Original Article

Causality Assessment of Different Set of Variables using Time Series Data Analysis — A Prospective Cohort Study

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Background : As per Targeted Intervention guidelines FSWs have to attend regular medical check-ups and counselling sessions quarterly a year. Go for RPR testing for syphilis and ICTC testing for HIV at least twice a year. STIs detection and treatment is done through Drop-In Centre (DIC) Clinics or Urban Health Centres.

Aims and Objectives : To assess Long-run causality between attendance at counselling sessions and regular medical check-ups. Causality between other pair of variables was also assessed.

Materials and Methods : *Study design* - Prospective cohort with retrospective comparison. Mix of primary and secondary data analysis was carried. Data was collected prospectively for 2013-14 and it was compared with programme data collected retrospectively for rest of the years. ***Study setting*** - Two different drop in centre clinics. Data entry and analysis was done using SPSS software and EViews software. Long-run causality assessment between attendance at counselling sessions and ICTC testing, attendance at counselling sessions and RPR testing etc. was done using time series analysis technique. First, Augmented Dickey - Fuller unit root test was done to check stationarity of data ie, whether data have equal mean and variance over a period of time), then Johansen co-integration technique was applied to check integration at same level of stationarity. Then final step of causality assessment was applied.

Results : Correlation between counselling sessions and regular medical check-ups among FSWs each year from 2009 to 2014 was statistically significant with p value <0.05. Correlation between counselling sessions and RPR testing for syphilis among them each year from 2009 to 2014 was statistically significant with p value <0.05.

Conclusion : Our study re-establishes the cause and effect relationship between regular medical check-ups and attendance at counselling sessions, RPR testing and ICTC testing, STD positivity, etcusing different steps of time series analysis. [*J Indian Med Assoc* 2023; **121(8):** 15-21]

Key words : Causality assessment, Targeted Interventions, Time Series Data Analysis, Drop-In Centre (DIC) Clinics.

Targeted interventions among Female Sex Workers bring awareness about health implications of unsafe sex and HIV/AIDS issues. The TIs reduce sex workers vulnerability to STIs and HIV/AIDS, through promotion of STI services, condom use, Behaviour Change Communication (BCC) through peer and outreach, building enabling environment, ownership building in the community and linking prevention to HIV related care and providing continuum of services.[1]

All TIs are rights based; they empower the high risk groups. NGOs/CBOs engaged in TIs are networked and linked to general healthcare facilities to ensure that HRGs access them without stigma or discrimination; they are also linked to community care

> **Editor's Comment :**
> ■ Based on different steps of time series analysis cause and effect relationship between regular medical check-ups and attendance at counselling sessions, RPR testing and ICTC testing, STD positivity is observed.

centres, counselling and testing centres and ART centres. The prevention strategies are thus linked to care and treatment and empower the HRGs against stigma and discrimination[1].

As per Targeted Intervention guidelines FSWs have to attend regular medical check-ups and counselling sessions quarterly a year. Go for RPR testing for syphilis and ICTC testing for HIV at least twice a year. STIs detection and treatment is done through Drop-In Centre (DIC) Clinics or Urban Health Centres. Presumptive treatment is given to those who are detected with new STDs and coming late to Drop-In Centre clinic after 6 months instead of coming regularly.

The targeted intervention project is run by our institute since 1997 and above mentioned services (regular medical check-ups, counselling sessions, RPR testing, ICTC testing, presumptive treatment) are

provided to enrolled beneficiaries. Moreover, other services like Information Education Communication and free condom distribution and other social welfare programmes are also being done. Service provision under this project is maintained through various records.

In our study we want to prove the long term association and causality (one to one cause and effect relationship/ one event leading to happening of other event). If we want to decrease the *RPR positivity for syphilis* and *ICTC positivity for HIV and STDs other than syphilis and HIV*"regular medical check-ups" and "attendance at counselling sessions" is very important. We are trying to identify the interrelationships among these set of variables, whether RPR positivity is leading towards ICTC positivity? We want to see is there any long run association between regular medical check-ups and attendance at counselling sessions, association between STD positivity and RPR positivity, HIV testing and HIV positivity, RPR positivity and HIV positivity etc ?

We have to tried to prove this thing and similar other long term associations with the help of causality assessment using econometric technique, time series data analysis.

