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Index based mapping of high risk behaviours for HIV among female sex workers in India

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***Background & objectives*: Integrated Behavioral and Biological Assessment (IBBA) study is the first cross-sectional survey to study large number of covariates of HIV/STI (sexually transmitted infection) in India. Generally, districts are identified as of HIV high or low based on its prevalence. Instead, it would be optimal to label the districts based on several high-risk related covariates in the concurrent set up. The objectives of the present study were to obtain an index for each district, to discover 'natural' clusters and a map with Kriged estimates.**

***Methods*: The study population consisted of 10461 female sex workers (FSWs) from 29 sites spread over 24 districts from five HIV high prevalent States. Covariates based on demographic characteristics, sexual practices, knowledge of HIV/STI and biological variables were studied. The analyses were done on weighted estimates based on principal component analysis, cluster analysis and Kriging technique. Five factors were extracted and improved using varimax rotation and standardized factor scores obtained. Natural clusters in a multivariate setting were identified. Each district was expressed as geographic co-ordinates and using the standardized scores the Kriged estimates were obtained.**

***Results*: The proxy determinants were 'never used a condom', 'wanted to use a condom but did not use', 'experience of condom breakage' and 'current STI that needs a doctor'. Dimapur district stood first rank demanding the greatest attention. The cluster analysis branded Dimapur, Warangal, Prakasam, and Chittoor districts as a cluster, which required greatest attention and kriged estimates showed the high-risk concentrated regions as Andhra Pradesh, Maharashtra and northeast region.**

***Interpretation & conclusions*: The results of this study may help the programme officials and policy managers to concentrate on the key factors, and districts/regions, which need greater attention in the order of priority.**

Key words Factor analysis - female sex workers - HIV - Kriging technique - mapping

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Table I. Percentage distribution of respondents according to surveyed districts of India, 2005-2006 by 15 covariates

