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Statistical Analysis of the Rate of Sero-positivity of HIV in Districts of Rajasthan

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Abstract

A statistical analysis for the comparison of the rate of sero-positivity of HIV at district level in the state Rajasthan.Our study has explored the geographical patterns of transmissibility of HIV/AIDS in Rajasthan of INDIA. We identified the variation between mean of rate of HIV positive cases during the years 2011-16 in ICTC and ANC Centre. We have used ANOVA to analyse the variation in districts of HIV positive patients in Integrated Counselling and Testing Centre (ICTC) and Antenatal Care Centre (ANC).

Keywords: Analysis of variance, Correlation, HIV/AIDS, literacy rate, HIV sero-positivity, Integrated Counselling and Testing Centre (ICTC), Antenatal Care Centre (ANC).

Introduction

All round the history, transmissible diseases have had a large influence on the human population. Although transmissible diseases are present in human populations at all times to some extent, the effects of epidemics are the most detectable and breath-taking. Although, with the disclosure of new, highly resistant strains of pathogens and new sexual attitudes and practices, many of these diseases have float up along with some new and even more terrifying ones. The viral diseases such as genital herpes, genital warts, and especially AIDS have confronted all our attempts to suppress them.[1][2]

HIV is the genesis of the spectrum of disease known as HIV/AIDS. HIV is a retrovirus that firstly affects components of the human immune system such as macrophages, CD4+ T cells, dendritic cells. It directly and indirectly destroys CD4+ T cells. HIV is an organ of the genus Lentivirus, part of the family Retroviridae.[3]

Two main clinical staging systems are used to sort out HIV and HIV-related disease for surveillance purposes: the WHO disease staging system for HIV infection and disease, and the CDC institution system for HIV contamination.[4] The CDC's institution system is more repeatedly adopted in developed countries. Since the staging system of WHO does not need laboratory tests, it issuited to the resource restricted situation come across in developing countries, where we can also use it to assist guide clinical management.[5] Despite of their differences, the two systems permit comparison for statistical purposes. The World Health Organization first establish a definition for AIDS in 1986.[6] Since then, the WHO classification has been updated and extended several times, with the most recent version being published in 2007.[7] The WHO system uses the following categories:

1. Primary HIV infection: May be either virulent or associated with acute retroviral syndrome.
2. Stage I: HIV infection is virulent with a CD4+ T cell count (also known as CD4 count) greater than 500 per microlitre (µl or cubic mm) of blood may include generic lymph node enlargement.
3. Stage II: Mild symptoms which may include minor mucocutaneous demonstrations and recurrent upper respiratory tract contaminations. A CD4 count of less than 500/µl.
4. Stage III: Advanced symptoms which may involve unexplained chronic diarrhoea for longer than a month, severe bacterial contamination including tuberculosis of the lung, and a CD4 count of less than 350/µl.
5. Stage IV or AIDS: severe symptoms which involve toxoplasmosis of the brain, candidiasis of the oesophagus, bronchi, trachea or lungs and Kaposi's sarcoma, a CD4 count of less than 200/µl. [8]

For finding out a reliable treatment method we need to analyse the days it took the patients to be cured from the infection. We will be

Using astatistical technique which can compare the three treatment samples and identify how different these samples are from one another. The analysis of variance is a powerful statistical tool for test of significance. The basic purpose of ANOVA is to test the homogeneity of several means. [9][10]. We are going to use ANOVA to prove/disprove that all the medication treatments were equally effective or not.

