A Study on Factors Affecting the Cure of Tuberculosis Infection in Nigeria via Three Factor ANOVA

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ABSTRACT
This study is on the factors affecting the cure of Tuberculosis infection. The data for the analysis were collected from Sacred Heart Hospital Abeokuta, Ogun State, and analyzed using three-factor Analysis of Variance (ANOVA). This was used independently to test for the significance of the effects of blood group, age, class of infection, and their various interactions. The statistical software packages known as Minitab version 17.0 and SPSS version 20.0 were used for the analysis. Based on the analysis of this work, it has been affirmed that patients with class one (+) infection consumes less time in treatment than their counterparts with class two (++) infection under the same condition of treatment. It was also affirmed that the older one gets in age, the longer it takes to get him treated of a tuberculosis (TB) infection. However, for people within the ages of childbirth to 49years, even with some observed differences in total time of treatment, there is no evidence that age really affects their rate of recovery. The result of multiple comparison of the age group reveals that the effect of age is only on ages from fifty years and above with more prolonged time of treatment when the whole patients are subjected to the same treatment.

Keywords: Three factor ANOVA, Tuberculosis, Post-hoc test, Blood group, Class of Infection, Age.

1. Background of the Study

In the history of mankind, several diseases have always plagued human existence. Today it is the dreaded acquired immune deficiency syndrome HIV/AIDS; the very recent Severe Acute Respiratory Syndrome (SARS) and yet many other less severe ones. Some times in the past, it was the turns of such disease like influenza, Ebola fever, malaria, typhoid fever, cholera and of course a good number of others. More so, at a time in the past, it was the turn of the dreaded tuberculosis disease which still poses threat to human existence.

Tuberculosis (TB), named after its causative bacterium: the mycobacterium tuberculosis, is one of the most important infectious diseases of the world. It was precisely in 1882 that a German physician, Robert Koch discovered the causative bacterium of this disease and subsequently named it after the micro-organism. Since then, it has made its impact felt through the ages, cutting across every race, age and sex. The familiarity with the history of the scourge and with its sociological, physiological, economic and medical important alerts one, as the study of few other diseases and to the mighty burden illness lay on mankind. Tuberculosis

infection/disease can attack any part of the body. However, the most notable one is the tuberculosis of the lungs, known as the pulmonary tuberculosis.

Pulmonary Tuberculosis (PTB) refers to any bacteriologically confirmed or clinically diagnosed case of TB involving the lung parenchyma or the tracheobronchial tree. Miliary TB is classified as PTB because there are lesions in the lungs. Tuberculous intra-thoracic lymphadenopathy (mediastinal and/or hilar) or tuberculous pleural effusion, without radiographic abnormalities in the lungs, constitutes a case of extrapulmonary TB. When it attacks any other part of the body, it is called extra pulmonary tuberculosis.

ExtrapulmonaryTuberculosis (EPTB) refers to any bacteriologically confirmed or clinically diagnosed case of TB involving organs other than the lungs, e.g. pleura, lymph nodes, abdomen, genitourinary tract, skin, joints and bones, meninges. A patient with both pulmonary and extrapulmonary TB should be classified as a case of PTB.

1.1. Statement of the problem

A disease for which effective cure and preventive measures was discovered decades ago is still a measure public health problem globally. Due to the resurgence of this disease, a research was carried out and it was estimated that by 2000's, approximately 1.7 billion people throughout the world's population would be infected with mycobacterium tuberculosis. It was further estimated that 95% of all cases would occur in the developing countries which Nigeria was one of. With the help of the interest groups by the TB control units of most state health ministries, very numerous research works were carried out in search of most appropriate prevention and treatment of the scourge.

However, a look at the most works reveal to the statistician that some of them need not be held to any esteem due to the poor nature of their experimental layout and their analysis on the basis of which generalization were made. The truth about most of the research works is totally misconstrued owing to poor statistical know-how. A clear case evidence of this argument is the un-proportionate retreat of this scourge of our environment.

As we believe, that a sound human health is the greatest asset to the society. As a result, we posit to solve this problem by carrying out this work which would serve as a reference point to prospective researchers in health related issues.

1.2. Review of Related Literatures

Many researches have been done in the past regarding incidence and mortality in Tuberculosis. The need to review some of these previous works and other related topics is necessary as it will add test to this study.

Young (2010) carried out a research on "an examination of known Tuberculosis risk factors and their correlation across the United States". Secondary data from the centers for Disease Control and Prevention (CDC) and US Census Bureau on line database were used. Simple linear regression, bivariate correlation and multiple linear regression were used as a statistical technique. Significant correlations were found at the stage level between TB disease rates and being non-hisparic white, foreign-born, GINI and AIDS diagnosis rates. No significant associations were found between TB disease rates and diabetes rates, smoking rates and alcohol abuse rates.

