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Comparative analysis of gender equality in students' enrolment in federal university Oye-Ekiti

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Abstract
In line with United Nations and human rights agitations, Nigerian governments over the years have made it a point of duty to ensure that its female population has the same opportunities as its male population. This research study examined gender equality in students' enrolment by admission in Federal University Oye-Ekiti, Nigeria. The results, using Analysis of covariance (ANCOVA), shows that the difference in students' enrolment by admission for the genders is statistically significant., hence there is gender discrimination in admission of students into various disciplines of the university.

Keywords: gender, students' enrolment, admission, analysis of covariance

1. Introduction

One of the eight milestone of Millennium Development Goals (MDGs), as set by world leaders in September 2000 for the International Community is to promote gender equality and empower women [1, 2]. This goal is vital, because our society has continued to regress downwards in quality of life due to lack of empowerment of women who are usually left to cater for the family after the exit/death of the man who is mostly the bread winner of the family. The fact that the man, who is the breadwinner, has a lower life expectancy of 46.4 years in Nigeria (which is 30% below the World average of 63.89 years, according to the United Nation's ranking [3]. Federal University Oye-Ekiti, being a corporate member of the global society and the institution of the Federal Government of Nigeria established by law, has an implied responsibility of helping to achieve this goal. One of the expected means by which it can help achieve this goal is by gender considerations in enrolment and admission of students.

Gender refers to society's division of humanity, based on sex, into two distinctive categories, namely male and female. Gender guides how male and female think about themselves, how they interact with each other, and what position they occupy in society as a whole. In global perspective, the preference for males is more pronounced in African and more Asian countries, and this accounts for the common discrimination against women in these countries [4].

The ironies of history are the fact that despite the role women play both at home and in the society, they have remained unnoticed and even belittled [5]. This is borne out of the notion that women's function of being homemakers and caring for children is not important. Women therefore are to be seen and not heard. This has grossly affected women enrolment in educational institutions, and revealed discrimination against women. At independence, the Nigerian state did not significantly reconstitute the inherited colonial patriarchal structures that limited women's participation in the public sphere. Hence, women still had limited access to both tangible and intangible societal resources. Till date, the female folk believed that the situation has still persisted as women are still faced with various handicaps and restrictions such as low participation in politics [6], widowhood rites and disinheritance [7, 8], female genital mutilation, poor access to education, healthcare, jobs, land, credit, early marriage and many others [9, 10].

However, Nigerian governments over the years have made it a point to ensure that its female population has the same opportunities the male population has. The 1999 constitution of Nigeria prohibits discrimination on the grounds of gender. Hence, the government established a National Committee on the Reform of Discriminatory Laws against Women, which has drafted a degree for the abolition of all forms of discrimination against women.

Moreover, in recent times, successive Nigerian governments, in reaction to the various International Conventions and Covenants on Women, have undertaken legislative and administrative reforms that would give women full access to economic and productive resources. These have resulted in an improvement in the status of women. Women now enjoy greater participation in governance and its institution [11, 12]. More women now occupy ministerial positions and seats in both legislative and judiciary arms of government. For example, during the 2003-2007 administration of President Olusegun Obasanjo, there were six women ministers out of a total of thirty-six and ten women special advisers out of a total of thirty-five as well as twenty-one female representative out of a total of three hundred and sixty [13]. However, there was an increase during the administration of President Good luck Ebele Jonathan, as more women were appointed into major offices in his cabinet. Women have also enjoyed an increased presence in the labour market and in education [14, 15, 16]. The aim of this research study therefore is to ascertain statistical gender equality/inequality in students' enrolment in Federal University Oye-Ekiti, because the issue of social justice and equity can only be attained when both sexes are given equal opportunities in education training.

2. Materials and methods

2.1 Source of data

The source of data is from the Annual Report of the Academic Planning Unit of the Federal University Oye-Ekiti [17, 18].

