, the assumption made is that the ages at mean parities are the same for the observed data and for the standard fertility pattern $Y_s$ (x) in table 4 below.

An illustration in each case is shown below using the data values of Bayelsa east.

i. Computation of $\beta$

Using equation 2.1.10

i.e

$$\frac{\ln p_3 - \ln p_2}{\ln p_1 - \ln p_2} = \frac{\left(e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}\right)}{\left(e^{-\beta Y_s(2)} - e^{-\beta Y_s(1)}\right)}$$

Or

$$\frac{\ln p_3 - \ln p_2}{\ln p_1 - \ln p_2} = \left(\frac{\left(e^{-Y_s(2)} - e^{-Y_s(3)}\right)}{\left(e^{-Y_s(2)} - e^{-Y_s(1)}\right)}\right)^{\beta}$$

Where

$P_1 = 1.3367$

$P_2 = 2.4519$, $P_3 = 3.6753$

$Y_s(1) = -0.3119$, $Y_s(2) = 0.3538$ and $Y_s(3) = 1.0663$ (table4,collum4).

Applying the formula above, we have,

$$\frac{\ln p3.6753 - \ln p2.4519}{\ln p1.3367 - \ln 2.4519} = \left(\frac{\left(e^{-0.3538} - e^{-1.0663}\right)}{\left(e^{-0.3538} - e^{-0.3119}\right)}\right)^{\beta}$$

i.e. $-0.66721387 = (-0.538755852)^{\beta}$

i.e. $-\ln 0.6672 = -\beta \ln 0.5388$

$$\beta = \frac{\ln 0.6672}{\ln 0.5399} = 0.6544$$

ii. Computation of $\alpha$ using equation 2.1.11

$$\text{i.e. } \alpha = -\ln\left(\frac{(\ln p_3 - \ln p_2)}{e^{-\beta Y_s(2)} - e^{-\beta Y_s(3)}}\right)$$

$P_3 = 3.6753$, $P_2 = 2.4519$

$Y_s(2) = 0.3538$, $Y_s(3) = 1.0663$

$\beta = 0.6544$

$\alpha = -\ln$

$\alpha = -\ln 1.3694$

$= -0.3144$

iii. Computation of F using equation 2.1.12

$$F = \exp\left(e^{-(-0.3144 - (0.6544 \times 1.0663))} - \ln 3.6753\right)$$

$= 7.2658$

iv. Computation for Y (X) using equation 2.1.13

E.g. Y (3) = - 0.3144+ (0.6544 x 0.3538)

= - 0.0829

v. Computation for F (x) using equation 2.1.14

$$F(X) = 7.2658 \exp\left(-e^{-Y(X)}\right)$$

$$F(3) = 7.2658 \exp\left(\left[-e\right] -0.0829)\right)\right)$$

= 2.4516

vi. $\frac{F(X)}{F} = \frac{F(3)}{F} = \frac{2.4516}{7.2658} = 0.3374$

vii. ASFR is obtained by using equation 2.1.15

i.e. $\frac{F(X) - F(X-1)}{n}$

E.g. for the age group 30-34, i.e. for i or x =4

$$\text{ASFR for } i = 4 = \frac{3.6753 - 2.4519}{5} = 0.2447$$

The results are shown in table 4. Similarly, estimates of Bayelsa central, Bayelsa west and the state were obtained.

The estimated result of the ASFR for the three zones and the state is shown in table 5 below.

Summary result of the total fertility rate for the observed of Brass and Gompertz methods are shown in table 6.

**Table 4:**

**Result of the Fitting of the Gompertz Relational Model: Bayelsa State**

| Age Group | Index (i)/(x) | Mean Parity P (i) | Standard Fertility Pattern Ys(x) | Y(x) | Cumulative Fertility F(x) | F(x) / F | ASFR |
|---|---|---|---|---|---|---|---|
| 15-19 | 1 | 0.5333 | -1.0789 | -1.0204 | 0.4533 | 0.0627 | 0.0907 |
| 20-24 | 2 | 1.3367 | -0.3119 | -0.5185 | 1.3548 | 0.1865 | 0.1803 |
| 25-29 | 3 | 2.4519 | 0.3538 | -0.0829 | 2.4516 | 0.3374 | 0.2194 |
| 30-34 | 4 | 3.6753 | 1.0663 | 0.3834 | 3.6753 | 0.5058 | 0.2447 |
| 35-39 | 5 | 4.6885 | 1.9534 | 0.9639 | 4.9653 | 0.6435 | 0.2573 |
| 40-44 | 6 | 5.0408 | 3.4132 | 1.9192 | 6.2743 | 0.8635 | 0.2625 |
| 45-49 | 7 | 5.3159 | 6.0564 | 3.6489 | 7.0792 | 0.9743 | 0.1610 |
| | | | | | | **TOTAL** | 1.4159 |
| | | | | | | **TFR** | 7.0795 |

N.B F(x) is fitted with:

