

## Degree and correlates of sexual mixing in female sex workers in Karnataka, India

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**Abstract.** *Background:* The degree of sexual mixing plays an important role in understanding disparities in sexually transmissible infections and HIV across social groups. This study examines the degree of sexual age mixing, and explores its individual and partnership level correlates among female sex workers (FSWs) in Karnataka, India. *Methods:* Data were drawn from special behavioural surveys conducted in 2006–07 among 577 FSWs in two districts of Karnataka: Belgaum and Bangalore. Sexual mixing in age was assessed as the difference in age between FSWs and their sexual partners, and the degree of assortativeness in sexual mixing was assessed using Newman's assortativity coefficient. *Results:* A total of 577 FSWs were interviewed; 418 of whom reported two or more partnerships, resulting in 942 partnerships. In about half (52%) of these partnerships, the age difference between the FSW and her sexual partner was 5 years or more. The degree of assortativity in age mixing was 0.098, indicating minimally assortative mixing. The disassortativeness in age mixing was positively associated with young age and no formal education, and negatively with duration in sex work. Partnerships which were of a commercial nature were more likely to be disassortative than noncommercial partnerships. *Conclusion:* The minimally assortative age mixing indicates sexually transmissible infections can transfer from members of one age group to another. Efforts are required to limit the transmission of infection from one group to other by promoting safer sexual behaviour.

**Additional keywords:** age mixing, commercial sex work, Newman's assortativity coefficient.

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### Introduction

Sexual network dynamics that include sexual mixing and concurrency play important roles in understanding disparities in sexually transmissible infections (STIs) and HIV across social groups.<sup>1,2</sup> Concurrent partnerships and high levels of sexual mixing between high-risk and low-risk groups can facilitate the rapid spread of STIs and HIV in a population.<sup>3</sup> The extent of sexual mixing between population subgroups determines the degree to which susceptible individuals are exposed to partners at risk, and the rate of disease transmission in the population.<sup>4–6</sup> Empirical research has highlighted that age mixing (age differences between partners) in sexual relationships can be

an important factor in explaining the spread of STIs and HIV in a population.<sup>7–11</sup> Furthermore, evidence suggests that large age-gaps between sexual partners are important drivers of the HIV epidemic in some communities.<sup>10,12,13</sup> Sexual relationships between older men and younger women increase the risk of acquiring infection among females.<sup>13–15</sup> When a young woman enters into a sexual relationship with a man older than her, she is at a higher risk of contracting HIV than if she entered a relationship with a man of her own age.<sup>12</sup>

In-depth understanding of the nature and degree of age mixing in sexual relationships is important to understand HIV transmission dynamics.<sup>4,16</sup> Though several studies in this

context have been undertaken in developed and Sub-Saharan countries, research examining the factors that regulate the formation of sexual mixing is scarce in India. In Indian societies, male dominance is prevalent in sexual relationships and plays a pivotal role in shaping these relationships.<sup>17</sup> The age difference between a female and her sexual partner can affect her power, status and autonomy.<sup>18</sup> Moreover, the higher the age difference, the greater the likelihood of male dominance. For female sex workers (FSWs), who are vulnerable in more than one way,<sup>19</sup> a relationship with a partner much older than them can put them at increased risk for STIs and HIV.<sup>20</sup> Therefore, one needs to understand the patterns of age mixing in FSWs, which may help in understanding the HIV transmission dynamics in India. Hence, this study examines the degree of sexual age mixing in FSWs, and explores its individual and partnership level correlates in Karnataka, India.

## Methods

### Data

Data were drawn from the special behavioural surveys conducted in 2007 among 577 FSWs in two districts: Belgaum and Bangalore. FSWs who were 18 years or older and had sex in exchange for cash or kind in the month before the survey were eligible to participate in the survey. The survey was implemented by the Centre Hospitalier Affilié Universitaire de Quebec Research Monitoring and Evaluation in India in collaboration with the Institute of Population Health and Clinical Research, St John's Medical College, the Karnataka Health Promotion Trust, Bangalore, India; and the University of Manitoba, Winnipeg, Canada.