2.2 Methodology

The method used for this study is Analysis of Co-Variance (ANCOVA) [19, 20, 21, 22]. This method combines the advantages of regression analysis and the analysis of variance, hence test for significance difference and regression coefficient (β) for both male and female students' enrolments can be done. Suppose y_{ij} are the values of an independent random variable having a normal distribution, with the respective mean μ_i and variance σ^2. Ordinarily, the mathematical model for a one-way analysis of variance is expressed as:

$$y_{ij} = \mu + t_i + e_{ij}, \qquad i = 1,2,\dots,t; j = 1,2,\dots,r \tag{1}$$

Where

y_{ij} Is the observed value from the unit j receiving treatment i

μ Is the overall mean

t_i Is effect of treatment i

e_{ij} Is the random error for unit j receiving treatment i

But because analysis of co-variance combines the advantages of regression analysis and analysis of variance, (1) can be expressed as:

$$y_{ij} = \mu + t_i + \beta(x_{ij} - \bar{x}) + e_{ij}, \qquad i = 1,2,\dots,t; j = 1,2,\dots,r_i \tag{2}$$

Where

β Is the coefficient of linear regression, and

x_{ij} Is the covariate effect.

If the treatment effects t_i are assumed in such a way that $\sum_{i=1}^{t} t_i = 0$, $\sum_{i=1}^{t}\sum_{j=1}^{r}(x_{ij} - \bar{x}) = 0$ And $e_{ij} \sim N(0, \sigma^2)$, from (2), the least square estimate for covariance Error Sum of Squares (SSE) can be defined as:

$$SSE = e_{ij}^2 = \sum_{i=1}^{t}\sum_{j=1}^{r}(y_{ij} - \mu - t_i - \beta(x_{ij} - \bar{x}))^2 \tag{3}$$

Differentiating (3) with respect to μ, such that $\frac{\partial SSE}{\partial \mu} = 0$ yields:

$$-2\sum_{i=1}^{t}\sum_{j=1}^{r}\left(y_{ij} - \mu - t_i - \beta(x_{ij} - \bar{x})\right) = 0$$

Dividing through by (-2) gives:

$$\sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij} - tr\hat{\mu} - r\sum_{i=1}^{t} t_i - t\beta\sum_{i=1}^{t}\sum_{j=1}^{r}(x_{ij} - \bar{x}) = 0$$

Since we assumed $\sum_{i=1}^{t} t_i = 0$ and $\sum_{i=1}^{t}\sum_{j=1}^{r}(x_{ij} - \bar{x}) = 0$, it follows that

$$\sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij} - tr\hat{\mu} = 0$$

Therefore, $\hat{\mu} = \frac{\sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij}}{rt} = \frac{y}{rt}$ (4)

To obtain the Sum of Squares for Treatment (SSt), differentiate (3) with respect to t, such that $\frac{\partial SSE}{\partial t} = 0$ yields:

$$-2\sum_{j=1}^{r}\left(y_{ij}-\mu-t_i-\beta\left(x_{ij}-\bar{x}\right)\right)=0$$

Dividing through by (-2) gives:

$$\sum_{j=1}^{r}y_{ij}-r\hat{\mu}-r\widehat{t_i}-\beta\sum_{j=1}^{r}\left(x_{ij}-\bar{x}\right)=0$$

It follows that

$$r\hat{\mu}+r\widehat{t_i}+\beta\sum_{j=1}^{r}\left(x_{ij}-\bar{x}\right)=y_i$$

Therefore, $\widehat{t_i}=\frac{y_i}{r}-\frac{y_{..}}{rt}-\hat{\beta}(\frac{x_{i.}}{r}-\frac{x_{..}}{rt})$

The adjusted mean of treatment i can be estimated as

$$\widehat{t_i}=\frac{y_i}{r}-\hat{\beta}(\frac{x_{i.}}{r}-\frac{x_{..}}{rt}) \quad (5)$$

To obtain the Sum of Squares due to regression (β), differentiate (3) with respect toβ, such that $\frac{\partial SSE}{\partial\beta}=0$ yields:

$$\sum_{i=1}^{t}t_i\sum_{j=1}^{r}\left(x_{ij}-\bar{x}\right)+\beta\sum_{i=1}^{t}\sum_{j=1}^{r}\left(x_{ij}-\bar{x}\right)^2=\sum_{i=1}^{t}\sum_{j=1}^{r}\left(x_{ij}-\bar{x}\right)(y_{ij}-\frac{y_{..}}{rt})=0$$

