Application of the Capture-Recapture Method for Estimating Number of Mobile Male Sex Workers in a Port City of Bangladesh

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ABSTRACT

Male sex workers (MSWs) and sex trades are not new in Bangladesh. Current HIV interventions for MSWs need to be expanded in the major cities, but the number of MSWs needs to be scientifically estimated. Although two-sample capture-recapture surveys are suitable for closed populations, this method was here applied to indirectly estimate the number of mobile MSWs in a conservative social setting, a port city of Bangladesh. Use of the method resulted in an estimation of 248 MSWs (95% confidence interval, 246-250) who picked up clients only at open and known contact venues. This estimate does not, however, reflect the total number as MSWs who worked in unknown hidden venues and could not be reached. Experience suggests that the two-sample capture-recapture method is a simple technique for reliably estimating an unrecognized population. The limitation of this method can be minimized by shortening the time gap between surveys, creating an enabling environment to encounter harassment of MSWs, and offering safety to peer-staff.

Key words: Capture-recapture method; Sex workers; Sex behaviour; Bangladesh

INTRODUCTION

With the emergence of HIV/AIDS, vulnerable populations, such as injecting drug users (IDUs), sex workers (SWs), and men who have sex with men (MSM), have become marginalized and hidden. HIV/AIDS interventions are primarily targeted at populations with high-risk behaviours in countries of low HIV prevalence. MSM have recently received substantial global attention. As in many other Asian countries, MSM are generally unrecognized in Bangladesh; this invisibility does not mean they do not exist. Cross-cultural evidence suggests that male-to-male sex has existed in Asia for a long time (1-3). Studies on MSM conducted in Bangladesh reveal

that MSM involved in buying and selling sex are vulnerable to the transmission of sexually transmitted infections (STIs/HIV) due to their unprotected sexual encounters with multiple sex partners (4-9). Results of recent studies among male sex workers in Dhaka showed that the prevalence of HIV and syphilis was 0% and 18.2% respectively (6). However, one case of HIV infection was detected among MSM in the first round of surveillance in Bangladesh (4). The high prevalence of syphilis among male sex workers (MSWs) indicates the existence of risky behaviour, which was also revealed by the national behavioural surveillance surveys. The consistent use of condoms in this population is very low, with an average of six clients a week (5-6). Considering the vulnerability of MSWs, in terms of HIV transmission and poor sexual health conditions (7-9), targeted HIV/AIDS interventions are already on board in several districts of Bangladesh which need to be expanded to other cities where the male sex trade exists. Estimation of the size of such a stigmatized population is crucial for designing an adequate resource-based well-planned HIV intervention.

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Many researchers have recently applied the capture-recapture method to estimate the size of unrecognized populations, such as IDUs and street-based female SWs (10-17). These studies used arrest records, addict registers, or clinic records as sources of capture-recapture data. These data have limitations because the sources do not account for those who do not attend service facilities or are less likely to be arrested (10). Therefore, the derived estimate does not necessarily reflect the entire population. On the other hand, applying the capture-recapture method to an unrecognized population in the community setting is limited because of difficulties in approaching such a population. This paper describes the procedure of applying the two-sample capture-recapture method in a community setting to estimate the size of a mobile, stigmatized, and unrecognized population, MSWs, in a conservative social setting, a port city of Bangladesh, in 2000.

Capture-recapture method: concept and assumptions

The basic concept of the capture-recapture method relates to the traditional notion of estimating the total number of fish in a pond. Fishing nets can be thrown into a pond to catch fish. After counting and marking, fish of the first catch (captured and marked C) are returned to the pond. After a few hours of allowing all marked fish to mix with unmarked ones, nets are thrown into the pond again. This time, the total number of fish caught (S) consists of both C-marked fish which were caught the first time (recaptured and marked R) and newly-caught fish (newly captured and marked K). It can be assumed that an unknown number of fish (U) will always remain in the pond and not be caught. Therefore, the total number of fish in the pond (N) is the sum of C, K, and U [N=C+K+U or N=C+(S-R)+U]. In the real world, the number U always remains unknown, and another simple formula can be applied to indirectly estimate the total number N. The formula assumes that two ratios are equal, i.e. C/N=R/S (10,18-20). In the case of a human population, it depends on the following assumptions:

(i) The population to be estimated must be geographically and demographically closed, which means that the same individuals must be present throughout the period of counting, i.e. when samples are taken. In the case of human populations, there should be no probability of increasing (immigration or births) or decreasing (deaths or emigration) the size of the population between the capture and recapture surveys.

