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Surveying of HIV/AIDS Incidence in Sudan

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1. Abstract.....	1
2. Introduction.....	2
3. Dependency Analysis.....	5
3.1. Omdurman Sample.....	5
3.2. Volunteers Cases.....	6
4. Descriptive Statistics for Khartoum Sample.....	6
4.1. Dependency Analysis for Khartoum Sample.....	8
4.2. Descriptive Statistics for Khartoum North Sample.....	9
5. Modeling HIV/AIDS in Khartoum State Data.....	11
6. HIV/AIDS Trends of the Three Centers (2009).....	15
6.1. Comparisons between the Three Centers.....	18
7. Summary, Conclusions and Recommendations.....	18
8. References.....	20

1. Abstract

The present paper introduces results of an analysis conducted on data collected from Khartoum state for the year 2009. It aims to apply statistical models for the HIV/AIDS data in Khartoum state centers of testing blood and counseling. AIDS is recognized as an emerging disease only in the early 1980s, AIDS has rapidly established itself throughout the world, and is likely to endure and persist well into the 21st century. AIDS has evolved from a mysterious illness to a global pandemic which has infected tens of millions less than 20 years. The importance of the study is to emphasize that the disease exists even under the special conditions of the country and its status. The study constructs three main hypotheses that non-linear models fit the HIV/AIDS data well especially binary logistic regression. Moreover, it is assumed that demographic variables affect the HIV/AIDS incidence in Khartoum state. It is also assumed that incidences of HIV/AIDS are increasing as manifested among volunteers in the three centers Khartoum, Khartoum North, and Omdurman. The main objective of the paper was to apply statistical models for HIV/AIDS in Khartoum state so as to obtain a good analysis, beside other sub objectives. Data were from secondary sources and volunteers centers for blood testing and counseling inside Omdurman, Khartoum, and Khartoum North teaching hospitals. Also data were collected through questionnaires designed to get all the information registered inside the three centers. The main idea of analysis was to apply and identify statistical model that related to AIDS by using statistical packages to construct the models depends on the collected data about HIV/AIDS of Khartoum state. The focus was on binary logistic regression, because it's suitable to the data collected from the three centers inside the three hospitals in Khartoum. Estimated coefficients and statistical tests were conducted to distinguish between the variables that related to HIV/AIDS incidence and spread through people in the three cities Khartoum, Khartoum North, and Omdurman. It is concluded that there is no effect of education level on HIV/AIDS infection for the data collected from Omdurman. However, there is dependency between HIV/AIDS incidence and occupation of volunteers. So the job of individuals affects the HIV/AIDS incidence inside

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Omdurman area. Also there is an association between HIV/AIDS incidence and social status of individuals. High numbers of positive HIV/AIDS in Omdurman center are among married people.

2. Introduction

Khartoum state is the capital of Sudan and has three areas, Khartoum, Khartoum North and Omdurman. It is smallest state of the country with an area of 20,140 km with the largest population 10 million people divided into seven localities urban, suburban and rural areas. There are counseling services for AIDS patients carried out by 80 counselors inside hospitals, health centers and higher education institutes. There are 20 volunteer centers for testing blood. The Data of the study were collected from Omdurman, Khartoum, and Khartoum North TeaChing Hospitals denoted by the records of Testing and Counseling Centers. The centers are ranked as the best centers in the state. They cover the majority of Khartoum state and represent all the its service centers. The data cover the period (2003-2009). During the period of the study 939 persons were subjected to HIV test in Omdurman center. 550 volunteers and 389 were suspected cases. So they represented the sample of the Omdurman center. Also 200 cases were collected from Khartoum hospital and 300 from Khartoum North hospital. The total sample size of the study is 1439 cases represented Khartoum state for the period under the study. The questionnaire of the study depends on the socio-economic variables and demographic variables existing in the records during the period of the study. Descriptive statistics is done to explain the main characteristics of the study population through the sample of Omdurman (939) cases. The result is as shown below

Table (1) Frequency distribution of tested people according to age

Age group	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
0 – 10	5	0.9	4	1
11 – 20	39	7.1	23	9
21 – 30	158	28.7	7	1.8
31 – 40	176	32.0	22	7
41 – 50	90	16.4	12	3.1
51 +	82	14.9	321	82.5
Total	550	100.0	389	100

Table (1) presents the age of investigators through volunteers, the two middle age groups (31-40) and (21- 30) years had a high percentages 32% and 28.7%, respectively, 16.4% for the group (41-50) , 14.9% for the elder age greater than 50. While the age group (11- 20) took the percent 7.1%, and the Children less than ten years show the small one 0.9%. The percentages of age among suspected investigators reveal that, the two middle age group (21-30) and (31-40) year had a high percentages 42.4% and 22% respectively. 9.5% For the age (41-50) , 3.9% for the elder age group 51+, the teenagers (11-20) had 13.9% and only 1% for the Children less than ten years. The two middle age groups for both volunteers and suspected cases had the high numbers; because the volunteers inside this age they face the problem of youth.

Table (2) shows the sex of volunteers and suspected cases. The majority of volunteers were males 60.5% and 39.5% females. While more than 59.4% were males and 40.6% females among suspected cases. This reflects the high percent for males who attend the centre.

Table (2) Frequency distribution of tested people according to sex

Sex	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Male	333	60.5	231	59.4
Female	217	39.5	158	40.6
Total	550	100.0	389	100

Table (3) illustrates the place of residence for the volunteers, the people who investigate were from Omdurman, Khartoum, and Khartoum North. Their percentages were 71.1%, 6% and 22.9%, respectively. Also the place of residence for the suspected cases, the percentages are 84.3% came from Omdurman, 7.2% from Khartoum North and only 8.5% from Khartoum. Thus the high percent from Omdurman because the center is inside the city, although its well known to the other cities of the state.

Table (3) Frequency distribution of tested people according to residence

Residence	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Khartoum	25	4.5	204	52.4
Khartoum North	33	6.0	160	41.1
Omdurman	391	71.1	17	4.4
Rural	101	18.4	8	2.1
Total	550	100.0	389	100

Table (4) shows the social status of the volunteers, 30.5% of them were single, 55% married 9.5% divorced, and 4.5% widowed. Beside the results of the Social status of suspected cases, 52.4% single, 41.1% married, 4.4% divorced and only 2.1% widowed. The married people gain the high 55%. That is due to their desire to check their health status.

