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Analysis of Vital Signs of Patients Treated of Malaria

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Abstract

This study discusses the vital signs of persons treated of malaria, while comparing them with those of healthy persons. The ultimate objective is to determine those that can be used to classify patients to be treated of malaria. Data on six (6) vital signs collected on 100 patients from the Federal University of Technologly, Owerri, Nigeria (FUTO) Medical Centre were analyzed using simple multivariate test statistics. The results of the analysis show that vital signs of persons treated of malaria are independent of sex, blood genotype and blood group. However, vital signs of persons treated of malaria differ significantly from those of healthy persons at even one percent level of significance. Simultaneous confidence interval indicates that all the vital signs considered contributed to the rejection of the hypothesis. It has, therefore, been recommended that all the vital signs should be considered in choosing patients to be treated for malaria.

Keywords: Malaria, Vital signs, Health Status, Multivariate Methods, Background Characteristics

1. Introduction

Malaria has remained one of the prominent and ancient diseases and thus, one of the greatest burdens to mankind, with a mortality rate that is unmatched by any modern diseases. This dreadful disease, caused by four different agents (plasmodium *falciparum*, plasmodium *vivax,* plasmodium malaria and *plasmodium ovale*) of the same genus is a major health problem in most Sub-Saharan Africa countries including Nigeria. Statistical records have shown that there may be three hundred to five hundred million new infection and one to three million infection related deaths annually caused by malaria and 90 % of these deaths occurs in and around Sub-Sahara Africa. According to WHO (2014), (i) malaria is the second highest cause of death in Africa after HIV/AIDS (ii) Nigeria and Democratic Republic of Congo (DRC) alone account for about 40 % of global deaths from Malaria and (iii) about 20 % percent of deaths among under-five children are due to malaria. According to Okonkwo, Soleye, Amusan, Ogun, Udeze, Nkamg, Ejembi and Faleye (2009), about 25 % of under-five mortality, 30 % of deaths at childhood and about 11% of maternal deaths in Nigeria are due to malaria related problems.

In response to this, people (patients) visit the hospitals when they discovered they are ill or having the symptoms of malaria which is associated with fever that occurs in regular episode with sweating and exhaustion, which often change the body temperature, blood pressure, body weight, respiration and pulse rate. Health variation has been a problem to both patients and nurses over their own lives. Vital signs have remained at the centre of diagnosis of many diseases including malaria. The fact that many health problems present similar symptoms as malaria imply that there must be a way of identifying those to be treated of malaria through the vital signs. In order to achieve the goals of maintaining a good health status, Nurses take measurement of vital signs before treating patients.

Patients who visit the hospitals differ in age, weight, feeding pattern, shape, blood group, genotype and different ailments. In some cases, vital signs may differ according to these characteristics and determine the kind of treatment that suits them.

Occasionally, the body temperature of a patient rises above the normal temperature which is 37^0C as well as other vital signs. Two individuals may have the same illness and temperature but they may not have the same pressure or body weight. These characteristics make a big difference in the type of treatment needed in a hospital. However, since body situation creates a visual image health status, this is why people are conscious about their own health and this is a challenge to nurses and doctors. The results of this study may be useful to nurses and doctors who can treat sicknesses without necessarily taking all the measurements of vital signs thereby improving efficiency to meet the demands of rapidly changing environment.

The ultimate objective is to determine the vital signs which may be used to determine the patients to be treated of malaria. The specific objectives are to (i) obtain estimates of the vital signs of persons treated of malaria (ii) compare the estimates (of the vital signs of persons treated of malaria) according to some characteristics of the patients, (iii) compare estimates of the vital signs of persons treated of malaria with vital signs of healthy persons and (iv) determine the vital signs and other background characteristics that ultimately determine the malaria status of the patients.

2. Methodology.

The data for this study consist of vital signs; pulse (measured as beats per minute (BPM)), temperature (measured in centigrade), blood pressure (systolic and diastolic measured in millimetre mercury (mmHg)) and respiration (measured in breathing per minute (BPM)). For a healthy person, the normal heart beat rate ranges from 60- 100 beats per minute (BPM), normal respiratory rate in adults is 18 breathings per minute (BPM), Systolic BP is low when it is below 100 mmHg and high when it is above 140 mmHg and Diastolic BP is low when it is below 60mmHg and High when it is above 90mmHg.