(ii) The first count (capture) must be perfect avoiding the possibility of double counting.

(iii) A mechanism must be in place to conform whether an individual was already counted or marked (captured). This ensures that marks or tags of the captured samples will not be lost and remain until the next counting (recapture).

(iv) All samples must be independent, with each individual, including the captured ones, having an equal chance of being counted. This suggests that when the captured individuals are allowed to re-mix with their own community, they have an equal chance of being recounted (recaptured) during the next sampling.

MATERIALS AND METHODS

Various activities were employed to create an enabling environment which was thought to be crucial for implementing the capture-recapture method, especially to empower MSWs and to encourage them to participate in project activities without any fear or confusion. These included: advocacy meetings with gatekeepers and powerbrokers in the community, network formation with the marginalized population, selection and recruitment of appropriate peer-staff, comprehensive training, and field interactions through observation and social mapping (Fig. 1). As Figure 1 indicates, these activities were not designed in a chronological order or as a one-time effort. For example, advocacy meetings, network formation, training, and observations were not performed one after another. Rather all of these activities were overlapping and ongoing in nature, which continued until the end of the fieldwork not only to encounter constraints but also to prepare the field for immediate intervention. The project received approval from the Research and Ethical Review Committees of ICDDR,B: Centre for Health and Population Research, Dhaka, Bangladesh. This offered the project staff a sense of authenticity to confidently interact with MSWs and the power structure of the sex trade.
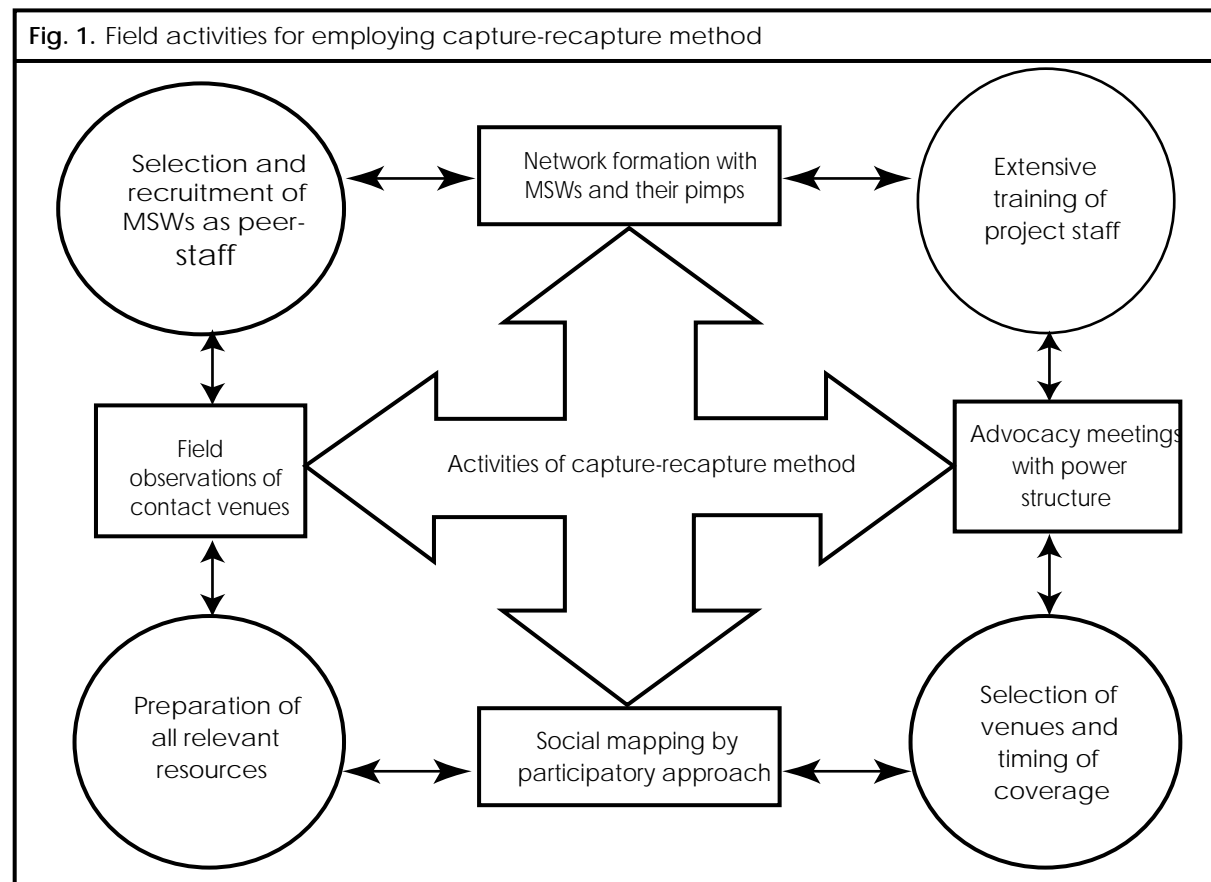
Advocacy meetings and network formation with MSM

