

# The Bali STD/AIDS Study

## Evaluation of an Intervention for Sex Workers

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**Background:** Prostitution has been an important factor in the spread of HIV infection in Asia. Interventions need to be developed to reduce the risk of transmission of sexually transmitted infections in this area.

**Goals:** To educate female sex workers about sexually transmitted infections and assess the impact of the educational intervention.

**Study Design:** Brothel areas in Denpasar, Bali, Indonesia, were divided into areas of high and low program (interventional) effort. The intervention included educational sessions for sex workers, treatment of sex workers for sexually transmitted disease (STD), condom distribution, and printed information for clients of the sex workers. A high-effort area was one in which a more intensive educational intervention occurred. A clinic was available for STD treatment in both areas. Behavioral surveys and STD testing were used to evaluate the programs. Six hundred female sex workers participated in behavioral surveys and STD examinations every 6 months for four rounds of data collection. Each round, about half of the women were new to the study. A total of 1586 women participated in at least one evaluation round. Changes were evaluated in AIDS knowledge, STD knowledge, and condom use, as well as in the prevalence of *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, syphilis, and *Trichomonas vaginalis*. Testing for HIV was conducted anonymously.

**Results:** Improvements were noted in the knowledge of sex workers about AIDS and STDs and in the reduction of some bacterial STDs. Women who remained in the study area for more than one round had increased knowledge of HIV infection/STDs and condom use and had reduced levels of syphilis, gonorrhea, and trichomonas infection ( $P < 0.01$ ). The additional education received by women in the high-effort program area was associated with a reduction in the prevalence of syphilis. Prevalence of HIV remained low throughout the study. The high level of turnover of female sex workers contributed to the maintenance of significant levels of STDs in this population.

**Conclusions:** Developers of HIV/STD prevention programs for sex workers need to consider the mobility of the sex worker

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population. Interventions combining behavioral and medical approaches can contribute to prevention of these diseases.

COMMERCIAL SEX HAS BEEN an important factor in the spread of HIV/AIDS in Asia. A number of programs have been developed to reduce the level of infection among sex workers and clients, including peer education, group education, counseling, condom distribution, and treatment of sexually transmitted diseases (STDs).<sup>1-7</sup> This article describes and evaluates an intervention program for female sex workers in Bali, Indonesia. The intervention protocol combined behavioral and medical approaches to HIV/STD prevention.

The HIV epidemic has been developing slowly in Indonesia. Although the number of reported cases understates the extent of the epidemic, as of September 2000, 1448 cases of HIV infection and AIDS had been reported. Most cases were reported to be transmitted by heterosexual contact (913 cases), followed in frequency by intravenous drug use (150) and homosexual contact (123).<sup>8</sup>

The intervention was developed on the basis of findings of behavioral research<sup>9</sup> and an earlier interventional study<sup>7</sup> in this area. The behavioral study, conducted from 1990 to 1994, included several groups of female and male commercial sex workers and their clients. With use of qualitative and quantitative survey techniques, the study showed that knowledge of AIDS and STD transmission and prevention was low among commercial sex workers and clients. In 1992 to 1993, women working in the low-price brothels reported condom use with only 19% of clients in the week before the interview.

Following the behavioral study, a short-term behavioral intervention was conducted in the low-price brothel areas in 1994.<sup>7</sup> Interventional activities included an education program for commercial sex workers, pimp training, condom

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sales and distribution, and printed information for clients. Baseline and evaluation surveys were conducted at the beginning and end of the 6-month period. AIDS knowledge, STD knowledge, and condom use increased significantly over the 6-month period. Condom use with clients more than doubled over the 6-month period in the intervention area (from 23% at baseline to 68% 6 months later).

The objective of the current project was to extend the earlier research to develop a more long-term approach toward HIV prevention in these areas that combined elements of the earlier behavioral study with STD treatment. The interventional components described above were effective in educating women about AIDS and STDs and in increasing reported condom use. In this study, two alternative interventional programs, one with a more intensive education program than the other, were tested. Since infection with other STDs may increase the probability of HIV infection,<sup>10</sup> women in the program were also tested and treated for STDs every 6 months, and a drop-in clinic was available in or near the brothel complexes. Measurements of STD infection were also incorporated to verify changes in condom use and their impact on STD transmission.

### Methods

#### *Context*

The current intervention was conducted in low-price brothel complexes surrounding Denpasar, Bali, Indonesia. The project was developed in seven large brothel complexes. These seven complexes include all of the low-price brothels in the study area. The clients are mainly Indonesian men. The women receive an average payment of about \$3.00 (US\$) from each client and serve three or four clients per day. The brothel complexes are organized into a number of smaller units, or "clusters," that consist of a small area of land with a structure consisting of several rooms. An area in each cluster is usually also set aside to sell cold drinks and light refreshments. Each one of these clusters is owned by a pimp, is supervised by the pimp or an assistant, and may include 4 to 12 women.