The method of analysis adopted in this study is the method of multivariate analysis. To compare the vital signs of persons treated of malaria with those healthy persons, the Hotelling's T^2 test for one sample case was adopted. To test the null hypothesis that the vector of vital signs of persons treated of malaria is the same as that of the healthy persons the Hotelling's T^2 statistic for one sample case is given by Morrison (1976) and Onyeagu (2003) as,

$$T_c^2 = n(\underline{\bar{X}} - \underline{\mu}_0)' \underline{S}^{-1} (\underline{\bar{X}} - \underline{\mu}_0) \tag{1}$$

where n is the sample size (number of persons treated of malaria), $\underline{\bar{X}}$ is the sample mean vector of the vital signs of persons treated of malaria, $\underline{S}$ is the sample variance-covariance matrix (estimating the population variance-covariance matrix Σ) of persons treated of malaria and $\underline{\mu}_0$ is the mean vector of vital signs of healthy persons (obtained from the health personnel). Under the null hypothesis (H_o) that mean vital signs ($\underline{\mu}_x$) of persons treated of malaria is the same as those of healthy persons ($\underline{\mu}_0$) (i.e. $\underline{\mu}_x = \underline{\mu}_0$),

$$F_C = \frac{n-p}{p(n-1)} T_c^2 \tag{2}$$

follows the F- distribution with p, n-p degrees of freedom when Σ is unknown. The null hypothesis is rejected at α level of significance if F_C is greater than the tabulated value ($F_{p,\, n-p, \alpha}$) or not rejected otherwise. Equivalently, the null hypothesis is rejected if $T_c^2 > T^2_{p, n-p, \alpha}$ or not rejected otherwise, where,

$$T^{2,\alpha}_{p, n-p} = \frac{p(n-1)}{n-p} F_{p,n-p,\alpha} \tag{3}$$

When $\underline{\mu}_x \neq \underline{\mu}_0$, this indicates that at least one of the vital signs differs significantly from the hypothesized value. In order to determine the vital sign which contributes to the rejection of H_o we apply the method of simultaneous confidence interval. When Σ is unknown, the simultaneous confidence interval is given by Onyeagu (2003) as

$$\underline{c}'\underline{\bar{X}} - \sqrt{\frac{1}{n}\underline{c}'\underline{S}^{-1}\underline{c}T^{2,\alpha}_{(p,n-p)}} \leq \underline{c}'\underline{\mu}_0 \leq \underline{c}'\underline{\bar{X}} + \sqrt{\frac{1}{n}\underline{c}'\underline{S}^{-1}\underline{c}T^{2,\alpha}_{(p,n-p)}} \tag{4}$$

where $\underline{c}$ is a non-null p-component vector, $T^{\alpha}_{(p,n-p)}$ is the positive square root of $T^{2,\alpha}_{(p,n-p)}$. For p = 5, the p- component vectors may be written as $c'_1 = (1,0,0,0,0)$, $c'_2 = (0,1,0,0,0)$, $c'_3 = (0,0,1,0,0)$, $c'_4 = (0,0,0,1,0)$ and $c'_5 = (0,0,0,0,1)$.

To compare mean vectors of two samples (example, the mean vectors of vital signs for male and female), the Hotelling's T^2 for two sample case is used. The Hotelling's T^2 test statistic for two sample case is given by Morrison (1976), Ogum (2002) and Onyeagu (2003) as,

$$T_C^2 = \frac{n_1 n_2}{n_1 + n_2} (\bar{X}_1 - \bar{X}_2)' \underline{S}_P^{-1} (\bar{X}_1 - \bar{X}_2) \tag{5}$$

when the population's variance-covariance matrices Σ_1 and Σ_1 are unknown.

$\bar{X}_1$ and $\bar{X}_2$ are respectively the mean vectors computed from samples of sizes n_1 and n_2 selected from the first and second populations and

$$\underline{S}_P = \frac{(n_1 - 1)S_1 + (n_2 - 1)S_2}{n_1 + n_2 - 2} \tag{6}$$

is the pooled variance – covariance matrix derived from the two sample variance – covariance matrices ($\underline{S}_1$ and $\underline{S}_2$) from the two populations assumed independent.
Under the null hypothesis H_o: $\mu_1 = \mu_2$ (i.e. the mean vectors are equal), the statistic

$$F_C = \frac{n_1+n_2-p-1}{p(n_1+n_2-2)} T_c^2 \qquad (7)$$

follows the F distribution with $p,\ n_1+n_2-p-1$ degrees of freedom, where T^2 is as defined in Equation (3.5). The null hypothesis will be rejected at α level of significance if $F_c > F(p, n_1 + n_2 - 1, \alpha)$ or not rejected otherwise.

