International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

The Utilize Accuracy Diagnostic Tests to Classification HIV/AIDS Infected Using Magnetic Resonance Imaging

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Abstract

This research has aimed to apply the accuracy diagnostic tests to find the classification method to classify HIV/AIDS infected from image properties use Magnetic Resonance Imaging (MRI) in Sudan. 118 sample sizes were taken to studied, half cases of sample size was infected group and the other was uninfected group. We conduct the properties of image show that there is significance different between infected with HIV/AIDS and uninfected; also the risk in HIV/AIDS infected group is higher than the risk in uninfected group by 0.054. In the other hand of was found that if the deformation of images increased than 0.694 there was a high probability of with HIV/AIDS infection, when the homogeneity of the image decreased than 0.27 there was a high probability of HIV/AIDS presence.

Key words: MRI; Deformation; Homogeneity; HIV/AID; uninfected.

1. Introduction

AIDS has become one of the most devastating diseases humankind has ever faced. Since the epidemic began, more than 60 million people have been infected with THE virus HIV/AIDS has become the sixth-largest cause of death worldwide. HIV continues to be a major global public health issue, having claimed more than 39 million lives so far.

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In 2013, 1.5 [1.4–1.7] million people died from HIV-related causes globally. There were approximately 35.0 [33.2–37.2] million people living with HIV at the end of 2013 with 2.1 [1.9–2.4] million people becoming newly infected with HIV in 2013 globally. Sub-Saharan Africa is the most affected region, with 24.7 [23.5–26.1] million people living with HIV in 2013. Also sub-Saharan Africa accounts for almost 70% of the global total of new HIV infections [1] .

There is always biological variability between people, and this includes the signs and symptoms people have when they are sick. Therefore, no diagnostic test is perfectly accurate: people can vary in how sick they are even though they have the same test results. A diagnostic test designed to detect such a condition can be used as a tool to assist the physician in detection. Desirable properties in diagnostic test include the following:

- The diagnostic test will indicate an event when the event is present, and
- The diagnostic test will indicate a nonevent when the event is absent [2] .

Our goal is to apply the diagnostic tests measuring the accuracy of diagnostic procedures, effect or risk measures through the infected and uninfected with Human Immunodeficiency virus HIV/AIDS using Magnetic Resonance Imaging (MRI) diagnostic, by design of case control study we took a sample classified for two groups the one group for uninfected with Human Immunodeficiency virus HIV/AIDS while the other for none infected. HIV stands for human immunodeficiency virus. It is the virus that can lead to acquired immunodeficiency syndrome, or AIDS. The history of HIV/ AIDS began in 1981 United State of America by Centers for Disease Control and Prevention (CDC).the number of people living with HIV in 2013 in range of (33.1 million – 37.2 million) according to the World Health Organization WHO.

HIV is a virus spread through body fluids that affects specific cells of the immune system, called CD4 cells, or T cells. Over time, HIV can destroy so many of these cells that the body can’t fight off infections and disease. When this happens, HIV infection leads to AIDS. Immune system tests: measure destruction of immune system including test of counting target immune cells [1].

2. Material and method

Research design can be classified in several ways, some of which are observational or experimental which relates to the purpose of the study, while the others prospective or retrospective and longitudinal or cross-sectional describe the way in which the data are collected [2].

3. Measuring the accuracy of diagnostic procedures

The accuracy of a diagnostic test or procedure has two aspects. The first is the test's ability to detect the condition it is testing for, thus being positive in patients who actually have the condition; this is called the sensitivity of the test. The second is the test’s ability to detect the condition it is testing the negative if the patients does not have disease. If a test has high sensitivity, it has a low false-negative rate; that is, the test does not falsely give a negative result in many patients who have the disease [1] .

How accurate is the test?"

There are two obvious errors: a diagnostic or a screening test can fail to identify a person who actually does have the disease, or else it could falsely classify someone as having the disease when in fact they do not. (Sometimes one type of error is more important than the other; you can ponder their relative importance under different circumstances...).

And, as always happens with life, if you adjust the threshold value of the test to reduce one type of error, you will find that the other type of error increases [3].