Table (4) Frequency distribution of tested people according to social status

Social Status	Volunteer		Suspected cases	
	Frequency	Percent	Frequency	Frequency
Single	168	30.5	204	52.4
Married	305	55	160	41.1
Divorced	52	9.5	17	4.4
Widowed	25	4.5	8	2.1
Total	550	100.0	389	100

Table (5) reports the job of volunteers, their job classified as, 34.2% unemployed, 17.3% were laborers, 8% employees, 28.4% had free job, 4.9% students, 3.1% tea sellers, and 4.2% drivers. The classification of job among suspected cases were, 33.7% for the unemployed, 16.7% free job, 14.7% employee, 8.5% lab our, 7% tee seller and 3.1 drivers. People without work represent considerable percent inside the two categories.

Table (5) Frequency distribution of the occupation tested people

Occupation	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Unemployed	188	34.2	131	33.7
Laborers	95	17.3	33	8.5
Employees	44	8.0	57	14.7
Free job	156	28.4	65	16.7
Students	27	4.9	69	17.7
Tea seller	17	3.1	22	7
Drivers	23	4.2	12	3.1
Total	550	100.0	389	100

Table (6) shows the education level for volunteers, 48.2% of them were illiterate, 27.5% primary education, 13.8%, secondary education, 8.2% for the university/postgraduate education. Illiterate investigated represents near half of the sample. The percentages of education level into suspected cases were, 27% secondary, 24.9% primary/basic, 22.4% illiterate, 22.1% university/postgraduate and 4.9% for the intermediate education. The results reflect the considerable effect of the illiteracy level on the HIV prevalence inside Khartoum state.

Table (6) Frequency distribution of tested people according to education level

Education level	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Illiterate	265	48.2	87	22.4
Primary/basic	151	27.5	97	24.9
Intermediate	45	8.2	19	4.9
Secondary	76	13.8	100	27
University/postgraduate	13	2.4	86	22.1
Total	550	100.0	389	100

Table (7) reports religious status of volunteers. 80.9% of them were Muslims and 19.1% Christian. This reflects that the people who live in Khartoum are predominantly Muslims. The percentages of religious status among suspected cases, 82.8% were Muslim and 17.2% Christian. The majority of volunteers were Muslims.

Table (7) Frequency distribution of tested people according to religion

Religion	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Muslims	445	80.9	322	82.8
Christians	105	19.1	67	17.2
Total	550	100.0	389	100

Table (8) signifies the symptoms of HIV/AIDS 26.5% lost of weight, 23.8% diarrhea, 21.1% fever, 14% cough, 4% skin rash, 3.3% (fever, lost of Weight, and diarrhea) , and 0.2% had no symptoms. The percentages of symptoms for suspected cases of HIV/AIDS, 82.5% indicates no clear symptoms, 7% for the diarrhea, 9% lost of weight, 3.1% skin rash and 1.8%, 1.0% for the cough and fever respectively.

Table (8) Frequency distribution of tested people according to symptoms

Symptoms	volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Fever	120	21.8	4	1
Lost of weight	146	26.5	23	9
Cough	77	14.0	7	1.8
Diarrhea	131	23.8	22	7
Skin rash	22	4.0	12	3.1
Fever +lost of weight	23	4.2	321	82.5
Fever+ diarrhea	4	0.7	-	-
Fever +loss +Weight +diarrhea	18	3.3		
No symptoms	1	0.2		
TB	8	1.5		
Total	550	100.0	389	100

Table (9) displays the risk factors, 57.5% were worried, 39.8% sexual, 1.6% blood transmission, 0.7% husband/wife and 0.4 % from parents to their Children. It is clear that people worried about their health status. Also, the percentages of risk factors for suspected cases, 44.5% worried, 23.7% sexual, 13.6% parents, 12.3% hasband/wife, 4.1% for the purpose of procedure, and 1.8% blood transmission.

Table (9) Frequency distribution of tested people according to risk factors

Risk Factors	volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Sexual	219	39.8	92	23.7
Worried	316	57.5	173	48.6
Blood transmission	9	1.6	7	1.8
Parents	2	0.4	53	13.6
Husband / wife	4	0.7	48	12.3

Total	550	100.0	389	100
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Table (10) shows the result of blood investigator, 66.5% were negative HIV/AIDS and 33.5% Positive. Suspected cases report the HIV test result, 77.4% were negative while 22.6% were positive. The results of volunteers and suspected cases reflect the incidence rate of HIV/AIDS and indicate the high rates that need more integrated efforts to stop increasing. The high percentages of HIV positive cases among individuals reflect precarious situation that needs policy makers to take precautions and immediate interventions, e.g., the government and Ministry of Health.

Table (10) Frequency distribution of tested people according to result

Result	Volunteers		Suspected cases	
	Frequency	Percent	Frequency	Percent
Negative	20	66.5	301	77.4
Positive	54	33.5	88	22.6
Total	550	100.0	389	100

3. Dependency Analysis

The purpose of this section to investigate the relation/dependency between HIV incidence and some socio-economic variables, results are reported using (χ^2) test for dependency.

3.1. Omdurman Sample

Table (11) reports the result of χ^2 is 11.428, df = 4 and p-value (0.022), that indicate the dependency of the two variable at 5% level of significance (result of HIV investigation and education level). As a result of the test the null hypothesis of the independent between the two variables is rejected. Also table (11) express the high number of illiterate persons are more infected with HIV. This result confirms the need of awareness regarding HIV infection, particularly among the illiterate.

Table (11) Chi-square test for Dependency between HIV incidence and education level.

HIV Test	Education Level				Total	χ^2	p-value
	Illiterate	Primary basic	Intermediate	University/ Postgraduate			
Negative	61	77	11	75	301	11.721	0.02
Positive	26	20	8	11	88		
Total	87	97	19	100	389		

Table (12) reports the result of the χ^2 test for dependency. The value of Chi-square is calculated at 16.29 with df = 6 and P-value = 0.012, which is significant at 5% level of significance. So the result support the idea of association between HIV infection and employment status of individuals. People who not work they have a high positive number (41) so this result ensures the fact that leisure time of youth affects the personal behavior.