Imam and Oyeyi (2008) carried out a Research on a Retrospective Study of Pulmonary Tuberculosis (PTB) Prevalence Amongst Patients Attending Infectious Diseases Hospital (IDH) in Kano, Nigeria. A retrospective study aimed at ascertaining the prevalence of Pulmonary TB amongst patients attending Infectious Diseases Hospital, Kano was conducted between January, 2006 and July, 2008. Sputum samples were obtained from three thousand, six hundred and seventy nine (3679) patients. Samples were smeared on glass slides, stained using ZiehlNeelsen Stain and later observed under light (oil immersion) microscopy. The results showed that were positive for tuberculosis had prevalence of 541 (14.7%) out of 3679 subjects. The age group 30-43 years had the highest prevalence of 145 (17.0%) out of 858 of PTB positive subjects. There was no significant difference between age groups and sex of subjects with PTB positivity {Chi-Square: 11.07 at P= 0.05 and Chi-Square =15.09 at P=0.01}; similarly, the difference between prevalence of PTB in male and female subjects between the three year period {Chi-Square =14.07 at P= 0.05 and Chi-Square =18.48 at P=0.01} was not significant. It is noteworthy that PTB is still a serious disease in this part of the world, thus, there is need for stepping up TB awareness, treatment and control program.

Ojezeh et al (2015) researched on a retrospective study on incidence of pulmonary tuberculosis and human immunodeficiency virus co-infection among patients attending National Tuberculosis and Leprosy Control Programme, Owocentre. A five year retrospective study from January 2008 to December 2012 was carried out using profiles of new cases of PTB individuals that attended National Tuberculosis and Leprosy Control Programme (NTBLCP), Owocentre. A total of 342 new cases were retrieved using a pre-designed case record forms. Vital information on demographic data, social and medical history were retrieved including laboratory results, treatment access and mortality report. The prevalence of HIV sero - positive individual with PTB among the 342 new cases retrieved was 14.0%. In the studied population, incidence of infection was higher among 35 - 44 years age group, 53.8% are males and 46.2% are females. A total of 28.1% was classified as cured, 9.1% died, and 10.5 % defaulted or transferred out.

Danjuma and Bashir (2013) carried out a research on Impact of HIV/AIDS on Economic Growth and Development in Nigeria. The study investigates the impact of HIV/AIDS on economic growth and development in Nigeria using primary and time series data. It also looked at the effect of the epidemic on savings and standard of living. To obtain the primary data, a total of 360 respondents comprising 180 persons infected with HIV/AIDS and 180 uninfected persons were selected using stratified sampling technique. The primary data were analyzed using frequencies, percentages and chi-square test. In analyzing the time series data, a Solow-type growth model is extended to incorporate some of the macroeconomic consequences of HIV/AIDS. Using this model, co-integration and error correction modeling techniques were adopted to examine the relationship between the variables. The findings show that HIV/AIDS prevalence is widely spreading and rapidly rising and has a negative impact on Real GDP growth in Nigeria. Also, recurrent health expenditure does not appear to be growth augmenting during the period HIV/AIDS was also found to adversely affect savings and standard of living of infected persons. Education of especially rural people on HIV/AIDS, voluntary HIV test before marriage, expansion of Anti-Retroviral Drugs (ARD) distribution, and poverty reduction polices have been recommended.

Tony et al (2015) carried out a retrospective study on the incidence of pulmonary tuberculosis and human immunodeficiency virus co-infection. He cited that the incidence of co-infection of PTB and HIV/AIDS in sub Saharan is alarming. The exotic nature of the duo infection may be responsible for high mortality among TB patients. He concluded that mortality due to co-infection is high and that there is need to put in more efforts to stem the trend of PTB and HIV/AIDS co-infection, he also said that variation in the pattern of co-infection in different localities may be associated with the living condition, cultural and socio economic factors. Possible factors like campaigns and easy access to treatments should be stepped up to reduce and curb the menace from spreading.

Having reviewed past research works, we shall examine the statistical analysis of the factors affecting the cure of Tuberculosis infections in Nigeria.

2.Methodology

2.1.Data Source

The data for this study is a secondary data collected from the T.B. unit of the Federal Medical Center Gbagada, Lagos State. The data collected on T.B. infections patients were done throughout their period of treatment in days, blood group, age and class of the T.B. infection for a period of three years (15th August 2011 to 6th February 2014). The collected data are as shown in the Tables 2 and 3.

2.2. Method of Analysis

The method to be employed in this project is the three-factor analysis of variance. We shall first discuss the model, thereafter some of their assumptions.

2.3. ANALYSIS OF VARIANCE

The analysis of variance methodology is concerned with the investigation of the factors likely to contribute significant effects, by suitable choice of experiments. It is a technique by which variations associated with different factors or defined sources may be isolated and estimated. The aim of ANOVA is to detect differences among several population means, and the techniques require the analysis of different forms of variance associated with random sample.