Therefore,

$$\hat{\beta}=\frac{\left(\sum_{i=1}^{t}\sum_{j=1}^{r}y_{ij}x_{ij}-\frac{y_{..}x_{..}}{rt}\right)-\left(\sum_{i=1}^{t}y_{i.}x_{i.}-\frac{y_{..}x_{..}}{rt}\right)}{\left(\sum_{i=1}^{t}\sum_{j=1}^{r}x_{ij}^2-\frac{x_{..}^2}{rt}\right)-\left(\frac{\sum_{i=1}^{t}x_{i.}^2}{r}-\frac{x_{..}^2}{rt}\right)}=\frac{S_{xy}-T_{xy}}{S_{xx}-T_{xx}}=\frac{E_{xy}}{E_{xx}} \quad (6)$$

Where

S_{xy} Is the Total Sum of Product,
T_{xy} Is the Treatment Sum of Product,
E_{xy} Is the Error Sum of Product,
S_{xx} Is the Total Sum of Squares,
T_{xx} Is the Treatment Sum of Squares,
E_{xx} Is the Error Sum of Squares, and
$\frac{S_{xy}^2}{S_{xx}}$ Is the Sum of Squares due to β

The following are the summary of Analysis of Variance (ANOVA) and Adjusted Analysis of Co-Variance (ANCOVA) tables:

Table 1(a): Summary of ANOVA Table

Source of Variation (S. V.)	Degree of Freedom (df)	x	y	xy
Treatment	$t-1$	T_x	T_{yy}	T_{xy}
Error	$t(r-1)$	E_{xx}	E_{yy}	E_{xy}
Total	$rt-1$	S_{xx}	S_{yy}	S_{xy}

Table 1(b): Summary of ANCOVA Table (Adjusted ANCOVA)

Source of Variation (S.V.)	Degree of Freedom (df)	Sum of Squares (SS)	Mean Squares (MS)	$F_{calculated} \sim F_{critical}$
Treatment	$t-1$	$SSt=SST-SSe$	$MSt=\frac{SSt}{t-1}$	$\frac{MSt}{MSe}\sim F_{\alpha,\ (t-1),\ t(r-1)-1}$

Error	$t(r-1)-1$	$SSe = E_{xy} - \frac{E_{xx}^2}{E_{yy}}$	$MSe = \frac{SSe}{t(r-1)-1}$	
Total	$rt-1$	$SST = S_{xy} - \frac{S_{xx}^2}{S_{yy}}$		

2.3 Hypothesis

The two pairs of hypothesis to be tested for the given data are:

The treatment effects (enrolment of male and female at each session of studies) are all equal, against the alternative, that they are not equal, i.e. $H_o: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$ vs $H_1: \mu_1, \mu_2, \mu_3, \mu_4, and\ \mu_5$ are not all equal in their means (7)

Decision Rule: Reject H_0 if $F_{calculated} > F_{\alpha,(t-1),\ t(r-1)-1}$ and conclude that there is significant difference in the enrolment of male and female at $\alpha = 0.05$

The covariance effects (regression coefficient) are not significant different,

i.e. $H_0: \beta = 0$ vs $H_1: \beta \neq o$ (8)

Decision Rule: Reject H_0 if $F_{calculated} = \frac{E_{xy}^2/E_{xx}}{s^2} > F_{\alpha,(t-2),\ t(r-1)-1}$ (9)

and conclude that $\beta \neq o$ and therefore, there is need for covariance analysis between enrolment of male and female students at $\alpha = 0.05$

Therefore, the adjusted mean $\bar{y}_i^I$ is given by:

$$\bar{y}_i^I = \bar{y}_i - \beta(\bar{x}_i - \bar{x}),\ \ i = 1,2,3,4,5 \tag{10}$$

Where

$\bar{y}_i^I$ Is the adjusted mean for male students (M),

$\bar{y}_i$ Is the mean of treatment i for male students (M) unadjusted,

$\bar{x}_i$ Is the mean of treatment i for female students (F), and

$\bar{x}_i$ Is the overall mean for female students (F),

The standard error of difference (SED) is useful for comparison of adjusted mean such as:

$$H_o: \mu_i - \mu_j = 0\ vs\ H_1: \mu_i - \mu_j \neq 0 \tag{11}$$

and the statistical model is given as:

$$SED_{(i\ vs\ j)} = \sqrt{s^2\left\{\frac{(t-1)}{r} + \frac{(x_i - x_j)}{E_{xx}}\right\}} \tag{12}$$

Assuming we are to compare two adjusted$(\bar{y}_i^I = \bar{y}_j)$, the statistical model is given as:

$$T = \frac{\bar{y}_i^I - \bar{y}_j}{SED_{(i\ vs\ j)}} \tag{13}$$

The decision rule will be: reject H_0 if $T = t_{e,\alpha/2}$ and conclude that there is a significant difference between the two means compared.

