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On the Multivariate Analysis of the level of Use of Modern Methods of Family Planning between Northern and Southern Nigeria

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Abstract

The recently published 2013 National Demographic and Health Survey (NDHS) results show a great apathy in the use of modern family planning methods, despite the whooping financial and material resources being plunged into it. Worried by this insignificant level of use, the need to discern where more of the apathy is (North or South) becomes inevitable. This paper, therefore, stratified the NDHS data on the level of use of the modern methods of Family Planning into two, adopted the Hotelling's T^2 technique of the Multivariate Analysis in determining whether any significant difference exists between the level of use in Northern and Southern part of Nigeria. The results obtained show a significant difference and a t-test of the difference of the means of the two strata shows that the level of use of modern methods of Family Planning is more in the Southern part than in the Northern part of the country.

Keywords: Family Planning; Modern Methods; Multivariate Analysis; Vector Means; Variance- Covariance Matrix, Hotelling's T^2.

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1. Introduction

Generally, accurate data is central to the management of issues to improve the quality of any given population. In Nigeria, the National Population Commission (NPC) is statutorily empowered, through censuses and surveys, to collate, analyze and disseminate demographic data and co-ordinate and monitor the national population policy for sustainable development. Stakeholders and policy makers rely, to a great extent, on the Commission for necessary national development data.

One of such surveys was the 2013 Nigeria Demographic and Health Surveys (NDHS) whose results were recently released with valuable indicators on the health and living standards of the Nigerian people. Extensive information on the levels of trends of fertility, family planning, maternal and child health and sexually transmitted infections in the country were obtained from the survey. The disgusting revelation from the survey results with respect to the level of use of family planning methods necessitated the convening of The 3rd Family Planning Conference with the theme 'Bridging the Gaps between Knowledge and Practice of Family Planning in Nigeria' in Abuja.

Family planning which can be seen as a voluntary step taken by individuals to prevent, delay or achieve a pregnancy has proved to be a powerful tool in combating poverty and reducing maternal mortality, especially if done effectively. Stake holders in the health sector, especially family planning experts were at the Conference to consider among other things the incredible disparity between knowledge of Family Planning in Nigeria which is put at 85% and the actual practice which is placed at only 10% [1].

Although there are modern and traditional methods of family planning, we have only restricted the work on the 8 modern methods of family planning captured in the survey. They include: Pill, IUD, Injectibles, Implants, Male condom, Lactational amenorrhea method (LAM), Standard days method and Other (which includes Male sterilization, Female condom and Diaphragm). Data on the level of practice of these methods were obtained from the survey results [2], stratified into two (North and South) and then subjected to further scientific analysis with a view to finding out the part of Nigeria has been responsible for this low level of use of family planning methods. This discovery will, undoubtedly, help during interventions by relevant Agencies.

2. Method

When we have a single variable X with two random samples of values from different populations and let x_{i1} denote the values of X in the first sample for $i = 1,2,...,n_1$ and x_{i2} denote the values of X in the second sample for $i = 1,2,...,n_2$, then the mean and variance for the jth sample are:

$$\bar{x}_j = \frac{\sum_{i=1}^{n_j} x_{ij}}{n_j} \qquad (1)$$

and

$$s_j^{\,2} = \frac{\sum \left(x_{ij} - \bar{x}_j\right)^2}{n_j - 1} \qquad (2)$$

Assuming normality for X in both samples, an appropriate test statistic for testing whether the two sample means are significantly different from zero involves calculating

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \qquad (3)$$

Where $s_p^{\,2}$ is the pooled estimate of variance and is given by

$$s_p^{\,2} = \frac{(n_1 - 1)s_1^{\,2} + (n_2 - 1)s_2^{\,2}}{n_1 + n_2 - 2} \qquad (4)$$

Then determining whether (3) is significantly different from zero, it is compared with the t-distribution with $n_1 + n_2 - 2$ degrees of freedom.

If we go on to use the above method for each of the 8 modern methods of family planning under discussion to determine if any of these methods appear to have had different mean values for North and South, the purpose of the paper would be defeated. Our interest is, not to individually look at them but, to know whether the 8 variables (methods) considered together would give a significant difference between North and South. Consequently, a Multivariate Analysis becomes inevitable and the Hotelling's T^2 test readily comes to mind.