2.4. Three-Factor ANOVA

In two-factor factorial design, the results may be extended to the three factor case where there are a levels of factor A, b levels of factor B, c levels of factor C, arranged in a factorial experiment. Thus, there will be abcn total observations if there are n replicates of the complete experiment (Montgomery; 1991). The three-factor analysis of variance model is given by:

$$y_{ijkl} = \mu + \tau_i + \beta_j + \gamma_k + (\tau\beta)_{ij} + (\tau\gamma)_{ik} + (\beta\gamma)_{jk} + (\tau\beta\gamma)_{ijk} + \varepsilon_{ijkl} \begin{cases} i = 1,2,\ldots,a \\ j = 1,2,\ldots,b \\ k = 1,2,\ldots,c \\ l = 1,2,\ldots,n \end{cases} \quad (1)$$

$$\sum_{i=1}^{a} \tau_i = \sum_{j=1}^{b} \beta_j = \sum_{k}^{c} \gamma_k = \sum_{i=1}^{a}\sum_{j=1}^{b} (\tau\beta)_{ij} = \sum_{i=1}^{a}\sum_{k=1}^{c} (\tau\gamma)_{ik} = \sum_{j=1}^{b}\sum_{k=1}^{c} (\beta\gamma)_{jk} = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c} (\tau\beta\gamma)_{ijk} = 0$$

$\varepsilon_{ijkl} \sim N(0, \sigma_e^2)$

y_{ijkl} is the i^{th} replication in the ijk^{th} treatment combination

μ is the universal constant, which is independent of the effects of the factors.

τ_i is the effect of the ith blood group.

β_j is the effect of the jth class of infection

γ_k is the effect of the kth age group

$(\tau\beta)_{ij}$ is the effect of the AxB interaction

$(\tau\gamma)_{ik}$ is the effect of the AxC interaction

$(\beta\gamma)_{jk}$ is the effect of BxC interaction

$(\tau\beta\gamma)_{ijk}$ is the effect of the interaction between ith blood group, jth class of interaction and kth age group

ε_{ijkl} is the observed random error associated with ijklth observation.

Assuming that A, B, and C are fixed; the analysis of variance table is shown in Table 1. The F-tests on main effects and interactions follow directly from the expected mean squares.

We will give the computing formulas for the sums of squares in Table 1. The total sum of squares for the three-factor analysis of variance model is;

$$SS_T = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c}\sum_{l=1}^{n} y_{ijkl}^2 - \frac{y_{....}^2}{abcn} \quad (2)$$

The sums of squares for the main effects are found from the totals for factors A($y_{i...}$), B($y_{.j..}$), and C($y_{..k.}$) as follows:

$$SS_A = \sum_{i=1}^{a} \frac{y_{i...}^2}{bcn} - \frac{y_{....}^2}{abcn} \quad (3)$$

$$SS_B = \sum_{j=1}^{b} \frac{y_{.j..}^2}{acn} - \frac{y_{....}^2}{abcn} \quad (4)$$

$$SS_B = \sum_{k=1}^{c} \frac{y_{..k.}^2}{abn} - \frac{y_{....}^2}{abcn} \quad (5)$$

To complete the two-factor interaction sums of squares, the totals for the A × B, A × C, and B × C cells are needed. It is frequently helpful to collapse the original data table into three two-way tables in order to compute these quantities. The sums of squares are found from

$$SS_{AB} = \sum_{i=1}^{a}\sum_{j=1}^{b} \frac{y_{ij..}^2}{cn} - \frac{y_{....}^2}{abcn} - SS_A - SS_B$$

$$= SS_{subtotals(AB)} - SS_A - SS_B \quad (6)$$

$$SS_{AC} = \sum_{i=1}^{a}\sum_{k=1}^{c} \frac{y_{i.k.}^2}{bn} - \frac{y_{....}^2}{abcn} - SS_A - SS_C$$

$$= SS_{subtotals(AC)} - SS_A - SS_C \quad (7)$$

and

$$SS_{BC} = \sum_{j=1}^{b}\sum_{k=1}^{c} \frac{y_{.jk.}^2}{an} - \frac{y_{....}^2}{abcn} - SS_B - SS_C$$

$$= SS_{subtotals(BC)} - SS_B - SS_C \quad (8)$$

Note that the sums of squares for the two-factor subtotals are found from the totals in each two-way table. The three-factor interaction sum of squares is computed from the three-way cell totals $\{y_{ijk}\}$ as

$$SS_{ABC} = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c} \frac{y_{ijk.}^2}{n} - \frac{y_{....}^2}{abcn} - SS_A - SS_B - SS_C - SS_{AB} - SS_{AC} - SS_{BC} \quad (9)$$

$$= SS_{subtotals(ABC)} - SS_A - SS_B - SS_C - SS_{AB} - SS_{AC} - SS_{BC} \quad (3.9b)$$

The error sum of squares may be found by subtracting the sum of squares for each main effect and interaction from the total sum of squares or by