Table 2: Students Enrolment per Faculty and per Gender from 2011/2012 T0 2017/2018 Session\

	2011/2012		2012/2013		2013/2014		2014/2015		2015/2016		2016/2017		2017/2018	
Faculties	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Agriculture	32	24	56	44	47	50	50	57	95	120	129	159	213	262
Arts							82	60	71	105	92	164	207	331
Education											218	251	215	325
Engineering	117	12	81	4	52	8	175	12	206	18	322	23	632	53
Mangement Sciences											153	168	440	479
Sciences	75	47	92	32	3	41	120	72	244	147	288	232	713	552
Social Sciences	85	98	122	93	88	90	140	103	160	158	305	305	541	521
Total	309	181	351	173	190	189	567	304	776	548	1507	1302	2961	2523

3. Results

Using the data on Table 2, the summary of the analyses of variance and covariance are as given in Tables 3a and 3b respectively. Table 3a is obtained due to the model in Table 1a. in this case, variable y is replaced by Male which denotes the number of male students, y is replaced by Female which denotes the number of female students and xy is replaced by Male ∩ Female which denotes the number of the cross-product between male and female students.

Table 3a: Summary of the Analysis of Variance (ANOVA)

Source of Variation	Degree of Freedom	Sum of Squares (Male)	Sum of Squares (Female)	Sum of Squares (Male ∩ Female)
Student Enrolment (Treatment)	6	592.897	497.780	2169376.479
Error	29	367.602	259.936	728576.493
Total	35	960.499	757.716	2897952.972

Table 3b: Summary of the Analysis of Co-Variance (ANCOVA)

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-ratio
Student Enrolment (Treatment)	6	2168962.538	361493.756	13.896
Error	28	728392.689	26014.025	
Total	34	2897355.227		

The tabulated value for the treatment effects (student's enrolment) at the level of studies is $F_{6,28,0.95} = 2.45$

4. Discussion and Conclusion

Since$F_{calculated}\ (i.e\ 13.896) > F_{tabulated}\ (i.e\ 2.45)$, the null hypothesis is rejected. In order words, the differences among the means obtained for both male and female student's enrolment is statistically significant. This means that there is no gender equality when considering student's enrolment into the university.

While considering the second hypothesis, it is observed that from equation (9)$F_{calculated}\ (i.e\ 0.1077) < F_{tabulated}\ (i.e\ 2.56)$. Thus, the null hypothesis is not rejected. Therefore, there is no need for covariance analysis between the genders. The Standard Error of Difference (SED) estimated from equation (12) is as follows: $SED_{(x_1,x_2)} = 149.7067$, $SED_{(x_1,x_3)} = 148.9408$, $SED_{(x_1,x_4)} = 143.3151$, $SED_{(x_1,x_5)} = 130.5786$, $SED_{(x_1,x_6)} = 79.1888$, $SED_{(x_1,x_7)} = 236.1804$, $SED_{(x_2,x_3)} = 148.5563$, $SED_{(x_2,x_4)} = 142.9155$, $SED_{(x_2,x_5)} = 130.1399$, $SED_{(x_2,x_6)} = 78.4633$, $SED_{(x_2,x_7)} = 236.4224$, $SED_{(x_3,x_4)} = 143.7136$, $SED_{(x_3,x_5)} = 131.0158$, $SED_{(x_3,x_6)} = 79.9077$, $SED_{(x_3,x_7)} = 235.9381$, $SED_{(x_4,x_5)} = 137.1469$, $SED_{(x_4,x_6)} = 89.6069$, $SED_{(x_4,x_7)} = 232.4277$, $SED_{(x_5,x_6)} = 107.3212$, $SED_{(x_5,x_7)} = 224.7981$and $SED_{(x_6,x_7)} = 199.3848$. The comparison between the estimated T's from equation (13) and the critical value (which is$t_{28,\ 0.05/2} = 2.05$)) show that there is no significance difference between the adjusted means. This is in agreement with the decision from the analysis of covariance table that there is no need for covariance regression coefficient.

From the research study, it was observed that there is ample evidence that there is gender inequality in admission quota in Federal University Oye-Ekiti.

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