Aim and Objectives

- To assess Long-run causality between attendance at counselling sessions and regular medical check-ups.
- To assess Long-run causality between attendance at counselling sessions and RPR testing.
- To assess Long-run causality between attendance at counselling sessions and ICTC testing.
- To assess Long-run causality between STD positivity and RPR positivity.
- To assess Long-run causality between STD positivity and HIV positivity.
- To assess Long-run causality between RPR positivity and HIV positivity.
- To assess Long-run causality between ICTC testing and RPR testing.
- To assess Long-run causality between ICTC positivity and ICTC testing.

Materials and Methods

Study design-Prospective cohort with retrospective comparison. This was a Prospective cohort study with comparison to existing programme data. Mix of primary and secondary data analysis was carried out among 2193 Female Sex Workers (FSWs) over a period of 5 years from 2009 to 2014. Data was collected prospectively for 2013-14 and it was compared with programme data collected retrospectively from 2009

to 2012. The selected FSWs were beneficiaries of project implemented by Community Medicine Department, Government Medical College under State AIDS Control Society. Permission from State AIDS Control Society and Institutional Ethical Committee was obtained.This data was validated & a tracking sheet was generated from 2009 onwards for 5 years. Study setting- Study was done at two different DIC NGOs/clinics and project field area of Surat City. Study tool and process of data collection-Study tool was designed with the help of records maintained by two Drop in Centre clinics as per National AIDS Control Organization (NACO) guidelines. Thus pre-tested semi-structured questionnaire was used for data collection of both clinics. Tracking sheets are maintained at DIC clinics to track each FSW. Tracking sheet comprised information on socio-demographic profile (age, marital status, education, employment status, alcohol consumption), Regular Medical Check-ups (RMC) (quarter wise and year wise), STDs, syndrome wise STDs, Presumptive Treatment (PT), Rapid Plasma Reagin (RPR testing for syphilis and its positivity), Integrated Counselling and Testing (ICTC and its status) and attendance at counselling sessions (quarter wise and year wise) etc. Data collection for each variable was done for each year from 2009 onwards till 2014. Data entry from different records, data cleaning and merging different variables of both clinics was done with the help of excel software. Information was collected separately for both clinics and later compiled into a single sheet. Combined sheet was used for further analysis. Validation of data was done during field visits and at DIC clinics.

Causality assessment using time series data analysis- This study investigates the Long-run causality between attendance at Counselling sessions and Regular Medical Check-ups (RMCs), attendance at counselling sessions and RPR testing, attendance at counselling sessions and ICTC testing, STD positivity and RPR positivity, STD positivity and HIV positivity, RPR positivity and HIV positivity, ICTC testing and RPR testing, ICTC positivity and ICTC testing. It was done using time series analysis technique.

The following time series econometric techniques were applied, First, Augmented Dickey-Fuller (ADF) unit root test was done to check stationarity of data ie, whether data have equal mean and variance over a period of time, then Johansen co-integration technique was applied to check integration at same level of stationarity ie, whether variables move parallel or not[2-4].

First step : The unit-root test was applied to identify whether a variable is stationary or not. The test also helps in finding the order of integration (at level or at

first difference) at which the variables become stationary. These types of tests are necessary to avoid spurious correlation between variables. Testing for the presence of unit root in the variables is the primary task before attempting cointegration. The augmented Dickey-Fuller unit root has been applied to test stationarity of data both at levels and at their first difference in our study. Variables which were tested for stationarity were Regular Medical Check-ups (RMCs), attendance at Counselling sessions, Presumptive Treatment (PT), STD Positivity (STD +ve), RPR Testing for syphilis (RPR), RPR Positivity (RPR +ve), ICTC Testing for HIV and ICTC positivity for HIV. Variables which are not integrated at order one, I(1) were not considered for further analysis.

Second step : Johansen Test for co-integration between different variables (counselling and regular Medical check-ups, counselling and RPR testing for syphilis, counselling and ICTC testing for HIV, RPR testing for syphilis and ICTC testing for HIV, STD positivity and RPR positivity for syphilis, STD positivity and ICTC positivity, RPR positivity for syphilis and ICTC positivity for HIV were applied. At this step the pair of variables which showed the integrated relationship were identified and considered for next step of analysis.

Third step : The pairs of variables which showed the one Co-integrating relationship in second step of analysis were considered for final step of analysis ie, - Long run causality test based on Vector Error Correction Model (VECM). On the basis of this final step test uni-directional and bi-directional causality between pair of variables was established.