When the test indicates that $\mu_1 \neq \mu_2$, this means that at least one of the vital signs differs from the hypothesized value. In order to determine the vital sign which contributes to the rejection, we apply the method of simultaneous confidence interval. The 100 (1- α) percent simultaneous confidence intervals for all linear compounds $C'(\mu_1 - \mu_2) = C'\sigma$ of the mean differences is given by Morrison (1976), Ogum (2002) and Onyeagu (2003) as

$$C'(\overline{\underline{X}}_1-\overline{\underline{X}}_2)-\sqrt{C'SC\left(\frac{n_1+n_2}{n_1n_2}\right)T^2_{Tab}} \leq C'\sigma$$

$$\leq C'(\overline{\underline{X}}_1-\overline{\underline{X}}_2)+\sqrt{C'SC\left(\frac{n_1+n_2}{n_1n_2}\right)T^2_{Tab}} \qquad (8)$$

where, $T^2_{Tab} = T^2_{(p,n_1+n_2-p-1,\alpha)}$.

To compare mean vectors for k> 2 samples, the multivariate analysis of variance was adopted. An example is comparing mean vectors of vital signs for patients of different blood group ($A^+, A^-, B^+, B^-, AB^+, AB^-, O^+$ and O^-) or different genotypes (AA, AS and SS). The test statistic for one-way multivariate analysis of variance, called Wilkes lambda criterion, is given by

$$\Lambda = \frac{|\underline{W}|}{|\underline{B} + \underline{W}|} \qquad (9)$$

where

$$|\underline{W}| = \left|\sum_{i=1}^{k}\sum_{j=1}^{n_k}(\underline{X}_{ij} - \overline{\underline{X}}_{10})(\underline{X}_{ij} - \overline{\underline{X}}_{10})'\right| \qquad (10)$$

is the determinant of the matrix of the within treatment sums of squares and

$$|\underline{B}| = \left|\sum_{i=1}^{k} n_i(\overline{\underline{X}}_{i0} - \overline{\underline{X}}_{00})(\overline{\underline{X}}_{i0} - \overline{\underline{X}}_{00})'\right| \qquad (11)$$

is the determinant of the matrix of the between treatment sums of squares. Under the null hypothesis that the mean vectors are equal in the populations from which the samples were selected, the statistic

$$\chi^2_c = -[\sum_{i=1}^{k} n_i - 1 - \frac{p+k}{2}] \ln \Lambda \qquad (12)$$

asymptotically, follows the Chi-Square distribution with p(k-1) degrees of freedom. Consequently, for large sample size $n = \sum_{i=1}^{k} n_i$, we reject H_0 at α level of significance if

$$-[\sum_{i=1}^{k} n_i - 1 - \frac{p+k}{2}] \ln \Lambda > \chi^2_{p(k-1),\, \alpha}$$

where $\chi^2_{p(k-1),\, \alpha}$ is the upper 100α percentile of the Chi- Square distribution.

3. Vital Signs of persons treated of Malaria

The mean vital signs of persons treated of malaria according to some characteristics computed from the available data are shown in Table 1. As Table 1 shows, all the mean vital signs of the persons treated of malaria appear to differ from those of healthy persons. While the mean pulse, blood pressure and temperature of patients appear slightly lower, the mean respirations of patients appear slightly higher than those of the healthy persons.

Table 1: Mean Vital Signs for Persons Treated of Malaria by Some of their Background Characteristics

Charateristic		Vital Signs Pulse	BP(sst)	BP(dst)	Temp	Resp	No of cases
All		76.68	113.20	72.25	36.71	19.74	100
Sex :	M	76.39	114.23	72.75	36.59	19.89	71
	F	77.38	110.69	71.03	36.99	19.38	29
Genotype	AA	76.69	113.07	71.93	36.98	19.89	75
	AS	76.64	113.60	73.20	35.90	19.28	25
	A+	76.55	113.28	72.27	36.55	19.59	64
	A-	80.00	100.00	65.00	36.50	22.00	(2)
	B+	75.38	112.38	70.95	36.92	19.62	21
Blood	B-	na	na	na	na	na	0
Group	AB+	80.00	116.00	74.00	37.17	20.60	10
	O+	68.00	120.00	90.00	37.20	18.00	(1)
	O-	78.00	115.00	75.00	37.10	20.00	(2)
Healthy Persons		**80.00**	**120.00**	**80.00**	**37.00**	**18.00**	

na = not applicable

Mean pulse, blood pressure, temperature and respiration of patients appear to vary slightly according to sex, blood genotype, and blood group.

