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TEST OF MULTICOLLINEARITY AMONG SOME SELECTED DISEASES: CASE STUDY OF ZONAL HOSPITAL IDAH , KOGI STATE (1994 - 2013)

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ABSTRACT

*This work is on test of Multicollinearity among some selected diseases, **a** case study of Zonal Hospital Idah – Kogi State (1994 - 2013). It was carried out in other to test for Multicollinearity in a model with three exogenous variables. Data on death and some of its causes (malaria, typhoid and anemia) were collected for the period of twenty years. The analysis was carried out using the Farrar-Glauber test of Multicollinearity. The results of the analysis revealed that there is presence of Multicollinearity in the model when tested at the 5% level of significance.*

INTRODUCTION

Health is the state of being or the condition of the body or mind. Being healthy suggests a situation of a body having good health, well strong and able to resist the organisms that cause diseases. Healthy means to be free from illness. As one of the components of health statistics, death rate is taken into consideration with reference to its cause(s). Although there are many diseases across the world, some are pertinent to some regions. Those that are common in West Africa are malaria, measles, chicken box, and anemia, to mention but a few.

Multicollinearity is a condition that exists when independent variables are correlated with one another. That is, a phenomenon in which two or more predictor variables in a multiple regression model is highly correlated. This means that one can be linearly predicted from the others with a substantial degree of accuracy. In this situation, the coefficient estimates of the multiple regression may change erratically in response to small changes in the model or the data. Multicollinearity does not reduce the predictive power or reliability of the model as a whole, at least within the sample data set; it only affects calculations regarding individual predictors. That is, a multiple regression model with correlated predictors can indicate how well the entire bundle of predictors predict the outcome variable, but it may not give valid results about any individual predictor, or about which predictors are redundant with respect to others (https://en.m.wikipedia.org/wiki/Multicollinearity). The adverse effect of Multicollinearity is that the estimated regression coefficients (b_1,b_2……..b_n) tend to have large sampling variability. That is, the standard errors are large. Consequently, when the coefficients are tested, the t - statistics will be small, which infers that there is no linear relationship between the affected independent variables and the dependent variables. In some cases, this inference will be wrong. Fortunately, Multicollinearity does not affect the F-test of the analysis of variance. Over the years, test of Multicollinearity had been in existence and wildly applied as to determine the collinearity or inter-correlation between two or more exogenous variables. These variables could be in area of health where related deadly diseases are tested. It could also be in the area of production where factors like capital, labour, income, investment, budget, etc. are put into considerations. The studies of Multicollinearity enable us to know the functional relationship as well as pattern of relationship that most exist between the variables. Multicollinearity exists in virtually all multiple regression models. In fact, finding two completely uncorrelated variables is rare. The problem becomes serious, however, when two or more independent variables are highly correlated.

Multicollinearity increases the standard errors of the coefficient. Increased standard errors in turn means that coefficients for some independent variables may be found not to be significantly different from 0. In other words, by overinflating the standard errors, multicollinearity makes some variables statistically independent when they should be significant. Without multicollinearity (and thus, with lower standard errors), those coefficients might be significant. We should note however that a little multicollinearity isn't necessarily a huge problem, but severe multicollinearity is a major problem because it increases the variance of the regression coefficient, making them unstable. The more variance they have, the more difficult it is to interpret the coefficients **(blog.minitab.com/ blog/understanding-statistics/handling-multicollinearity-in-regression-analysis)**.