Generally, given p variables $X_1, X_2, ..., X_P$ and 2 samples with n_1 *and* n_2. Obtain 2 sample mean vectors X_1 *and* X_2 and 2 sample covariance matrices C_1 *and* C_2. A pooled estimate, C, of these matrices is given by:

$$C = \frac{(n_1 - 1)C_1 + (n_2 - 1)C_2}{n_1 + n_2 - 2} \qquad (5)$$

Then the Hotelling's T^2 test-statistic becomes:

$$T^2 = \frac{n_1 n_2 \left(\bar{X}_1 - \bar{X}_2\right)' C^{-1} \left(\bar{X}_1 - \bar{X}_2\right)}{n_1 + n_2} \qquad (6)$$

Equation 6 is named after Harold Hotelling who developed it [3] as a generalization of Student's t- statistic of Equation 3. Specifically, the Hotelling's T^2 distribution arises in multivariate statistics in undertaking tests of the differences between the (multivariate) means of different populations, where tests for univariate problems would make use of a *t*-test [4].

A significantly large value for this statistic is evident that the mean vectors are different for the 2 sampled populations. The significance or insignificance of T^2 is most simply determined by using the fact that in the null hypothesis case of equal population means the transformed statistic

$$F = \frac{(n_1 + n_2 - p - 1)T^2}{(n_1 + n_2 - 2)p} \tag{7}$$

Follows an F distribution with $p \; and \; (n_1 + n_2 - p - 1)$ degrees of freedom, [5].

3. Data Analysis and Results

The hypothesis of interest becomes:

$$H_0 : \overline{X}_{South} = \overline{X}_{North}$$

$$H_1 : \overline{X}_{South} \neq \overline{X}_{North}$$

R Statistical Software [6] has been used to perform analysis and the following results obtained:

$$\mathbf{C}_{\mathbf{South}} = \begin{pmatrix} 0.0760 & -0.0964 & -0.0946 & -0.1040 & 0.0194 & -0.3167 & 0.1660 & -0.0035 \\ & 3.1694 & 0.7086 & 2.8894 & -0.0415 & 2.7820 & -0.2457 & -0.1763 \\ & & 3.7931 & 1.1116 & -0.0785 & 3.8200 & -0.3533 & -0.0103 \\ & & & 5.9114 & -0.1154 & 1.4784 & -0.5677 & 0.0255 \\ & & & & 0.0738 & -0.2109 & 0.0363 & 0.0023 \\ & & & & & 10.3031 & -0.9479 & -0.2128 \\ & & & & & & 1.8597 & -0.0548 \\ & & & & & & & 0.0576 \end{pmatrix},$$

$$\mathbf{C}_{\mathbf{North}} = \begin{pmatrix} 0.4557 & 0.3233 & 0.1922 & 0.8468 & 0.1874 & 0.4246 & 0.1132 & 0.0237 \\ & 2.3013 & 1.2127 & 3.9812 & 0.6408 & 2.4718 & 0.0517 & 0.1093 \\ & & 1.1542 & 1.6824 & 0.7120 & 1.4157 & 0.0624 & 0.0709 \\ & & & 10.6036 & 1.6392 & 3.2394 & 0.2731 & 0.1881 \\ & & & & 0.7480 & 0.4255 & 0.10545 & 0.0522 \\ & & & & & 3.3561 & 0.0509 & 0.1097 \\ & & & & & & 0.0531 & 0.0134 \\ & & & & & & & 0.0217 \end{pmatrix},$$

where, $\mathbf{C}_{\text{South}}$ and $\mathbf{C}_{\text{North}}$ are variance covariance matrices corresponding to Southern and Northern Nigeria.

$$\bar{\mathbf{X}}_{\text{South}} = \begin{pmatrix} 0.2706 \\ 3.6765 \\ 2.1941 \\ 5.0529 \\ 0.2412 \\ 4.7059 \\ 0.9706 \\ 0.1294 \end{pmatrix}, \quad \bar{\mathbf{X}}_{\text{North}} = \begin{pmatrix} 0.4750 \\ 1.2850 \\ 0.6050 \\ 2.9400 \\ 0.5200 \\ 1.0150 \\ 0.1400 \\ 0.1200 \end{pmatrix}, \quad (\bar{\mathbf{X}}_{\text{South}} - \bar{\mathbf{X}}_{\text{North}}) = \begin{pmatrix} -0.2044 \\ 2.3915 \\ 1.5891 \\ 2.1129 \\ -0.2788 \\ 3.6909 \\ 0.8306 \\ 0.0094 \end{pmatrix},$$

$$(\bar{\mathbf{X}}_{\text{South}} - \bar{\mathbf{X}}_{\text{North}})' = (-0.2044\ 2.3915\ 1.5891\ 2.1129\ -0.2788\ 3.6909\ 0.8306\ 0.0094).$$