A series of advocacy meetings were conducted with powerbrokers who had contact with the target population. They mainly included law-enforcement agents and local influential men who are involved in various criminal and illegitimate activities and exert unauthorized power on others, popularly known as *mastans* (local influential

people who are involved in illegal activities by exerting unauthorized power). These advocacy meetings took place with various groups of people depending on the needs in the field. Venues of advocacy meetings were selected based on their preferences. We presented several MSM and MSWs to discuss and share their experiences with the participants at advocacy meetings. This strategy provided a social space to both powerbrokers and MSWs to discuss many sensitive and hidden issues.

Recruitment of peer-staff and comprehensive training

MSM are generally unrecognized in Bangladesh due to their involvement in stigmatized and socially-unacceptable sexual relationships with other males. The most celebrated MSM are feminized men, locally known as *kothi.* Although they use a special dialect (*kothi* language) among themselves and possess a sense of community, they too are generally unrecognized like all

Fig. 1. Field activities for employing capture-recapture method

Along with advocacy meetings, we also began the process of network formation with MSM, especially with MSWs. Two MSM peer-staff who have good interactions with MSM and MSWs in the port city were hired from an NGO, named Bandhu Social Welfare Society (BSWS), working with MSM since 1997 in Bangladesh. With the assistance of Bandhu staff, we had access to MSWs of the port city. We disseminated information about our project activities and invited MSWs to visit the project office where they were offered a safe social space to rest and relax. A medical doctor treated and counselled them if required.

other MSM. Therefore, recruitment of peer-staff was essential for conducting fieldwork. In total, 20 MSM, current and ex-MSWs, and pimps of male sex trade were recruited for conducting the survey. We were not rigid about the qualifications of peer-staff, rather the ability to read, write, and count was considered sufficient to conduct capture-recapture surveys. The peer-staff handled the field situation confidently and sincerely and gained the cooperation of the target population. Besides the peer-staff, we also recruited one non-MSM research officer for overall supervision and three staff from BSWS who worked as interviewers and supervisors.

Comprehensive training on issues, such as basic information on STIs/HIV/AIDS, sexual health, human sexuality, methods of qualitative research, including capture-recapture, and the need for HIV interventions in Bangladesh, was conducted to empower the peer-staff. The training was ongoing, and we arranged regular feedback sessions to analyze the nature of problems so as to appropriately respond to them.