$$SS_E = SS_T - SS_{subtotals(ABC)} \quad (10)$$

Table 1: The Analysis of Variance Table for the Three-Factor Fixed Effects Model

Source of variation	Sum of squares	Degree of freedom	Mean square	Expected means squares	F_0
A	SS_A	a – 1	MS_A	$\sigma^2 + \frac{bcn\Sigma\tau_i^2}{a-1}$	$F_0 = \frac{MS_A}{MS_E}$
B	SS_B	b – 1	MS_B	$\sigma^2 + \frac{acn\Sigma\beta_j^2}{b-1}$	$F_0 = \frac{MS_B}{MS_E}$
C	SS_C	C – 1	MS_C	$\sigma^2 + \frac{abn\Sigma\gamma_k^2}{c-1}$	$F_0 = \frac{MS_C}{MS_E}$
AB	SS_{AB}	(a – 1)(b – 1)	MS_{AB}	$\sigma^2 + \frac{cn\Sigma\Sigma(\tau\beta)_{ij}^2}{(a-1)(b-1)}$	$F_0 = \frac{MS_{AB}}{MS_E}$
AC	SS_{AC}	(a – 1)(c – 1)	MS_{AC}	$\sigma^2 + \frac{bn\Sigma\Sigma(\tau\gamma)_{ik}^2}{(a-1)(c-1)}$	$F_0 = \frac{MS_{AC}}{MS_E}$
BC	SS_{BC}	(b – 1)(c – 1)	MS_{BC}	$\sigma^2 + \frac{an\Sigma\Sigma(\beta\gamma)_{jk}^2}{(b-1)(c-1)}$	$F_0 = \frac{MS_{BC}}{MS_E}$
ABC	SS_{ABC}	(a – 1)(b – 1)(c – 1)	MS_{ABC}	$\sigma^2 + \frac{n\Sigma\Sigma\Sigma(\tau\beta\gamma)_{ijk}^2}{(a-1)(b-1)(c-1)}$	$F_0 = \frac{MS_{ABC}}{MS_E}$
Error Total	SS_E SS_T	abc(n – 1) abcn – 1	MS_E	σ^2	

2.5. Post Hoc Test

In general, after rejecting the null hypothesis in an ANOVA test, one might be tempted to make a comparison between each pair of factor level means using the test procedures. But how many such comparisons need to be made? For r levels, there are $\binom{r}{2} = \frac{1}{2}r(r-1)$ pairs to be compared.

There are many method for multiple comparison but TUKEY`S HSD Method shall be used in this study. For three-factor ANOVA, the pair wise differences of sample means will be compared to

$q[r,(r-1)(c-1);1-\alpha]\sqrt{\frac{MSE}{c}}$ for factor A

$q[c,(r-1)(c-1);1-\alpha]\sqrt{\frac{MSE}{r}}$ for factor B

Table 2: Data on treatment period (in days) of tuberculosis (T.B) Infection (August 15, 2001 – February 6, 2014)

S/N	Class of Infection	Blood Group	Age	Total Period of Treatment	S/N	Class of Infection	Blood Group	Age	Total Period of Treatment	S/N	Class of Infection	Blood Group	Age	Total Period of Treatment
1	++	A	22	71	67	++	O	38	81	133	++	O	37	51
2	++	O	10	61	68	++	B	12	85	134	++	O	74	120
3	++	A	15	71	69	++	B	67	102	135	++	B	70	137
4	+	B	16	49	70	+	O	31	47	136	++	A	34	83
5	++	A	18	55	71	+	O	22	55	137	++	AB	79	96
6	+	A	29	56	72	++	A	33	81	138	+	O	54	60
7	++	AB	71	72	73	++	O	22	84	139	++	O	17	71
8	++	A	23	89	74	+	B	51	66	140	++	B	64	99
9	++	O	44	66	75	+	O	76	102	141	++	A	21	53
10	+	A	22	48	76	++	AB	28	79	142	++	A	32	79
11	+	O	61	76	77	+	O	39	50	143	++	O	20	92
12	+	O	70	116	78	++	O	68	119	144	+	A	40	50
13	++	AB	47	72	79	+	A	24	62	145	++	B	48	71
14	+	B	66	96	80	+	A	32	48	146	+	A	18	48
15	+	O	18	92	81	++	O	63	124	147	+	O	65	101
16	++	A	51	89	82	++	B	47	71	148	++	AB	57	71
17	++	O	21	72	83	++	A	68	112	149	++	A	47	85
18	++	O	30	64	84	+	A	45	57	150	++	O	20	84
19	+	O	76	93	85	+	A	71	83	151	+	A	7	46
20	+	B	72	90	86	+	AB	28	61	152	++	O	59	91
21	++	A	19	71	87	++	B	15	51	153	++	O	37	62
22	++	O	60	104	88	+	O	15	49	154	++	A	25	61
23	++	A	41	81	89	+	B	46	57	155	++	B	19	71
24	++	A	25	74	90	+	O	44	52	156	++	O	27	91
25	+	O	11	49	91	++	A	39	100	157	+	A	9	51
26	++	A	52	62	92	++	O	35	61	158	++	O	36	84
27	+	A	18	66	93	+	O	42	49	159	++	A	31	82
28	+	AB	53	73	94	+	AB	16	57	160	+	O	7	55
29	++	O	16	97	95	++	A	59	71	161	+	A	22	48
30	++	B	39	71	96	++	O	14	81	162	++	B	44	63
31	+	O	33	48	97	+	O	27	48	163	++	A	74	119
32	+	O	36	60	98	+	A	15	48	164	++	O	19	72
33	++	A	19	85	99	++	A	30	82	165	+	O	37	50
34	+	A	36	47	100	++	AB	60	110	166	+	A	20	46
35	++	O	26	72	101	++	O	19	63	167	+	B	10	49
36	+	O	56	61	102	++	A	37	51	168	+	AB	16	50
37	++	O	32	75	103	+	O	28	58	169	++	O	60	98
38	++	A	41	72	104	++	B	72	172	170	++	O	45	81
39	+	B	32	61	105	++	O	49	71	171	+	O	42	48
40	+	A	59	59	106	++	A	21	73	172	++	AB	9	66
41	+	A	20	55	107	+	A	39	48	173	+	O	15	70
42	++	O	54	82	108	+	B	32	59	174	++	A	53	81
43	+	AB	31	60	109	++	O	27	62	175	++	B	63	95
44	+	B	29	49	110	++	A	74	152	176	++	O	11	50
45	+	O	40	47	111	++	O	22	51	177	++	B	61	89
46	++	AB	18	81	112	++	O	45	66	178	+	O	40	69
47	++	O	24	61	113	+	O	67	91	179	++	AB	33	66
48	++	B	28	75	114	++	A	44	62	180	++	A	54	71
49	+	O	22	49	115	++	O	32	71	181	++	O	13	67