In multiple regression model, there are indicators that helps to detect the presence of multicollinearity. Some of them among others includes:

i. Large changes in the estimated regression coefficients when a predictor variable is added or deleted.
ii. Insignificant regression coefficients for the affected variables in the multiple regression, but a rejection of the joint hypothesis that those coefficients are all zero (using an F – test)
iii. If a multivariable regression finds an insignificant coefficient of a particular explanator, yet a simple linear regression of the explained variable on this explanatory variable shows its coefficient to be significantly different from zero, this situation indicates multicollinearity in the multivariable regression.
iv. Perturbing the data: Multicollinearity can be detected by adding random noise to the data and re – running the regression many times and seeing how much the coefficients change.
v. Construction of a correlation matrix among the explanatory variables will yield indications as to the likelihood that any given couplet of right-hand side variables are creating multicollinearity problems. Correlation values (off-diagonal elements) of at least 4 are sometimes interpreted as indicating a multicollinearity problem. This procedure is, however, highly problematic and cannot be recommended. Intuitively, correlation describes a bivariate relationship, whereas collinearity is a multivariate phenomenon (https://en.m. wikipedia.org/wiki/multicollinearity)

STATEMENT OF THE PROBLEM

This study on test of multicollinearity among some selected diseases is embarked upon to solve problem of collinearity or interrelationship among some selected diseases - malaria, typhoid, and anemia which are the most prevalent diseases in Idah (the case study) and its environs. It will cover primarily death and some causative diseases - malaria, typhoid, and anemia which are prevalent in the study area - Zonal Hospital Idah, Kogi State (1994 – 2013). The χ^2 test analysis in the Farrar-Glauber's test will enables the researcher to know the existence and severity of multicollinearity among the three selected disease.

The aim of this work includes the estimation of the parameters of the components of the Farrar-Glauber's test statistic and to investigate if there is any relationship or collinearity among the various diseases that are prevalent among the people in the study area.

TYPHOID FEVER

Typhoid fever is a common worldwide bacterial disease transmitted by the ingestion of food or water contaminated by bacteria *Salmonella typhi*. It is also known as enteric, or commonly just typhoid. Typhoid fever and paratyphoid fever are clinically indistinguishable diseases, collectively called enteric fever (www.medicalnewstoday). The disease has received various names such as gastric fever, slow fever, nervous fever, pathogenic fever, infantile remittent fever, etc. In the early 1900s there were thousands of typhoid fever cases and many people died of this disease. Most of these cases arose when people drank water

contaminated with sewage or ate food handled by or Prepared by individuals who were shedding the typhoid fever bacterium (*Salmonella typhi*). This necessitated the need for public health. Joanne et al; (2011), reveals that, public health is the science of protecting populations and improving the health of human communities through education, promotion of healthy styles, and prevention of diseases and injury.

SYMPTOMS

Typhoid fever, at the initial stage is characterized by very high fever that run as high as 39 or 40 degrees Celsius, generalized aches(e.g. headaches) and pains, sweating, Lethargy, weakness, fatigue, gastroenteritis, diarrhea and rash (rose – colored spots on the lower chest or upper abdomen). If left untreated, a second stage of typhoid may result with a continuation of a high fever, severe constipation or diarrhea that resembles pea soup, extreme weight loss, and an uncomfortable, distended abdomen. The final stage of symptoms, known as the typhoid state, leaves a person delirious and lying motionless with the eyes half closed. During the fourth week of illness, improvement slowly begins to come and the fever is likely to decrease gradually over ten days. Although the illness is very rare in the developed world, it is still a serious health threat in the developing world. It is treatable with antibiotics (www.medicalnewstoday).

PREVENTION

Typhoid fever can be prevented through proper sanitation and hygiene. Proper and persistent washing of hands and careful food preparation are advisable since the disease spreads in places where human feces come in contact with food and drinking water. People in endemic areas should avoid drinking untreated water, raw foods and vegetables. They should choose to consume hot foods where bacteria cannot survive (www.medicalnewstoday).

MALARIA FEVER

Malaria fever is a deadly disease that could be easily caused by mosquitoes. It's a result of several causes and characterized by the occurrence of chills, fever, and sweating in distinct paroxysms. At times, it might be intermittent fever or remittent fever (www.thefreedictionary.com/malaria). Due to the nearness of river of some communities, several people are prone to malaria attack which may lead to their death if not taken care of.