Table 1: show how to calculate the diagnostic tests

True Status of Nature (S)	Source	Test Result (T)	
		Positive (+)	Negative (-)
	Disease (+)	A	B
	No disease (-)	C	D

Source: NCSSM Statistics Leadership Institute July, 1999

3.1 Sensitivity

Sensitivity can be defined in many equivalent ways: the probability of a positive test result in patients who have the condition; the proportion of patients with the condition who test positive; the true-positive rate. This is given

as formula $P(S^+/T^+) = \frac{a}{a+b}$ (1)

Also can be defined as the probability that the test says a person has the disease when in fact they do have the disease [3].

3.2 Specificity

The second aspect of accuracy is the test's ability to identify those patients who do not have the condition, called the specificity of the test. If the specificity of a test is high, the test has a low false-positive rate; that is, the test does not falsely give a positive result in many patients without the disease. Specificity can also be defined in many equivalent ways: the probability of a negative test result in patients who do not have the condition; the proportion of patients without the condition who test negative ; this is $P(S^-/T^-) = \frac{d}{c+d}$ (2).

Minus the false-positive rate. The phrases for remembering the definition of specificity are negative in health or specific to health. Also specificity can defined as the probability that the test says a person does not have the disease when in fact they are disease free [3].

Sensitivity and specificity of a diagnostic procedure are commonly determined by administering the test to two groups: a group of patients known to have the disease (or condition) and another group known not to have the disease (or condition). The sensitivity is then calculated as the proportion (or percentage) of patients known to have the disease who test positive; specificity is the proportion of patients known to be free of the disease who test negative. Of course, we do not always have a gold standard immediately available or one totally free from error. Sometimes, we must wait for autopsy results for definitive classification of the patient's condition, as with Alzheimer's disease [4].

False Positive

A false positive occurs when the test reports a positive result for a person who is disease free. The false positive rate is given by

$$P(S^-/T^+) = \frac{c}{a+c} \quad . \qquad (3)$$

Ideally we would like the value of c to be zero, however, this is generally impossible to achieve in a screening test involving a large population.

False Negative

A false negative occurs when the test reports a negative result for a person who actually has the disease. The false negative is given by $P(S^+/T^-) = \frac{b}{b+d}$. (4)

Which false result is the more serious depends on the situation. But in generally worry more about false positive in screening test. We don't want to tell someone that they have a serious when they do not really have it.

3.3 Using Sensitivity & Specificity to revise probabilities

The values of sensitivity and specificity cannot be used alone to determine the value of a diagnostic test in a specific patient; they are combined with a clinician's index of suspicion (or the prior probability) that the patient has the disease to determine the probability of disease (or nondisease) given knowledge of the test result. An index of suspicion is not always based on probabilities determined by experiments or observations; sometimes, it must simply be a best guess [4] .which is simply an estimate lying somewhere between the prevalence of the disease being investigated in this particular patient population and certainty. A physician's best guess generally begins with baseline prevalence and then is revised upward (or downward) based on clinical signs and symptoms. Some vagueness is acceptable in the initial estimate of the index of suspicion; in the section titled, "Decision Analysis," we discuss a technique called sensitivity analysis for evaluating the effect of the initial estimate on the final decision.

Positive Predictive value (PV+)

PV^+ = P (Disease/Positive test) the estimated of the predictive value positive.

Negative Predictive value (PV-)

PV^- predictive value negative = p (no disease/negative test) the estimated of the predictive value negative.

3.4 Effect Measures

Dichotomous outcome variables in biostatistical applications usually represent events such as the development of a disease, a change in disease severity, or mortality. The parameters of interest are the population proportions, or the conditional probabilities in the events of the two populations. For example, consider the example in which one group receives treatment 1 and the other receives treatment 2 and the event of the interest is stroke, the two parameters are the probability of having a stroke during a 5-years follow-up period conditional on receiving treatment 1 (p1) and probability of having a stroke during the 5-years follow-up period conditional on receiving treatment 2 (p2). The probability of having the outcome of the interest is often called the risk of the outcome. A number of statistics are used to compare conditional probabilities of outcomes between populations (or treatments). Measures of difference in risk are known as effect measures. Three of these measures are the risk difference, the relative risk, and the odds ratio [2] .

Risk Difference ($\hat{R}D$)

The simple difference between risks is called the risk difference and is estimated as follows:

Estimated of risk difference = $\hat{R}D = \hat{p}_1 - \hat{p}_0$ the risk difference is interpreted similar to risk ratio. A risk difference of zero indicates no difference in risks, a positive $\hat{R}D$ indicates higher risk in group 1, and a negative $\hat{R}D$ indicates lower risk in group 1.