Field observations and social mapping

A trained team visited the field to observe both participants and non-participants for a week. In addition to observations, the team used a participatory approach to conduct social mapping with the assistance of other MSWs. These social maps displayed a comprehensive layout of contact venues for the male sex trade in the city, other gathering places for MSWs, and the nature and timetable for daily activities and interactions. Based on this information, we designed a survey strategy, selecting the contact venues and timing for survey work and assigning survey teams to suitable venues.

Field implementation of two-sample capture-recapture surveys

Following the preliminary observations and social mapping exercises, the research team conducted the capture-recapture surveys. During field observations and social mapping, the survey team observed all cruising venues and identified six potential areas where MSWs commonly wait for clients. Another four areas were identified where the presence of MSWs was limited and irregular. We observed that MSWs travelled from the main cruising venues to other areas; therefore, all venues were covered. Ten survey teams, each consisting of two peer-staff, were formed. Four field supervisors supervised the overall survey. Each team member covered previously-selected venues based on their familiarity with the area.

The team members distributed a red-coloured mini-card to every MSW in the contact area, irrespective of age or status. MSWs were requested to keep the card with them for a week because we planned to begin the recapture survey just after a week. As some MSWs moved from one venue to another, before being given a card, each MSW was asked whether he had already received one. If an MSW had not received a card earlier, he was given one. The card had no benefit for the recipient, so there was no reason to hide it or try to obtain another one. If someone claimed that he had already

received a card, he was asked to show it. If he failed to show the card, the survey team would verify his statement by asking pertinent questions, such as where, when, and from whom he received the card.

MSWs come to the contact venues at around 3-4 pm and usually wait for clients until midnight. The survey teams began their work at 2 pm and distributed cards without a break until midnight when sex trade interactions had finished. The members of each team were asked not to overlap with each other's assigned areas, and the distribution of cards (capture survey) was completed in one day.

The recapture survey began one week after the first capture survey. Another coloured card (yellow) was distributed. The recapture survey (distribution of cards) was conducted with the same schedules and resources as the capture survey. Cards were distributed in the same cruising areas by the same teams, and MSWs were again asked whether they had already received cards. Sex workers, who had received red cards during the first capture survey, were given a new yellow card, while those who had not received a card already (a completely new face) were given red cards. With few exceptions, most MSWs who received a red card had the card with them and were able to show it to the team. The survey team did not encounter any notable problems during the survey and reported satisfactory cooperation from MSWs.

RESULTS

Outcome of integrated fieldwork: a way of reducing vulnerability

Integrated field activities were conducted mainly to reduce the vulnerability of MSWs. This was essential for successful implementation of the capture-recapture surveys. We made extensive networking among MSWs and pimps, conducted comprehensive training of peer-staff, operated ongoing advocacy meetings with powerbrokers throughout the fieldwork, and performed participatory social mapping exercises. MSWs were empowered for being able to participate in these extensive field activities. These activities also reduced the chance of harassments by the police and *mastans*. The advocacy meetings ensured the safety and confidence of peer-staff. It also diminished sensitivities regarding the male sex trade and encountered barriers being imposed by the power structure during fieldwork. The network among MSWs was useful for creating self-esteem and a

supportive field environment. We observed that trained peer-staff professionally communicated with MSWs and provided assistance if requested. They referred MSWs with health problems to the appropriate healthcare facilities in the city and sent MSWs with psychosexual problems to the project counsellor.