Statistical Analysis : Data entry and analysis was done using SPSS software version 22 and E Views software 7.0 version.

RESULTS

Results were obtained from analysis of 2193, Female Sex Workers obtaining services from the DIC and Municipal Corporation linked health centres. Mean age of FSWs was 32.48±4.67 years.

Correlation between counselling sessions and regular medical check-ups among FSWs each year from 2009 to 2014 was statistically significant with p value <0.05. Correlation between counselling sessions and RPR testing for syphilis among them each year from 2009 to 2014 was statistically significant with p value <0.05. Year wise correlation between counselling sessions and ICTC testing for HIV among them from 2009

to 2014 was also statistically significant with p value <0.05.

In Table 1, Augmented Dickey-Fuller unit root (ADF test) suggests that all series are integrated of order one, I(1) at their levels except for presumptive treatment (PT). It means all variables have equal mean and variance at the same level except presumptive treatment. For further analysis, series whose order of integration is the same are only retained for empirical analysis. Therefore, *Presumptive Treatment (PT) has not been considered for further analysis*.

Table 2 to Table 8 expresses the results of the co-integration test using "Johansen test for co-integration (Trace Test). Pair of variables which were tested forco-integration at this stage were counselling and regular Medical check-ups, counselling and RPR testing for syphilis, counselling and ICTC testing for HIV, RPR testing for syphilis and ICTC testing for HIV, STD positivity and RPR positivity for syphilis, STD positivity and ICTC positivity, RPR positivity for syphilis and ICTC positivity for HIV.

Null hypothesis - there is no co-integration/no co-integrated equation among the variables.

Alternate Hypothesis - there is co-integration among the variables.

If the value of The Trace-Statistic and maximum Eigen value test statistics comes out to be greater than the critical values 5% levels. We reject the null hypothesis of no co-integration among the variables.

Table 1 — *Augmented Dickey Fuller (ADF) unit root test for ordinal variables*					
Variables	At Level		At First Difference		Con-clusion
	ADF	Sign	ADF	Sign.	
Regular Medical Check-ups (RMCs)	-1.28	0.61	-1.96	0.04	I (1)
Counselling	-1.28	0.61	-1.96	0.04	I (1)
Presumptive Treatment (PT)	-19.82	0.00	-3.34	0.03	I (0)*
STD Positive (STD +ve)	-0.72	0.48	-2.25	0.02	I (1)
RPR Testing for syphilis (RPR)	-1.31	0.60	-13.66	0.00	I (1)
RPR Positive (RPR +ve)	-4.54	0.00	-6.79	0.00	I (1)*
ICTC Testing	-1.23	0.64	-13.92	0.00	I (1)
ICTC positive	-4.42	0.00	-9.07	0.00	I (1)*
*R square value is high for this model					

Table 2 — *Johansen Test for co-integration between counselling and Regular Medical Check-ups*				
Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	13.63	15.49	0.09	No Co integrating
At most 1 (r > 0)	0.18	3.84	0.67	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	13.45	14.26	0.06	No Co-integrating
At most 1 (r + 1)	0.18	3.84	0.67	Relationship
Source : Estimated by researcher				

We reject the null hypothesis of no co-integration only if both the trace-statistic and maximum Eigen values are greater than the critical values 5% levels and if both the trace-statistic/maximum Eigen values are lesser than the critical values 5% levels we accept the null hypothesis of no-difference.

From Tables 2-8 on the basis of trace-statistic values and maximum Eigen values test statistics results have been expressed.

There is no long run relationship between attendance for counselling sessions at DIC clinics and undergoing Regular Medical Check-ups (RMCs)(Table 2).

There is long run relationship between attendance for counselling sessions at DIC clinics and undergoing RPR testing for Syphilis (Table 3).

There is long run relationship between attendance for counselling sessions at DIC clinics and undergoing ICTC testing for HIV (Table 4).

There is long run relationship between RPR testing for Syphilis among FSWs and their ICTC testing for HIV (Table 5).

There is long run relationship between STD positivity observed among FSWs and their RPR positive status for Syphilis (Table 6).

There is long run relationship between STD positivity observed among FSWs and their ICTC positivity for HIV (Table 7).

There is long run relationship between RPR positivity for Syphilis among FSWs and their ICTC positivity for HIV (Table 8).