Table (12) Chi-square test for Dependency between HIV incidence and occupation

HIV Test	Occupation							Total	χ^2	p-value
	Not work	Labor	Employee	Free job	student	Tee seller	driver			
Negative	90	26	47	49	64	16	9	301	16.9	0.01
Positive	41	7	10	16	5	6	3	88		
Total	131	33	57	65	69	22	12	389		

Table (13) reports the result of the χ^2 test for dependency between HIV infection and social status. The value of the χ^2 is calculated at 24.9 with df = 3, P-value 0.0001, which is significant at 1%, this indicate the significance result for the test. So the hypothesis of dependency between the two variables is accepted. We may note that although single individuals are assumed to have more positive HIV cases, the high number of positive HIV test is found among married persons. This result may be attributed to the fact that the infection of one married partner increases the probability of infection of the other partner, giving rise to higher incidence of the disease.

Table (13) Chi-square test for dependency between HIV incidence and social status

HIV Test	social status				Total	χ^2	p-value
	single	married	Divorced	Widowed			
Negative	178	107	12	4	301	2326	0.0001

Positive	26	53	5	4	88		
Total	204	160	17	8	389		

The table illustrates the χ^2 test between HIV incidence and religion $\chi^2 = 12.11$ with $df = 1$, and p -value = 0.001, at 1% level. This indicates the high significance. We notice that, Christians (26) are relatively more infected with HIV than Muslim, although Muslims gain (62) infected person.

3.2. Volunteers Cases

Table (14) show the Chi- square test for dependency between incidence and education level χ^2 calculated = 00 with p -value (0.08). The result indicates independency of the two variables. So education didn't influence HIV/AIDS incidence.

Table (14) Chi-square test for Dependency between HIV incidence and education level

HIV Test	Education Level				Total	χ^2	p-value
	illiterate	Primary basic	intermediate	University/Post			
Negative	185	99	46	6	366	000	0.08
Positive	80	52	30	7	184		
Total	265	151	76	13	550		

Table (15) reports the χ^2 test for dependency between HIV incidence and social status. χ^2 calculated= 16.104 with p -value (0.001) , which indicate a dependency between the two variable at 1% level of significance. Thus, positive HIV test of the married persons is very high (55%) which suggest that, there must be awareness of the individuals then all the society.

Table (15) Chi-square test for dependency between HIV incidence and social status

HIV Test	social status				Total	χ^2	p-value
	single	Married	divorced	Widowed			
Negative	119	211	25	11	366	16.014	0.001
Positive	49	94	27	14	184		
Total	168	305	52	25	55		

Table (16) illustrates χ^2 test for dependency between HIV incidence and occupation.. χ^2 calculated is 12.59 with p -value (0.05) so there is dependency between the job of individuals and HIV infection (i.e. the job affect the HIV/AIDS incidence).

Table (16) Chi-square test for dependency between HIV incidence and occupation.

HIV Test	Occupation							Total	χ^2	p-value
	Not work	Labour	employee	Free job	student	Tee seller	driver			
Negative	137	62	23	95	22	9	15	366	12.59	0.05
Positive	51	33	21	58	5	8	8	184		
Total	188	95	44	156	27	17	23	550		

4. Descriptive Statistics for Khartoum Sample

Table (17) reports frequency distribution of volunteer according to age, the middle age groups (21-30) and (31-40) had 48.5%, 28% respectively, 1.5% for the age group (0-10), 8.5% for the age group (11-20) year, 9 % for (41-50) and 4.5% for the elder group (51+) people have 51 years and more.

Table (17) Frequency distribution of volunteer age

	Frequency	Percent
0-10	3	1.5
11-20	17	8.5
21-30	97	48.5
31-40	56	28
41-50	18	9
51+	9	4.5
Total	200	100

We note that, volunteer concentrated in the two middle age group (20-30) (31-40) , that is due to concerned of these age groups about their health situation and they seek about security health.

Table (18) reports frequency distribution of volunteer according to sex; about quarter percent (74%) of volunteer were males and 26% females.

Table (18) Frequency distribution according to Sex.

	Frequency	Percent
Male	148	74.0
Female	52	26.0
Total	200	100.0

Table (19) illustrate frequency distribution of volunteer according to education level, illiterate people (12%) of the volunteers, (31%) primary/Basic education, 4% were intermediate education, while (26.5%) for both secondary and postgraduate levels. Also we can say there is a high percent of tested people among the last two classification of education level.

Table (19) Frequency distribution according to education level

	Frequency	Percent
Illiterate	24	12
Primary/basic	62	31
Intermediate	8	4
Secondary	53	26.5
University/postgraduate	53	26.5
Total	300	100

Table (20) reports Frequency distribution of tested people 21% for employee and free job, 19.5% for labor and people without work and 19% for the student. (20) Frequency distribution according to occupation.

Table (20) Frequency Distribution of tested people

	Frequency	Percent
Unemployed	39	19.5
Labor	39	19.5
Employee	42	21
Free job	42	21
Student	38	19
Total	200	100

Table (21) shows the frequency distribution of volunteer according to religion, most of them 86% were Muslims and 14% Christian.

Table (21) Frequency Distribution according to Religion

	Frequency	Percent
Muslim	172	86
Christian	28	14
Total	200	100

Table (22) reports frequency distribution of volunteer according to social status, about 54% were single, 37% married, 5% divorced, and only 4% widowed. The percent of single people indicate they worried about the health.

Table (22) Frequency distribution according to social status

	Frequency	Percent
Single	108	54
Married	74	37
Divorced	10	5
Widowed	8	4
Total	200	100

These results indicate the high percent of single volunteer of Khartoum, which may influence the HIV/AIDS situation. According to table (23) there were 61.5% of volunteer attend to the center because of their sexual behavior, 16.5 of them were worried, 5% for blood transmission, 4.5 for the infected parent, and 12.5% for the husband/wife reasons. People doing sex always, they live in dangerous situation. The high percent of the sexual behavior reflect that people didn't care about the claim of sexual as one of the major method to be infected with HIV/AIDS.

Table (23) Frequency Distribution according to the Risk Factors

	Frequency	Percent
Sexual	123	61.5
Worried	33	16.5
Blood transmission	10	5
Parent	9	4.5
Husband/wife	25	12.5
Total	200	100

Table (24) reports the HIV/AIDS incidence, 64% were negative HIV/AIDS, while 36% were positive HIV/AIDS, and this percent of positive people indicates high prevalence of HIV/AIDS among Khartoum hospital volunteers and suspected cases.