Terminology for ANOVA

Grand Mean

Mean is a simple or arithmetic average of a range of values. There are two types of means that we will use in calculating ANOVA, that are separate sample means and the grand mean. The grand mean is the mean of all observations combined or the mean of sample means, irrespective of the sample.[11]

Hypothesis

In mathematical form, hypothesis can be represented as:

Null Hypothesis: H_o: $\mu_1 = \mu_2 = \ldots = \mu_n$

Alternative Hypothesis: H_1: $\mu_l \neq \mu_m$

Where, $\mu_l$and μ_m belong to any two sample means out of all the samples considered for the test. In other words, the null hypothesis states that all the sample means are equal or the factor did not have any significant effect on the results. Whereas, the alternate hypothesis states that at least one of the sample means is different from another. But still we cannot tell which one specifically differs. For which, we use other methods that we will discuss later in this article.[12]

Review of Literature

T K Giri et al., 1995 [13]done an in-depth analysis of the subjects which revealed that the adult males seemed to have the highest propensity for HIV infection in parts of the country.Kyung Hee Chang and June Myung Kim 2001 [14]studied the age and sex distribution of HIV infection in Korea along with the transmission root of the infection and concluded that the HIV infection was persistently increasing in Korea at that time.NityaVyas et al., 2009 [15]study was conducted to analyse previous six-year prevalence data of HIV infection in the Northwest region of India and predict future trends for a couple of years.

Jun-Jie Wang et al., 2010 [16] study aims to explore dynamic characteristics of the HIV mother to child transmission (MTCT) epidemic in China and concluded that the prevalence of HIV positive women should be reduced and more pregnant women should be tested for HIV.V N Sharma, Ajay Kumar 2012 [17] out of all 148 blood samples were HIV positive, 53 AIDS affected and 118 blood samples from age and sex matched normal individuals.

KondreddySrikanth 2013 [18] work embodies a systematic study of the process of policy development in India with a special focus on policy for HIV-TB co-infection. All the four stakeholders agreed that evidence from scientific research was crucial for evolving policy.Itagimath S.R. 2015 [19] study the spread of HIV/AIDS in North-Karnataka using suitable statistical techniques/models and understand specific issues such as spread of HIV/AIDS in recent years, Mode of spreading HIV/AIDS, etc.

Rajneesh Kumar Joshi 2019 [20]study found sixty-three districts with consistently high HIV prevalence clustered in the South and the North-east regions of India. Population size, density and urbanisation were found to be positively associated with consistently high HIV prevalence in these districts.

Method and Data

The objective of this study is to identify the variation of HIV/AIDS epidemic among the districts in Rajasthan, the primary and secondary data is collected from different departments and the agencies of the state government. On the basis of secondary data collected from RSACS and HSS, the data of HIV positive cases and total number of ICTC and ANC clients. This analysis is done using the statistical technique of analysis of variation. For this, district wise yearly data of total population of Rajasthan in years 2011-2016 is considered. By the use of one-way ANOVA, we can identify whether there is difference between the percentage of sero-positivity of ICTC and ANC clients in districts. In our study, we analyse the correlation between districts wise literacy rate of Rajasthan from census 2011 and the district wise total percentage of sero-positivity of ICTC clients in year 2011-2016. Also, the correlation between the district wise literacy rate of year 2011 and district wise number of ICTC clients in tested in year 2011-16.

A Statistical Analysis of HIV/AIDS of ICTC Centre in Rajasthan

General data was collected of Integrated Counselling and Testing Centre (ICTC) clients and analysed from a total of 48,45,134 patients who was tested during the period of five years i.e. from 2011 to 2016. Out of which 39,481 found to be seropositive for HIV antibodies with sero-positive rate 0.82%.[]

Table 4.1: Details of patients tested and HIV positive in Rajasthan, India for the period 2011 to 2016

Total Number of HIV positive Patients	Total Number of Tested patients	Percentage of Sero-positivity
4845134	39481	0.82%

We have graphical representation of district wise sero-positivity of ICTC clients for 5 years from 2011 to 2016. We can see theoretically that there can be some difference in district wise percentage of sero-positivity of ICTC clients.