Joanne et al (2011) also reveals that malaria is an Arthropod-borne diseases and the most important human protozoa is plasmodium, the causative agent of malaria. WHO (2014) reveals that more than (2.8-3.2) billion people are affected worldwide each year, and over 1.4 million (mostly children) die annually of malaria in African alone.

Malaria is caused by four species of plasmodium. These are P. Falciparum, P. Malaria, P. Vivax, P. Ovale. The parasite first enters the bloodstream through the bite of an infected female anopheles mosquito. After some time or period, the infected person will be contacted with the disease called malaria. WHO (1955), began a worldwide malaria eradication program that finally collapsed in 1976 due to the resistance to the vaccine developed to be used in other to eradicate the disease by mosquitoes. Scientists were able to develop a new vaccine and more potent drugs due to scientific discovery.

SYMPTOMS

The pathological changes caused by malaria involve not only the erythrocytes but also the spleen and other visceral organs. Classic symptom first develop with the synchronized releases of merozoitesand erythrocyte debris into the bloodstream, resulting in the malaria paroxysms challing chills,then burning fever followed by sweating. This means that the fever and chills are caused by a malaria toxin that induces macrophages to

release interleukin-1. Several of these paroxysms constitute an attack. After one attack, there is remission that casts from a few weeks to several months, and then there is a relapse. Between paroxysms, the patients feel normal. Anemia can result from the loss of erythrocytes and the spleen and liver often hypertrophy. Children and non-immune individuals can die of cerebral malaria.

CONTROL

Although it is not very easy to control malaria absolutely, the best approach is to vaccinate people in endemic areas at a very young age. It is worth nothing that individuals who are travelling to areas where malaria is endemic should receive Chemophopylactic treatment with Chloroquine, Primaquine, etc. Other control measure is the use of mosquito net.

ANEMIA

Anemia is a deficiency in the number or quality of red blood cells in the body (www.Betterhealth.vic.gov .au/anemia). It is a condition caused by a lack of red blood cells. It means that the body's tissues and organs cannot get enough oxygen. According to Denise (2013)'anemia is a condition that develops when ones blood lack enough healthy red blood cells or hemoglobin'. Hemoglobin is the main part of red blood cells and builds oxygen. If one have too few/abnormal red blood cells or abnormal/low hemoglobin, the cells in his/her body will not get enough oxygen.

Anemia exists because organs aren't gathering what they need to function properly. Anemic is the most common blood condition in U.S. it affects 3.5 million Americans. Woman and people with chronic diseases are at increased risk of anemia. It is important to note that certain form of anemia are hereditary and infants may be affected from the time of birth. Women in the childbearing years are particularly susceptible to iron-deficiency anemia because of the blood loss from menstruation and the increased blood supply during pregnancy. Other adults also may have a greater risk of developing anemia because of poor diet and other medical conditions.

There are many types of anemia. All are very different in their causes and treatments. Iron- deficiency anemia is the most common type of anemia and is very treatable with diet changes and iron supplements. Some form of anemia like the ones that develops during pregnancy are even considered normal. However, some types of anemia may present lifelong health problems.

CAUSES OF ANEMIA

Wikipedia reveals that there are more than 420 types of anemia which are divided into three groups. These are:

1. anemia caused by blood loss
2. anemia caused by decreased or faulty red blood cell production
3. anemia caused by destruction of red blood cells.

Anemia Caused by Blood Loss: Red blood cells can be lost through bleeding which can occur slowly over a long period of time, and can often go undetected. This kind of chronic bleeding commonly results from the followings: Gastro internal conditions such as ulcers, hemorrhoids, gastritis inflammation of the stomach and cancer, menstruation and childbirth in women especially if menstrual bleeding is excessive and if there are multiple pregnancies.