State & District	N	Biological variables (a)		Demographic variables (b)		Sexual debut (c)		Condom practices (d)			Sexual partners (e)			HIV/STI awareness (f)		*Current* STI (g)
		HIV	Any STI*	Cannot read & write	Current age ≤25 yr	Duration of sex work >5 yr	Age at started selling sex <22 yr	Never used a condom	Wanted to use but did not in past month	Experienced condom breakage last month	10 or more clients past week	Have an occasional client	Have regular clients	Never heard of any STI	Incorrect belief about AIDS transmission - (global indicator)#	Current STI symptom that requires a doctor
Andhra Pradesh																
Chittoor	401	8.0	14.4	60.0	20.1	33.0	38.4	1.9	64.6	45.7	45.1	98.8	99.5	4.3	81.6	43.2
East Godavari	422	26.3	18.9	62.3	27.7	48.1	47.7	0.4	17.1	24.4	44.6	93.2	89.2	3.4	89.8	21.9
Guntur	405	21.3	11.1	60.4	28.4	37.3	37.7	3.1	18.4	29.1	60.3	97.6	99.7	2.8	83.3	49.8
Hyderabad	399	14.3	24.1	85.7	28.3	29.6	32.6	3.3	39.7	16.4	11.6	93.1	81.3	12.4	81.7	51.5
Karimnagar	412	21.1	10.2	77.3	30.1	43.5	42.1	5.4	20.4	21.4	17.8	88.5	99.6	19.2	87.3	65.0
Prakasam	404	11.1	7.6	63.8	36.8	29.8	40.3	0.8	64.6	54.4	60.8	99.8	96.8	3.8	87.0	38.1
Visakhapatnam	411	14.2	11.2	54.1	32.2	45.2	38.9	0.5	26.1	0.0	52.6	99.0	96.9	1.1	73.6	22.3
Warangal	417	10.8	12.5	78.4	30.5	49.6	61.6	5.7	26.3	24.9	18.3	100.0	99.5	8.9	81.0	89.0
Karnataka																
Bangalore(BB)	334	9.7	16.4	45.5	28.1	20.0	23.9	0.8	33.5	28.7	42.7	96.6	89.1	17.4	48.3	39.0
Bangalore (SB)	335	13.9	20.6	48.8	27.8	22.0	24.3	0.6	30.8	23.3	46.5	98.5	87.2	12.2	51.3	40.0
Belgaum	380	34.2	12.3	82.2	27.2	58.0	60.6	0.0	16.0	10.7	60.5	99.4	97.0	11.4	78.4	27.7
Bellary	420	16.5	9.8	62.3	31.0	56.0	52.6	0.0	17.9	8.3	45.2	88.4	96.8	18.6	75.1	34.6
Shimoga	390	9.5	9.5	58.3	24.2	37.0	23.9	1.1	33.6	12.9	12.8	95.7	98.0	34.0	73.2	38.5
Maharashtra																
Kolhapur	115	33.0	30.4	70.0	34.0	32.0	43.0	1.0	6.0	11.0	41.0	95.0	77.0	49.0	91.0	39.0
Mumbai (ALL)-	403	13.6	9.0	73.0	46.0	17.0	34.0	12.0	26.0	11.0	6.0	67.0	83.0	58.0	72.0	15.0
Mumbai (BB)	407	28.1	25.3	83.6	34.0	53.9	53.8	0.6	20.0	20.8	53.0	91.1	76.5	33.0	82.7	16.0
Mumbai (SB)	394	19.2	26.6	72.0	30.1	49.6	43.4	0.3	14.1	15.9	30.9	90.7	67.8	59.2	92.5	11.9
Parbhani	367	16.1	13.2	86.0	35.0	12.0	35.0	7.0	10.0	10.0	44.0	93.0	70.0	17.0	63.0	16.0
Pune (BB)	404	38.7	40.2	76.6	38.7	51.3	56.9	0.1	3.7	13.5	60.8	99.2	76.3	30.2	40.0	8.8
Pune (NBB)	257	37.0	50.2	75.0	26.0	40.0	35.0	0.0	9.0	14.0	37.0	98.0	75.0	35.0	89.0	13.0
Thane (BB)	401	18.6	12.7	63.8	43.7	48.0	51.6	0.0	4.7	5.9	38.8	98.3	96.9	22.4	45.6	15.4
Thane (SB)	394	7.0	20.7	42.8	47.5	17.9	34.2	0.0	6.1	7.5	25.5	96.5	86.8	29.2	34.9	9.8
Yavatmal	153	37.3	57.5	78.0	50.0	23.0	44.0	1.0	7.0	28.0	71.0	99.0	65.0	57.0	90.0	18.0
Tamil Nadu																
Chennai	410	2.2	12.6	67.0	13.0	27.0	15.0	2.0	11.0	2.0	11.0	85.0	92.0	22.0	41.0	3.0
Coimbatore	410	6.3	14.5	33.5	28.6	26.6	17.0	1.3	25.4	11.0	18.1	80.0	98.5	89.7	28.1	17.3
Dharmapuri	408	12.4	14.0	63.5	17.3	37.3	24.2	1.3	14.4	14.1	45.6	95.8	99.8	9.6	32.5	41.1
Madurai	402	4.3	11.9	50.1	18.6	39.7	24.9	2.9	28.7	7.3	11.4	80.4	96.1	6.6	36.5	23.1
Salem	402	12.5	10.8	66.0	24.1	25.3	26.4	3.4	28.2	10.4	27.9	77.8	94.3	15.5	61.2	20.4
Nagaland																
Dimapur	426	11.6	39.1	36.0	64.0	30.0	71.0	22.0	55.0	17.0	16.0	99.5	99.0	27.0	85.0	67.0

*Positive for reactive syphilis serology, *N. gonorrhoea* or *C. trachomatis* (one or more)
BB, brothel based; SB, street based; NBB, non-brothel based; STI, sexually transmitted infection
#Global indicator - compris□

Table II. Principal component analysis - Varimax rotation factor matrix

Variable		Factor loadings					
		Factor I	Factor II	Factor III	Factor IV	Factor V	Communalities
(a)	HIV			0.649			0.882
	STI			0.672			0.755
(b)	CANNOTRW				0.877		0.83
	CUAGEL25				0.918		0.855
(c)	DURSEXM5					0.825	0.816
	AGSEXL22					0.613	0.923
(d)	NEVER_C	0.665					0.86
	WANT_CNO	0.873					0.823
	BREAK_C	0.769					0.856
(e)	TENMORE		0.880				0.817
	OCC_C		0.797				0.791
	REG_C		0.603				0.882
(f)	NEVERSTI						0.633
	GLOBALIN						0.807
(g)	CURRSTI	0.739					0.722
Eigen value		3.981	3.153	2.319	1.533	1.267	
variance (%)		26.541	21.021	15.457	10.219	8.445	
Total variance explained (%)			81.683				