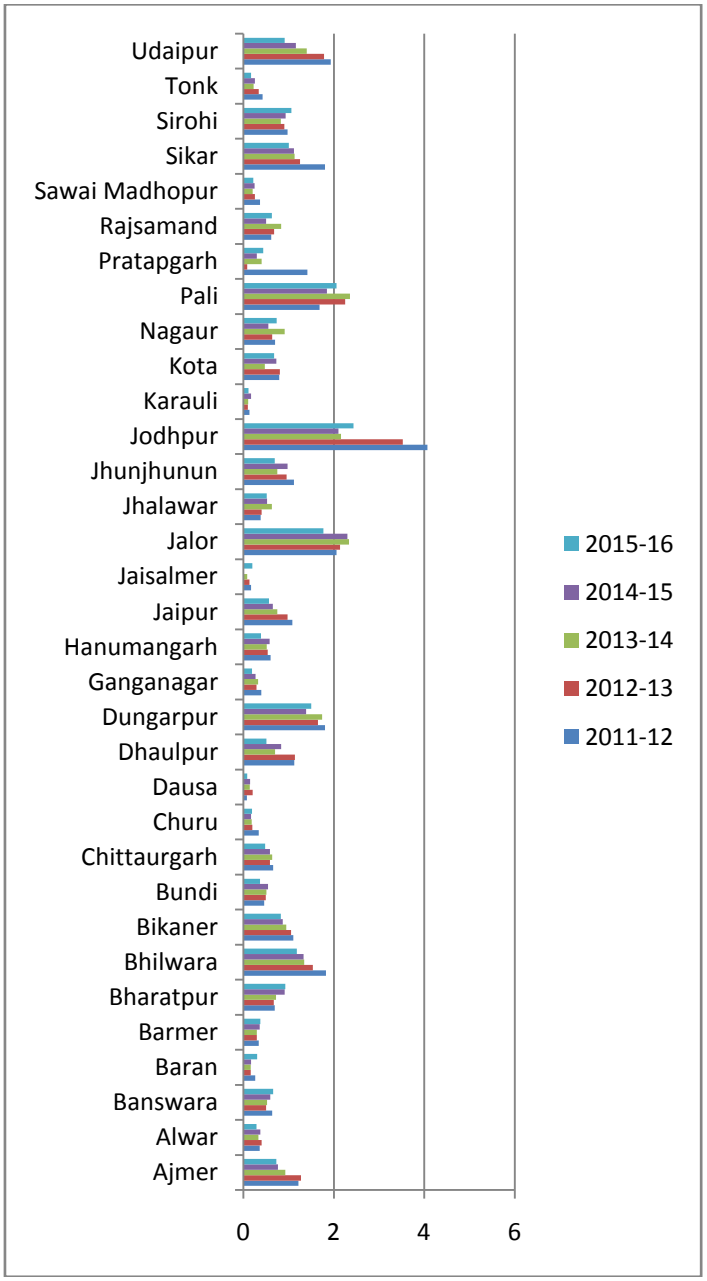

Figure 4.1: District wise representation of percentage sero-positivity of ICTC clients in year 2011-2016

A year wise analysis shows that 8, 09, 857 patients in ICTC centre were tested for HIV and HIV sero-positive rate is 1.06% in year 2011-12. Further, the rate of HIV positive cases was declined to 0.96% in year 2012-13 from 1.06% in year 2011-12. The rate of HIV positive gradually decreased to 0.79% in year 2013-14. In year 2014-15, it was 0.73% and in 2015-16, it was 0.65%.