A = - 0.3144

B = 0.6544

F = 7.2658

**Table 5:**

**Result of the Estimated Asfr for the Three zone and the State using the Gompertz Relational Model**

| | | Observed Average (mean) Children ever born (mean parity) | | | | Estimated Average (mean) CEB (Parity) | | | | Adjusted ASFR | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age Group | Index | Bayelsa East | Bayelsa Central | Bayelsa West | Bayelsa State | Bayelsa East | Bayelsa Central | Bayelsa West | Bayelsa State | Bayelsa East | Bayelsa Central | Bayelsa West | Bayelsa State |
| 15-19 | 1 | 0.5333 | 0.4967 | 0.5000 | 0.5052 | 0.4533 | 0.1016 | 0.2828 | 0.2052 | 0.0907 | 0.0203 | 0.0566 | 0.0410 |
| 20-24 | 2 | 1.3367 | 1.3259 | 1.3265 | 1.3282 | 1.3548 | 1.2963 | 1.3179 | 1.3208 | 0.1803 | 0.2389 | 0. 2070 | 0.2231 |
| 25-29 | 3 | 2.4519 | 2.7717 | 2.7802 | 2.7103 | 2.4516 | 2.7717 | 2.7802 | 2.7103 | 0.2194 | 0.2951 | 0.2925 | 0.2779 |
| 30-34 | 4 | 3.6753 | 3.7290 | 4.0044 | 3.8714 | 3.6753 | 3.7229 | 4.0044 | 3.8714 | 0.2447 | 0.1902 | 0.2448 | 0.2322 |
| 35-39 | 5 | 4.6885 | 4.6824 | 4.7127 | 4.7003 | 4.9618 | 4.1903 | 4.8180 | 4.6523 | 0.2573 | 0.0935 | 0.1627 | 0.1562 |
| 40-44 | 6 | 5.0408 | 4.9565 | 5.1111 | 5.0573 | 6.2743 | 4.3539 | 5.2482 | 5.0745 | 0.2625 | 0.0327 | 0.0860 | 0.0844 |
| 45-49 | 7 | 5.3159 | 5.0909 | 5.1810 | 5.1818 | 7.0792 | 4.3755 | 5.3485 | 5.1760 | 0.1610 | 0.0043 | 0.0201 | 0.0204 |
| | | | | | | | | | Total | 1.4159 | 0.8750 | 1.0697 | 1.0352 |
| | | | | | | | | | TFR | 7.0795 | 4.3751 | 6.3485 | 6.1760 |

Table 6

Summary of the Result of the total Fertility rate for the Observed, Brass and Gompertz Methods

| Observed Rate | Brass Method (ASFR) | Gompertz Method (ASFR) |
|---|---|---|
| Bayelsa East 6.4145 | 5.9555 | 7.0795 |
| Bayelsa Central 6.7915 | 6.6465 | 4.3751 |
| Bayelsa West 6.7390 | 6.4145 | 5.3485 |
| Bayelsa State 6.6890 | 6.3760 | 5.1760 |

From the result shown above, estimated rates from the brass method are closer to the observed rates in each case.

## RESULT AND CONCLUSION

From the distribution in table 3 and 5, the results of the mean parity equivalent and the adjusted rates from both estimates are generally good in the middle except for the upper and lower tails. This may be because of some unavoidable errors of varying dimensions and patterns, which might have affected the data of which the techniques used must have corrected as much as possible.

From the analysis of the two methods, it was observed that the estimated mean parities or parity equivalents rise steadily with age reaching the peck. This observation is in line with the assertion by Kpedekpo (1982) that "data on lifetime fertility by the ages of women from most developing countries show that it tends to rise steadily with age, reaching a maximum in the 45-49 age groups."

The estimated total fertility rates obtained from both methods at the state level lies within the estimates reported for Nigeria by researchers' world over.

It appears that fertility rate in the study area is high and it varies among the three zones which is difficult to explain but some of the reasons could be as a result of Variation in age at marriage, Availability of family planning and contraceptive services, Religion believe, Occupation and Cultural believe.

Since a greater percentage of the population resides at the rural areas a knowledge of family planning and the provision of primary health care services are necessary at the wards and Local government headquarter. This work will no doubt help planners and policy makers in the heath sector to formulate programs that are aimed to:

(a) Bring these services closer to the people to dissuade them from child mortality. If this is done, parents would have confidence to produce only children that they can cope with.

(b) Mobilize enlightenment personnel in place to educate them on the use of contraceptive and the importance of birth control.

## APPENDIX

### COALE AND TRUSSEL COEFFICIENT FOR INTERPOLATION BETWEEN COMULATED FERTILITY RATES, Q (i) TO ESTIMATE PARITY EQUIVALENTS, F(i)

(a) For fertility rates calculated from births in a 12-months period by age of mother at the time of survey.

Table 1

| AGE GROUP | INDEX | COEFFICIENT | | |
|---|---|---|---|---|
| | (i) | a(i) | b(i) | c(i) |
| 15-19 | 1 | 2.531 | -0.188 | 0.0024 |
| 20-24 | 2 | 3.321 | -0.754 | 0.0161 |
| 25-29 | 3 | 3.265 | -0.627 | 0.0145 |
| 30-34 | 4 | 3.442 | -0.563 | 0.0029 |
| 35-39 | 5 | 3.518 | -0.763 | 0.0006 |
| 40-44 | 6 | 3.862 | -0.481 | 0.0001 |
| 45-49 | 7 | 3.828 | 0.016 | -0.0002 |

Source: COALE A..J. AND TRUSSEL T.J. (1975)

A new method of estimating standard fertility measures from incomplete data population index, Vol. 41 No.2.

Coale and Trussel Coefficient for Calculation of Weighting Factors to Estimate Age Specific Fertility Rates for Conventional Age Groups from Age Groups Sheted by Six months

Table 2:

| AGE GROUP | INDEX | COEFFICIENT | | |
|---|---|---|---|---|
| | (i) | X(i) | Y(i) | Z(i) |
| 15-19 | 1 | 0.31 | 2.287 | 0.114 |
| 20-24 | 2 | 0.068 | 0.999 | -0.233 |
| 25-29 | 3 | 0.094 | 1.219 | -0.977 |
| 30-34 | 4 | 0.120 | 1.139 | -1.531 |
| 35-39 | 5 | 0.162 | 1.739 | -3.592 |
| 40-44 | 6 | 0.270 | 3.454 | -21.497 |

Source: Coale A.J. & Trussel T. J. (1975)
A new method of estimating standard fertility measures from incomplete data population index, Vol.41 No.2

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