Table (24) Frequency distribution of HIV/AIDS result

	Frequency	Percent
Negative	128	64
Positive	72	36
Total	200	100

4.1. Dependency Analysis for Khartoum Sample

To test the dependency between the HIV/AIDS incidence and some socio-economics variables, study used Chi-square test for this purpose.

Table (25) reports the dependency test between HIV/AIDS incidence and education level. χ^2 value = 41.85 df = 4, P- value = 0.00001, P-value is less than the significance level 1% so we accept the alternative hypothesis there is association between the HIV/AIDS indicate and education level. This is evidence that HIV/AIDS related to education level of people, and it is the crucial factor of determination the incidence of HIV/AIDS among citizens.

Table (25) Chi-square test for dependency between HIV/AIDS incidence and education level

HIV Test	Education Level					Total	χ^2	P-value
	illiterate	Primary	Intermediate	Secondary	University/post			
Negative	8	26	7	40	47	8	41.85	0.00001
Positive	16	36	1	13	6	16		
Total	24	62	8	53	53	24		

Table (26) illustrates dependency between the HIV/AIDS and occupation, the $\chi^2 = 21.27$, df = 4, P-value = 0.0001 which is less than the level of significance 1% so we fail to reject the alternative hypothesis that, the two variables are dependent. This result ensures the fact that single people tend to have positive HIV/AIDS according to their behavior and situation in the community.

Table (26) Chi-square test for dependency between HIV/AIDS and occupation

HIV Test	Education Level					Total	χ^2	P-value
	Not work	Labor	Employee	Free job	student			
Negative	18	18	31	28	33	128	21.271	0.001
Positive	21	21	11	14	5	72		
Total	39	39	42	42	38	200		

Table (27) reports the test of independency between HIV/AIDS and social status. $\chi^2 = 42.299$, df = 3, P-value = 0.0001. This result indicates the relation between HIV/AIDS incidence and social status.

Infections of single people seem to be related to their sexual behavior that may lead to relations between males and females. That helps the dissemination of the disease among the youth.

Table (27) Chi-square test for dependency between HIV/AIDS and Social Status

HIV Test	Social Status				Total	X ²	P-value
	Single	Married	Divorced	widowed			
Negative	91	29	5	3	128	42.29	0.00001
Positive	17	45	5	5	72		
Total	108	74	10	8	200		

4.2. Descriptive Statistics for Khartoum North Sample

Table (28) reports frequency distribution of tested people according to sex, there were 64.7% males and 33% Females.

Table (28) Frequency distribution of sex

	Frequency	Percent
Male	194	64.7
Female	106	33
Total	300	100.0

Table (29) shows the frequency distribution of tested people according to age, the two middle age groups (21-30) (31-40) had 33.3%, 29.3% respectively, people age (11-20) years had 12.7%, persons less than ten years score 2% only, (41-50) age group had 8% and the last age group 51+ gain 14.7%.

Table (29) Frequency Distribution of Volunteer Age

	Frequency	Percent
0-10	6	2
11-20	38	12.7
21-30	100	33.3
31-40	88	29.3
41-50	24	8
51+	44	14.7
Total	300	100

Table (30) illustrates education level of study population, illiterate people 30% primary/Basic education 27.3%, 22.3% for the secondary and 20.7% for the university/postgraduate volunteers. We note the high percent of illiterate people who attend the centre, which indicate they are concerned about being infected by AIDS.

Table (30) Frequency distribution of education level

Criteria	Frequency	Percent
Illiterate	88	30
Primary/basic	82	27.3
Secondary	67	22.3
University/postgraduate	62	20.3
Total	300	100

Table (31) reports frequency distribution of volunteer according to religion, most of them were Muslims (87%) and 14.3% for the Christian.

Table (31) Frequency distribution of religion

Religion	Frequency	Percent
Muslim	257	87
Christian	43	14.3
Total	300	100

Table (32) shows that high percent of volunteers (46.3) were single, 42.7% married and 6%, 5% for the divorced and widowed respectively. It is clear that the social status of volunteers were concentrated in single and married group.

Table (32) Frequency distribution of social status

Social Status	Frequency	Percent
Single	137	46.7
Married	126	42.7
Divorced	18	6
Widowed	14	4.7
Total	300	100

Table (33) reports frequency distribution of tested people according to occupation, 26.3% unemployed, 23.3% laborers, 22% employee, 13% free job 11.7% student, 1.3% tee sellers.

Table (33) Frequency distribution of occupation

State of Work	Frequency	Percent
Unemployed	75	25
Labor	69	23
Employed	64	21.3
Free job	43	14.3
Student	35	11.7
Total	300	100

Table (34) displays the distribution of place of residence, 83.3% from Behree, 11% for rural areas, 3% from Khartoum and only 2.7% from Omdurman. We note that the high percent 83.3% for Khartoum North because the center inside it and there were considerable percent 2.7% from Omdurman, it may due to the stigma of AIDS patient. People tend to check their blood away from residence, because of the AIDS stigma and the expected *social exclusion*.

Table (34) Frequency distribution of place of residence

	Frequency	Percent
Khartoum	9	3
Khartoum North	250	83.3
Omdurman	8	2.7
Rural	33	11
Total	300	100

Table (35) shows the risk factors, 28% sexual, 22.3% worry, 4% blood transmission, 1% parent, 23% symptoms, 19.3% procedures. The results explain the fact that sexual behavior and symptoms that appear on the volunteers became reasons for attending the centre and check HIV/AIDS. There is a rational assumption that the two percentages are the same, i.e., the symptoms of patients due to their *sexual practice*.

Table (35) Frequency distribution of risk factors

	Frequency	Percent
Sexual	84	28
Worries	67	22.3
Blood transmission	12	4
Parent	3	1.5
Symptoms	76	23
Procedures	58	19.3
Total	300	100

Table (36) reports the HIV/AIDS incidence, through the result of test, 87% were negative HIV/AIDS, while (14.3%) were positive.

Table (36) Frequency distribution of HIV/AIDS result

	Frequency	Percent
Negative	257	87
Positive	43	14.3
Total	300	100

Table (37) reports the dependency between HIV/AIDS and education level. χ^2 value = 10.07, df = 3, P- value = 0.018, According to P-value, we reject null hypothesis that the two variable are independent and accept the alternative one they are dependent. So education affect HIV/AIDS incidence in Khartoum North area.