Risk Ratio

Also called relative risk (RR), compares the risk of health events (disease, risk factor, death) among one group with the risk among other group.

$$\hat{R}R = \frac{risk\ of\ disease\ in\ a\ group\ of\ interest}{risk\ of\ disease\ of\ comparison\ group} \qquad (5)$$

Interpretation of risk ratio:

1. A risk ratio is equal to one indicates identical risk among two group.
2. A risk ratio is greater than one indicates that an increased risk for the group in the numerator (exposure group).
3. A risk ratio is less than one indicates a decrease risk for the numerator (exposure group) [5].

3.5 Results and discussions

The details of analysis based on many measures of diagnostic tests, two measures of effects measures, and used independent sample two test to test the hypotheses .

Descriptive of the Data: bars and pie charts used to present descriptive statistics obvious in figure (1) and (2) respectively:

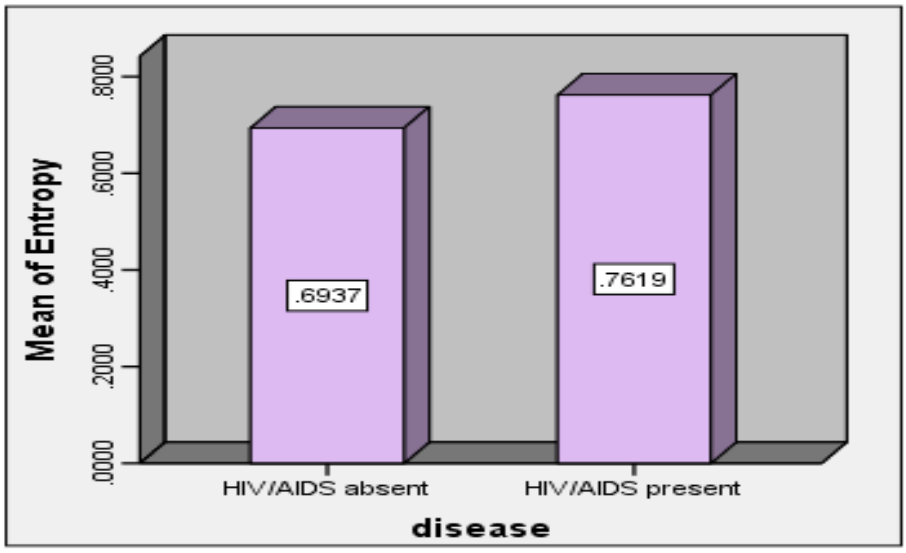

Figure 1

Source: preparation using SPSS by researchers

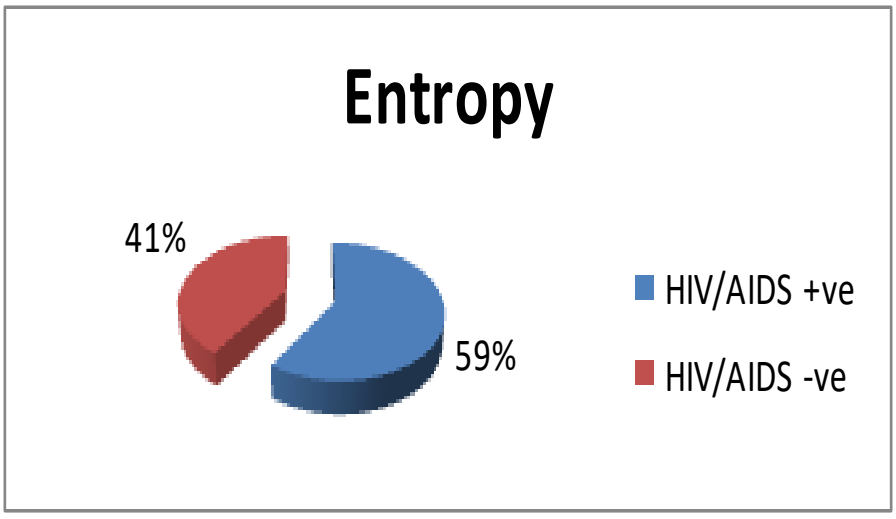

Figure 2: The distribution of disease according to mean of deform of image (entropy).

Source: preparation using EXCEL by researchers

Percentage of HIV/AIDS groups according to deform of image (entropy).