A probability sampling method was employed and samples were drawn using a two-stage sampling design. In the first stage, hotspots where FSWs congregate to solicit clients such as brothels, streets, parks, cinema halls and homes were selected. In the second stage, respondents were selected from the selected hotspots. The sampling frame for this survey was developed by the survey research team with the help of local nongovernmental organisations who were implementing an HIV prevention program among FSWs in the study districts. For each hotspot, data were gathered on the number of FSWs present, segregated by the time slot when sex work was undertaken (e.g. 0900–1500 hours, 1500–1900 hours, etc.) and by typology of sex work (home-based, brothel-based and street-based).

The typology of the hotspot was considered as a stratification variable. The number of interviews to be conducted in each hotspot type was allocated proportionately according to its size. A fixed number of hotspots from each type were selected. Different sampling approaches were used to select hotspots in nonstreet (home and brothel) and street-based settings due to the differences existing in the nature of sex work in these settings.<sup>21</sup> Home- and brothel-based hotspots were selected using the conventional cluster sampling approach, where the first hotspot was selected using a random number and subsequent hotspots were selected using a sampling interval (total number of clusters divided by the number of clusters to be selected). For selection of street-based hotspots, a time–location cluster sampling approach was used, where a hotspot was replicated multiple times to form a cluster for each time slot when FSWs

congregated at the hotspot. In the second stage, FSWs were selected randomly from the selected hotspots.

A target sample size of 200 FSWs in Belgaum and 400 in Bangalore was determined. At the end of the survey, samples of 208 FSWs in Belgaum and 369 in Bangalore were achieved. Sample weights were calculated to account for the unequal selection probability of respondents and nonresponse rates within each hotspot. The survey instrument was developed in English and translated into Kannada, the local language of Karnataka. The translated forms were reviewed by study investigators fluent in both English and Kannada. The questions asked in the survey instrument were taken from the previous research studies conducted in India among sex workers.<sup>22–24</sup> Trained investigators with verbal and written skills in Kannada conducted face-to-face interviews.

### Measures

#### *Sexual mixing in age*

Sexual mixing in age was assessed as the difference in age between FSWs and their sexual partners; a sexual partnership was considered disassortative age mixing (coded as 1) if the age difference between FSW and her sexual partner was more than 5 years; otherwise, the partnership was considered assortative sexual mixing (coded as 0).

#### *Sociodemographic covariates*

Information on the sociodemographic and sex work-related characteristics like age (categorised into three categories: <25 years old, 25–34 years old and 35+ years), educational status (no formal education *v.* some formal education), marital status (currently married, formerly married, never married or *devadasi*, a traditional form of sex work prevailing in northern Karnataka<sup>25</sup>), income beside sex work (no *v.* yes), residential status (local *v.* nonlocal), duration of sex work (categorised into three categories: <5 years, 5–9 years and 10+ years), number of clients per day (grouped into two categories: <3 *v.* 3+), place of solicitation (home-based, brothel-based or street-based) and nature of solicitation (independently *v.* with the help of brokers or pimps) were collected using single-item questions. These variables were used as covariates in the multiple logistic regression analysis when predicting disassortative sexual mixing in FSWs.

#### *Statistical analysis*

Univariate, bivariate and multivariate analyses were conducted. Univariate analysis was conducted to present the profile of the respondents. Further, to examine sexual mixing patterns, a partnership level database was created, where each observation included information on the characteristics related to a specific sexual relationship. In the survey, each FSW was asked to furnish different information on her six most recent sexual partners (three commercial and three noncommercial), including the start and end date of relationship, the nature of the relationship and the partner's age. In this type of data structure, observations within one respondent are highly correlated and hence, to account for this, the generalised estimating equations method was used.<sup>20,26</sup> The generalised estimating equations model provides more efficient estimators

of regression parameters, and also provides reasonably accurate standard errors and hence confidence intervals (CIs) with correct coverage rates. Results from multivariate analysis were presented in the form of odds ratios and their corresponding 95% CIs.