CANNOTRW, cannot read & write; CUAGEL25, current age ≤ 25 yr; DURSEXM5, duration of sex work >5 yr; AGSEXL22, age at started selling sex <22 yr; NEVER_C, never used a condom; WANT_CNO, wanted to use but did not past month; BREAK_C, experienced condom breakage last month; TENMORE, 10 or more clients past week; OCC_C, have an occasional client; REG_C, have a regular clients; NEVERSTI, never heard of any STI; GLOBALIN, incorrect belief about AIDS transmission - (global indicator); CURRSTI, current STI symptom that requires a doctor

Worldwide, AIDS is an equal opportunity disease for women[1]. Women are generally more susceptible in contracting the HIV infection simply because of their receptive nature. According to WHO, in India there are a large number of impoverished and disabled women who are not economically sound and hence they are forced to find opportunities for their survival or betterment. Behavioural factors of such women getting indulged in unprotected sex (without the use of condoms) and with multiple sexual partners place them at the greatest risk of contracting HIV and other sexually transmitted infections (STIs). According to National AIDS Control Organization (NACO), there are 8.3 lakh female sex workers (FSWs) in India[2]. Initially NACO demarcated Indian States as high, medium and low prevalence States and later as Category A, B, C and D based on the HIV prevalence rate (based on antenatal care attendees) in the districts, for prioritization of programme implementation[3]. When several variables related to HIV/STI transmission are available, it would be ideal to identify the risk status of the States/districts by considering the multiple high risk related covariates. Hence an attempt was made to *(i)* find an index or a score for each district surveyed, based on multiple high-risk related covariates of HIV/STI concomitantly; *(ii)* get a map based on 'natural' clusters (districts) in a multivariate set up; and *(iii)* obtain a map overlay of India with kriged estimates.

Material & Methods

Study type: Integrated Behavioural and Biological Assessment (IBBA) study is the first cross-sectional survey to study both the behavioural and biological variables of HIV/STI in India. Numerous covariates of HIV/STI transmission for FSWs were studied.

Study population: Five highly endemic States for HIV/STI were identified namely Andhra Pradesh,

Table III. The standardized scores for the districts surveyed in India 2005-2006

No.	Districts	Initial score (INS)	Standardized score (STDS)	Rank
1	Dimapur	68.09	100.00	1
2	Warangal	50.77	88.23	2
3	Prakasam	49.53	87.38	3
4	Yavatmal	39.93	80.86	4
5	Belgaum	33.56	76.54	5
6	Chittoor	33.07	76.20	6
7	Guntur	27.00	72.08	7
8	Mumbai (BB)	25.71	71.20	8
9	East Godavari	21.19	68.13	9
10	Karimnagar	20.99	68.00	10
11	Pune (BB)	15.55	64.30	11
12	Kolhapur	13.93	63.19	12
13	Pune (NBB)	11.60	61.61	13
14	Hyderabad	10.88	61.12	14
15	Bellary	4.29	56.64	15
16	Mumbai (SB)	-0.47	53.41	16
17	Visakhapatnam	-2.72	51.88	17
18	Thane (BB)	-8.59	47.89	18
19	Bangalore (SB)	-10.27	46.75	19
20	Parbhani	-13.04	44.86	20
21	Bangalore(BB)	-15.27	43.35	21
22	Shimoga	-20.08	40.08	22
23	Dharmapuri	-27.68	34.92	23
24	Mumbai (ALL)	-36.39	28.99	24
25	Salem	-38.08	27.85	25
26	Thane (SB)	-43.07	24.46	26
27	Madurai	-55.46	16.04	27
28	Chennai	-75.91	2.14	28
29	Coimbatore	-79.06	0.00	29

