Review Article

Accumulation of Biological and Behavioral Data of Female Sex Workers Using Respondent-Driven Sampling Around the World: Systematic Review

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ABSTRACT

Background: Respondent-Driven Sampling **(**RDS) is generally used to study hidden or hard-to-reach populations. The objective of the present work is to describe the initiation, implementation, and complications that arise during RDS of female sex workers (FSWs) around the world.

Method: Behavioural and biological data of FSWs collected through RDS was mined from peer-reviewed articles, published during 2010-2022. Review protocol was developed and registered in the PROSPERO (registration number CRD42022346470) and published separately.

Results: It was found that most of the RDS (69 articles, globally) were largely successful in the recruitment of FSWs, with varying response rates.

Conclusion: Present outcomes supports the application of RDS in surveillance for any such population by providing a minimal set of parameters of testing procedures (methodology) including methods to evaluate the quality also.

INTRODUCTION

The Respondent-driven Sampling (RDS) method is a non-probability sampling method that approximates probability sample design, allowing for extrapolating results to the target population. Studying communities that are hidden or difficult to reach has certain limits, which are typically addressed by this approach.[1] In the early 1990s, the phrase "hard-to-reach population" was coined in the field of public health to describe poor socioeconomic and low literacy populations, ethnic minorities, and those, who are not successfully reached by the health workers through various healthcare initiatives.

The phrase "hidden population" was created by social science researchers to refer to the population with an inadequate sampling frame. This may occur either they belong to an unorthodox occupational group (female sex workers) or closed social groups (men who have

sex with men), or have unsocial behaviours (injecting drug users), or very small population size belong to an ununorthodox occupational group (transgenders), among others.[1]

RDS was originally developed by Heckathorn[2] as a chain-reference sampling method that traces data from one individual to another by relational succession. Stochastic Markov chain modeling, snowball sampling, and the theory of biased networks (homophily model) are all combined in this method[1]. The idea that every individual, regardless of the size of the network, is indirectly connected to every other individual through around six intermediaries is another notion the authors rely on to explain the "small world" phenomena. In the event that this premise is accurate, any randomly selected individual can be reached in the sixth wave of a reference chain, including the most socially isolated individuals[2]. Additional sociological theories—particularly behavioral theories—provide additional justifications for the "small world" phenomena. RDS has been used in a number of countries to gather data from populations at higher risk of HIV exposure, including female sex workers (FSW), men sex with men (MSM), injecting drug users (PWUD, PWID), and other individuals deemed "hard-to-reach" because of social stigma and engagement in socially unaccepted behavior.[1,3] With the guidance of agencies like the US Centers for Disease Control and Prevention, UNAIDS, the Global Fund, WHO and others, this sampling technique has been used over the years to generate data on the baseline and trend analysis for prevalence estimation, study on risk behaviors, and the impact of the program on HIV and other sexually transmitted infections through biological and behavioral assessments.[3]

In a range of contexts the sampling technique is proven viability and success in attracting hidden populations of IDUs, resulting in a quick acquired of long and diverse recruitment chains. It has been used in a number of countries to gather biological and behavioral information from male who have sex with male (e.g., Bangladesh, Cambodia, Uganda, United States) and sex workers (e.g., Vietnam, India).[3–4] RDS begins with a set number of participants, referred to as "seeds," who are selected from the target population, chosen with care by the surveillance team. Samples are created through peers giving coupons to one another.Each participant receives a limited quantity of coupons, which restricts the excessive contributions made by those with more connections to other members of the same network. These save participants from providing specific details on their recruits, allowing researchers to see the recruitment process in action.[5] To guarantee continued involvement and appropriate recruitment, those who are taking part in the survey and enlisting peers are given "incentives." A protracted recruitment chain made up of numerous "waves" of recruits may emerge from this recruitment process. As the recruitment chains lengthen, the sample arrangement becomes less dependent on the purposefully chosen seeds.[6] Following sample collection, statistical modifications are made to account for variations in network sizes and recruiting efforts, yielding data on estimates that are representative of the population's network.The fact that most [1-2,5] FSWs are mobile and frequently move between solicitation points, within and to other districts, towns, states, and provinces, which makes them difficult to reach. [7] Some ladies are difficult to locate as they engage in part-time sex work. Higher paid sex workers have the option to stay anonymous, such as those who use apps, the internet, or agencies to solicit. Through bio-behavioural surveillance efforts, FSWs in many countries have also been sampled using a probability sampling technique time location sampling (TLS). TLS, however, can only represent FSWs those are readily recognizable at visible places; as a result, it may omit potentially significant information from other kinds of FSWs. Since there hasn't been much experience with RDS yet, more testing is necessary to confirm this modality. The viability

of using this sampling technique to find hidden populations of FSWs in environments where access to FSWs and the organization of sex work are tightly regulated, and where there is minimal or no interaction between the target population and community resources, is not well understood.[7] In this context, objective of the present article is to describe implementation and outcome of RDS practices to accumulate biological and behavioral informations of FSW population, around the world.