50	+	A	54	72	116	++	AB	62	102	182	+	O	21	79
51	+	O	19	49	117	++	O	61	107	183	+	A	32	81
52	++	AB	46	61	118	+	AB	62	71	184	++	B	21	49
53	++	B	74	118	119	++	A	27	56	185	++	O	20	50
54	+	A	17	50	120	++	B	49	66	186	+	A	60	88
55	+	B	53	62	121	++	A	49	109	187	++	A	25	101
56	++	O	79	146	122	++	A	20	62	188	++	O	62	108
57	++	O	17	73	123	+	O	41	57	189	++	B	33	93
58	+	A	65	91	124	++	A	55	61	190	+	O	70	85
59	+	O	52	72	125	++	A	60	98	191	++	A	43	96
60	++	A	68	108	126	++	B	18	71	192	++	A	32	50
61	++	A	47	85	127	+	O	55	51	193	++	O	72	112
62	+	O	40	49	128	+	AB	37	65	194	++	O	14	97
63	+	B	39	49	129	++	O	36	91	195	++	A	72	112
64	++	O	44	82	130	++	A	26	74	196	+	A	50	83
65	+	A	45	56	131	+	A	25	50	197	+	AB	51	87
66	+	A	49	62	132	+	A	16	49	198	++	O	45	91

Source: T.B. Unit, Sacred Heart Hospital, Lantoro Abeokuta Ogun State by permission of the Hospital Management.

Table 3: Presentation of data in ANOVA Layout

Factor A(Blood Group)	Factor B Class of Infection	Factor C (Age Group)				
		≤ 19	20 – 34	35 – 49	50 – 64	≥ 65
A	+	66, 50, 48, 49, 48, 46, 51	56, 48, 55, 62, 48, 50, 48, 46, 81	47, 56, 62, 57, 48, 50	59, 72, 88, 83	91, 83
	++	71, 55, 71, 85	71, 89, 74, 81, 82, 73, 56, 62, 74, 83, 53, 79, 61, 82, 101, 50	81, 72, 85, 100, 51, 62, 109, 85, 96	89, 62, 71, 61, 98, 81, 71	108, 112, 152, 119, 112
B	+	49, 49	61, 49, 59	49, 57	62, 66	96, 90
	++	85, 51, 71, 71	75, 49, 93	71, 71, 66, 71, 63	99, 95, 89	118, 102, 172, 137
AB	+	57, 50	60, 61	65	73, 71	87
	++	81, 66	79, 66	72, 61	110, 102, 71	96, 72
O	+	92, 49, 49, 49, 55, 70	48, 49, 47, 55, 48, 58, 79	60, 47, 49, 50, 52, 49, 57, 50, 48, 69	76, 61, 72, 51, 60	116, 93, 102, 91, 101, 85
	++	61, 97, 73, 81, 63, 71, 72, 50, 67, 97	72, 64, 72, 75, 61, 84, 62, 51, 71, 92, 84, 91, 50	66, 82, 81, 61, 71, 66, 91, 51, 62, 84, 81, 102, 91	104,82, 124, 107, 91, 98, 108	146, 119, 120

2.6. Analysis of Data

2.6.1. Determination of Incidence Rate of Recorded T.B. Infection by Blood Group and Age Percentage

In this section, the percentage rate of incidence of tuberculosis infection is determined separately for blood group and age.

Percentage rate by blood group
This is given by

$\frac{H_i}{N} \times 100\%$; i = 1, 2, 3, 4

where

1 = blood group A
2 = blood group B
3 = blood group AB
4 = blood group O

2.6.2. Test for Normality Assumption

In testing for the normality assumption, the null and alternative hypotheses are;

H_0: The data is from a normal population

H_1: The data is not from a normal population

Using the MINITAB Software via Anderson-Darling method, the output is displayed below. The result shows that the null hypothesis is not rejected since the p-value is greater than 0.05, which means that the data for normality assumption is satisfied.