Table (37) Chi-square test for Dependency between HIV Incidence and Education Level

HIV Test	Education Level				Total	χ^2	P-value
	Illiterate	Primary /basic	intermediate	Secondary			
Negative	78	63	57	59	257	10.07	0.018
Positive	11	19	10	3	43		
Total	89	82	67	62	300		

Table (38) reports Chi-square test for dependency between HIV/AIDS incidence and occupation. χ^2 = 6.964, df = 7, P-value = 0.433 the P-value is greater than (0.055) the level of significance, so we can't reject the null hypothesis of the test, there is no relation between the occupation of the tested people and the HIV/AIDS result.

Table (38) Chi-square test for Dependency between HIV/AIDS and Occupation

HIV Test	Education Level					Total	χ^2	P-value
	Not work	Labour	employee	Free job	Student			
Negative	18	18	31	28	33	128	21.271	0.0001
Positive	21	21	11	14	5	72		
Total	39	39	42	42	38	200		

Table (39) reports the dependency analysis between HIV/AIDS incidence and the social status of volunteers who enter the center. The $\chi^2 = 214$, df = 3, P-value = 0.0001. This suggests the acceptance of the alternative hypothesis "there is relation between the two variables". This result coincides with the result of Khartoum result.

Table (39) Chi-square test for Dependency between HIV/AIDS and Social Status

HIV Test	Social Status				Total	χ^2	P-value
	Single	married	Divorced	widowed			
Negative	130	107	10	10	257	214	0.0001
Positive	9	21	8	5	43		
Total	139	128	18	15	300		

5. Modeling HIV/AIDS in Khartoum State Data

We deal with the collected data (Khartoum state data) the sample was 1439 members of volunteers and suspected cases. The model tries to find the relation between dependent variables (HIV/AIDS) incidence and socio-economic and demographic variables (independent variables) through the application of binary logistic regression. The value labels of the dependent variable (HIV/AIDS) incidence (0 denote negative test and 1 is positive test of result) . Step one of the model create a reduce model (i.e. model without predictor) or the model with the constant only, which is gives the results, Wald statistic = 282.935 with P-value (0.0001). So the model represented by the constant is significance at 1% level of significance. And this is the null model (model without predictor). For the purpose of product full model or final model (with predictor) binary logistic regression is done to obtain the model with education level, the model results as follows, the estimated model

Table (40) Estimated Model Coefficients of Education Level

Effect	B	S.E	Wald	Sig.	OR	95%CL of OR
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Education	0.173-	0.042	17.189	0.0001	0.841	0.76,0.94
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Table (41) Test of the model

Model	-2log likelihood	Chi-square	Sig
Null	1677.21		
Final	1657.989	17.669	0.00001

Table (42) Goodness of fit test

	Chi-square	Sig
Hosmer-lemeshow	18.145	0.00000
Deviance	18.6	0.000033

(Log Xact output)

Table (40) above reports, Wald statistic = 17.189, P-value (0.0003) . which support the rejection of the null hypothesis that (the coefficient is zero) . So the education level is statically significance at 1% level of significance. It is very clear through this result, the education level of volunteer affect the HIV/AIDS incidence (i-e the education level of a person play an important role of getting negative or positive HIV/AIDS) . The odd ratio (0.84) indicates that (illiterate people) have HIV/AIDS positive 0.84 times more than the other types of education level. Or we can say, people without education have HIV/AIDS 0.84 times more than educated people. To test the overall model, the Chi-square value (17.667) with P-value (0.00016) ,which indicate the statistically significance at 1%level of significance. So the model can be put into consideration and its result is acceptable. hosmer and lemeshow test, the L-H value = 18.146, P-value (0.002) , we can judge that the test is significant at 1% level of significance, so there is difference between observed and predicted value, the model is not fitting the data well. The deviance statistics (18.6) confirm the result of fitting.

Table (43) Estimated coefficient for binary logistic regression (occupation)

Effect	B	S.E	Wald	Sig	OR	95%CL of OR
Occupation	0.071-	0.037	3.741	0.053	0.932	0.87,1.01

Table (44) Test of the model

Model	-2log likelihood	Chi-square	Sig
Null	167567		
Final	1671.781	3.786	0.052

Table (45) Goodness of fit test

	Chi-square	Sig
Hosmer-lemeshow	18.145	0.00000
Deviance	18.6	0.000033

Table (43) followed by table (44) reports that Wald statistic = 3.741, P-value (0.053) which indicate insignificance of the occupation at 1% Level of significance. The result of insignificance explains, there is no direct effect of the predictor variable occupation on the HIV/AIDS incidence. Odd ratio of the variable is (0.932). So the people without job have positive HIV/AIDS 0. 932 time more than people without work. The overall model is statistically significance according to χ^2 value = 3.786 with P-value (0.05). So the occupation has no significant affect on HIV/AIDS of volunteers who attend the centers. Hosmor-lemeshow test value = 31.69, P-value = 0.0001, so the model is not well fitted. According to table (46) and table (47) bellow, Wald statistic = 70.398, P-value (0.0001) which indicate the statistically significance of the coefficient, the independent variable (Social Status) influence the HIV/AIDS incidence positively. The odds ratio EXP (B) = 1.94 which means the single people of Khartoum area have positive HIV/AIDS 1.94 times more than people (married, divorced, widowed) .This can be support by the test of the over all significance of the model. χ^2 = 73.449whith P-value (0.000012) so the model is statistically significance at 1% level of significance. H-L value = 3.196, P-value (0.074) so the model is well-fitting the data of Khartoum state.

Table (46) Estimated coefficient for binary logistic regression(social status) ◦

Effect	B	S.E	Wald	Sig	OR	95%CL of OR
Social	0.661	0.079	70.39	0.00	1.937	1.66,2.26

Table (47) Fitting Information of the model

Model	-2log likelihood	Chi-square	Sig	Hosmer-lemeshow
Null	16721			
Final	1602.118	73.449	0.072	0.074

A constructed binary logistic regression that depends on the two predictors variables, social and education level. That is to test the effect of them on the dependent variable, HIV/AIDS incidence. The results are, Wald statistic for the social status = 70.398, p-value = 0.011 and Wald statistic for education = 6.493, p-value = 0.0001, the result of wald test explain the significance of the two important variables. Also odd ratio of social and education were 1.937, 0.895 respectively. Thus the change in the log odd ratio of HIV/AIDS per social and education is 1.937, 0.89

In order to test the overall significance of the $\chi^2 = 80.019$, p-value = 0.00001, which insures the significance of the model. Hosmer-Lemeshow test done to test the goodness of fitting, H-L = 31.45, p-value = 0.0001, so the model didn't fit the data.