Further, the degree of sexual mixing was assessed using the assortativity coefficient ( $r$ ) suggested by Newman,<sup>27</sup> which is calculated using a mixing matrix. A mixing matrix is the proportional cross-tabulation of partnerships between people who do and do not have the attributes of interest. The degree of assortative mixing can be derived from Eqn 1:

$$r = \frac{\sum_i e_{ii} - \sum_i a_i b_i}{1 - \sum_i a_i b_i} = \frac{Tre - \|e^2\|}{1 - \|e^2\|}, \quad (1)$$

where  $e$  is the matrix whose elements are the cell values ( $e_{ij}$ ) of the mixing matrix;  $Tre$  is the trace of the matrix (i.e. the sum of the diagonal elements of the matrix);  $\|e^2\|$  is the sum of the squared values of the elements in the matrix, and  $\sum_{ij} e_{ij} = 1$ ,  $\sum_j e_{ij} = a_i$  and  $\sum_i e_{ij} = b_j$ , where  $a_i$  and  $b_j$  are the proportion of each type of edge end that is attached to vertices of type  $i$ .

The coefficient value lies between  $-1$  and  $+1$ . The formula above gives the value  $0$  if there is no assortative mixing. A coefficient above  $0$  represents assortative mixing,  $1$  indicates that all partnerships are concordant for the characteristic and a value of  $-1$  indicates completely disassortative mixing, where no-one in the population is partnered with someone who shares the same characteristic. An assortativity coefficient of  $0$  indicates that the characteristic has no influence on partnering (random mixing). Disassortative mixing produces coefficients between  $-1$  and  $0$ . Coefficient values close to  $0$  can be interpreted as disassortative mixing because random mixing will most often result in pairs that differ with respect to the characteristic. All the analyses were performed using STATA ver. 11.1 (StataCorp, College Station, TX, USA).

## Results

Survey respondents were, on an average, 31 years old (s.d.: 7 years) and had been practising sex work for 6 years (s.d.: 5.9 years) (Table 1). More than two-thirds had no formal education (71%), obtained income only from sex work (70%), were not natives of the study district (70%), and about one-quarter (26%) were currently married. Public places were the primary place of solicitation for the majority of respondents; ~62% FSWs were street-based, compared with only 17% and 21% in home and brothel settings respectively.

Table 2 suggests that sexual mixing in age was minimally assortative among FSWs: the degree of assortativeness as measured by Newman's assortativity coefficient was 0.098 (Belgaum, 0.093; Bangalore, 0.098). The assortativeness in age mixing increases with the increasing duration of sex work. For example, for FSWs who had been in sex work for less than 5 years, the assortativity coefficient was 0.025; for those who had been in sex work for 10+ years, the coefficient value was 0.197. The degree of assortativeness in age mixing was higher among FSWs who had three or more clients in a typical day compared with those who had less than three clients in a day. Relationships with sexual partners that were shorter

**Table 1. Sociodemographic and sex work related characteristics of female sex workers, Karnataka, India, 2006–07**

Background characteristics	% or mean (s.d.)	N
Age (in years)		
<25	20.5	120
25–34	40.4	250
35+	39.1	207
Mean (s.d.)	30.8 (7.0)	
Educational status		
No formal education	71.2	389
Formal education	28.8	188
Marital status		
Currently married	25.9	173
Formerly married	56.0	290
Never married or <i>devadasi</i>	18.2	114
Income beside sex work		
No	69.9	380
Yes	30.1	197
Residential status		
Local	32.2	217
Nonlocal	67.8	359
Duration in sex work (in years)		
<5	46.3	288
5–9	27.3	156
10+	26.4	133
Mean (s.d.)	6.4 (5.9)	
Number of clients per day		
<3	55.3	333
3+	44.7	244
Place of solicitation		
Home	16.8	152
Brothel	21.3	146
Street	61.9	279
Nature of solicitation		
Independently	72.9	385
Brokers or pimps	27.1	190
Total	100.0	577

than 2 years' duration were more assortative in nature than those relationships that were of longer duration.

Of the 577 FSWs interviewed, only 418 FSWs reported two or more partnerships, resulting into 942 partnerships. In about half (52%) of these partnerships, the age difference between the FSW and her sexual partner was 5 years or more (Table 3). The chance of disassortativeness in age mixing was more likely to occur among FSWs who were less than 25 years old compared with those aged 35 years or older (57% v. 42%, adjusted odds ratio(AOR): 1.8, 95% CI: 1.1–2.9), in those with no formal education compared to those with some level of education (55% v. 46%, AOR: 1.6, 95% CI: 1.1–2.4) and those practising sex work for less than 5 years compared with those who had been in sex work for 10 years or more (58% v. 42%, AOR: 2.0, 95% CI: 1.3–3.1). Partnerships which were of a commercial nature were more likely to be disassortative in nature than noncommercial partnerships (54% v. 46%, AOR: 1.6, 95% CI: 1.1–2.1).