Table 4.2: Year wise seropositive rates of HIV in Rajasthan for the period 2011-2016

Year	Total Number of Tested patients	Total Number of HIV positive Patients	Percentage of Sero-positivity
2011-12	809857	8608	1.06%
2012-13	761947	7316	0.96%
2013-14	997278	7922	0.79%
2014-15	1113925	8135	0.73%
2015-16	1162127	7500	0.65%

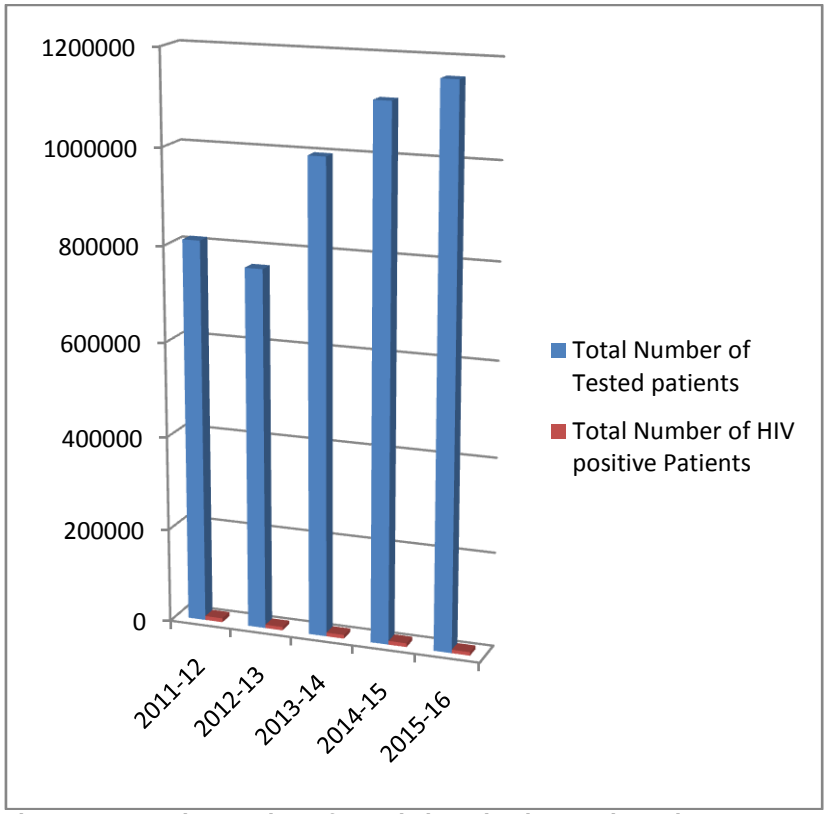

Figure 4.2:Y-axis represents the number of people in Rajasthan and X-axis represents the year wise distribution

District wise distribution of Rate of HIV positive cases

The one-way ANOVA was applied to verify whether the rate of the sero-positive of HIV was unequally distributed between the districts during the years 2011-16. To examine whether group means differ or not, we need to test the assumptions of the one-way ANOVA.

Table 4.3: Results of One-Way ANOVA for ICTC clients

H_o: $\mu_1=\mu_2= \ldots =\mu_n$; n=33

H_1: At least two of them are not equal

ANOVA

Total	Within Groups	Between Groups	Source of Variation
73.04875	7.69130	65.35745	SS
164	132	32	Df
	0.05827	2.04242	MS
		35.05252	F
		0.00000	P-value
		1.53137	F critical

Since, P-value is less than 0.05, the null hypothesis is rejected. That is, there are at least two of the districts having different mean of rate of HIV positive cases during the years 2011-16.

The assumption of independence and the assumptions of normality were met for this set of data. Also, the assumption of homogeneity of variance was not met (P-value < 0.05 for Levene Statistic for test for homogeneity of variance). If a statistical procedure is little affected by violating an assumption, the procedure is said to be robust with respect to that assumption. The One-way ANOVA is robust with respect to violations of the assumptions, except in the case of unequal variances with unequal sample sizes. That is, the ANOVA can be used when variances are only approximately equal if the number of subjects in each group is equal and since we have equal sample sizes for all the groups we can assume that variances are approximately equal and proceed with one-way ANOVA. So, we conclude that there was significant variation between the districts of the Rajasthan.

We also know that literacy rate in an area does affect the number of clients tested for HIV in the same area. If in an area literacy rate is high, this implies that the population should be more aware about the disease. This helps them to take precautions about any disease.