The results of the final step in establishing cause and effect relationship between tested variables (Table 9). If the error correction term for co-integrating equation between tested variables is negative and significant we can say there is unidirectional/bi-directional causal relationship between two variables. On the basis of this final step of testing unidirectional/bi-directional causal relationship is established between following variables and results are shown in Table 9.

The result showed that the error correction term for co-integrating equation with RPR testing as the dependent variable is negative and significant and error correction term for co-integrating equation with counselling as the dependent variable is non-negative and significant. It means that there is long run unidirectional causal relationship running from counselling to RPR testing.

Similarly, there is long run unidirectional causal relationship running from counselling to ICTC

Table 3 — *Johansen Test for co-integration between counselling and RPR testing for syphilis*

Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	46.14	15.49	0.00	One Co integrating
At most 1 (r > 0)	4.28	3.84	0.03	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	41.85	14.26	0.00	One Co-integrating
At most 1 (r + 1)	4.28	3.84	0.03	Relationship
Source : Estimated by researcher				

Table 4 — *Johansen Test for co-integration between counselling and ICTC testing for HIV*

Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	46.60	15.49	0.00	One Co integrating
At most 1 (r > 0)	4.12	3.84	0.04	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	42.47	14.26	0.00	One Co-integrating
At most 1 (r + 1)	4.12	3.84	0.04	Relationship
Source : Estimated by researcher				

Table 5 — *Johansen Test for co-integration between RPR testing for syphilis and ICTC testing for HIV*

Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	33.07	15.49	0.00	One Co integrating
At most 1 (r > 0)	9.85	3.84	0.00	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	23.22	14.26	0.00	One Co-integrating
At most 1 (r + 1)	9.85	3.84	0.00	Relationship
Source : Estimated by researcher				

Table 6 — *Johansen Test for co-integration between STD positivity and RPR positivity for Syphilis*

Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	36.83	15.49	0.00	One Co integrating
At most 1 (r > 0)	13.07	3.84	0.03	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	23.75	14.26	0.00	One Co-integrating
At most 1 (r + 1)	13.07	3.84	0.00	Relationship
Source : Estimated by researcher				

Table 7 — *Johansen Test for co-integration between STD positivity and ICTC positivity*				
Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	29.37	15.49	0.00	One Co integrating
At most 1 (r > 0)	2.36	3.84	0.12	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	27.00	14.26	0.00	One Co-integrating
At most 1 (r + 1)	2.36	3.84	0.12	Relationship
Source : Estimated by researcher				

Table 8 — *Johansen Test for co-integration between RPR positivity for Syphilis and ICTC positivity for HIV*				
Johansen Test for Co-integration (Trace Test)				
Hypothesized No of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	22.88	15.49	0.00	One Co integrating
At most 1 (r > 0)	3.72	3.84	0.05	Relationship
Johansen Test for Co-integration (Maximum Eigen value Test)				
Hypothesized No of CE(s)	Max-Eigen Statistic	0.05 Critical Value	Prob.	Conclusion
None (r = 0)	19.15	14.26	0.00	One Co-integrating
At most 1 (r + 1)	3.73	3.84	0.05	Relationship
Source : Estimated by researcher				

testing, long run unidirectional causal relationship running from RPR testing to ICTC testing, long run bi-directional relationship running between STD positivity and RPR positivity, long run unidirectional causal relationship running from ICTC positivity to STD positivity (Table 9).

DISCUSSION

Importance of Regular Medical Check-ups, attendance at counselling sessions, RPR testing for syphilis and ICTC testing for HIV positivity is established in literature. Under targeted intervention guidelines high risk group population enrolled under this project have to undergo these tests as per guidelines. We want to improve their testing as much as possible. Usually targets are set to achieve maximum coverage of beneficiaries for undergoing these screening tests so that we can identify health problems at the early stage through screening tests and minimize its further transmission and ensure timely completion of treatment.

Wairiki WMV, *et al* in a systematic review (2012) reported several successful behavioural interventions including interventions to reduce HIV/STI incidence and prevalence, change behaviour, promote condom use, improve condom availability, and increase sexual health knowledge[5].