METHOD

Details of the methods for the present article is developed as a separate protocol registered in the PROSPERO (registration number CRD42022346470) and published in a peer reviewed journal.[8]

Eligibility criteria

A total of 438 articles and abstracts are initially included after the initial search. Present search is further refined by removing abstracts and texts as duplicated (n = 177), without relevant protocols (n = 49), or claimed but not using RDS (n = 75) and review articles (n = 68). There were several publications found for a particular study and all related articles were reviewed and included on the previously prepared extraction sheet. This brings about 69 articles representing 76 different surveys included in the present work Figure 1, based on WHO classifications of regions.[9]
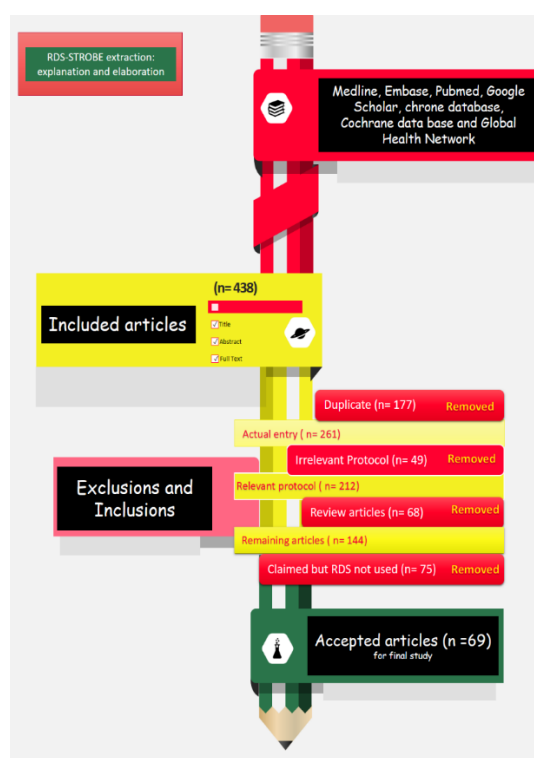

Figure 1. Flow digram of RDS extraction

Data extraction

The data has been extracted from 69 full text (Table 1) published articles[10-77] through Epi Info™ (Ver. 6.0) generated modified data extraction tool accordance to the STROBE-RDS

(Strengthening the Reporting of Observational Studies in Epidemiology for Respondent-Driven Sampling) guideline. That was arranged into six sub-tables in Table-1 based on WHO classifications of regions:[9] African Region (AFR), Region of the Americas (AMR), South-East Asian Region (SEAR), European Region (EUR), Mediterranean Region (EMR), and Western Pacific Region (WPR). The included reviewed indicators whose apprising design and implementation of the survey are observed and subjected to further analysis. Indicators informing survey design and implementation, year of publication, criteria for eligibility, specimen type/s collected for lab testing, pre-survey research was conducted or not, number and position of recruitment sites, methods of interview, the actual number of seeds at the start and at the end (and whether seeds were added or failed during data collection), amount and kind of primary and secondary incentives (in USD), calculated target and final sample size, design effect used in sample size calculation, the duration of data collection (in weeks), maximum number of waves, and maximum number of coupons distributed to each recruiter. Further analysis was carried out to find whether equilibrium or convergence was assessed or not, whether data were adjusted for network size, software used or not, etc.

Preparation of map

Topographical sheets of world map have been scanned, geo-referenced, and then digitized with the help of quantum geographic information system (Q-GIS), a free, open-sourced, cross-platform desktop-based GIS application, written in C++, Python, QT languages and provides services like viewing, editing, analysis of geospatial data. Data based on the region has been entered to the newly prepared digitized map as the non-spatial data or attributes[78].

Case definition

In the present study, female sex workers are considered as those who are females and born biologically same, and actively engaged in sailing sex in terms of money/ gift or both.[79]

Data analysis

Frequencies were used to describe the studies and their findings. The details of starting year of the study and pre-survey investigation, suitability of age, number of seeds at the beginning and end of the survey, duration of the survey, ultimate sample size, assessed design effect, the span of longest recruitment chain, and adjustment of RDS were reported accordingly. Thematic analysis was performed to identify the outcomes (challenges, reasons, and suggested interventions) common between studies.[80-83] The evidence was synthesized manually and the conceptual model was presented in a tabular sheet.