Anemia caused by decreased or faulty red blood cell production: This is the type of anemia caused when the body produces few blood cells or the blood cells may not function correctly. In either case, anemia can result. Red blood cells may be faulty or decreased due to abnormal red blood cells or lack of minerals and vitamin needed or red blood cells to work properly. Conditions associated with these cause of anemia

includes the followings: Sickle cell anemia, iron-deficiency anemia, vitamin deficiency bone marrow and stein cell proteins. Sickle cell anemia is an inherited disorder that affects African- Americans. Red blood cells become crescent- shaped because of genetic defect. They breakdown rapidly and so oxygen does not get to the body's organs causing anemia as well as pains.

Anemia caused by destruction of red blood cells: A condition in which red blood cells are destroyed and removed from the blood stream before their normal lifespan is over is referred to as hemolytic anemia (www.nhlbi.nih.gov/health (2014)). Also, according to April Kahn (2012), hemolytic anemia occurs when red blood cells die sooner than the bone marrow can produce them. This is scientifically termed hemolysis. The two forms of hemolytic anemia are intrinsic and extrinsic hemolytic anemia. Extrinsic develops when the spleen traps and destroys healthy red blood cells. This can also be due to infections, tumors, autoimmune disorders, medication side effects, leukemia, or lymphoma. On the other hand, intrinsic hemolytic anemia develops when the red blood cells produced by the body are defective. This condition is often inherited, such as people with sickle cell anemia or thalassemia.

SYMPTOMS

Some of the symptoms of anemia are; fatigue, tiredness, lethargy, breathing difficulties after exercise, dizziness, leg pains, pale complexion etc.

GENERAL PREVENTIVE AND CONTROL MEASURES

1 Vaccination is one of the most common effective weapons for microbial disease prevention and vaccines constitute one of the greatest achievements of modern medicine.
2. Many of the current vaccines in use for humans consist of whole organisms that are either inactivated (killed) or attenuated (alive but not strong enough to harm).
3. Epidemiological control measures can be directed toward reducing or eliminating infection sources, breaking the connection between sources and susceptive individuals.

SOURCE OF DATA

The data used in this research work is a secondary data from Zonal Hospital Idah, Kogi State (1994 – 2013) with the interest of studying death and its curses in respect to malaria, typhoid and anemia.

Table 1: Total number of deaths and deaths caused by malaria, typhoid and anemia.

S/N	Year	No of death	Malaria (y_1)	Typhoid (y_2)	Anemia (y_3)
1	1994	72	13	15	23
2	1995	66	10	11	9
3	1996	64	20	10	15
4	1997	125	30	28	20
5	1998	99	10	25	23
6	1999	94	15	25	30
7	2000	129	35	27	38
8	2001	111	27	22	21
9	2002	95	23	24	30
10	2003	96	21	25	15
11	2004	105	31	37	18
12	2005	135	40	37	20
13	2006	124	18	17	20
14	2007	95	15	27	30
15	2008	69	20	15	14
16	2009	54	10	15	12
17	2010	43	14	12	8
18	2011	37	10	5	7
19	2012	59	13	17	8
20	2013	131	30	12	8

METHODOLOGY

This research work is basically concerned with testing the interrelationship or intercorrelation among the exogenous variables. The two possible tests of multicollinearity are the Farrar-Glauber test and the Frisch's confluence analysis test. For this work however, we shall consider only the Farrar-Glauber test.

THE FARRAR- GLAUBER TEST OF MULTICOLLINEARITY

Farrar-Glauber test for multicollinearity was introduced by D.E. Farrar and R.R. Glauber in 1967. It involves 3 stages of analysis. These stages are:

1. The use of χ^2 test to determine the presence and severity of multicollinearity in a model with several exogenous variables.
2. The use of F-test to locate the multicollinear factors/variables in the model.
3. The application of t-test to detect the pattern of multicollinearity (that is to detect how Variables are collinear) in model..

Stage 1: The use of χ^2 - test

The hypothesis to be tested is:
H_o: $x_{i's}$ are orthogonal (there is no multicollinearity)
H_1: $x_{i's}$ are not orthogonal (there is multicollinearity).