Meda N, *et al* in Senegal (1999) reported that regular screening of sex workers regardless of symptoms, regular screening and treatment with high quality diagnostics, where available, can be highly cost-effective, given sex worker's high rates of curable STIs. Clinical services for sex workers that include regular screening coupled with prevention messages have reported increase in condom use and reductions in STI and HIV prevalence. Regular screening and treatment services for sex workers in Senegal have been credited with contributing to low and stable HIV seroprevalence in Senegal (where sex work is legal)[6].

Services like regular medical check-ups, presumptive treatment, detection of STDs and its syndromic management were provided at DIC clinic while RPR testing and ICTC testing were done at Municipal Corporation linked Health Centres. Peer educators and outreach workers accompanied the sex workers for testing at health centres and reports were collected by outreach workers on given date. If confirmed positive, sex workers were given treatment

Table 9 — *Long run causality test based on VECM: Counselling and RPR testing counselling & ICTC testing, ICTC & RPR testing, STD positive & RPR positive, STD positive & ICTC positive.*					
Direction of Causality	Direction of Causality	ECM_{t-1}	T-Statistic	P-Value	Result
Causality between RPR testing and Counselling	Causality from Counselling to RPR testing	-2.48	-3.23	0.00	Uni directional
	Causality from RPR testing to Counselling	1.02	2.53	0.02	Causality
Causality between ICTC testing and counselling	Causality from counselling to ICTC testing	-2.60	-3.48	0.00	Uni directional
	Causality from ICTC testing to counselling	1.02	2.53	0.02	Causality
Causality between ICTC testing and RPR testing	Causality from RPR testing to ICTC testing	-20.76	-6.20	0.00	Uni directional
	Causality from ICTC testing to RPR testing	5.27	1.14	0.27	Causality
Causality between STD +ve and RPR +ve	Causality from STD +ve to RPR +ve	-0.06	-3.41	0.00	Bi- directional
	Causality from RPR +ve to STD +ve	-1.82	-5.45	0.00	Causality
Causality between ICTC +ve and STD +ve	Causality from STD +ve to ICTC +ve	0.72	3.05	0.00	Uni directional
	Causality from ICTC +ve to STD +ve	-3.06	-8.55	0.00	Causality
Source: Estimated by researcher					

for STDs, syphilis or HIV at DIC clinic or were accompanied for appropriate treatment at skin clinic or ART centre.

In a systematic review done by Richard Steen (2012), it was concluded that periodic presumptive treatment can reduce prevalence of gonorrhoea, chlamydia and ulcerative STIs among sex workers populations where prevalence is high. Sustained STI reductions can be achieved when periodic presumptive treatment is implemented together with peer interventions and condom promotion. Additional benefits may include impact on STI and HIV transmission at population level[7].

Presumptive treatment was given to Female Sex Workers who were newly enrolled with the TI project for getting services. FSWs who have not visited the DIC clinic within 6 months duration due to any reason were also provided with presumptive treatment. In a study done by Richard Steen (2003) Targeted presumptive periodic treatments attempt to bypass the need for treatment seeking, since STIs are frequently asymptomatic, with the aim to reduce incidence by reducing the pool of infected individuals in populations with high STI prevalence or incidence[7].

Assessment of rate of adherence to targeted screening program for prevention of STIs was done using parameters like —

(1) How many FSWs have received regular medical check-ups (RMCs)?

(2) Presumptive treatment given to how many sex workers?

(3) How many have completed course of syndromic management for STDs?

(4) How many underwent RPR testing for syphilis?

(5) How many underwent ICTC testing for HIV?

Looking to the importance of on-going TIs each and every component is very much essential for effective running of the TI project. As per TI guidelines, FSWs have to undergo regular medical check-up quarterly each year. In this study, quarter wise proportion of Regular Medical Check-up testing was calculated. What we have done in our study is, we have tried to identify the long term causality among different set of variables, and how different variables are associated with each other. Whether RMC can be helpful in improving attendance at counselling sessions or vice versa or both run parallel (bi-directional causality)? We have tried to answer these types of questions using time series data analysis as this project is following the FSWs since long time and record maintenance is also being done. Data was collected retrospectively from 2009 to 2012 while for 2013-2014 it was collected prospectively.

Data of variables like Regular Medical Check-ups,

presumptive treatment, RPR testing (for syphilis), ICTC testing (for HIV), attendance at counselling sessions, STDs (sexually transmitted diseases), RPR positivity for syphilis and ICTC positivity for HIV was collected quarter wise each year from 2009 onwards till 2014.