RESULTS

The available previously published articles on RDS were belongs to the following WHO regions 8: 34 studies from the African Region (AFR), 11 studies from the Region of the Americas (AMR), 11 studies from the South-East Asian Region (SEAR), four from the European Region (EUR), 6 studies from the Eastern Mediterranean Region (EMR) and 9 studies from the Western Pacific Region (WPR) (Figure 2). There were ten articles from India, nine articles from Brazil, six from Zimbabwe, five from China, four articles each from Togo, Swaziland, South Africa, and Papua-New Guinea; three articles each from Sudan and Kenya; two articles each from Uganda, Namibia, Iran, and Burkina Faso. The rest of the included countries had one article from each (Table 1).

The key challenges faced by researchers while recruiting FSWs using RDS have been described here in detailed. The challenge reported by most of the studies is the poor response rate,[84-86] which was measured in different ways by low coupon return rate and the considerable number of seeds being non-productive. As a result, the workers either did not complete recruiting the desired sample within the stipulated time, had to increase the duration of data

collection, or added new seeds when the data collection process was ongoing.[79] The key reasons for poor response rate were found to be less mixing/ networking of FSWs and their high level of independence, external control of FSW restricted freedom of movement and perception of inadequate incentive and their mistrust towards researchers due to poor community involvement[67]. Moreover, accessibility, acceptability, and timing of RDS sites and social stigma also resulted from low coupon returns.[80] Pre-surveillance formative research involving community representatives (community representatives are often former or current sex workers themselves, who can understand and address the unique challenges faced by their community) was considered as crucial for assessing network characteristics and feasibility of RDS in the study setting. Other interventions for improving response included intensive rapport building, provision of services along with research, finalization of RDS site, and nature of incentive after discussion with study participants.[81]

Selection bias could occur due to high homophily, i.e. tendency of participants to recruit others with similar characteristics.[82] This could be minimized by weighted analysis and statistical modelling.[83] RDS could miss a selected geographical pocket where seeds were non-productive, and their characteristics could be significantly different from those who were selected.[84] The use of primary and secondary incentives was likely to attract the FSWs with poor socioeconomic status, but unlikely to involve those with higher purchasing power.[85] A meticulous seed selection could decrease such selection bias by recruiting FSWs from different geographical divides, social statuses and occupational differences.[84]

Research had revealed that known HIV-infected persons could have a high probability of refusing to attend RDS sites and get tested for HIV, compared to their counterparts, as a result, RDS could under-estimate prevalence of HIV.[85] On the other hand, inaccurate reporting of network size could result in a biased sampling weight, which could adversely affect the outcome.[86] Scientists are suggested that the accuracy of reporting network size could be checked by collecting network size-related data both during the main interview and in the follow-up interview (while collecting secondary incentives), and conducting test-retest reliability of this estimate.[87]

Among the 69 previously published articles, 64 articles are found to be reported HIV prevalence point estimations above zero, and one article selected was not on HCV instead of HIV. 32 articles (46.37 %) included all three components to facilitate the design of calculated design effect for HIV prevalence. 6 articles (8.7 %) conveyed the design effect less than 1.0, 22 articles (31.9 %) carried the design effect of 1.0 and 4 articles (5.8 %) carried the design effect of more than 1.0., which directed that larger sample size is always required to calculate correct HIV prevalence. As mentioned by many researchers, it was of utmost importance to carry out a detailed formative evaluation of network characteristics and occupational differentials of this high-risk group before deciding whether RDS was feasible or not. After deciding to introduce RDS, the next step should be thorough rapport building (through key informant interview or consultation meeting or both) with the community, and selection of seed and venue (location and timing) through proper guidance from community representatives.

Table 1. Methodological and analytical data extracted from previously published articles.