#### *Description of the Intervention*

The concepts for program design and hypothesis-testing in the current study were drawn from two dominant models used in HIV infection prevention. The educational sessions for the sex workers were based on these two models. The Health Belief Model posits a role for beliefs about the consequences of one's actions and assumes that the behavior arises after a rational computation of a set of information. According to this model, health behavior decisions are made through a computational analysis of susceptibility to a disease, disease severity, and relative costs and benefits of health-threat-reducing activities.<sup>11</sup> Application of the Health

Belief Model in our previous Indonesian work has demonstrated the importance of the model's components, health beliefs, and susceptibility to HIV infection/STD to condom use among female sex workers.<sup>7,8</sup>

A second model was drawn from social cognitive theory. This model, proposed by Bandura,<sup>12</sup> notes that translating health knowledge into self-protection from AIDS requires social and self-regulative skills and a sense of personal power to exercise control over sexual behavior. Perceived self-efficacy is concerned with an individual's belief in his or her ability to mobilize the motivation, cognitive resources, and courses of action needed to exercise control over life events. Behavioral research on Indonesian sex workers documented a strong relationship between self-efficacy and condom use.<sup>7,8</sup>

The intervention consisted of educational sessions for sex workers, printed information for clients, and condom distribution. The intervention areas were divided into areas of high and low program effort. The brothels were divided into these groups by assessment of the size of the brothel area and the client mix (e.g., hotel workers, sailors) in each area. Areas were divided to create a balance of these two factors in each area. In the high-effort areas, women received three educational sessions every 6 months. In the low-effort areas, the women received only one session every 6 months. The brothels were visited by field workers two or three times per week to ensure that supplies of condoms and printed information were adequate. The printed information, in the form of pamphlets and posters, was available to clients in all the brothel areas.

The educational sessions for women were designed to (1) increase AIDS/STD knowledge, (2) increase perceived susceptibility to these diseases, (3) improve skills related to condom use and partner negotiation, and (4) increase awareness of STD symptoms and the need for STD screening and treatment. A video was developed that included typical experiences of female sex workers, including negotiating about condom use with different types of clients, becoming infected with an STD, and visiting with children and other family members in Java. The first session dealt mainly with informational issues about AIDS, STDs, and the symptoms of illness. The later sessions extended the discussion of STDs, condom use, and negotiation about condom use.

Women in the complexes were tested and treated for STDs every 6 months. A drop-in center located near the complex was available for STD treatment during the study period. Women were encouraged to visit the clinic for treatment of genital symptoms.

The intervention was evaluated through a series of behavioral surveys of sex workers and clients and through STD testing of sex workers. The baseline survey was conducted in 1997 to 1998, and three additional surveys were conducted at 6-month intervals (Table 1). Face-to-face interviews were conducted with female sex workers' clients in

TABLE 1. Demographic Characteristics of Study Participants

Variable	Round 1 (Baseline)	Round 2	Round 3	Round 4
Mean age (y)	25.3	25.7	25.9	26.1
Mean education (y)	4.6	4.9	5.0	5.5
Married (%)	6.0	3.8	6.0	5.7
Never married (%)	12.8	11.8	11.9	15.4
Divorced/separated/widowed (%)	81.2	84.4	82.1	78.9
Clients per day, mean	2.9	3.6	3.6	3.8
New enrollees each round	100%	63%	48%	46%
Price for sex (Indonesian rupiah)	11,019.	13,053.	15,346.	18,993.
Price for sex (U.S. dollars)	\$2.70	\$1.03	\$1.89	\$2.56
Mean income/day	\$7.84	\$3.73	\$6.82	\$9.71
Dates of study	11/97-2/98	6/98-9/98	11/98-2/99	6/99-9/99
N	631	629	614	618

brothel areas. Interviewers underwent training for several days for obtaining informed consent, orientation to the field situation, probing, asking sensitive questions, and recording answers. The interviews consisted of questions on AIDS/STD knowledge, condom beliefs, self-efficacy of condom use, sexual behavior, condom use, and STD symptoms and diagnoses. Interviews were conducted in private areas in the brothel complexes. All women working in the brothels were invited to participate, and more than 99% of these women participated in the survey interviews.

After an interview was conducted, the woman was offered a physical examination for STD assessment. About 95% of the women consented to a vaginal examination. Women traveled to a nearby clinical site for the examination. Samples of cervical mucus were tested with a probe system for *Neisseria gonorrhoeae* (Abbott LCx; Abbott Laboratories, Abbott Park, IL) and *Chlamydia trachomatis* (Abbott LCx); with polymerase chain reaction (PCR) for herpes simplex virus (HSV) types 1 and 2 (primers obtained from Midland Certified Reagent Company, Midland, TX) and human papilloma virus (HPV); and for *Trichomonas vaginalis* (InPouch TV, BioMed Diagnostics, San Jose, CA). Serum was tested for syphilis with a *Treponema pallidum* hemagglutination assay (TPHA) and rapid plasma reagin (RPR) test, and anonymous HIV testing was conducted with enzyme-linked immunosorbent assays (ELISA) and Western blot analysis. Women were considered positive for syphilis if the TPHA was positive and the RPR test was positive with a titer of at least 1:8.