From figure (1) and (2), show that the mean of deforming of images for HIV/AIDS infected is 0.7619, and the percent of cases the test reports developed with HIV/AIDS is 59%. While the mean of deforming for no infected cases is 0.6937, and the percent of cases the test reports no HIV/AIDS is 41%.

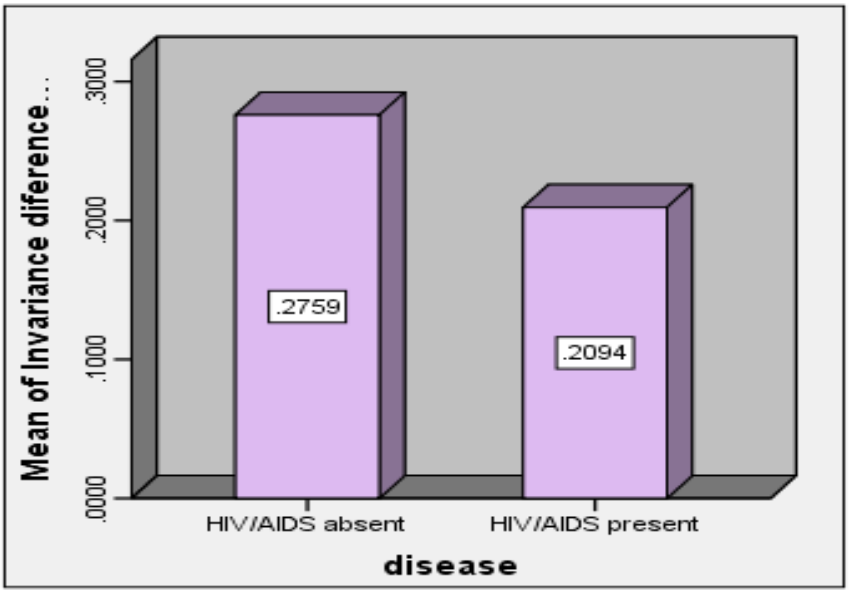

Figure 3

Source: preparation using SPSS by researchers

The distribution of disease according to mean of homogeneity of image (inverse difference moment).

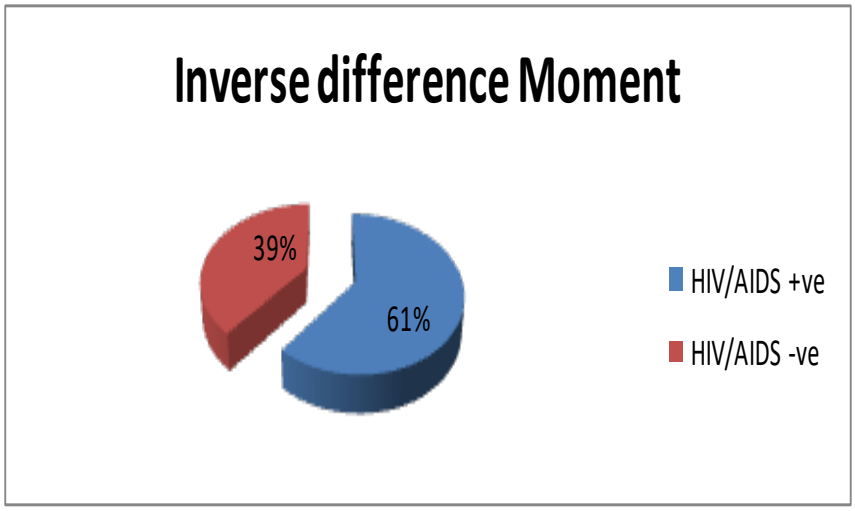

Figure 4

Source: preparation using EXCEL by researchers

Percentage of HIV/AIDS groups according to homogeneity of image (inverse difference moment). From figure (3) and (4), we show that the mean of homogeneity of images for HIV/AIDS infected is 0.2094, and the percent of cases the test reports developed with HIV/AIDS is 61%. While the mean of homogeneity for no infected cases is 0.2759, and the percent of cases the test reports no HIV/AIDS is 39%.

3. Calculate the Measuring of Diagnostic Tests and interpreting

Table 2: calculate the diagnostic test and effect measures

Source		**Diagnostic Test**		**Total**
		Positive	negative	
HIV/AIDS	Abnormal (Disease)	37	22	59
	Normal (No Disease)	34	25	59
Total		71	47	118

Source: preparation using SPSS by researchers

The sensitivity

The sensitivity=0.63 this implies that the probability of a person who has the disease when in fact they do have the disease is 0.63.