Author	Year	Country	Pre-survey assessment	No. of sites	Interview method	Initial seeds	Final seeds	Primary incentives ($)	Secondary incentives ($)	Target sample size	Final sample size	Maximum no. of waves	Duration of data collection (week)	Data adjusted	Lowest age limits (FSW)	Inconsistent condom use (%)
African Region (AFR)																
Abdelrahim et al.	2010	Sudan	NR	1	IA	NR	NR	10	10	NR	321	NR	8	Yes	NR	NR
Vandenhoudt, et al	2013	Kenya	Yes	1	ACASI	15	NR	4	1.25	480	481	6	12	Yes	NR	NR
Johnston, et al.	2013	Mauritius	NR	2	IA	5	5	17.5	7	NR	299	8	2	Yes	NR	NR
Fonner et al.	2014	Swaziland	Yes	1	IA	3	9	3	2.5	324	325	NR	20	NR	18	17.84
Baral et al.	2014	Swaziland	Yes	1	IA	NR	NR	NR	NR	NR	328	NR	12	No	18	61.7
Yam et al.	2014	Swaziland	Yes	1	IA	NR	NR	NR	NR	NR	325	NR	12	Yes	16	NR
Musyoki et al.	2015	Kenya	Yes	1	NR	6	NR	2	2	600	596	10	8	Yes	18	35.4
Schwitters et al.	2015	Uganda	Yes	1	ACASI	4	NR	4	1.25	1500	1501	25	36	Yes	15	40
Mtetwa et al.	2015	Zimbabwe	Yes	3	IA	22	22	5	2	NR	836	6	48	NR	18	NR
Holland	2016	Burkina Faso	NR	2	IA	10	10	3	4	700	694	NR	28	Yes	18	NR
Quaife et al.	2016	South Africa	Yes	1	IA	7	10	3.14	1.26	200	200	NR	24	No	16	NR
Holland et al.	2016	Togo	NR	2	IA	10	10	101	10	700	679	NR	28	Yes	18	NR
Hargreaves et al.	2016	Zimbabwe	NR	14	CASI	4	9	NR	NR	2800	2800	5	20	Yes	18	NR
Ouedraogo et al.	2017	Burkina Faso	Yes	5	IA	3	10	4	3	NR	471	NR	64	Yes	18	37.7

Lafort et al.	2017	Kenya	Yes	1	IA	16	16	NR	NR	400	400	NR	12	Yes	NR	NR
Lafort et al.	2017	Mozambique	Yes	1	IA	13	13	NR	NR	400	308	NR	12	Yes	NR	NR
Lafort et al.	2017	South Africa	Yes	1	IA	11	11	NR	NR	400	458	NR	12	Yes	NR	NR
Amogne et al.	2019	Ethiopia	Yes	11	IA	NR	NR	5	2.5	4400	4900	NR	24	Yes	15	25.5
Twahirwa Rwema et al.	2019	Senegal	NR	3	IA	12	12	NR	NR	NR	758	14	12	Yes	18	48
Parmley et al.	2019	South Africa	Yes	2	IA; CAPI	30	30	9.5	4.5	400	410	NR	28	No	18	NR
Lasater et al.	2019	Togo	Yes	1	NR	5	5	NR	NR	350	3545	NR	28	Yes	18	NR
Chabata et al.	2019	Zimbabwe	Yes	14	IA	6	8	NR	NR	2800	2883	5	16	NR	18	39.2
Cowan et al.	2019	Zimbabwe	Yes	19	NR	NR	NR	5	2	NR	6096	7	6 years	Yes	18	28.3
Fearon et al.	2019	Zimbabwe	No	7	NR	6	8	NR	NR	NR	1439	5	92	Yes	18	81
Owen et al.	2020	eSwatini	NR	1	IA	14	14	NR	NR	325	325	7	12	Yes	16	66.5
Jonas et al.	2020	Namibia	Yes	4	ACASI	33	52	10	2	NR	1188	15	48	Yes	18	71.6
Hakim et al.	2020	Sudan	Yes	1	CASI	4	9	20	21	NR	838	17	20	Yes	15	19.8
Chabata et al.	2020	Zimbabwe	NR	6	IA	6	10	3	2	1810	1842	NR	24		18	19.6
Boothe et al.	2021	Mozambique	Yes	1	IA	13	13	NR	NR	400	308	NR	12	Yes	15	NR
Bitty-Anderson et al.	2021	Togo	Yes	1	IA	NR	NR	NR	NR	348	1036	NR	8	No	18	45.8
Yeo et al.	2022	South Africa	Yes	2	IA; CASI	11	11	19	1.5	NR	664	NR	32	No	18	NR
Hakim et al.	2022	Sudan	Yes	2	IA	4	9	20	21	NR	838	NR	56	Yes	15	38