So, we are interested to find the correlation between literacy rate in year 2011 taken from the census 2011 and the number of clients tested in the ICTC which is the total of 5 years from 2011 to 2016. Also, the correlation between the literacy rate and the percentage of sero-positivity in the districts also find

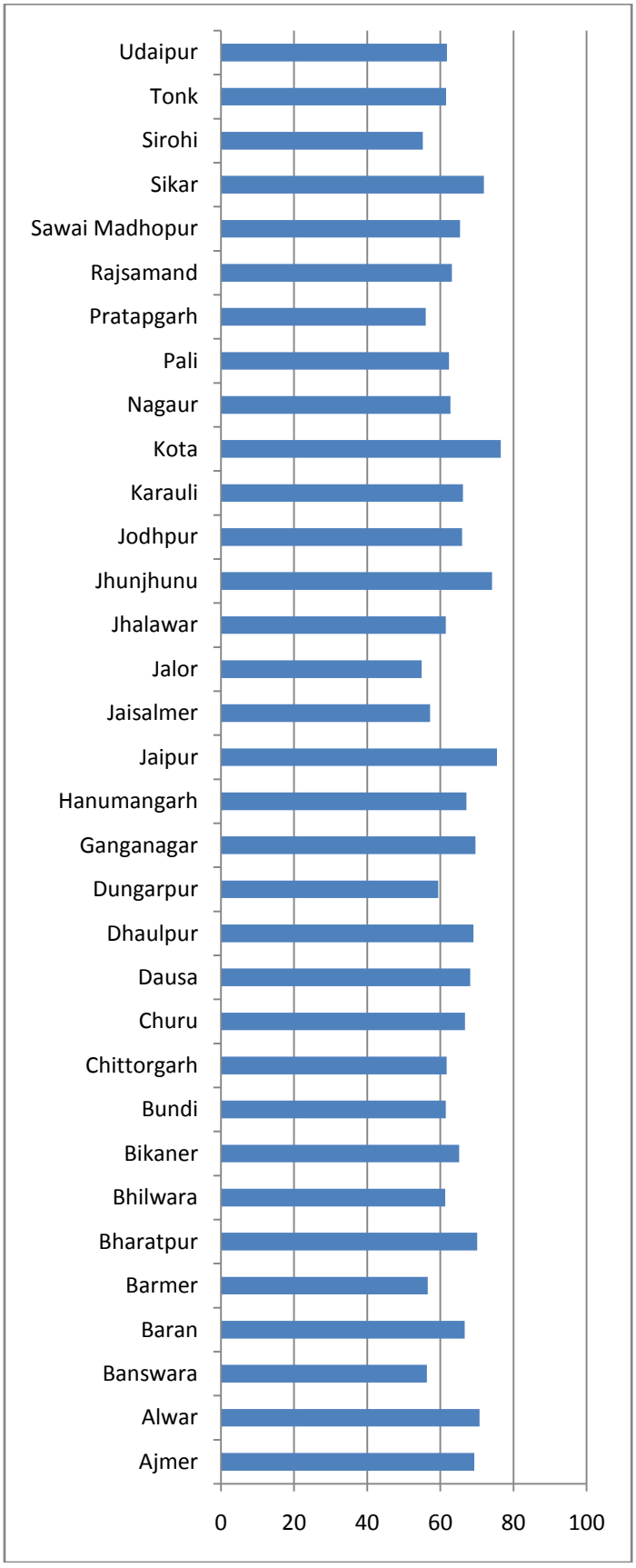

Figure 4.3: District wise literacy rate of Rajasthan in 2011

The correlation between literacy rate and number of persons tested is 0.359718 i.e., positive.[21] This implies that as the literacy rate increase, the number of persons tested for HIV also increase. The correlation between literacy rate and population percentage of sero-positive cases in Rajasthan is -0.10428 i.e. negative. This implies that as the literacy rate increase the percentage of sero-positive cases of HIV decrease.