To determine the significance of the difference between the vital signs of males and females treated of malaria, the test statistics in equations 5 to 7 were used. From the available data, the mean vectors and variance-covariance matrices for sample sizes for male n(M) = 71 and for female n(F) = 29) are respectively,.

$$\underline{\bar{X}}_M = \begin{pmatrix} 76.39 \\ 114.23 \\ 72.75 \\ 36.59 \\ 19.89 \end{pmatrix}, \underline{\bar{X}}_F = \begin{pmatrix} 77.38 \\ 110.69 \\ 71.03 \\ 36.99 \\ 19.38 \end{pmatrix}$$

$$\underline{S}(M) = \begin{pmatrix} 38.8423 & 19.310 & 12.9014 & -0.6752 & 3.30221 \\ 19.3099 & 124.748 & 56.0865 & 4.2505 & -1.23139 \\ 12.9014 & 56.087 & 62.7062 & -3.2765 & -0.54326 \\ -0.6752 & 4.251 & -3.2765 & 16.3079 & 0.86189 \\ 3.3022 & -1.231 & -0.5433 & 0.8619 & 2.84427 \end{pmatrix}$$

$$\underline{S}(F)=\begin{pmatrix} 33.1724 & -8.128 & -15.0493 & -0.03300 & 0.17241 \\ -8.1281 & 113.793 & 74.2611 & 1.32635 & -1.69951 \\ -15.0493 & 74.261 & 73.8916 & 1.61453 & -0.04926 \\ -0.0330 & 1.326 & 1.6145 & 0.41495 & 0.15985 \\ 0.1724 & -1.700 & -0.0493 & 0.15985 & 4.31527 \end{pmatrix}$$

Hence, using Eqn (6)

$$\underline{S}_P=\begin{pmatrix} 37.2223 & 11.4706 & 4.9155 & -0.4917 & 2.4080 \\ 11.4705 & 121.6180 & 61.2792 & 3.4150 & -1.3651 \\ 4.9155 & 61.2796 & 65.9020 & -1.8791 & -0.4021 \\ -0.4917 & 3.4153 & -1.8791 & 11.7671 & 0.6613 \\ 2.4080 & -1.3650 & -0.4022 & 0.6613 & 3.2646 \end{pmatrix}$$

using eqn 5,

$$T_C^2 = 6.8297$$

and using eqn 7,

$$F_C = 1.3102$$

When compared with the tabulated value (2.29) at 0.05 level of significance and (5, 94) degrees of freedom, the calculated value (1.3102) indicates that vital signs of males and females treated of malaria do not differ significantly from each other. Hence, in further discussion, the two are combined.

To determine the significance of differences in vital signs of persons treated of malaria according to blood genotype, the test statistics in Equations (5) through (7) were also used. From the available data, the mean vectors are

$$\underline{\overline{X}}_{AA}=\begin{pmatrix} 76.69 \\ 113.07 \\ 71.93 \\ 36.98 \\ 19.89 \end{pmatrix},\quad \underline{\overline{X}}_{AS}=\begin{pmatrix} 76.64 \\ 113.60 \\ 73.20 \\ 35.90 \\ 19.29 \end{pmatrix},\quad n(AA)=75,\ n(As)=25$$

The variance –covariance matrices are

$$\underline{S}(AA)=\underline{\overline{X}}_1=\begin{pmatrix} 40.7020 & 10.818 & 5.9387 & 0.08121 & 3.83171 \\ 10.8180 & 121.550 & 60.8829 & 1.63387 & -0.74955 \\ 5.9387 & 60.883 & 69.5225 & 0.29856 & -0.33153 \\ 0.0812 & 1.634 & 0.2986 & 0.44062 & 0.13013 \\ 3.8317 & -0.750 & -0.3315 & 0.13013 & 2.90739 \end{pmatrix}$$

$$\underset{\sim}{S}(AS)=\overline{\underset{\sim}{X}}_2=\begin{pmatrix} 27.3233 & 10.517 & 0.3667 & -1.9640 & -2.43667 \\ 10.5167 & 132.333 & 67.1667 & 8.1400 & -1.46667 \\ 0.3667 & 67.167 & 56.0000 & -8.1117 & 0.73333 \\ -1.9640 & 8.140 & -8.1117 & 45.9129 & 1.60533 \\ -2.4367 & -1.467 & 0.7333 & 1.6053 & 4.29333 \end{pmatrix}$$