**Table 2.** Newman's assortativity coefficient (*r*) measuring the degree of age mixing calculated from a mixing matrix of six age groups (<25 years, 25–29 years, 30–34 years, 35–39 years, 40–44 years and 45+ years) by selected characteristics of female sex workers in Karnataka, India, 2006–07

	<i>r</i>
Duration in sex work	
<5 years	0.025
5–9 years	0.053
10+ years	0.197
Number of clients per day	
<3	0.065
3+	0.125
Place of solicitation	
Home	0.084
Brothel	0.070
Street	0.103
Nature of solicitation	
Independently	0.097
Pimps or brokers	0.094
Duration of relationship	
≤1 year	0.117
2–4 years	0.052
5+ years	0.084
District	
Belgaum	0.093
Bangalore	0.098
Total	0.098

## Discussion

This study examined the pattern and degree of sexual age mixing among FSWs with their sexual partners in the state of Karnataka, India. In about half of the sexual relationship between FSWs and their sexual partners, the age difference was 5 years or more. The degree of assortativeness measured using Newman's assortativity coefficient indicated the existence of minimally assortative age mixing in the sexual partnerships of FSWs, which is similar to the findings observed in other studies conducted in other settings.<sup>9,28</sup> Moreover, sex workers in Belgaum had more disassortativeness in age mixing compared with those in Bangalore. This could be one of the reasons that could explain the higher STI and HIV prevalence in Belgaum district compared to in Bangalore. The minimal assortativeness in age mixing suggests that STIs can transfer from members of one age group to another. Moreover, a relationship with a man older than the FSW can result in imbalanced power dynamics favouring the man. Such power structure, coupled with the prevailing gender dynamics, can influence the negotiation skill of sex workers and hence hamper the use of condoms in sexual acts.<sup>15,17,29</sup>

The study findings suggest that younger FSWs (<25 years) and those who are new to sex work (in sex work for <5 years) were more likely to have disassortative age mixing. The fact that men are interested in having sex with a younger woman may be one of the reasons that younger FSWs were having clients older than them. Higher disassortativeness among young

**Table 3.** Unadjusted percent and adjusted odds ratios (AOR) predicting disassortative age mixing among female sex workers with sociodemographic and behavioural characteristics as predictor variables, Karnataka, India, 2006–07

*n* = 942 most recent heterosexual partnerships. Logistic regression models were adjusted for all other covariates in the model. CI, confidence interval

Background characteristics	Number of partnerships	% of disassortative partnership	AOR (95% CI)
Age (in years)			
<25	208	57.1	1.8 (1.1–2.9)
25–34	391	59.2	1.8 (1.2–2.5)
35+	343	42.1	Referent
Educational status			
No formal education	603	54.5	1.6 (1.1–2.4)
Formal education	339	45.7	Referent
Marital status			
Currently married	270	49	Referent
Formerly married	465	53.7	1.1 (0.8–1.7)
Never married or <i>devadasi</i>	207	50.6	0.9 (0.5–1.5)
Duration in sex work (in years)			
<5	457	58.2	2.0 (1.3–3.1)
5–9	246	51.2	1.5 (1.0–2.3)
10+	239	42.4	Referent
Income beside sex work			
No	626	52.1	Referent
Yes	316	51.7	1.1 (0.8–1.6)
Residential status			
Local	370	55.3	Referent
Nonlocal	570	50.7	0.7 (0.5–1.1)
Place of solicitation			
Home	276	53.3	Referent
Brothel	210	48	0.7 (0.4–1.2)
Street	456	52.8	1.1 (0.7–1.7)
Alcohol consumption			
No	370	55.3	Referent
Yes	570	50.7	1.3 (0.9–1.7)
Type of relationship			
Nonpaying	236	46.1	Referent
Paying	706	53.7	1.6 (1.1–2.1)
District			
Belgaum	343	53.4	1.5 (1.0–2.3)
Bangalore	599	51.3	Referent
Total	942	52.0	

FSWs could also be partly a function of the age distribution of their clientele. Their young age undermines their ability to resist the older men's advances and negotiate condom use.<sup>30,31</sup> In addition, the lack of an enabling environment and poor negotiation skills among these sex workers could make them more vulnerable to HIV risk when having sex with a client older than them.<sup>31</sup> Past research in India that suggests FSWs who are relatively new to work are more likely to experience sexual coercion by their clients,<sup>32,33</sup> which could also be due to the age difference between the FSW and the client.