Calculation of capture-recapture survey data

Given the assumptions, the capture-recapture technique can be applied to the following calculations for a two-sample closed population model, known as the Lincoln-Petersen model (13). This calculation is based on the principle that the proportion of recaptured members is assumed to be similar to the proportion of captured members compared to the total population. This means that, at the population level, the proportion (i.e. C/N) of members of a population (N) originally captured (C) during the first round of survey is equal to the proportion (i.e. R/S) of recaptured members (R) and the total number of sample counted during the second round of counting (S). Therefore, the formula stands C/N=R/S, e.g. N=(CxS)/R. However, if the sample size is small, or no individual was recaptured during the second sample, R/S may not be equal to C/N. To overcome this weakness, a modified formula was used by other researchers (10,21):

$$N_c^{\wedge} = [\{(C+1)(S+1)\}/(R+1)] - 1 \qquad \text{(Formula I)}$$

The variance of $N_c^{\wedge}$ can be estimated by the following formula:

$$\text{var}(N_c^{\wedge}) = [(C+1)(S+1)(C-R)]/[(R+1)^2(R+2)] \qquad \text{(Formula II)}$$

An approximate 95% confidence interval (CI) (normal distribution for $N_c^{\wedge}$ is assumed) can be estimated as

$$N_c^{\wedge} \pm 1.965 \, [\text{var}(N_c^{\wedge})]^{0.5} \qquad \text{(Formula III)}$$

The first capture found 190 MSWs and the second capture 170 MSWs, with 130 MSWs identified in both the samples (Fig. 2 and Table). By applying values of C, S, and R in the formula I, II, and III, the estimated size of MSWs appeared to be 248 (95% CI, 246-250).

Estimation based on an alternate method

We used a direct technique to estimate the number of mobile MSWs in the cruising venues. During field observations and social mapping, the estimated numbers of MSWs working in different cruising venues were collected from key-informants, current male sex workers (who were not project staff), and pimps of male sex trade.

We did not ask them to make a quick estimation on the spot. Rather we allowed them a week to come up with the best possible estimates. Thus, estimations for every

Fig. 2. The capture-recapture overlapping dimension
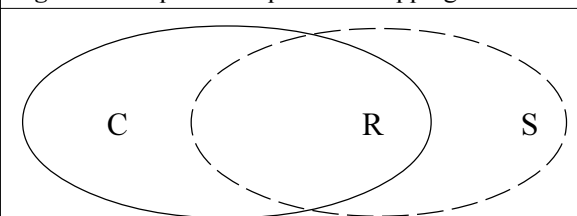
Where,

N_c=?	Indirectly estimated the total size of population (we wanted to estimate)
C=190	Total number of MSWs receiving red cards during the first round of distribution (captured)
S=170	Total number of MSWs receiving both red and yellow cards during the second round of distribution
R=130	Number of MSWs receiving yellow cards in the second round of distribution who also received red cards during the first round (recaptured)

Table. Numbers of mobile MSWs captured and recaptured in a two-sample survey

Sample 1	Sample 2		
	Present	Absent	Total
Present	130 [R]	60	190 [C]
Absent	40	[unknown]	(N-C)
Total	170 [S]	(N-S)	N=unknown

cruising venue and for the whole city were collected from 30 key-informants. The average number of these direct estimates for the whole city was 224.

DISCUSSION

Estimation of the size of any stigmatized and unrecognized population for an intervention is an important consideration for donors and policy-planners. Programme managers should know the size of a target population for designing interventions in terms of planning project staff and other resources. Therefore, before launching any intervention with a marginalized population such as MSWs, researchers and programme managers can jointly undertake a capture-recapture exercise not only for estimation, but also for creating an enabling environment for future HIV interventions through integrated fieldwork of the capture-recapture method.

Confronting the vulnerability of marginalized MSWs was a major challenge to be overcome. As such, the community application strategy for the capture-recapture surveys was aimed at reducing their vulnerability. Failure to do this could make them further vulnerable by exposing an unrecognized sub-population to the public. The ongoing and integrated field activities under ethical approval assisted the survey team to pleasantly interact with MSWs and to empower them as well.