The specificity

The specificity = 0.42 this implies that the specificity is the proportion of the normal cases that are correctly classified by the test are negative is 0.42.

The false positive

False positive = 0.49 this implies that the test reports a positive result for a person who is disease free is 0.49.

The false negative

False negative = 0.47 this implies that the test reports a negative result for a person who actually has the disease.

Predictive value positive

PV^+ = P (Disease/Positive test) the estimated of the predictive value positive =0.52

Predictive value negative

PV^- predictive value negative = p (no disease/negative test) the estimated of the predictive value negative = 0.532.

Effect Measures

The estimated conditional probability or risk of HIV/AIDS given the control group is $\hat{p}_0 = \frac{34}{59} = 0.576$. The estimated conditional probability or risk of HIV/AIDS given the cases group is $\hat{p}_1 = \frac{37}{59} = 0.63$. Risk difference is estimated as $\hat{R}D = \hat{p}_1 - \hat{p}_0 = 0.63 - 0.576 = 0.054$ the risk in HIV/AIDS group is 0.054 higher than the risk in uninfected.

The relative risk

The relative risk is the ratio of the risks and is estimated as follows

$$\text{Relative risk} = \frac{\hat{p}1}{\hat{p}0} = \frac{0.63}{0.576} = 1.094$$

A Relative risk is greater than one (1.094) indicates that a higher risk in HIV/AIDS group is infected.

Statistics of HIV/AIDS infected and uninfected through the values of two variables values of deforms of images (entropy) and values of the homogeneity of image (inverse difference).

Mean of Imaging Properties: Table (3) Group Statistics

Table 3

Source	disease	Mean	Std. Deviation
Entropy	Normal	.693712	0.1798075
	Abnormal	.761856	0.1459152
Inverse difference	Normal	.275910	0.1848487
	Abnormal	.209361	0.1468727

Source: preparation using SPSS by researchers

From the above table shows the mean of entropy for uninfected group is 0.694; while for infected group with HIV/AIDS is 0.762. Also shows the mean of inverse difference for uninfected group is 0.28; while for infected group with HIV/AIDS is 0.21.

To test two follow hypotheses is there significance different between HIV/AIDS infected and none by using means of entropy and is there significance different between HIV/AIDS infected and none by using means of inverse difference. We used the independent sample two tests [6].

Test of Hypothesis: the hypotheses tested are the homogeneity and the deforming of images could differ

between cases of HIV/AIDS infected and cases of no infected with HIV/AIDS.

Table 4: Test statistic

Source	T	Df	Sig	Std.Error difference
Entropy	-2.26	116	0.03	0.030
Inverse difference	2.165	116	0.032	0.031

Source: preparation using **SPSS** by researchers From the test statistic's table the entropy shown significant result (sig = 0.03) that means there is significance different between the mean of infected group and none infected.

The hypothesis is there significance different between HIV/AIDS infected and none by using means of inverse difference.

The results from table of statistics above shown there is significance difference between the mean of infected group none infected.(sig=0.032)

4. Results

From the analysis we obtain many results and recommendations such as:

1. The probability of a person who has the disease when in fact they do have the disease is 0.63. And the proportion of the normal cases that are correctly classified by the test are negative is 0.42. also the test reports a positive result for a person who is disease free is 0.49. and a negative result for a person who actually has the disease 0.47.
2. The estimated of the predictive value positive 0.52 and the estimated of the predictive value negative 0.532. The estimated conditional probability or risk of HIV/AIDS given the control group is ($\hat{p}_{0)}$ 0.576. The estimated conditional probability or risk of HIV/AIDS given the cases group ($\hat{p}_{1)}$ 0.63,
3. The risk in a group of HIV/AIDS infected is 0.054 higher than the risk in uninfected group. Deform of image (entropy) shown significance different between the mean of infected group and none infected. and the degrees of measure of Inverse difference significance different between the mean of infected group and none infected.

5. Recommendations

1. Although diagnosing with Resonance Magnetic image costs high cost but the study recommends because of rigorous diagnosis and conclusive result.
2. When the value of deformation of come approximately 0.76 there is a high doubts HIV/AIDS present.
3. We decided that there are doubts HIV/AIDS present when the homogeneity of the image be around 0.21.

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