Laboratory tests for syphilis, trichomonas infection, and candidal infection were processed at the Kerti Praja Foundation in Denpasar, Bali. The testing for gonorrhea, chlamydial infection, and HSV infection was conducted at the University of Michigan Hospital Clinical Microbiology Laboratories (Ann Arbor, MI). The PCR testing for HPV was conducted at Wayne State University (Detroit, MI). The HIV testing was conducted at the laboratories of the Naval Medical Research Unit in Jakarta, Indonesia. Treatment was provided according to a syndromic diagnosis at the time of examination. The World Health Organization's protocol for

syndromic treatment was followed during the first round and was then modified to increase sensitivity to STDs in this population. When laboratory results were obtained from laboratories out of the area at a later date, untreated women were contacted and medication was provided.

The specimens for molecular testing to be performed at the University of Michigan were inoculated into transport tubes supplied by Abbott Laboratories for use with the LCx test, were immediately frozen at  $-4^{\circ}\text{C}$ , and were transported to a  $-70^{\circ}\text{C}$  freezer within 5 hours. Shipment to Michigan occurred quarterly, and specimens remained frozen on dry ice during transport.

Quality assurance was maintained in the Bali laboratory with the use of trained laboratory technicians for all testing and for testing of known positives, when available, to ensure the quality of the reagents. Quality control at the University of Michigan laboratories included routine inclusion of negative and positive controls.

When women visited the clinic for services between study rounds, the modified World Health Organization protocol for syndromic treatment was followed. Of the women who underwent STD examinations during round 2, 16.5% had visited the clinic at least once between rounds 1 and 2 (11% visited once and 5.5% visited twice or more). Of the women who underwent STD examinations during round 3, 20.1% had visited the clinic between rounds 2 and 3 (13.1% visited once and 7% visited twice or more). Finally, of the women who underwent STD examinations during round 4, 23% had visited the clinic between rounds (15% visited once and 8% visited twice or more).

The protocol for the study was approved by the Health Sciences Institutional Review Board of the University of Michigan and the review board of the Kerti Praja Foundation.

#### Measures

*AIDS knowledge* was measured by adding the number of correct answers to 16 questions on AIDS transmission, prevention, and treatment.

*STD knowledge* was measured by adding the number of correct answers to 12 questions on STD transmission, prevention, and treatment.

*Condom use* was measured by the number of clients who used a condom, divided by the number of clients served on the day before the interview, multiplied by 100.

*STD prevalence* was measured according to whether a woman had such infection, on the basis of the diagnostic criteria described above. Presence of infection was coded as 1, and absence of infection was coded as 0.

*Age* was a woman's age in single years.

*Round* refers to the round number of the evaluation survey and examinations.

*New* participants were assigned a code of 1 if this was their first round of participation; otherwise, they were assigned a code of 0.

*High-effort program area* was associated with a code of 1 for women working in an area where the more-intensive educational program was conducted; otherwise, the code was 0.

#### Statistical Methods

Initially, differences between groups and time periods were evaluated by means of analysis of variance. After this, linear and logistic models were estimated with use of statistical software (Statistical Analysis System, version 6.2; SAS Institute, Cary, NC) and the Proc MIXED procedure. This procedure uses restricted maximum likelihood estimation for parameter estimation and allows adjustment for covariance between individuals due to repeated measures and study cluster. *Study cluster* is the unit in which a woman works, consisting of a pimp and 4 to 10 other women. For categorical dependent variables, the associated GLIMMIX procedure was used to estimate the logistic models. An observation was included in the data file for each time a woman participated in an interview or STD examination. The model included identification number and cluster as random variables and age, program area, round number, and whether the woman was new in that round as independent variables. The interaction variable "round \* program" area (the interaction of round and program area) was also included as an independent variable. The coefficient of the variable round \* program area is important to the evaluation of education for commercial sex workers, because it indicates whether the rate of change in the dependent variable was different for the two program areas. With the interaction term in the model, the dichotomous variable program area indicates whether the program areas differed initially on the dependent variable. Hence, the models evaluate whether the rate of change was different in the two program areas, controlling for initial differences in the dependent variable and for the age and mobility of sex workers.

## Results

### Demographics

The demographic characteristics of the study participants are shown in Table 1. The women's average age was in the mid-twenties, and the average number of years of schooling was about 5 years. About 80% of the women were widowed, divorced, or separated. Although reports tend to be understated, the women reported that they had been working in Bali for a mean of 13 months and a median of 6 months.

The number of clients per day and the price for each sex act varied over the study period. A very severe economic crisis was experienced by Indonesia between round 1 and round 2. The amount of money that a woman earned per client was reduced sharply in real terms because of the decline in the value of the rupiah. The number of clients the women served each day also increased, but their mean income per day recovered in the later rounds.

The study area was characterized by a significant turnover of sex workers each round. The study defined all women as new in the first round. The proportion of women who were new was 63% in the second round and then decreased to 48% and 46% in the third and fourth rounds. The large proportion of new women in the second round may be due to the economic crisis. A decrease in the supply of clients during this time, as well as the increasing need for income among all women, may have influenced the rate of turnover in the complexes. Women may have had to work longer hours and serve more clients each day to earn enough money. As discussed below, this changing composition of the complexes was considered in the program evaluation.