The test Statistic is:

$\chi^2_{cal} = -[(n-1) - \frac{1}{6}(2k+5)] \log_e$ [Standardize Determinant Value (SDV)]
Where loge = In, n = number (or size) of sample and K = number of independent variables

$$\text{S.D.V.} = \begin{vmatrix} 1 & r_{12} & r_{13} \\ r_{12} & 1 & r_{23} \\ r_{13} & r_{23} & 1 \end{vmatrix}$$

The correlation coefficients between the exogenous variable computed through the product moment correlation:

$$r_{xixi} = \frac{s_{yiyj}}{\sqrt{(s^2_{xi}\, s^2_{xj})}} = \frac{n\sum x_i x_j - \sum x_i \sum x_j}{\sqrt{[(n\sum x_i{}^2 - (\sum x_i)^2)(n\sum x_j{}^2 - (\sum x_j)^2]}}$$

Level of significance: $\alpha = 0.05$
Critical value: $\chi^2_{tab.} = \chi^2_{½\, k(k-1),\ \alpha}$

Decision rule: reject H_o if $\chi^2_{cal.} \geq \chi^2_{tab.}$ otherwise do not reject.

Stage 2: The use of F- test

The hypothesis to be tested is:

H_o: $R_{xi.x_2x_3 \ldots\ldots\ldots x_k} = 0$ ($X_{i's}$ are not multicollinear) vs H_1: $R_{xi.x_2x_3 \ldots\ldots\ldots x_k} \neq 0$ ($X_{i's}$ are multicollinear)

The test Statistic is:

$F_{cal.} = \frac{(R2\ xi.x2x3------Xk)/(k-1)}{(1-R2xi.x2x3---Xk)/(n-k)}$, Where n = sample size and k = number of explanatory variable.

Critical value: $F_{tab} = F_{(k-1),(n-k),\alpha\ df}$
Level of significance: $\alpha = 0.65$
Decision rule: Reject H_o if $F_{cal} \geq F_{tab}$, otherwise do not reject

Stage 3: The use of t- test

The hypothesis to be tested is:
H_o: $r_{xixj.x1x2.....xk} = 0$ (X_i and X_j are not intercorrelated) vs
H_1: $r_{xixj.x1x2.....xk} \neq 0$ (X_i and X_j are intercorrelated)

The test Statistic:

$t_{cal} = (r_{xixj.x1x2.....xk})\sqrt{n-k/(1-r^2_{xixj\cdot x1x2.....xk})}$
where n=sample size and k= number of explanatory variable.

critical value: $t_{tab} = t_{(n-k),\alpha}$

Decision rule: Reject H_o if $t_{cal} \geq t_{tab}$, otherwise, do not reject.
Using the above methods, the analysis of the given data is shown below..

DATA ANALYSIS

From the data presented above, we have:

Stage 1
The respective correlation coefficients:

$r_{x1x2} = r_{12} = \frac{20(9173)-405(406)}{\sqrt{(20(9793)-(405^2)((20(9702)-(406^2)}} = 0.6241$ (to 4d.p) , where:

n = 20, $\sum X_1X_2$ = 9173, $\sum X_1$ = 405, $\sum X_1^2$ = 9793, $\sum X_2$ =406, $\sum X_2^2$ = 9702

$r_{x1x3} = r_{13} = \frac{20(7965)-405(369)}{\sqrt{[20(9793)-(405)^2][20(8279)-(369)^2]}} = 0.3220$ (to 4d.p) , where:

n = 20, $\sum X_1X_3$ = 7965, $\sum X_1$ = 405, $\sum X_1^2$ = 9793, $\sum X_3^2$ = 8279, $\sum X_3$ =369

$r_{x2x3} = r_{23} = \frac{20(8371)-(406)(369)}{\sqrt{[20(9702)-(406)^2][20(8279)-(369)^2]}} = 0.6006$ (to 4d.p) , where:

n = 20, $\sum X_2X_3$ = 8371, $\sum X_2$ = 406, $\sum X_2^2$ = 9702, $\sum X_3$ = 369 $\sum X_3^2$ = 8279