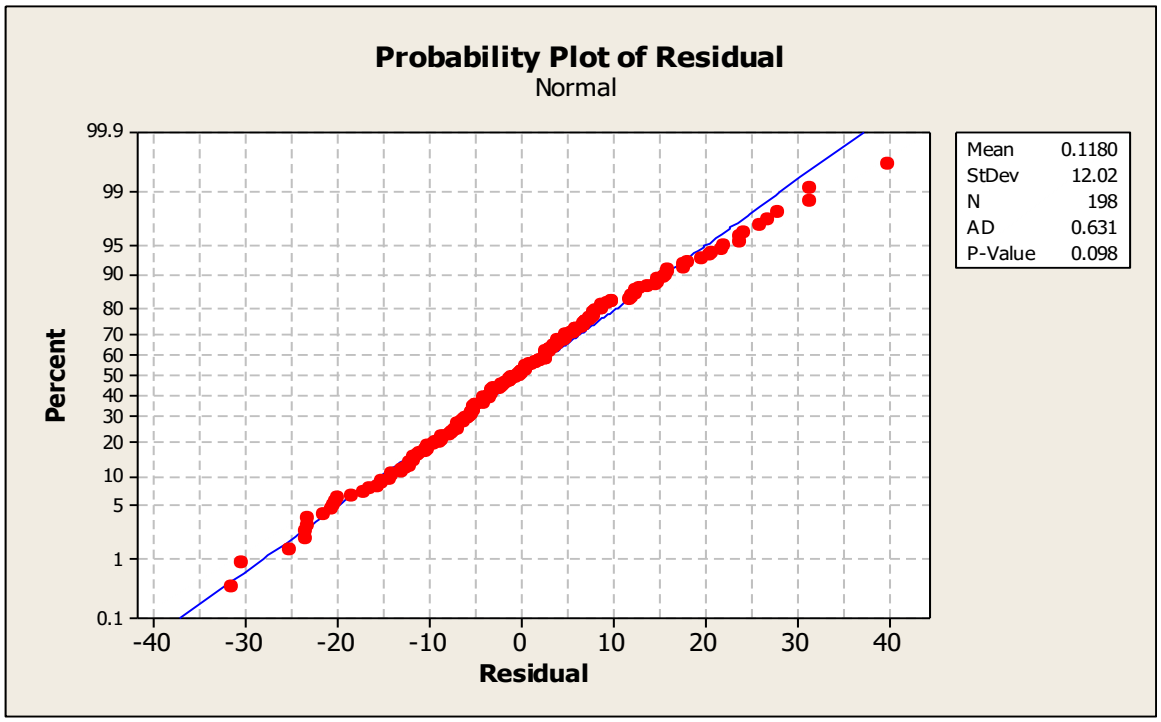

Fig. 1: Normal Probability Plot of Residual for T.B. Infection

2.6.3. Three Factor ANOVA Test

In this section, we shall carry out all tests individually as it reflects the objectives and hence the interaction shall also be tested. For ease of the computation, the SPSS Software version 20.0 was used for the analysis, and the output is displayed in Table 4.

Table 4: ANOVA Table for the Three Factor Model for Unbalanced Data

Tests of Between-Subjects Effects
Dependent Variable: Dependent

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Model	1153896.798[a]	40	28847.420	159.706	.000
Factor A	617.038	3	205.679	1.139	.335
Factor B	12063.919	1	12063.919	66.789	.000
Factor C	25729.539	4	6432.385	35.611	.000
Factor A * Factor B	698.853	3	232.951	1.290	.280
Factor A * Factor C	2445.531	12	203.794	1.128	.341
Factor B * Factor C	370.787	4	92.697	.513	.726
Factor A * Factor B * Factor C	3102.140	12	258.512	1.431	.157
Error	28539.202	158	180.628		
Total	1182436.000	198			

a. R Squared = .976 (Adjusted R Squared = .970)

2.6.4. Test for the Effect of Blood Group in the Treatment of Tuberculosis

The null and alternative hypotheses are;

$H_0 : \tau_i = 0$, $i = 1,2,3,4$ (Relationship does not exist within the blood group)

$H_1 :$ not all $\tau_i = 0$ (Relationship exists within the blood group).

From the output of the SPSS in Table 4, the p-value (0.335) is large, that is greater than 0.05, we do not reject the null hypothesis, which implies that blood group does not affect the treatment time of Tuberculosis infection.

2.6.5. Test for the Effect of Class of Infection in the Treatment of Tuberculosis

The null and alternative hypotheses are;

$H_0 : \beta_j = 0$, $j = 1,2$

$H_1 :$ not all $\beta_j = 0$

From the output of the SPSS in Table 4, the p-value (0.000) is small, that is less than 0.05, and we reject the null hypothesis, which implies that the class of infection affects treatment of Tuberculosis infection.

2.6.6. Test for the Effect of Age in the Treatment of Tuberculosis Infection

The null and alternative hypotheses are;

$H_0 : \gamma_k = 0$, $k = 1,2,3,4,5$

$H_1 :$ not all $\gamma_k = 0$

From the output of the SPSS in Table 4, the p-value (0.000) is small, that is less than 0.05, and we reject the null hypothesis, which implies that age affects treatment of Tuberculosis infection.

2.6.7. Turkey HSD (A Post Hoc Test)

This test is conducted to determine the level(s) of age factor that is/are significant, having rejected the null hypothesis. In general, a Post Hoc Test is employed in the analysis of variance if and only if the null hypothesis is rejected to determine the treatments that contributed to the rejection of H_0. In this study, the

null hypothesis for the effect of Age in the treatment of T.B. was rejected; hence a post hoc test will be conducted. Turkey HSD shall be used to determine which Age group means that are different, however SPSS Software was used to run the multiple comparison and the output is presented in Table 5.