$n_{\text{South}} = 17$, and $n_{\text{North}} = 20$.

$$\mathbf{C} = \frac{(n_{\text{South}} - 1)\mathbf{C}_{\text{South}} + (n_{\text{North}} - 1)\mathbf{C}_{\text{North}}}{n_{\text{South}} + n_{\text{North}} - 2}$$

$$\mathbf{C} = \begin{pmatrix} 0.2821 & 0.1314 & 0.0611 & 0.4122 & 0.1106 & 0.0857 & 0.1373 & 0.0112 \\ & 2.6982 & 0.9823 & 3.4821 & 0.3289 & 2.6136 & -0.0843 & -0.0213 \\ & & 2.3605 & 1.4215 & 0.3506 & 2.5148 & -0.1276 & 0.0338 \\ & & & 8.4586 & 0.8371 & 2.4344 & -0.1113 & 0.1138 \\ & & & & 0.4398 & 0.1346 & 0.0738 & 0.0294 \\ & & & & & 6.5319 & -0.4057 & -0.0377 \\ & & & & & & 0.8790 & -0.0178 \\ & & & & & & & 0.0381 \end{pmatrix},$$

$$\mathbf{C}^{-1} = \begin{pmatrix} 4.4497 & 0.2392 & 0.2034 & -0.2158 & -0.8390 & -0.1812 & -0.6946 & -0.5715 \\ & 1.3865 & 0.1928 & -0.4826 & -0.2994 & -0.4412 & -0.0810 & 1.7292 \\ & & 0.8922 & -0.0563 & -0.6420 & -0.3937 & -0.0284 & -0.4830 \\ & & & 0.3394 & -0.1628 & 0.0928 & 0.0601 & -0.9234 \\ & & & & 3.5430 & 0.3470 & -0.1760 & -1.3359 \\ & & & & & 0.4500 & 0.1214 & 0.1134 \\ & & & & & & 1.3306 & 0.8822 \\ & & & & & & & 32.1018 \end{pmatrix}.$$

$$T^2 = \frac{(n_{South})(\ n_{North})}{(n_{South} + \ n_{North})}(\bar{X}_{South} - \bar{X}_{North})' C^{-1}(\bar{X}_{South} - \bar{X}_{North}) = \ \mathbf{53.6704}$$

$$F = \frac{(n_{South} + \ n_{North} - p - 1)}{p(n_{South} + \ n_{North} - 2)} T^2 = \mathbf{5.3670}$$

where $p = 8$ is the number of variables (methods of contraceptive).

$$F_{0.05,\ p,\ n_{South}+n_{North}-P-1} = F_{0.95,\ 8,\ 28} = \mathbf{2.2913}$$

Decision: H_0 is rejected since $F_{calculated} > F_{tabulated.}$ Hence, we conclude that there is a significant difference between the mean level of use of modern Family Planning Methods in the Southern and Northern Nigeria.

To know where the level of use is more, another simple test (Welch Two Sample t-test**)** is carried out.

$$H_0 : \bar{X}_{South} \geq \bar{X}_{North}$$

$$H_1 : \bar{X}_{South} < \bar{X}_{North}$$

Table 1: Summary of Results

	Mean South	**Mean North**	**t**	**Df**	**p-value**
Statistics	2.1551	0.8875	-1.5841	9.664	0.9273

Decision:

The information in Table 1 shows no sufficient evidence against the null hypothesis at 5% level of significance. This is because of the large p-value of 0.9273 which is greater than 0.05.

4. Conclusion

The work considered the recently published 2013 National Demographic and Health Survey (NDHS) data on the level of use of modern family planning methods. Stratified the data into two -Northern and Southern Nigeria and adopted the Hotelling's T^2 technique of the Multivariate Analysis in determining whether any significant difference exists between the level of use in Northern and Southern Nigeria. The results obtained show a significant difference. Another test to show whether the mean level of use of modern family planning methods is greater in the South than the North was carried out and results shown in Table 1 indicate that the null hypothesis cannot be rejected. Hence, we conclude that there is more level of use of the methods in the Southern than in

the Northern Nigeria. In other words, the Northern part of Nigeria accounts more for the generally low level of use of modern family planning methods. From the findings, the paper recommends more intervention and advocacy on the level of use of the modern family planning methods in the Northern part of the country.

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