Definition of the population to be estimated is critical and should be consistent with the method of data collection. The current estimate obtained reflects the number of floating MSWs who attend the known and open cruising venues in the urban area, such as market places, bus and railway stations, streets, *mazars* (religious gathering places), playgrounds (stadiums), and parks, for selling sex. The estimate does not, however, reflect the total number of MSWs in the whole metropolitan area, as the survey could not cover MSWs who did not attend such open cruising venues. The peer-staff knew some MSWs who worked in closed and hidden venues in residences or hotels and outside the metropolitan area. The survey also did not cover those MSWs who were unknown to them, although a broader population was reached by interacting outside their own network. They also received assistance from other MSWs who could identify MSWs working in a specific cruising venue. Since the cruising area was covered from 2 pm until midnight, it was unlikely that MSWs who attended that cruising venue were missed.

Immediately at the end of the project, the Bandhu Social Welfare Society launched an intervention programme in the port city. Members of their field staff were recruited from ex-MSWs, pimps of the sex trade, and non-MSM having good working experience with the male sex trade. According to their direct estimation, the average number of male sex workers was 312. Thus, we calculated an average of 268 from two separate direct estimates, which is closer to the indirect estimate revealed in the capture-recapture method. We obtained direct estimations from several key-informants who had long relations with the male sex trade. Selection of key-informants was crucial, and getting a quick and on the spot number might result in over- or under-estimation. Key-informants were given time to provide the best possible estimation of a specific venue known to them; these might be the reasons for the direct estimate appearing closer to the indirect estimate of the capture-recapture method.

MSWs are not a closed population since there are new recruits to the sex trade and temporary or permanent absence from the cruising areas. For example, 65% of the sampled MSWs had migrated from other districts. Few incidents of trafficking in the male sex trade were reported. Both MSWs and their clients claimed that middle-aged MSWs were in less demand due to reduced physical attractiveness. A considerable number of MSWs travelled from one venue to another for clients and were not usually working regularly in one specific area. Some left the trade and returned to their home district. Some kept visiting the cruising venues to work as pimps. A regular MSW may be absent from the contact venue to avoid harassment and arrest by the police or to accompany clients outside the city for a sex-tour, known as 'a programme', or because of political unrest, strikes, or the holy month of *Ramadan*. To make the population as closed as possible, the time gap between the two counts was reduced to one week to minimize the effect of this mobility (22,23).

A simple card was used that could be kept in a pocket or inside a wallet. During distribution of red cards during both the survey rounds, each male sex worker was carefully asked whether he already received a card. Only three MSWs had lost the card or failed to show it during the second round of distribution; this did not, however, affect the estimation.

Assumption of independence of the sample is crucial. Field experience suggests that distributing a card to an MSW during the first round of coverage did not affect the probability of re-sampling in the second round of distribution. We could not identify any reason for an MSW to keep himself isolated from his community due to receiving the card. In addition, possession of a card had no impact on a male sex worker's re-appearance in the cruising venues. MSWs who received a red card in the first coverage were able to go back to their community and had time to mix with their peers without any known difficulties. The peer-staff conducted the total procedure in a cooperative and friendly manner, which did disrupt the sex trade or create any trouble in any way. Therefore, we were not aware of any factor within the sampling period, which would influence an MSW to be more or less likely to be recaptured. Therefore, the assumption of independence was successfully maintained in the case of an open population.

In the case of a mobile population and the disruption of assumptions, a multi-sample capture-recapture

method by using a log-linear model is thought to be appropriate (24,25). Additionally, it is also argued that the two-sample capture-recapture method is suitable for estimating a closed population (10). However, this study has demonstrated the field applicability of the two-sample capture-recapture method at the community level to indirectly estimate a marginalized mobile population in a conservative social setting.

The time gap between the two surveys was reduced to minimize the effect of mobility of population on estimation. We need to remember that the current estimate only reflects mobile MSWs who usually wait to pick up clients at the open cruising venues of the port city. Therefore, this estimate has limitations for not covering other groups of MSWs who operate sex trade in hidden venues unknown to our project staff. Our experience suggests that the crucial steps to obtain a reliable estimate are to create an enabling environment for the marginalized population to minimize the extent of harassment by the police and *mastans* and to offer safer work relations for the project staff to confidently interact in the field.

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