A Statistical Analysis of HIV/AIDS of ANC Centre in Rajasthan

General data was collected of Antenatal Care Centre (ANC) clients and analysed for a total of 17,30,098patients who had tested during the period five years from 2011 to 2016. Out of which 1,772 found to be seropositive for HIV antibodies with sero-positive rate 0.10%.

Table 4.4 Details of patients tested and HIV positive in Rajasthan, India for the period 2011 to 2016

Total Number of HIV positive Patients	Total Number of Tested patients	Percentage of Sero-positivity
17, 30, 098	1, 772	0.10%

We have graphical representation of district wise sero-positivity of ANC clients for 5 years from 2011 to 2016. We can see theoretically that there can be some difference in district wise percentage of sero-positivity of ANC clients.

The year wise analysis shows that 2, 98, 182 patients in ANC centre were tested for HIV and HIV sero-positive rate is 0.12% in year 2011-12. Further, the rate of HIV positive cases was declined to 0.11% in year 2012-13 from 0.12% in year 2011-12. The rate of HIV positive gradually decreased to 0.10% in year 2013-14. In year 2014-15, it was 0.10% and in 2015-16, it was 0.10%.

Table 4.5 Year wise seropositive rates of HIV in Rajasthan for the period 2011-2016

Year	Total Number of Tested patients	Total Number of HIV positive Patients	Percentage of Sero-positivity
2011-12	298182	348	0.12%
2012-13	278690	291	0.11%
2013-14	360413	350	0.10%
2014-15	395850	394	0.10%
2015-16	396963	389	0.10%

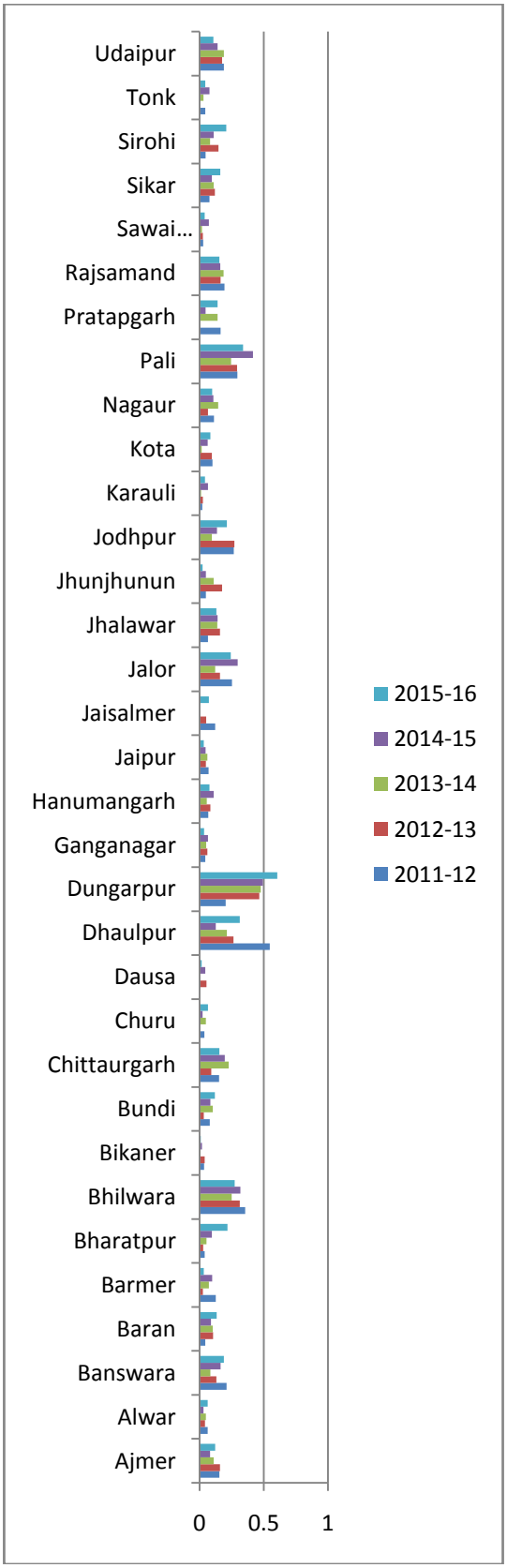

Figure 4.4: District wise representation of percentage sero-positivity of ANC clients in year 2011-2016