Biobehavioural research in India reports that HIV prevalence is substantially higher among younger sex workers than in older



ones.<sup>23</sup> This can be partly due to the high degree of disassortativeness in sexual age mixing in younger FSWs, as previous research indicates that sexual relationships between older men and younger women increase the risk of acquiring infection among women.<sup>13–15</sup> For younger FSWs, the likelihood of being infected with HIV by a sexual partner of the same age would be lower than the risk from an older sexual partner. Further, research from rural Zimbabwe suggests that young women can only acquire HIV infection from previously infected partners and this is most likely to happen if they form partnerships with older partners.<sup>34</sup> This is due to the fact younger males will have lesser exposure time to be infected with HIV than an older male and the likelihood of being infected with HIV increases with age.<sup>35,36</sup> This study did not collect information about the HIV status of FSWs and their sexual partners; however, future research should collect these data to understand these dynamics better.

The findings also indicated that commercial relationships were more disassortative in nature as compared with noncommercial relationships, which could be due to the very nature of the profession these females are in. In commercial relationships, FSWs do not have the choice of selecting a partner using certain criteria; rather, the amount of money paid plays a vital role in decision making and also in negotiating for safer sex. Empirical research has shown that on most occasions, FSWs tend to agree to sex, as well as to varieties of sexual acts such as anal sex and oral sex, if clients pay them more money.<sup>37</sup> However, FSWs' noncommercial relationships may be of a romantic nature and hence they may have a chance to choose sexual partners. Nevertheless, in both types of relationships, assortativeness is very low. Moreover, in commercial relationships, FSWs may be in a better position to use condoms in sex acts than they are in noncommercial relationship, which could be due to the degree of intimacy in these relationships. HIV prevention programs can develop structural interventions where noncommercial partners can be involved and information related to safer sex can be provided to them.

The findings of this study should be interpreted in the light of the following study limitations. Information on partnerships was collected using the partner calendar method where FSWs were asked to provide information on the characteristics of their partners. Though this method provides rich information about partners, there may be some extent of recall bias or error when providing information about partner, especially if the relationship was of very short duration. *Post hoc* analysis suggests that, on average, partnerships continued for 2 years, which is sufficient time to understand someone's demographic profile. Moreover, a similar approach has been used in other studies and it has been demonstrated that this method of data collection can provide reliable information about sexual partners.<sup>11,38</sup> The findings may also be biased to a certain extent by to social desirability bias due to self-reports of sensitive information. To reduce social desirability, precautions were taken at the time of the survey by interviewing respondents in private locations and ensuring the confidentiality of the interviews. Though this study examined sexual mixing in age, there are several other factors that are important to HIV transmission dynamics,

and these should be examined. For example, sexual mixing in place of residence or marital status should be investigated, as these two groups can spread infection from one geographical area to another and, more importantly, to females in the general population.

In summary, this study provides important insights into the degree of sexual age mixing between FSWs and their sexual partners. The study documented that more than half of the relationships among FSWs in Karnataka were disassortative in nature. These findings have important policy implications. FSWs should be provided with information related to the HIV risk associated with an age difference between the FSW and the sexual partner. Such information is more important for young and new sex workers. Effective counselling services can be provided to young and new sex workers to address their vulnerability issues. Brothel owners can also be educated regarding the age difference-related HIV risk. Moreover, HIV prevention programs should work to improve the negotiation skills of FSWs. Interventions can be planned, where the nonpaying regular partners of FSWs can be counselled about the HIV risk associated with condom nonuse. The minimally assortative age mixing indicates that cross-generational sex is prevalent among FSWs in India, and STIs and HIV can spread from one generation to another if proper preventive measures are not taken. Moreover, age mixing and other sexual network dynamics should be considered by program planners when drafting strategies for HIV prevention programs.

## Conflicts of interest

None declared.

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