Table (48) Estimated coefficient for binary logistic regression (social status, education)

Variable	B	S.E	Wald	Sig	OR	95%CL of OR
Constant	-1.944	0.182	114.519	0.000	0.143	
Social	0.623	0.079	70.398	0.011	1.937	1.66,2.26
Education	-0.11	0.043	6.493	0.000	0.895	0.823, 0.975

Table (49) Test of the model Table(49)

Model	-2log likelihood	Chi-square	Sig	Hosmer-lemeshow
Null	16721			
Final	159548	80.019	0.000	0.074

According to table (49) the model include two important variable, social status and Occupation .The result signify that, Wald statistics = 60.385, with p-value = 0.011, odds ratio 1.865, which suggests that the change in the log odds of the HIV/AIDS incidence per social status illustrates the association between HIV/AIDS and social status, which is statistically significance. Beside that, occupation variable influence the dependent variable (HIV/AIDS) incidence significantly at 5% level of significance wald = 6.493, p-value = 0.00012. The odds ratio (0.895) suggest that, changing in the log odds ratio of HIV/AIDS incidence per occupation between 0.823 and 0.97

Table (50) Estimated coefficient for Binary logistic regression Social Status and Job

Variable	B	S.E	Wald	Sig	OR	95%CL of OR
Constant	-2.143	0.183	137.599	0.000	0.117	
Social	0.655	0.079	67.235	0.000	1.937	1.66,2.26
Occupation	-0.016	0.038	0.176	0.675	0.984	0.914, 1.060

Source SPSS output

Table (51) Test of the model

Model	-2log likelihood	Chi-square	Sig
Null	16721		
Final	1602.118	73.449	0.072

Table (52) reports Wald statistic for the education level = 1.246 with P-value = 0.264, and for the second variable occupation is 14.784 with P-value = 0.0001. The occupation is not significant and education statistically significance at 1% level of significance,. This result reflects the influence of education level to HIV/AIDS among volunteers. Also χ^2 test is done to test the overall mode, $\chi^2 =$

18.923, P-value = 0.00001, so the overall model is statistically significance at 1% level of significance. Hosmer and lemeshow test explain the result as H-L = 31.589 with P-value = 0.000, which suggests that, the model fail to fill the data well.

Table (52) illustrates the results of modeling HIV/AIDS depend on two predictors variable occupation and education level, wald statistics for occupation 1.246 with p-value 0.264 which is not significant, While education level is appear to be statistically significant wald = 6.493, p-value = 0.000. So the model influence by the education level. Also odds ratio of occupation (0.96) indicate that people without job have positive HIV/AIDS 0.96 times more than working people. Beside that is the odd ratio of education level (0.85). Thus people without education have a chance to be infected by the disease 0.85 time more than educated people. The over all model is significance at 5% level of significance according to table (52) $\chi^2 = 18.9$, P-value = 0.00012. The goodness of fitting is tested through hosmer-lemeshow test and deviance statistics, H-L = 31.6, p-value = 0.0003, D = 84, p-value = 0.00001. Therefore, the model fail to fit the data well.

Table (52) Estimated Coefficient for Binary Logistic Regression (occupation, education)

variable	B	S.E	Wald	Sig	OR	95%CL of OR
Constant	-.671	0.101	43.909	0.000	0.511	
Occupation	-0.042	0.037	1.246	0.264	0.959	0.892,1.032
Education	-0.11	0.043	6.493	0.000	0.849	0.781, 0.923

Table (53) Test of the model

Model	-2log likelihood	Chi-square	Sig
Null	167568		
Final	1656.65	18.923	0.000

Table (54) illustrates the full model with the three predictors variables (social status, occupation, education). According to the model estimation, it is very clear that, social status and education level both of them gains statistically significance, wald statistics for social status = 59.26, p-value = 0.0001, and Wald statistics for education 6.321 pvalue = 0.012. The overall model significance is tested through $\chi^2 = 114.845$, p-value = 0.000, the model is acceptable at 1% level of significance. Hosmer-lemeshow = 34.15, p-value = 0.000. This result suggests that the model is not well fitted. Results insures the validity of the model. The three factors, social, education and occupation influence HIV/AIDS in spite of the insignificance of occupation variable. They verify the hypothesis of the study that the demographic variables affect HIV/AIDS incidence in Khartoum state.

Table (54) Estimated coefficient for binary logistic regression (social status, occupation, education)

Variable	B	S.E	Wald	Sig	OR	95%CL of OR
Constant	-1.94	0.198	96.726	0.000	0.143	
Social	0.623	0.081	59.26	0.000	1.865	1.591, 2.186
Occupation	-0.0016	0.038	0.0018	0.997	1.00	0.928, 1.078
Education	-0.11	0.044	6.321	0.012	0.895	0.822, 0.976

Table (55) Test of the model

Model	-2log likelihood	Chi-square	Sig
Null	167567		
Final	159548	80.02	0.000

Table (56) Estimated coefficients for a multiple logistic regression model

Variable	B	S.E.	Wald	Sig.	$OR\hat{R}$
Social status			49.25	0.0000	
Single	-1.519	0.303	216	0.0000	0.219
Married	-0.805	0.288	7.817	0.005	0.447
Divorced	-0.23	0.35	0.432	0.511	0.795
Occupation			10.805	0.147	
Labor	4.85	13.5	0.129	0.719	127.8
Employee	0.22	13.501	0.138	0.710	151.7
Free Job	4.859	13.502	0.130	0.719	123.9
Student	0.19	13.501	0.138	0.710	151.2
Tee seller	4.61	13.504	0.095	0.758	64.1

Driver	27	13.504	0.153	0.696	191
Solider	04	13.506	0.139	0.709	154.6
Education level			17.995	0.001	
Primary/basic	0.56	0.248	108	0.024	1.75
Intermediate	1.006	0.252	1995	0.000	2.74
Secondary	0.631	0.287	4.855	0.028	1.9
university	0.682	0.254	7.203	0.007	1.98

6. HIV/AIDS Trends of the Three Centers (2009)

Table (57) and figure (1) presents the trend of positive HIV/AIDS for Omdurman center for both males and females. It is very clear that males positive cases is large than female positive cases except in the two months may and august.