Upon analysis, it was found that there was a *long run unidirectional causal relationship* running from *attendance at counselling sessions to RPR testing*. It emphasizes that those who were going for attending counselling sessions were also undergoing RPR testing for syphilis. If we want to improve RPR testing, sex workers must be motivated for attending counselling sessions also. There was a long run unidirectional causal relationship running from attendance at counselling sessions to ICTC testing. Similarly if we want to improve ICTC testing for HIV, sex workers must be motivated for attending counselling sessions. If we want to improve the RPR testing for syphilis and ICTC testing for HIV attendance at counselling sessions is very much important (*Each FSW has to attend counselling sessions at the DIC Clinic. There is a separate post of counsellor at the clinic. They have to attend minimum four counselling sessions each year (quarterly)*). Our study is proving this relationship as one-to-one cause and effect relationship. There are very few studies in medical literature which can prove these associations between different set of variables on the basis of cause and effect relationship. Overs Cin WHO tool kit (2005) gives the importance of attendance at counselling sessions, Effective STD control in commercial sex is feasible and has been achieved in diverse settings. When STD interventions are implemented with the active involvement of sex workers themselves, chances for success are greater and additional benefits accrue— increased sexual health knowledge and skills acquired by sex workers lead to greater diffusion of prevention information through often hard-to-reach transmission networks. Rather than remaining passive recipients of services, sex workers can become "part of the solution"[8]. Causal relationship is also in agreement with correlation findings of our study results; correlation between attendance at counselling sessions and RPR testing for syphilis among FSWs was positive and statistically significant ($p<0.05$) each year from 2009-10 to 2013-14. Correlation between attendance at counselling sessions and ICTC testing for HIV among FSWs was also positive and statistically significant ($p<0.05$) each year from 2009-10 to 2013-14.

According to WHO, greater than or equal to 5% sex workers were infected with Syphilis in 18 of 31 countries in 2017[9]. As per policy of targeted intervention programme, each FSW has to undergo at least two

times RPR testing for syphilis each year. RPR testing is very much important for detection of active syphilis and its timely treatment.

Lucy M in a study in rural Uganda (2002) establishes that HIV transmission has been shown to be strongly associated with repeated Sexually Transmitted Infections (STIs) and sexual behaviour[10].

As per the NACO guidelines, all core HRGs should be tested for HIV once every six months. These include interventions to change behaviour, promote the use of condoms, improve condom availability, introduce voluntary HIV counselling and testing, educate about sexual health and the effective management of STDs[11].

There was a *long run unidirectional causal relationship* running from *RPR testing to ICTC testing*; Those who are going for RPR testing are also availing ICTC testing for HIV. In TI project, also as per guidelines, sex workers should undergo RPR testing and ICTC testing simultaneously twice a year. Somehow those who are undergoing ICTC testing each and every one is not availing RPR testing these reasons need to be explored, according to TI programme both should be done simultaneously.

There was strong *long run bi-directional relationship* running between *STD positivity and RPR positivity*; means STD positivity and RPR positivity are interrelated to each other as evident in literature also, those having STDs are at risk of getting syphilis and vice versa.

There was *long run unidirectional causal relationship* running from *HIV positivity to STD positivity*; those who were HIV positive were at risk of getting other STDs this is also in correspondence with available literature. In Mahapatra B, *et al* (2013), Karnataka study among FSWs, HIV prevalence was positively and significantly related to Syphilis prevalence. For example, 21% of clients with Syphilis were also HIV positive, compared to 5% of clients who were not infected with Syphilis (p<.0001)[12].

CONCLUSION

Importance of targeted interventions in any TI project cannot be ignored. Screening tests like Regular Medical Check-ups (RMCs), attendance at counselling sessions, RPR testing for syphilis, ICTC testing for HIV, positivity for sexually transmitted diseases (STDs), RPR positivity for syphilis and ICTC positivity for HIV are interrelated to each other.

Our study re-establishes the cause and effect relationship between regular medical check-ups and attendance at counselling sessions, RPR testing and ICTC testing, STD positivity, RPR positivity and HIV positivity using different steps of time series analysis. Unidirectional and bi-directional causal relationship

between pair of variables has been identified. Results of time series data analysis are also in match with positive correlation observed between regular medical check-ups and counselling sessions, RPR testing and counselling sessions and ICTC testing and counselling sessions.

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