Hence, the pooled variance-covariance matrix is

$$\underset{\sim}{S}_p=\begin{pmatrix} 37.4256 & 10.7443 & 4.5741 & -0.4197 & 2.2966 \\ 10.7442 & 124.1907 & 62.4218 & 3.2272 & -0.9252 \\ 4.5741 & 62.4219 & 66.2109 & -1.7611 & -0.0707 \\ -0.4197 & 3.2273 & -1.7611 & 11.5767 & 0.4914 \\ 2.2966 & -0.9256 & -0.0707 & 0.4914 & 3.2468 \end{pmatrix}$$

$$T_C^2 = \frac{75x25}{75+25} X\ 0.2230 = 4.36875$$

$$F_C = \frac{75+25-5-1}{5(75+25-2)} x\, 4.36875 = 0.8381$$

Again, the calculated value (0.8381) is less than the tabulated (2.29) at (5, 94) degrees of freedom and five percent level of significance, indicating that vital signs do not differ significantly according blood genotype. Therefore, further discussion of vital signs will be based on the two genotypes combined.

With five classes, analysis of vital signs by blood group was done using the multivariate analysis of variance statistic in equations 9 to 12. The Wilks lambda given by MINITAB 17 software is by eqn 9.

$$\Lambda = 0.832.$$

Hence, the Chi-Square

$$\chi_c^2 = -[100-1-\frac{5+5}{2}]*\ln(0.832) = 17.288$$

When compared with tabulated value at $\alpha = 0.05$ level of significance with 20 degrees of freedom ($\chi^2_{p(k-1),\alpha} = \chi^2_{20,0.05}$) $= 31.4$, the calculated value indicates the vital signs do not differ significantly according to blood group. From the foregoing, it has been shown that vital signs of persons treated of malaria do no differ significantly according to sex, blood genotype and blood group. Therefore, further discussions are based on vital signs of all the groups combined.

To determine whether or not vital signs of persons treated of malaria differ significantly from those of healthy persons, the test statistic in Equations (1) through (3) were used. The mean vectors for healthy persons ($\underset{\sim}{\mu}$) and persons treated of malaria ($\overline{\underset{\sim}{X}}$) are (for n = 100 persons) respectively;

$$\underline{\mu} = \begin{pmatrix} \text{Pulse} \\ \text{BP(sst)} \\ \text{BP(dst)} \\ \text{Temp} \\ \text{Resp} \end{pmatrix} = \begin{pmatrix} 80 \\ 120 \\ 80 \\ 37 \\ 18 \end{pmatrix}, \ \underline{\bar{X}} = \begin{pmatrix} 76.68 \\ 113.20 \\ 72.25 \\ 36.71 \\ 19.74 \end{pmatrix},$$

and variance –covariance matrice is

$$\underline{S} = \begin{pmatrix} 37.0481 & 10.630 & 4.5152 & -0.4045 & 2.27960 \\ 10.6303 & 122.990 & 61.9192 & 3.0853 & -0.97778 \\ 4.5152 & 61.919 & 65.8460 & -2.0030 & -0.21717 \\ -0.4045 & 3.085 & -2.0030 & 11.6818 & 0.61220 \\ 2.2796 & -0.978 & -0.2172 & 0.6122 & 3.28525 \end{pmatrix}$$

Hence, using eqn 1,

$$T^2 = 100 \times 2.4053$$

and using eqns 3.2,

$$F_C = \frac{100-5}{5*(100-1)} * 240.53 = 46.1623$$

From the F-tables, $F_{p,n-p,\alpha} = F_{5,\ 95,\ 0.05} \in (\ F_{5,\ 60,\ 0.05},\ F_{5,\ 120,\ 0..05}) = (2.37,\ 2.29)$,

$$F_{5,\ 95,\ 0.01} \in (\ F_{5,\ 60,\ 0.01}\ , F_{5,\ 120,\ 0.01}) = (3.34,\ 3.17)$$

Since the calculated value (46.16) is greater than the tabulated at even one percent level of significance, we reject the null hypothesis and conclude that vital signs of persons treated of malaria differ significantly from those of healthy persons.