Table (57) Trends of HIV/AIDS in Omdurman 2009

months	male positive	female positive
January	1	2
February	6	6
march	7	7
April	7	1
May	6	3
June	8	7
July	14	3
august	4	3
September	4	7
October	4	2
November	4	1
December	5	5

Figure .1 Trends of HIV /AIDS Positive Cases in Omdurman center

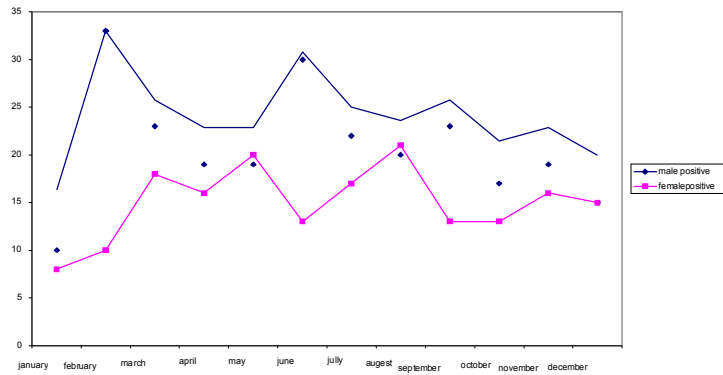


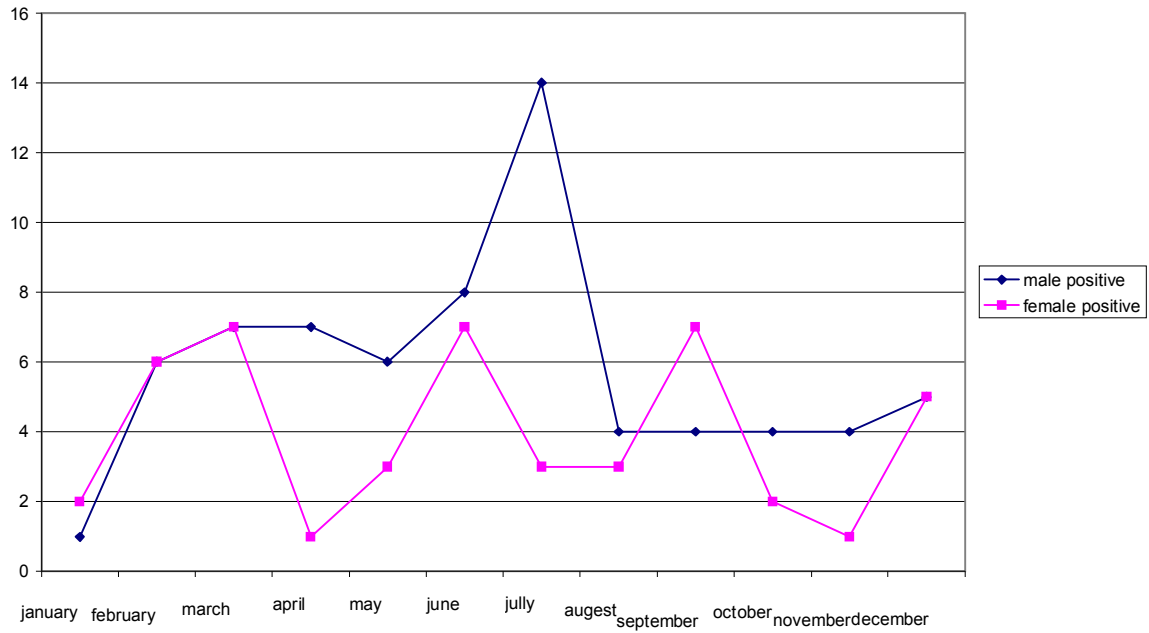
Table (58) and figure (2) presents HIV/AIDS situation which is increased through months in January there (1) case of positive male and (2) cases of positive female. The number grow over the time until it reached its maximum point in July (14) males and (7) for females in September. The trend of female positive cases is less than the trend of male's positive cases except in September female positive cases more than males' positive cases. In the last month of the year the cases of positive HIV/AIDS are equal for both males and females.

Table (58) Trend of HIV/AIDS in Khartoum 2009

Months	male positive	female positive
January	1	2
February	6	6
march	7	7
April	7	1
May	6	3
June	8	7
July	14	3
august	4	3
September	4	7
October	4	2
November	4	1
December	5	5

Source Ministry of Health 2009

Figure 2 Trends of HIV/AIDS Incidence of Khartoum



Source: Ministry of health, Khartoum state

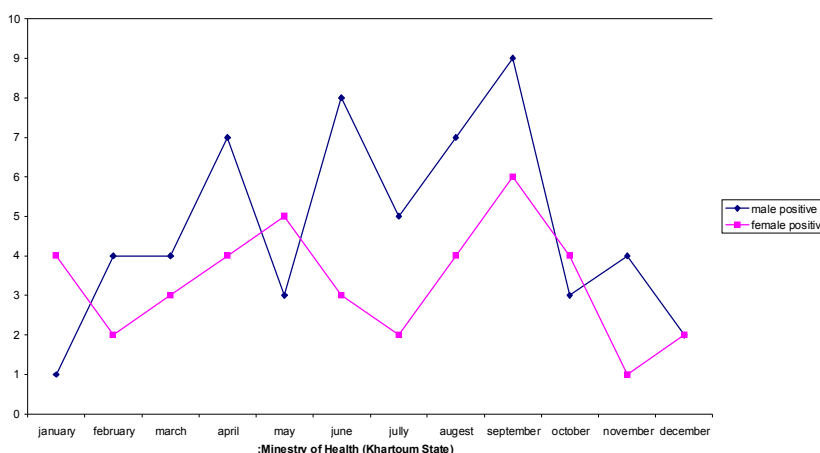
Table (59) and (3) figure trends of HIV/AIDS incidence of Khartoum North center. The graph indicate increasing in the incidence over time. In January it records (10) positive of males while (8) positive of females. The numbers of positive males and females rise up gradually, and then fell down into low level (2) cases for both males and females in December.