### AIDS/STD Knowledge, Condom Use, and STD Prevalence

*Differences by study round and program area.* Table 2 shows the measures of AIDS knowledge, STD knowledge, condom use, and STD prevalence per study area and round. At the start of the study, the levels of STD infection were very high, particularly for *N gonorrhoeae* (60.5% prevalence) and *C trachomatis* (41.3%). The reported level of condom use was also high (69.9% prevalence).

When the entire population of all areas was considered, there were small increases in AIDS knowledge (from a mean of 10.8 correct answers to 12.4 correct answers;  $P < 0.001$ ), STD knowledge (from 5.7 correct to 6.7 correct;  $P < 0.001$ ), and condom use (from 69.9% to 75.4%;  $P = 0.01$ ) over the study period. There were also significant decreases in the prevalence of syphilis (10.9% to 4.2%;  $P < 0.001$ ) and trichomonas infection (11.3% to 3.4%;  $P < 0.001$ ). Differences between the high-effort and low-effort program areas were also notable. Differences were significant for all variables ( $P < 0.01$ ) except syphilis ( $P > 0.05$ ). In general, the high-effort program area had higher levels of

TABLE 2. Measures of AIDS Knowledge, STD Knowledge, Condom Use, and STD Prevalence per Program

Program Area, Measure	Round 1 (Baseline)	Round 2	Round 3	Round 4
<b>High effort</b>				
AIDS knowledge	11.3	13.4	14.3	13.7
STD knowledge	5.8	7.0	6.9	7.2
% Condom use	77.1	74.1	76.8	77.7
<b>STD prevalence</b>				
Syphilis	15.3	4.5	0.5	3.0
<i>Trichomonas vaginalis</i>	9.8	4.7	2.5	0.5
<i>Neisseria gonorrhoeae</i>	50.9	51.1	48.1	50.0
<i>Chlamydia trachomatis</i>	33.5	30.8	28.6	36.0
N	225	204	200	202
<b>Low effort</b>				
AIDS knowledge	10.6	11.0	11.1	11.8
STD knowledge	5.7	5.9	5.6	6.4
% Condom use	65.7	66.4	65.1	74.4
<b>STD prevalence</b>				
Syphilis	8.4	6.8	2.8	4.8
<i>Trichomonas vaginalis</i>	12.2	7.0	6.3	4.8
<i>Neisseria gonorrhoeae</i>	66.1	60.2	59.1	55.0
<i>Chlamydia trachomatis</i>	45.8	42.7	48.7	48.0
N	406	425	414	416
<b>All</b>				
AIDS knowledge	10.8	11.8	12.1	12.4
STD knowledge	5.7	6.3	6.0	6.7
% Condom use	69.9	68.9	68.8	75.4
<b>STD prevalence</b>				
Syphilis	10.9	6.1	2.1	4.2
<i>Trichomonas vaginalis</i>	11.3	6.3	5.2	3.4
<i>Neisseria gonorrhoeae</i>	60.5	57.0	55.6	54.0
<i>Chlamydia trachomatis</i>	41.3	39.0	42.33	44.0
N	631	629	614	618

The values for knowledge are mean numbers of questions answered correctly. Other values are percentages of subjects; some values may be based on a smaller number of cases because of missing data. Differences across rounds for all areas were significant for AIDS knowledge ( $P < 0.001$ ), STD knowledge ( $P < 0.001$ ), syphilis ( $P < 0.001$ ), trichomonas infection ( $P < 0.001$ ), and condom use ( $P = 0.01$ ) but not for chlamydial infection or gonorrhea. Differences between the high-effort program area and the low-effort program area were significant ( $P < 0.01$ ) for all measures except syphilis. STD = sexually transmitted disease.

AIDS knowledge, STD knowledge, and condom use and lower levels of STD.

**Differences by number of rounds in program and program area.** As discussed above, this population is very mobile, and the study results may be affected by the frequent influx of new women. To examine trends by the amount of time spent in the program area, the data were retabulated to indicate knowledge, condom use, and STD prevalence rates by the number of rounds women participated in the examinations and interviews. These data are shown in Table 3 and graphed in Figure 1.

The amount of time that women spent in the complexes was strongly related to their AIDS/STD knowledge, condom use, and level of STD. The first time women were interviewed for the study, they had lower AIDS knowledge, STD knowledge, and condom use scores than when they

were interviewed in later rounds. Indeed, the AIDS knowledge score among women averaged 9.9 at the first interview but increased to 14.3 at the second interview and to 16.1 at the third or fourth interview ( $P < 0.01$ ). Condom use increased from 65% at the first interview to 83% at the third or fourth interview ( $P < 0.01$ ).