In order to determine those vital signs that contributed to the rejection of null hypothesis (H_o), Equation (4) was used. Recall

$$C'\underline{S}^{-1}C = \begin{pmatrix} 0.0292 & -0.0034 & 0.0012 & 0.0033 & -0.0218 \\ -0.0034 & 0.0164 & -0.0154 & -0.0075 & 0.0076 \\ 0.0012 & -0.0154 & 0.0299 & 0.0095 & -0.0052 \\ 0.0033 & -0.0075 & 0.0095 & 0.0904 & -0.0207 \\ -0.0218 & 0.0076 & -0.0052 & -0.0207 & 0.3253 \end{pmatrix}$$

$$\underline{\mu_0} = \begin{pmatrix} \text{Pulse} \\ \text{BP(sst)} \\ \text{BP(dst)} \\ \text{Temp} \\ \text{Resp} \end{pmatrix} = \begin{pmatrix} 80 \\ 120 \\ 80 \\ 37 \\ 18 \end{pmatrix}, \ \underline{\bar{X}} = \begin{pmatrix} 76.68 \\ 113.20 \\ 72.25 \\ 36.71 \\ 19.74 \end{pmatrix},$$

Using eqn 3.3,

$$T^{2,\alpha}_{P,\ n-p} = \begin{cases} 12.0884, \text{ at } \alpha = 0.05 \\ 16.8821, \text{ at } \alpha = 0.01 \end{cases}$$

(a) PULSE

$c'_1 = (1,0,0,0,0)$, $c_1'*\overline{X} = 76.68$, $c'_1 \underline{S}^{-1} c_1 = 0.0292$,

Hence, using eqn 4, the decision intervals obtained are (76.62, 76.74) for 95 % and (76.61, 76.75) for 99 %.
Since 80 lies outside the interval (76.61, 76.75) it indicates that pulse contributed to rejection of the hypothesis

(b) BP (sst)

$c_2' == (01000)$, $c_2'*\overline{X} = 113.20$, $c'_2 \underline{S}^{-1} c_2 = 0.0164$,

Using eqn 4, the 99 % decision interval for BP (sst) is (113.14, 113.25).
Since 120 lies outside the interval (113.1471, 113.2526) it indicates that BP (sst) contributed to rejection of the hypothesis

(c) BP (dst)

$c_3' == (00100)$, $c_3'*\overline{X} = 72.25$, $c'_3 \underline{S}^{-1} c_3 = 0.0299$,

The 99 % decision interval for BP (dst) is (72.18, 72.32) does not contain the hypothesized value (80), indicating that BP (dst) contributed to the rejection of the hypothesis.

(d)Temperature

$c_4' = (00\ 010)$, $c_4'*\overline{X} = 36.71$, $c'_4 \underline{S}^{-1} c_4 = 0.0904$,

Similarly, the hypothesized value (37) is not contaned in the 99 % decision interval (36.59, 36.83) for Temperature, indicating that temperature contributed to the rejection of the hypothesis.

(e)Respiration

$c_5' = (00\ 001)$, $c_5'*\overline{X} = 19.74$, $c'_5 \underline{S}^{-1} c_5 = 0.3253$,

$$T^{2,\alpha}_{P,\ n-1} = \frac{p(n-1)}{n-p} F^{\ \alpha=0.01}_{P,\ n-p} = 16.8821$$

The 99 % decision interval for respiration, (19.51, 19.97) does not contain 18, the hypothesized value, indicating that respiration also contributed to rejection the null hypothesis

4. Conclusion

This study has examined the vital signs of persons treated of malaria while comparing them with those of healthy persons. The aim is to determine those necessary for selecting patients to be treated of malaria. Multivariate analysis techniques were applied to analyse data on vital signs collected from FUTO Medical Centre.

The result of the analysis show that in all the vital signs considered, vital signs of persons treated of malaria are significantly different from those of healthy persons. In particular, while the mean pulse, blood pressure and temperature of patients are significantly lower, the mean respirations of patients are significantly higher than those of the healthy persons. These indicate that all the vital signs must be considered in other to determine patients to be treated of malaria.

It is recommended that a careful measure of these vital signs should be taken and be used to appropriately determine patients to be treated of malaria. It is also been recommended that vital signs of patients treated of typhoid fever be studied and compared with the results of this study since the two (malaria and typhoid) exhibit similar symptoms.

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