So that the S.D.V. $= \begin{vmatrix} 1.0000 & 0.6241 & 0.3220 \\ 0.6241 & 1.000 & 0.6006 \\ 0.3220 & 0.6006 & 1.000 \end{vmatrix} = 0.3875$

Since n = 20, k = 3 and S.D.V. = 0.3875, we have:
χ^2cal = -((20-1)-⅙(2(3)+5)ln0.3875) = -20.7381(to 4 d.p)

$\chi^2_{tab} = \chi^2_{½\,k(k-1),\,\alpha} = \chi^2_{½(3(3-1),\,0.05} = \chi^2_{3,0.05} = 7.815$

Decision/Conclusion

Since $\chi^2_{cal} = 20.7381 < \chi^2_{tab} = 7.815$, we reject Ho and conclude that, there is presence of multicollinearity in the model.

Stage 2

Before we carry out the F-test analysis, we first obtain the multiple correlation between the variables x_1, x_2, and x_3.

Recall that $r_{12} = 0.6241$, $r_{13} = 0.3220$, $r_{23} = 0.6006$. So that:

$R_{1.23} = \sqrt{[(r^2_{12} + r^2_{13} - 2r_{12}r_{13}r_{23})/(1-r^2_{23})]}$

$= \sqrt{[(0.6241^2 + 0.3220^2 - 2(0.6241)(0.3220)(0.6006)/(1- 0.6006^2)]} = 0.6276$ (to 4 d.p)

$R_{2.13} = \sqrt{[(r^2_{12} + r^2_{23} - 2r_{12}r_{13}r_{23})/(1-r^2_{13})]}$

$= \sqrt{[(0.6241^2 + 0.6006^2 - 2(0.6241)(0.3220)(0.6006)/(1- 0.3220^2)]} = 0.7534$ (to 4 d.p)

$R_{3.12} = \sqrt{[(r^2_{32} + r^2_{13} - 2r_{12}r_{13}r_{23})/(1-r^2_{12})]}$

$= \sqrt{[(0.3220^2 + 0.6006^2 - 2(0.6241)(0.3220)(0.6006)/(1- 0.6241^2)]} = 0.6044$ (to 4 d.p)

From the results obtained above, we have:

$$F_{1cal} = \frac{R^2_{1.23}/(k-1)}{(1-R^2_{1.23})/(n-k)} = \frac{0.6276^2/(3-1)}{(1-0.6276^2)/(20-3)} = 5.5227 \text{ (to 4 d.p)}$$

$$F_{2cal} = \frac{R^2_{2.13}/(k-1)}{(1-R^2_{2.13})/(n-k)} = \frac{0.7534^2/(3-1)}{(1-0.7534^2)/(20-3)} = 11.1580 \text{ (to 4 d.p)}$$

$$F_{3cal} = \frac{R^2_{3.12}/(k-1)}{(1-R^2_{3.12})/(n-k)} = \frac{0.6044^2/(3-1)}{(1-0.6044^2)/(20-3)} = 4.8908 \text{ (to 4 d.p)}$$

$F_{tab} = F_{(k-1),(n-k),\,\alpha} = F_{2,17,0.05} = 3.57$

Decision/conclusion

Since F_{cals} are $> F_{tab,}$ we reject H_0 and conclude that the variable y_i are multicollinear at 5% level. Hence, there is existence of multicollinearity in the model.