The prevalence of several STDs decreased substantially in relation to the number of rounds present. The prevalence of *N gonorrhoeae* infection decreased from 62% to 43% ( $P < 0.001$ ), and that of trichomonas infection decreased from 7.9% to 3.5% ( $P < 0.001$ ). The prevalence of syphilis also decreased, from 6.8% to 3.6% ( $P < 0.001$ ). The prevalence of chlamydial infection did not change significantly. The high-effort program area generally had higher levels of AIDS and STD knowledge and of condom use and lower

TABLE 3. Measures of AIDS Knowledge, STD Knowledge, Condom use, and STD Prevalence, per Number of Rounds for Which Participants were in the Program Area

Program Area, Measure	First Round	Second Round	Third or Fourth Round
<b>High effort</b>			
AIDS knowledge	10.6	15.9	17.3
STD knowledge	5.6	8.0	8.5
% Condom use	70.5	81.4	89.1
<b>STD prevalence</b>			
Syphilis	9.0	1.8	2.6
<i>Trichomonas vaginalis</i>	9.8	4.7	2.5
<i>Neisseria gonorrhoeae</i>	56.0	49.0	33.0
<i>Chlamydia trachomatis</i>	34.0	31.0	29.0
N	480	187	164
<b>Low effort</b>			
AIDS knowledge	9.6	13.5	15.1
STD knowledge	5.2	7.0	7.9
% Condom use	63.1	77.1	78.4
<b>STD prevalence</b>			
Syphilis	5.9	6.0	4.3
<i>Trichomonas vaginalis</i>	8.9	5.3	3.8
<i>Neisseria gonorrhoeae</i>	64.0	53.0	50.0
<i>Chlamydia trachomatis</i>	46.0	44.0	50.0
N	1106	343	211
<b>All</b>			
AIDS knowledge	9.9	14.3	16.1
STD knowledge	5.3	7.3	8.2
% Condom use	65.3	78.5	82.7
<b>STD prevalence</b>			
Syphilis	6.8	4.6	3.6
<i>Trichomonas vaginalis</i>	7.9	4.6	3.5
<i>Neisseria gonorrhoeae</i>	62.0	52.0	43.0
<i>Chlamydia trachomatis</i>	43.0	39.0	41.0
N	1489	496	359

The values for knowledge are mean numbers of questions answered correctly. Other values are percentages of subjects; some values may be based on a smaller number of cases because of missing data. Differences across rounds for all areas were significant for AIDS knowledge ( $P < 0.001$ ), STD knowledge ( $P < 0.001$ ), syphilis ( $P < 0.001$ ), trichomonas infection ( $P < 0.001$ ), and condom use ( $P < 0.01$ ) but not for chlamydial infection or gonorrhea. Differences between the high-effort program area and the low-effort program area were significant ( $P < 0.01$ ) for all measures except syphilis. STD = sexually transmitted disease.

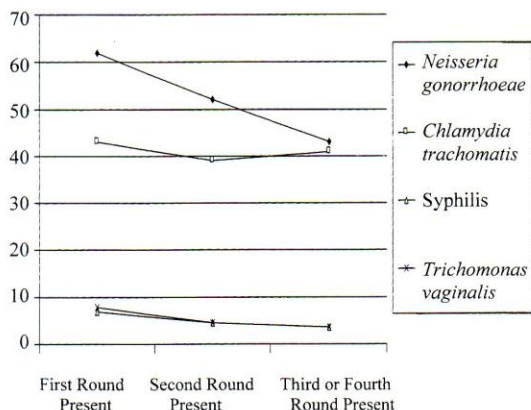


Fig. 1. Trends in prevalence of sexually transmitted diseases by number of rounds in program.

levels of STD. These differences were significant ( $P < 0.01$ ) for all variables except syphilis.

The presence of certain sexually transmitted viral pathogens—human papillomavirus (38.3%) and herpes simplex viruses 1 and 2—(2%) was assessed at the beginning of the study, but such infections were not included in the program evaluation because no curative treatments were available. The prevalence of human papillomavirus infection at round 4 was 29.7%. The prevalence of herpes simplex virus was

assessed only at round 1. HIV prevalence was assessed anonymously at each round, and the prevalence remained low during the study (1/600 in round 1, 1/600 in round 2, 2/598 in round 3, and 2/544 in round 4).

#### Multivariate Analysis

Comparisons between the study areas discussed above may be confounded by differences in the age of the women and duration of stay in the study complexes. To assess differences between areas, controlling for differences in age, entry of new women, and initial levels of knowledge, condom use, and sexually transmitted infection, we used linear and logistic regression mixed models. Dependent variables for the linear models were AIDS knowledge, STD knowledge, and condom use. Dependent variables for the logistic models were syphilis and STDs due to *N gonorrhoeae*, *C trachomatis*, and *T vaginalis*. Independent variables were age of woman, program area, study round, and whether the woman was new to the study in that round. An interaction term, round \* program area, was added to the model to test whether the two program areas were changing at different rates. Initial models also included number of clients per day and the woman's education, but these variables were dropped because of their lack of significance in the models.