Table 5: SPSS Output for the Multiple Comparisons

Multiple Comparisons
Dependent Variable: Dependent
Tukey HSD

(I) Factor C	(J) Factor C	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-2.0541	2.85762	.952	-9.9397	5.8316
	3.00	-3.2832	2.94022	.798	-11.3969	4.8304
	4.00	-18.0844*	3.21798	.000	-26.9645	-9.2042
	5.00	-44.8541*	3.47950	.000	-54.4559	-35.2522
2.00	1.00	2.0541	2.85762	.952	-5.8316	9.9397
	3.00	-1.2292	2.65466	.990	-8.5548	6.0965
	4.00	-16.0303*	2.95934	.000	-24.1967	-7.8639
	5.00	-42.8000*	3.24180	.000	-51.7459	-33.8541
3.00	1.00	3.2832	2.94022	.798	-4.8304	11.3969
	2.00	1.2292	2.65466	.990	-6.0965	8.5548
	4.00	-14.8011*	3.03919	.000	-23.1879	-6.4144
	5.00	-41.5708*	3.31484	.000	-50.7183	-32.4234
4.00	1.00	18.0844*	3.21798	.000	9.2042	26.9645
	2.00	16.0303*	2.95934	.000	7.8639	24.1967
	3.00	14.8011*	3.03919	.000	6.4144	23.1879
	5.00	-26.7697*	3.56352	.000	-36.6034	-16.9360
5.00	1.00	44.8541*	3.47950	.000	35.2522	54.4559
	2.00	42.8000*	3.24180	.000	33.8541	51.7459
	3.00	41.5708*	3.31484	.000	32.4234	50.7183
	4.00	26.7697*	3.56352	.000	16.9360	36.6034

Based on observed means.
The error term is Mean Square (Error) = 180.628.
*. The mean difference is significant at the 0.05 level.

From the SPSS output, the ten pairs absolute mean differences are
$|\mu_1 - \mu_2|$ is insignificant, $|\mu_1 - \mu_3|$ is insignificant, $|\mu_1 - \mu_4|$ is significant
$|\mu_1 - \mu_5|$ is significant, $|\mu_2 - \mu_3|$ is insignificant $|\mu_2 - \mu_4|$ is significant
$|\mu_2 - \mu_5|$ is significant, $|\mu_3 - \mu_4|$ is significant, $|\mu_3 - \mu_5|$ is significant,
$|\mu_4 - \mu_5|$ is significant

Where $\mu_1, \mu_2, \mu_3, \mu_4, \mu_5$ are the mean age grade level of ≤ 19, 20 – 34, 35 – 49, 50 – 64 and ≥ 65 respectively.
From the comparisons above, it can be concluded that levels 5 (≥ 65) and 4 (50 – 64) caused the factor age group to be significant.

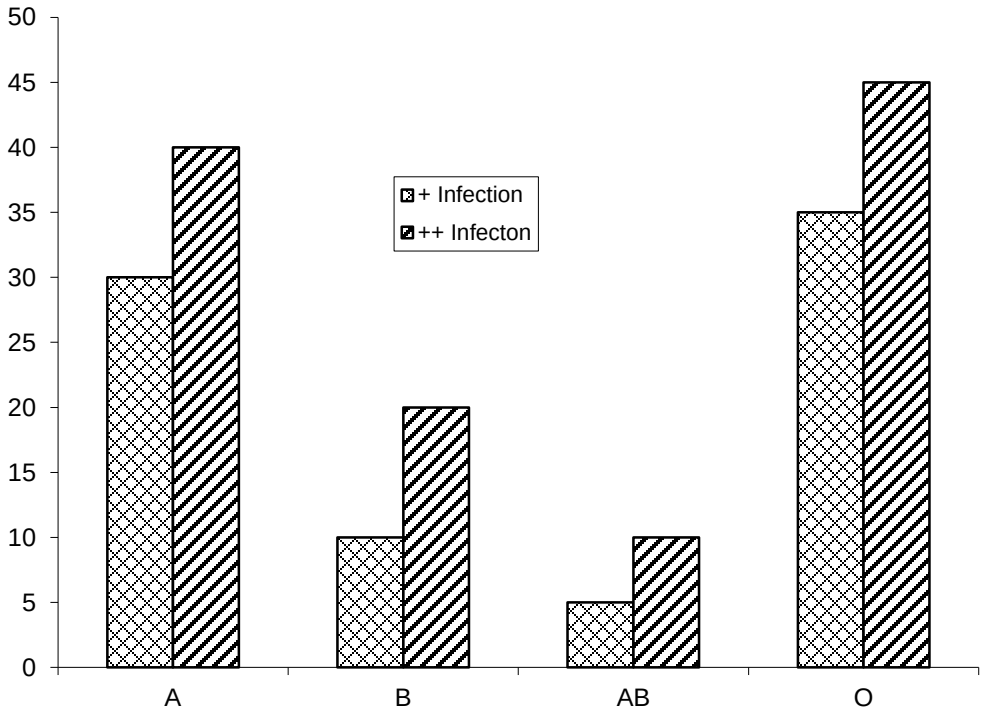

Fig. 2: Multiple Bar Charts on the Incidence Rate of Tuberculosis Infection According to Blood Group