Minimum initial score (MI_INS) = -79.06; Maximum initial score (MA_INS) = 68.09

$$STDS = \frac{(MA\text{- INS of the DISTRICT} - MI\text{ - INS})}{(MA\_INS + MI\_INS)} * 100$$

Karnataka, Maharashtra, Tamil Nadu and Nagaland. The study population consisted of 10,461 respondents from 29 high risk groups from different sites (hereafter referred to as sites) spread over 24 districts surveyed among the above five States. Forty-four covariates of HIV/STI transmission for FSW based on demographic characteristics, sexual history, condom practices, knowledge and awareness of HIV/STI and biological variables were examined. The study period varied for each site from August 2005 to September 2006. Female sex workers were defined as any female 18 yr or older, who sold sex for money at least once in the preceding one month of the survey.

Sampling strategy: A probability sampling method was used in all sites. A conventional cluster sampling was used when numbers and persons do not change like brothels; a time-location cluster (TLC) sampling was used for street-based FSWs and respondent-driven sampling (RDS) was used for populations in which FSWs did not congregate in identifiable locations and the population is hidden like bar girls.

The target sample size for FSWs was 400 per group, per district. There were fewer than 400 members in case of less population in the district or when the refusal rate was high.

The methodology, data collection, ethical consent, weighting procedure, laboratory methods, *etc*. are discussed elsewhere[4,5].

Statistical analysis: Principal component analysis (PCA) was used to find optimal ways of combining variables into a small number of subsets and factor analysis was used to identify the structure underlying such variables and to estimate scores. Our attempt was to make the original data set into relatively a smaller number of independent factors and to find the estimates of factor scores, which is a linear combination of standardized indicators[6-8].

All the estimates used in the analysis were weighted based on the inverse probability of selection. The original data set contained 44 high-risk related covariates. These covariates were examined using the correlation matrix. Fifteen highly correlated covariates were identified and used for further analysis. Majority of the FSW populations were highly concentrated in the five selected States. The final data set used in the analysis was of size 29 (sites) x15 (covariates) (Table I).

Using the method of principal components a smaller subset of five factors extracted (Eigen value greater than one). These factors were improved using varimax rotation and factor scores obtained. Then the initial score for each site was obtained using per cent variation as weights on factor scores. The initial scores were standardized for comparative purposes. The above analysis was done using the SPSS software[9].

Table IV. Clusters obtained using square of the Euclidean distance and various agglomerative methods using covariates of HIV for Indian States

Methods	Cluster I	Cluster II	Cluster III	Cluster IV
	Dimapur	Kolhapur	Belgaum	Bangalore (SB)
Complete linkage method	Hyderabad	Mumbai (BB)	Bellary	Bangalore (BB)
	Karim Nagar	Mumbai (SB)	Chitoor	Chennai
	Warangal	Pune (BB)	East Godavari	Coimbatore
		Pune (NBB)	Guntur	Dharmapuri
		Yavatmal	Parbhani	Madurai
			Prakasam	Mumbai (ALL)
			Thane (BB)	Salem
			Visakhapatnam	Shimoga
				Thane (SB)
Average linkage method	Chitoor	Kolhapur	Belgaum	Bangalore (SB)
	Dimapur	Pune (BB)	Bellary	Bangalore (BB)
	Prakasam	Pune (NBB)	East Godavari	Chennai
	Warangal	Yavatmal	Guntur	Coimbatore
			Hyderabad	Dharmapuri
			Karim Nagar	Madurai
			Visakhapatnam	Mumbai (ALL)
				Mumbai (BB)
				Mumbai (SB)
				Parbhani
				Salem
				Shimoga
				Thane (BB)
				Thane (SB)
Wards minimum variance	Chitoor	Kolhapur	Belgaum	Bangalore (SB)
Method	Dimapur	Pune (BB)	Bellary	Bangalore (BB)
	Prakasam	Pune (NBB)	East Godavari	Chennai
	Warangal	Yavatmal	Guntur	Coimbatore
			Hyderabad	Dharmapuri
			Karim Nagar	Madurai
			Visakhapatnam	Mumbai (ALL)
				Mumbai (BB)
				Mumbai (SB)
				Parbhani
				Salem
				Shimoga
				Thane (BB)
				Thane (SB)