Results of these models are shown in Table 4. In the linear model for condom use, study round did not have a significant effect upon condom use. Condom use was most

TABLE 4. Linear Mixed Models of the Effects of the Intervention on Condom Use, AIDS Knowledge, STD Knowledge, and STD Prevalence Among 1,566 Women

Linear Regression Variable	Coefficient	SE	95% Confidence Limits	t*	P value
Dependent: Condom use					
Intercept†	61.7	5.52	50.88,72.52	11.18	<0.01
Round	0.20	0.93	0.0,2.02	0.22	0.82
High-effort area	10.21	4.12	2.13,18.29	2.48	0.01
Round/high-effort area‡	-1.90	1.40	-4.64,0.84	-1.36	0.17
Age	0.56	0.17	0.23,0.89	3.28	<0.01
First enrollment	-12.73	1.81	-16.28,-9.18	-7.01	<0.01
Dependent: AIDS knowledge					
Intercept	13.90	0.73	2.13,18.29	18.95	<0.01
Round	-0.19	0.12	-0.43,0.05	-1.64	0.10
High-effort area	0.44	0.54	-0.62,1.5	0.82	0.41
Round/high-effort area	0.28	0.16	-0.03,0.59	1.75	0.07
Age	0.01	0.02	-0.03,0.05	0.63	0.53
First enrollment	-4.21	0.22	-4.64,-3.78	-19.38	<0.01
Dependent: STD knowledge					
Intercept	7.24	0.39	6.48,8.00	18.64	<0.01
Round	-0.10	0.06	-0.22,0.02	-1.55	0.12
High-effort area	0.19	0.29	-0.38,0.76	0.64	0.52
Round/high-effort area	0.09	0.09	-0.09,0.27	1.00	0.32
Age	0.01	0.01	-0.01,0.03	0.91	0.36
First enrollment	-2.10	0.12	-2.34,-1.86	-16.95	<0.01

\* t statistic for significance of coefficient.

† y intercept for estimated linear equation.

‡ Interaction of round and program area.

STD = sexually transmitted disease.

TABLE 5. Logistic Mixed Models of the Effects of the Intervention on Condom Use, AIDS Knowledge, STD Knowledge, and STD Prevalence Among 1,566 Women

Logistic Regression Variable	Coefficient	SE	Odds Ratio	95% Confidence Limits	t*	P Value
Dependent: <i>Neisseria gonorrhoeae</i>						
Intercept <sup>†</sup>	1.80	0.30	6.04	3.36,10.89	6.04	<0.01
Round	-0.05	0.05	0.95	0.54,1.05	-1.05	0.29
High-effort area	-0.63	0.23	0.53	0.33,0.83	-2.74	0.01
Round/high-effort area <sup>‡</sup>	0.16	0.08	1.17	1.00,1.37	1.92	0.05
Age	-0.06	0.01	0.94	0.92,0.96	-6.87	<0.01
First enrollment	0.52	0.10	1.68	1.38,2.05	5.03	<0.01
Dependent: <i>Chlamydia trachomatis</i>						
Intercept	1.13	0.30	3.09	1.72,5.57	3.74	<0.01
Round	0.08	0.05	1.08	0.84,1.19	1.52	0.13
High-effort area	-0.46	0.23	0.63	0.40,0.99	-1.98	0.05
Round/high-effort area	-0.01	0.08	0.99	0.84,1.15	-0.17	0.87
Age	-0.06	0.01	0.94	0.92,0.96	-6.70	<0.01
First enrollment	0.11	0.10	1.11	0.92,1.36	1.02	0.31
Dependent: Syphilis						
Intercept	-4.63	0.58	0.01	0.00,0.03	-7.93	<0.01
Round	-0.32	0.08	0.72	0.62,0.85	-3.87	<0.01
High-effort area	1.86	0.35	6.45	3.23,12.75	5.37	<0.01
Round/high-effort area	-0.78	0.13	0.46	0.35,0.59	-5.90	<0.01
Age	-0.01	0.02	0.99	0.95,1.03	-0.65	0.51
First enrollment	0.76	0.16	2.13	1.56,2.93	4.77	<0.01
Dependent: <i>Trichomonas vaginalis</i>						
Intercept	-3.45	0.59	0.03	0.01,0.10	-5.87	<0.01
Round	-0.28	0.08	0.75	0.65,0.88	-3.28	<0.01
High-effort area	-0.09	0.35	0.91	0.46,1.81	-0.26	0.79
Round/high-effort area	-0.15	0.11	0.86	0.58,1.06	-1.35	0.18
Age	-0.03	0.20	0.97	0.65,1.43	-1.58	0.11
First enrollment	0.41	0.16	1.50	1.10,2.06	2.61	<0.01

\* t statistic for significance of coefficient.

<sup>†</sup> y intercept for estimated linear equation.<sup>‡</sup> Interaction of round and program area.

STD = sexually transmitted disease.

strongly affected by whether it was the woman's first visit to the program: condom use points were reduced by almost 13% if it was her first visit ( $P < 0.01$ ). Age also affected condom use: older women were most likely to use condoms ( $P < 0.01$ ). The high-effort program area had higher initial condom use scores, by about 10% ( $P < 0.01$ ). Study round and the interaction between study round and program area were not significantly associated with levels of condom use ( $P > 0.05$ ).