Test 3 (t-test)

In this case, we first compute the partial correlation coefficient among the exogenous variables.
Recall that $r_{12} = 0.6241$, $r_{13} = 0.3220$, $r_{23} = 0.6006$

$$r_{12.3} = \frac{r_{12}-r_{13}r_{23}}{\sqrt{(1-r_{13}^2)(1-r_{23}^2)}} = \frac{0.6241-(0.3220)(0.6006)}{\sqrt{[(1-0.3220^2)(1-0.6006^2)]}} = 0.5690$$

$$r_{13.2} = \frac{r_{13}-r_{12}r_{23}}{\sqrt{(1-r_{12}^2)(1-r_{23}^2)}} = \frac{0.6241-(0.3220)(0.6006)}{\sqrt{[(1-0.3220^2)(1-0.6006^2)]}} = -0.0845$$

$$r_{23.1} = \frac{r_{23}-r_{12}r_{13}}{\sqrt{(1-r_{12}^2)(1-r_{13}^2)}} = \frac{0.6006-0.6241(0.3220)}{\sqrt{(1-0.6241^2)(1-0.3220^2)}} = 0.5402$$

For the t-calculated, we have;

$$t_{1cal} = \frac{r_{12.3}\sqrt{n-k}}{(1-r_{12.3}^2)} = \frac{0.5690\sqrt{20-3}}{(1-0.5690^2)} = 3.4692$$

$$t_{2cal} = \frac{r_{13.2}\sqrt{n-k}}{(1-r_{13.2}^2)} = \frac{-0.0845\sqrt{20-3}}{(1-(-0.0845)^2)} = -0.3509$$

$$t_{3cal} = \frac{r_{23.2}\sqrt{n-k}}{(1-r_{23.2}^2)} = \frac{0.5402\sqrt{20-3}}{(1-(0.5402^2)} = 3.1451$$

The critical values for the t_{cal} are all the same, hence $t_{tab} = t_{(n-k),\alpha} = t_{17,0.05 = 2.11}$

Decision/conclusion

Base on the stated hypothesis above, we have:

1. Since $t_{1cal} = 3.4692 > t_{tab.} = 2.11$, we reject H_0 and conclude that X_1 and X_2 are intercorrelated at 5% level of significance.
2. Since $t_{2cal} = -0.3509 < t_{tab} = 2.11$, we do not reject H_0 but accept and conclude that X_1 and X_3 are not interrelated. Hence X_1 and X_3 are not the cause of multicollinearity in the model.
3. Also, since $t_{3cal} = 3.1451 > t_{tab.} = 2.11$, we reject H_0 and conclude that X_2 and X_3 are intercorrelated at 5% level of significance. Hence, X_2 and X_3 are responsible for the multicollinearity in the model.

FINDINGS

From the analysis carry out in this work, there is a clear indication of positive relationship between the diseases understudy. That is, the correlation coefficient between malaria and typhoid is 0.62, that of malaria and anemia is 0.32 and that of typhoid is 0.60

In testing for the multicollinearity, the χ^2 - test, F - test and t-test all show an evidence of existence of multicollinearity among the exogenous variable as the above test were conducted at 5% level of significance and the Null hypotheses were rejected in favour of the alternative hypotheses.

CONCLUSION

Conclusively, from the above analysis, it was discover that there is existent of multicollinearity among the exogenous variable using Farrar-Glauber test at 5% level of significance. The χ^2 test indicates the presence and severity of multicollinearity in the model with the exogenous variable. This is as a result of the tendency for the diseases (malaria, typhoid, anemia) to move together over time since these diseases are usually influenced by same factors and consequently act in the same pattern to those factors they arise overtime.

RECOMMENDATIONS

Having examined the process used in the above analysis and the drawn inferences, the following recommendations are made:

1. The research reveals that the three diseases have tendency to move together over time as they are cause by the same factors. Thus, the government and any non- governmental agencies who are interested in public enlightenment against any of these diseases should make sure that such enlightenment puts into consideration the three diseases simultaneously.

2. In the same way, doctors or health personnel's should make sure that they carry out necessary tests for the three diseases on any patient suffering from any one of the diseases. This will help in earlier detection of their presence.
3. It is also recommended that in any research work, before multiple regression analysis is carried out, it is necessary to first test for multicollinearity among the exogenous variables. This is because, if there is the presence of multicollinearity in the time series data, the regression parameters will be insignificant and the regression model formed cannot be used for forecasting.

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