Table (59) Trend of HIV/AIDS in Khartoum North 2009

months	male positive	female positive
January	1	4
February	4	2
march	4	3
April	7	4
May	3	5
June	8	3
July	5	2
august	7	4
September	9	6
October	3	4
November	4	1
December	2	2

Source Ministry of Health 2009

Figure 3 Trends of HIV/AIDS Incidence of Khartoum North



6.1. Comparisons between the Three Centers

In general, HIV/AIDS positive cases among volunteers and suspected cases of the three centers under the study are in critical situation of the disease. There must be more efforts exerted to stop the spread of the pandemic into Khartoum state and other states of the century. However, in all and according to the data, Omdurman center has the high positive cases either for males or females. It seems that there is considerable number of people attend the center more than the other two centers Khartoum and Khartoum North, so the high incidence is acceptable. The demographic weight could be one reason as Omdurman is the most densely populated city in Khartoum state. Moreover, it has the largest numbers of refugees among them. Unofficial refugees' numbers in Omdurman city exceed two millions in less than ten years. They come from the troubled regions of the Southern and Western Sudan. The refugees also live with less than adequate sanitary conditions with minimized incomes and less employment. They work mostly in marginal and irregular jobs which call for an educated guess that it can be prostitution, begging or thievery.

7. Summary, Conclusions and Recommendations

The study was conducted in Khartoum state for the period (2003-2009) aims to apply statistical models for the HIV/AIDS data in Khartoum state centers of testing blood and counseling. AIDS is recognized as an emerging disease only in the early 1980s, AIDS has rapidly established itself throughout the world, and is likely to endure and persist well into the 21s century. AIDS has evolved from a mysterious illness to a global pandemic which has infected tens of millions less than 20 years. The study construct three main hypotheses they are first, Non-linear models fit the HIV/AIDS data well especially binary logistic regression. Second, demographic variables affect the HIV/AIDS incidence in Khartoum state. Third, HIV/AIDS will be increasing among volunteers in the three centers Khartoum, Khartoum North, and Omdurman.

The main objective of the paper was to apply statistical models for HIV/AIDS in Khartoum state so as to obtain a good analysis, beside other sub objectives. The Methodology was divided into two parts. Source of Data depending on secondary data collected from the volunteers centers for blood testing and counseling inside Omdurman, Khartoum, and Khartoum North teaChing hospitals. The data collected through questionnaires was designed so as to get all the information registered inside the three centers. Study stems the good models and techniques. The main idea of analysis is to apply and identify statistical model that related to AIDS by using statistical packages to construct the models depends on the collected data about HIV/AIDS of Khartoum state. Mainly the study depends on Statistical package for Social Science (SPSS) and Log Xact to estimate the coefficients of the models and the other statistical test related to them. The importance of the study comes from the

importance of the AIDS issue itself, because it destroys human capital. Our focus here was on binary logistic regression, because it's suitable to the data collected from the three centers inside the three hospitals in Khartoum. Also estimates coefficient and statistical tests done to distinguish between the variables that related to HIV/AIDS incidence and spread through people in the three cities Khartoum, Khartoum North, and Omdurman. Through analysis of data we obtain the main findings that are the incidence rate of HIV/AIDS among volunteers and suspected cases Omdurman center is 33.5, Khartoum state is 36, and 14.3 for Khartoum North center. So the rate of Khartoum data is the highest one. In order to test the dependency between HIV/AIDS incidence and some socio-economic variables, the study concludes that there is no effect of education level on HIV/AIDS infection for the data collected from Omdurman. However, there is dependency between HIV/AIDS incidence and occupation of volunteers. So the job of individuals affects the HIV/AIDS incidence inside Omdurman area. Also there is an association between HIV/AIDS incidence and social status of individuals. High numbers of positive HIV/AIDS in Omdurman center are among married people. In the suspected cases of Omdurman center, there is no effect of education level on HIV/AIDS incidence. Education does not influence AIDS Situation for the suspected cases. For Khartoum data the study obtains the dependency between HIV/AIDS and some socioeconomic variables, there is dependency between HIV/AIDS incidence and education level of volunteers. That confirms that AIDS related to education status of individuals. Also social status is related to HIV/AIDS among volunteers according to Chi-square test which insures the dependency.

For Khartoum North data dependency analysis reports that, there is dependence between HIV/AIDS incidence and education level, so education influence HIV/AIDS incidence among people inside Khartoum North area. Also the same result was found through the test between HIV/AIDS incidence and occupation, which reflect the fact that the job of individuals affects their HIV/AIDS infection.

The study construct binary logistic model for Khartoum state, the predictors variables of the models were social status, education level and occupation. The variables social, education were found to be significance where Occupation is insignificant. We conclude that, the three variables are very important to affect the dependent variable HIV/AIDS incidence inside Khartoum state during the period of the study. The overall model test gains statistical significance at 1% level of significance, although there is insignificance association between HIV/AIDS incidence and Occupation.

The study conducted diagram for the HIV/AIDS positive cases during 2009 for the three centers. The figure of Omdurman centers reports increasing of positive cases for males and female. It seems that males' positive cases were greater than females positive cases except in May and August. For Khartoum hospital cases the incidence is increasing over the time for both sexes. But in September, females' positive cases are higher than males' positive cases. In Khartoum North center, trends of HIV/AIDS incidence during 2009 is at increasing rate for the positive cases of both males and females rising gradually then fell down into low level in the last month of the year (December) .

It is concluded that, education level and occupation influence HIV/AIDS incidence in Khartoum data only and social status is found to have the strong factor affect HIV/AIDS incidence for the three centers under the study. For more description of the HIV/AIDS in Khartoum state represented by the testing and Counseling' centers, data about positive HIV/AIDS for both males and females during 2009. The trend of HIV/AIDS incidence is increased among both sexes, but males were infected more than females. The study has the following recommendation

1. Provides good system for the HIV/AIDS data to follow-up prevalence of the disease annually.
2. Assess the current situation of the pandemic and try to establish strategic plan to stop or eradicate the disease among people mainly adults.
3. The interrelation between HIV/AIDS incidence and socio-economic variables need to be evaluated by the other specific studies.
4. The awareness about the dangerous of the disease still very weak so community, agencies, government, civil society, and non-governmental organization they should play an important role to raise the awareness.

5. There must be follow-up mechanisms for the volunteers in terms of their Place of residence and reasons for blood testing to know the contribution of them in the HIV/AIDS incidence through logistic regression model.

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