For AIDS knowledge and STD knowledge, the most important predictors were whether the woman was new to the program. AIDS knowledge was 4.2 points less ( $P < 0.01$ ) and STD knowledge was 2.1 points less if she was new ( $P < 0.01$ ). Study round, program area, the interaction of round and program area, and a woman's age were not statistically significant at the 0.05 level.

Logistic regressions were estimated for the four bacterial STDs (Table 5). For *N gonorrhoeae*, the model indicated that older women were less likely to be infected (relative risk [RR] = 0.94 per year older;  $P < 0.01$ ) and that women who were new to the program were more likely to be infected (RR = 1.68;  $P < 0.01$ ). Prevalence of gonorrhea was initially lower in the high-effort program area (RR = 0.53;  $P < 0.01$ ), and the interaction between program area

and round was positive and significant. The advantage of being in the high-effort program area rather than the low-effort area was strong initially, but it decreased over the study period (RR = 0.62 in round 1, 0.73 in round 2, 0.86 in round 3, and 0.99 in round 4).

The analysis for chlamydia also indicated that older women were less likely to be infected (RR = 0.94 per year;  $P < 0.01$ ). Being enrolled in the study for the first time was not a significant factor, and changes by round were not significant. The high-effort program area had a lower initial rate of chlamydial infection (RR = 0.63;  $P < 0.05$ ) than did the low-effort program area.

The model for syphilis indicated significant relations with all variables except age. An elevated risk of syphilis was related to enrollment in the study for the first time (RR = 2.13;  $P < 0.01$ ). The risk of syphilis decreased significantly by round (RR = 0.72 per round;  $P < 0.01$ ), and this effect was modified by the program area in which the woman was working ( $P < 0.01$ ). In comparison with that in the low-effort program area, the decline was much steeper in the high-effort area, where the relative risk of syphilis declined from 2.94 in round 1 to 1.35 in round 2, 0.61 in round 3, and 0.28 in round 4.

Finally, the model for trichomonas infection showed a

significant decrease by program round but did not indicate significant differences by program area. The relative risk of trichomonas infection was 0.75 each round ( $P < 0.01$ ). The risk of trichomonas infection was greater on a woman's first enrollment ( $RR = 1.50$ ;  $P < 0.01$ ) than for later visits.

### Discussion

This intervention for female sex workers and clients made some progress in educating sex workers about AIDS and STDs and in reducing some bacterial STDs. The additional education received by women in the high-effort program area also reduced the prevalence of syphilis. The prevalence of trichomonas infection declined similarly in both areas. For women present at least two rounds in either area, HIV/STD knowledge and condom use increased, and the occurrence of gonorrhea, syphilis, and trichomonas infection decreased. Chlamydial infection persisted across program rounds among all women.

For most measures, there were no differences in how the program areas changed over time. Increases in knowledge of AIDS and STD, increases in reported condom use, and decreases in some of the sexually transmitted infections were equally likely in the low-effort and high-effort areas. A low-effort, less-expensive intervention may be the better choice of program for this area.

This area is characterized by a very mobile group of women working in the complexes. In general, about half of the women were new in each survey round. These new women had markedly higher levels of STD and much less knowledge of AIDS and other STDs than women who were present for some time. As discussed above, among women who spent 6 months in either program area, knowledge and condom use increased and the prevalence of STDs was reduced. Reaching out to new women in these complexes is essential to decrease the prevalence of sexually transmitted infections.

During the time of the study, Indonesia experienced a severe economic and political crisis. The most dramatic change in the economy occurred between round 1 and round 2 of the study. As can be seen in Table 1, the income of sex workers dropped substantially during this time, but it recovered by the end of the study. In terms of the effect on the intervention, because women were earning less per client, they may have been pressured to have more clients per day. They may also have been less able to insist on condom use with clients. A surveillance study conducted in two other Indonesian cities revealed an increase in sexually transmitted infections in sex workers over this period.<sup>13</sup> It is possible that during a period of economic stability, the effects of the intervention may have been larger.

This was the first study in Indonesia to measure the prevalence of *N gonorrhoeae* and *C trachomatis* in a large sample of female sex workers by means of the DNA am-

plification LCx method on cervical mucus. The prevalence of these infections was much higher at the beginning of the study than was anticipated (other Indonesian studies had documented rates of infection about half the level of these rates). Reducing the prevalence of these infections proved to be very difficult, possibly because of the high prevalence in the population, ease of transmissibility, short incubation period, and long period of infectivity.<sup>6</sup> This difficulty in controlling gonorrhea and chlamydial infection among sex workers has been observed in African studies as well.<sup>2,6</sup> The high prevalence of these infections also suggests the potential for the spread of HIV infection in this area.

Both mass treatment followed by syndromic or laboratory-based treatment and syndromic or laboratory-based treatment alone have been used in previous intervention trials involving commercial sex workers.<sup>2,6</sup> Both approaches resulted in reductions in STDs among sex workers. Mass treatment might be considered for this population because of the very high levels of infection. Indeed, in some rounds, the percentage of women treated for gonorrhea or chlamydial infection after syndromic diagnosis approached 80%. However, the need for syndromic follow-up care, reliance on medication rather than prevention, and antibiotic resistance must be considered.<sup>14,15</sup> The availability of accurate, rapid diagnostics for areas with limited laboratory capabilities would help insure timely treatment of women and would reduce the overuse of antibiotics.