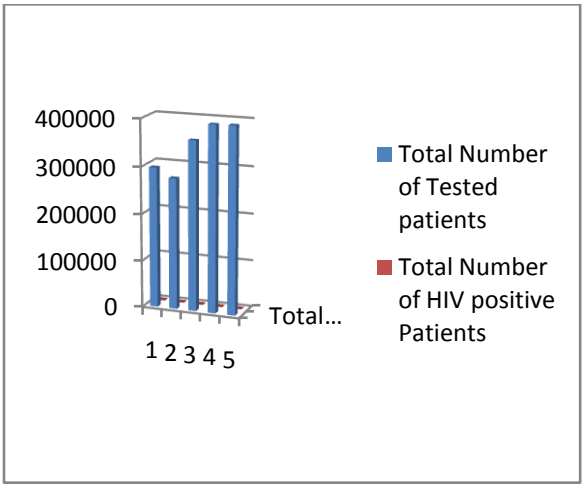

Figure 4.5: Y-axis represents the number of people in Rajasthan and X-axis represents the year wise distribution.

District wise distribution of Rate of HIV positive cases

The one-way ANOVA is applied to verify whether the rate of the sero-positive of HIV is unequally distributed between the districts during the years 2011-16. To examine whether group means differ or not, we need to test the assumptions of the one-way ANOVA.

*Table 4.6:*Results of One-Way ANOVA for ANC clients

H_o: $\mu_1=\mu_2= \ldots =\mu_n$; n=33

H_1: At least two of them are not equal

ANOVA

Total	Within Groups	Between Groups	Source of Variation
1.97059	0.42180	1.54879	*SS*
164	132	32	*Df*
	0.00319	0.04840	*MS*
		15.14648	*F*
		0.00000	*P-value*
		1.53137	*F critical*

Since, P-value is less than 0.05, the null hypothesis is rejected. That is, there are at least two of the districts having different mean of rate of HIV positive cases during the years 2011-16.

The assumption of independence and the assumptions of normality were met for this set of data, Also, the assumption of homogeneity of variance was not met (P-value < 0.05 for Levene Statistic for the test of homogeneity of variance). If a statistical procedure is little affected by violating an assumption, the procedure is said to be robust with respect to that assumption. The One-way ANOVA is robust with respect to violations of the assumptions, except in the case of unequal variances with unequal sample sizes. That is, the ANOVA can be used when variances are only approximately equal if the number of subjects in each group is equal and since we have equal sample sizes for all the groups we can assume that variances are approximately equal and proceed with one-way ANOVA. We conclude that there was significant variation between the districts of the Rajasthan.

Conclusion

Our study has explored the geographical patterns of transmissibility of HIV/AIDS in Rajasthan of India. We identified the variation between mean of rate of HIV positive cases during the years 2011-16 in ICTC and ANC Centre. We have used ANOVA to analyse the variation in districts of HIV positive patients in Integrated Counselling and Testing Centre (ICTC) and Antenatal Care Centre (ANC).

We conclude that there is a significant difference between mean of rate of HIV positive cases during the years 2011-16 in ICTC and ANC Centre.

Also, in our study the correlation between literacy rate and number of person tested for HIV sero-positivity we observe the correlation is positive. So, as the literacy rate increase, the number of person tested for HIV also increase. The correlation between literacy rate and population percentage of sero-positive cases in Rajasthan is negative. This implies that as the literacy rate increase the percentage of sero-positive cases of HIV decrease.

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