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Original Research

Combining the randomized response technique and the network scale-up method to estimate the female sex worker population size: an exploratory study

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ABSTRACT

Objectives: Recall bias, barrier effects, transmission error, and response bias affecting the network scale-up method (NSUM) led the Joint United Nations Programme on HIV/AIDS and the World Health Organization to designate NSUM as a developing method for estimating the size of high-risk populations in 2010. The method has subsequently been adjusted for three of these biases. The present study, therefore, aimed to explore the combination of the randomized response technique (RRT) and NSUM to adjust the last remaining bias.

Study design: RRT was used in an NSUM survey to estimate the population proportion of female sex workers (FSWs) in Taiyuan, China, in 2012.

Methods: Multiplier method estimates and national-level estimates of the population proportion of FSWs were used as criteria to assess the aforementioned results.

Results: Successful interviews were completed with 96.4% of the respondents selected for the NSUM survey. The NSUM estimate fell within the range of the national-level estimates of the population proportion of FSWs in Asia and was close to the estimate yielded by the multiplier method.

Conclusions: In the present study, the combination of RRT and NSUM obtained a high response rate and produced a reliable estimate of the size of a high-risk population.

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Introduction

High-coverage interventions are required to reduce HIV transmission effectively among populations at high risk for HIV, such as female sex workers (FSWs), injecting drug users (IDUs), and men who have sex with men (MSM), and reliable estimates of the size of these high-risk populations are essential for comprehensive combination HIV prevention.[1–3] Therefore, the Joint United Nations Programme on HIV/AIDS (UNAIDS) and the World Health Organization (WHO) have explored various size estimation methods.[1,2] Unfortunately, data on the estimated size of high-risk populations in many countries remain unavailable.[4] There is a strong need for developing more cost-effective size estimation methods, especially for use in developing countries. For this reason, in 2010, the network scale-up method (NSUM) became the latest method recommended by UNAIDS and the WHO.[2] This method has the unique advantage of producing size estimates for multiple high-risk populations using a single survey.[2,5] This means that, using NSUM, size estimates for FSWs, IDUs, and MSM could be generated through one survey, in contrast to all of the previous methods which were only able to estimate the size of one of these populations per survey. Therefore, a successful NSUM survey is comparable to a cross-sectional study that is able to produce a data set containing the comprehensive and current information necessary for a successful and rapid HIV/AIDS response.

Unfortunately, NSUM was characterized by four known biases that required adjustment, leading UNAIDS and the WHO to consider it a developing method. These biases are recall bias, barrier effects, transmission error, and response bias.[2] In 2010, McCormick et al.[6,7] adjusted for recall bias, and in 2011, Salganik et al.[8,9] adjusted for barrier effects and transmission error. Thus, adjusting for response bias is the last step in improving NSUM. In an NSUM survey, respondents from the general population are required to report the proportion of high-risk individuals in their personal networks. However, such sensitive questions often cause response bias, which influences respondents to answer in ways that are not genuine.[2,5,10] Thus, protecting the privacy of respondents is the most important factor in obtaining an accurate or truthful response when sensitive questions are asked. The randomized response technique (RRT) is a survey technique designed to eliminate response bias. This technique allows respondents to answer a question that is randomly received from a pool of sensitive and unrelated survey questions.[10,11] The researchers implementing this technique do not know which question the respondent is answering. Before the interview, respondents will be told how the RRT works, so they know no one knows the question they are answering. Therefore, sensitive questions are more likely to be answered truthfully.[10,11] After the interview, the researchers can use a formula to calculate the mean response of the sensitive question. As a result, for the respondents, privacy is protected. In the meantime, for the researcher, the truthful information can be obtained, although it is at the population level instead of the individual level. The present study aimed to explore the combination of RRT and NSUM to adjust for response bias in NSUM.

Study design

RRT was used in an NSUM survey to estimate the population proportion of FSWs in the female population aged 15–49 years in the urban district of Taiyuan, China, in 2012.

Methods

The estimate of the population proportion of FSWs in this same time period and location yielded by the multiplier method and national-level estimates of the population proportion of FSWs in Asia were used as criteria to assess the results. As a method recommended by UNAIDS and the WHO, the multiplier method has been the most commonly used method for estimating the size of high-risk populations.[1,2,12] The national-level estimates of the population proportion of FSWs in Asia were taken from a worldwide systematic literature review on the population proportion of FSWs in the female population aged 15–49 years.[13] MEDLINE and the relevant surveillance reports from national or regional branches of the WHO and UNAIDS from 1995 to 2005 were searched. Published and unpublished studies from 57 cities in Asia were reviewed, and mapping, census, and the multiplier method were applied to estimate the population proportion of FSWs.

The multiplier method

The multiplier method uses overlapping information from two data sources to estimate the size of a high-risk population. The first source should be available data from a random or non-random program, where the high-risk individuals attend institution or service. The second source should be a representative survey, where respondents from the high-risk population provide information on whether they participated in the program. The number of participants is divided by the proportion of the respondents to the survey stating that they participated in the program to estimate the size of the high-risk population. To apply this method, two assumptions should be met: (1) every member of the high-risk population was given the chance to participate in the program and to respond to the survey; and (2) participating in the program is independent of being a respondent to the survey.[1,2,12,14]

The network scale-up method

NSUM was proposed by Bernard, Killworth, Johnsen, and Robinson in 1991,[15] based on the basic principle of the personal network structure of the general population reflecting the social network structure in a given region.[16–22] Initially, NSUM is conducted in two steps. The first step is the estimation of the average size of the personal networks of the general population (c_0) using the known populations method in a region with the formula $c_0 = (m_0 \times t)/e_0$, where t is the latest annual average population in the region; e_0 is the sum of a list of specific populations, such as those whose last names are on a given list of last names (e.g. An, Chang, Lan, Mei, Mo, and Niu), for which the actual size of the population is known by researchers (hereafter in this text, these populations are