The reported rates of condom use in this study were generally very high, ranging from 65% to 78% during the study rounds. Although some overreporting of use is likely in this population, even this level of condom use exposes sex workers substantially to infection, given the number of different sex partners. Indeed, among the sex workers reporting 70% condom use, more than half reported unprotected sex with a client in the past day.

Although these condom-use rates increased for women who remained in the program for at least 6 months, they did not reach 100%. The project may have encountered a plateau effect, whereby it became difficult to increase the use of condoms without increasing the efforts to educate clients about AIDS and other STDs. Future investigators should consider a more intensive outreach to the client population.

### Conclusion

In summary, this intervention, which included both behavioral and biomedical approaches, made some progress in educating women about STDs and in reducing the prevalence of syphilis, trichomonas infection, and gonorrhea. The data from the study show that the mobility of the sex worker population is of great importance in determining the prevalence of sexually transmitted infections in the area. Future studies must involve more intensive outreaching to clients and to sex workers new to the area. Rapid diagnostic meth-



ods for gonorrhea and chlamydial infection would also aid in infection control.

### References

1. Archibald CP, Chan RKW, Wong ML, et al. Evaluation of a safe sex intervention programme among sex workers in Singapore. *Int J AIDS STD* 1994; 5:268–272.
2. Laga M, Alary M, Nzila N, et al. Condom promotion, sexually transmitted diseases treatment, and declining incidence of HIV-1 infection in female Zairian sex workers. *Lancet* 1994; 344:246–248.
3. Ngugi EN, Plummer FA, Simonsen JN, et al. Prevention of transmission of human immunodeficiency virus in Africa: effectiveness of condom promotion and health education among prostitutes. *Lancet* 1998; 348:1249.
4. Van Griensven GJP, Limanonda B, Ngaokew S, Na Ayuthaya SI, Poskyachinda V. Evaluation of a targeted HIV prevention programme among female commercial sex workers in the south of Thailand. *Sex Transm Infect* 1998; 74:54–58.
5. Walter D, Hargono R, Laga M, et al. STD rates over one year among Indonesian sex workers exposed in different degrees to a peer health education programme in Surabaya (Abstract no. 650/PTCD058). Presented at: the Fifth International Congress on AIDS in Asia and the Pacific; October 1999; Kuala Lumpur, Malaysia.
6. Steen R, Vuylsteke B, De Coito T, et al. Evidence of declining STD prevalence in a South African mining community following a core-group intervention. *Sex Transm Dis* 2000; 27:1–8.
7. Ford K, Wirawan DN, Fajans P, Muliawan P, MacDonald K, Thorpe L. Behavioral interventions for reduction of sexually transmitted disease/HIV transmission among female commercial sex workers and clients in Bali, Indonesia. *AIDS* 1996; 10:213–222.
8. Cases of HIV/AIDS in Indonesia reported through September, 2000. <http://www1.rad.net.id/aids/data.htm>.
9. Ford K, Wirawan DN, Fajans P. AIDS knowledge, risk behaviors, and condom use among four groups of female sex workers in Bali, Indonesia. *J Acquir Immune Defic Syndr Hum Retrovirol* 1994; 10:569–576.
10. Dalbetta G, Serwadda D, Mugrditchian D. Controlling other sexually transmitted diseases. In: Gibney L, DiClemente RJ, Vermund SH, eds. *Preventing HIV in Developing Countries: Biomedical and Behavioral Approaches*. New York: Plenum Press, 1999: 109–136.
11. Rosenstock I, Strecher V, Becker M. The health belief model and HIV risk behavior change. In: DiClemente RJ, Peterson JL. *Preventing AIDS: Theories and Methods of Behavioral Interventions*. New York: Plenum Press, 1994:5–24.
12. Bandura A. Perceived self efficacy in the exercise of control over AIDS infection. In: Mays VW, Albee GW, Schneider SF, eds. *Primary Prevention of AIDS: Psychological Approaches*. London: Sage, 1989:128–141.
13. Surjadi C, Pariani S, Heriwati A. The economic crisis in Indonesia and its effect on commercial sex workers in Jakarta, Surabaya, and Manado, Indonesia (Abstract no. 840/TCD14–01). Presented at: the Fifth International Congress on AIDS in Asia and the Pacific; October 1999; Kuala Lumpur, Malaysia.
14. Wirawan DN, Ford K, Reed B, Partha M, Sutarga M. Sensitivity and specificity of syndromic diagnosis of STDs among sex workers in Bali, Indonesia (Abstract 79/33235). Presented at: the International Conference on AIDS; 1998; Geneva, Switzerland.
15. Wirawan DN. STD treatment for female sex workers. Presented at: the Indonesian National AIDS Conference; 2000; Jakarta, Indonesia.