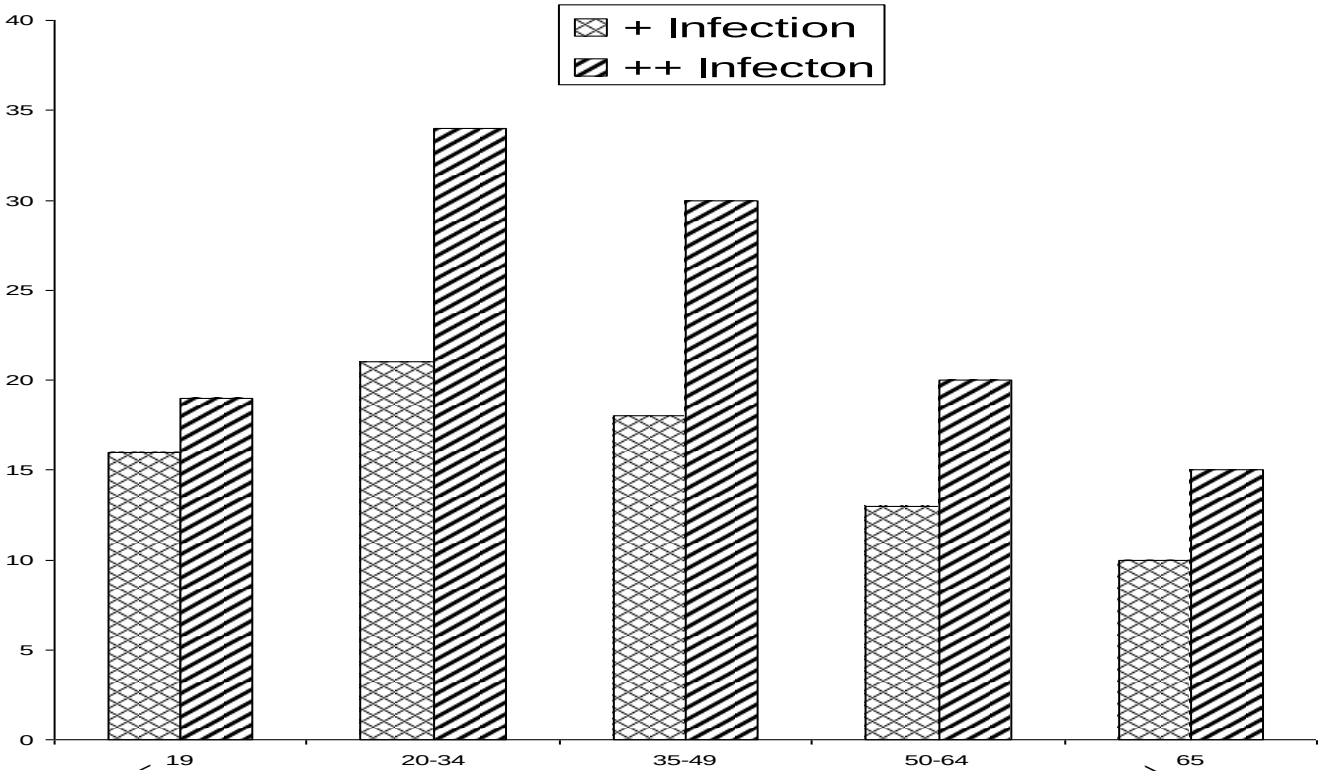

Fig. 3: Multiple Bar Charts on the Incidence Rate of Tuberculosis Infection According to Age group Level

Figures 2 and 3 show multiple bar charts of the incidence rate of the tuberculosis infection. The first (Fig. 2) considers this with respect to the blood groups of the patients while the second (Fig. 3) is with respect to the age groups of the patients.

3. Conclusion

This study was on the analysis of the factors affecting the cure of T.B. infection. The three-factor analysis of variance statistical technique was used in this study. The normality test was in line with the assumption of ANOVA using the Anderson-Darling test statistic via Minitab Software. The test was carried individually using the three factors considered in this study. It was revealed from the analysis that the blood group does not affect treatment time of Tuberculosis infection; class of infection affects treatment of Tuberculosis infection, and age group affects the treatment of Tuberculosis. A post Hoc test was conducted using the Tukey HSD on the age group, and it was revealed that levels 5 (≥ 65) and 4 (50-64) caused the significance nature of age grade factor

Based on the analysis of this work, it has been affirmed that patients with class one (+) infection consumes less time in treatment than their counterparts with class two (++) infection under the same condition of treatment.

It was also affirmed that the older one gets in age, the longer it takes to get him treated of a tuberculosis (TB) infection. However, for people within the ages of childbirth to 49years, even with some observed differences in total time of treatment, there is no evidence that age really affects their rate of recovery. The result of multiple comparison of the age group reveals that the effect of age is only on ages from fifty years and above with more prolonged time of treatment when the whole patients are subjected to the same treatment.

Finally, this work shows that in spite of the observed differences in our measurement, there is no evidence that a particular blood group causes a TB infectious patient to get treated of his infection faster than the other.

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