Bitty-Anderson et al.	2022	Togo	Yes	8	IA	NR	NR	NR	NR	495	1036	NR	12	No	18	33.7
Region of the Americas (AMR)																
Damacena et al.	2011	Brazil	Yes	10	ACASI	2	4	2	1	2500	2523	6	48	Yes	18	NR
Damacena et al.	2011	Brazil	NR	NR	ACASI	5	5	NR	4	300	289	NR	52	NO	NR	NR
Johnston et al.	2012	Honduras	Yes	1	ACASI	5	5	2	3.5	200	182	11	8	Yes	NR	NR
Dennis et al.	2013	El Salvador	NR	NR	CASI, IA	10	10	NR	NR	NR	787	NR	NR	NO	NR	NR
Lima et al.	2017	Brazil	Yes	10	ACASI	5	10	NR	NR	1000	2523	NR	48	Yes	18	NR
Ferreira-Janior et al.	2018	Brazil	Yes	12	IA	5	10	NR	NR	4200	4245	NR	20	Yes	18	NR
Martins et al.	2018	Brazil	Yes	2	CAPI	5	5	3.02	2.01	400	402	NR	16	NR	18	NR
Szwarcwald et al.	2018	Brazil	Yes	12	IA	5	10	5	2.5	4200	4328	NR	20	Yes	18	NR
Braga et al.	2021	Brazil	Yes	12	SA	NR	NR	NR	NR	4200	4328	NR	24	Yes	18	NR
Kolling et al.	2021	Brazil	Yes	12	SA	NR	NR	NR	NR	4200	4328	NR	24	Yes	18	NR
Matteoni et al.	2021	Brazil	Yes	12	IA	5	10	5	2.5	4200	4328	NR	20	Yes	18	NR
South-East Asian Region (SEAR)																
Blankenship et al.	2010	India	Yes	1	IA	5	5	NR	NR	NR	1485	NR	12	Yes	24	NR
Gupta et al.,	2011	India	Yes	1	IA	NR	NR	NR	NR	NR	812	NR	12	Yes	NR	NR
Barua et al.	2012	India	NR	NR	SA	10	10	NR	NR	400	426	11	8	NO	NR	NR
Erausquin et al.	2012	India	No	1	IA	5	5	0	0	2335	2276	NR	40	Yes	18	38.8
Medhi et al.	2012	India	Yes	1	IA	10	9	NR	NR	400	426	11	8	NO	NR	NR

Armstrong et al.	2013	India	Yes	1	IA	NR	NR	NR	NR	400	426	NR	NR	Yes	18	55.8
Lafort et al.	2016	India	Yes	1	IA	8	8	NR	NR	400	400	NR	12	Yes		NR
Reed et al.	2016	India	NR	3	IA	NR	NR	4.7	NR	NR	2335	NR	12	NR	18	NR
Manathunge et al.	2020	Sri Lanka	Yes	3	IA	2	7	2	1	1100	1180	9	20	Yes	18	20
European Region (EUR)																
Zohrabyan et al.	2013	Moldova	NR	NR	IA	5	5	16	12	350	299	6	16	Yes	NR	NR
Wirtz et al.	2015	Russia	Yes	3	IA	NR	NR	NR	NR	NR	754	NR	12	NR	18	14.6
McLaughlin et al.	2019	Armenia	Yes	3	IA	NR	NR	7	3	NR	NR	9	24	NR	18	NR
Jonsson et al.	2019	Sweden	Yes	1	IA	57	34	11	NR	595	415	15	21	Yes	18	NR
Eastern Mediterranean Region (EMR)																
Mahfoud et al.	2010	Lebanon	NR	NR	NR	NR	NR	6.6	2	NR	81	NR	NR	Yes	NR	NR
Kriitmaa, et al.	2010	Somalia	NR	1	IA w/ CAPI	6	NR	4	3	146	237	NR	8	Yes	NR	NR
Valadez et al.	2013	Libya	Yes	1	IA	NR	13	NR	NR	314	69	10	20	Yes	NR	NR
Ahmadi et al.	2012	Iran	Yes	8	IA	N	N	0	0	NR	144	NR	48	NR	18	19
Navadeh et al.	2012	Iran	NR	1	IA	8	12	4	2	NR	177	NR	16	Yes	NR	NR
Johnston et al.	2015	Morocco	Yes	4	IA	4	10	NR	NR	NR	1447	10	8	Yes	18	NR
Western Pacific Region (WPR)																
Li et al.	2010	China	No	1	ACASI; IA	3	4	0	0	NR	320	16	20	Yes	16	82.6
Li et al.	2012	China	NR	1	NR	NR	3	16	8	NR	NR	20	16	Yes	15	NR
Yamanis et al	2013	China	Yes	1	IA	7	7	19.66	12.1	454	515	11	16	NR	18	0
Liu et al.	2016	China	NR	3	NR	NR	3	16	8	NR	1245	20	16	Yes	15	NR

Guida et al.	2019	China	Yes	3	CAI	4	5	10	3	1200	1245	11	12	No	35	37.2
Weikum etal.	2019	Papua New Guinea	Yes	3	IA	5	5	12	2	2100	2091	NR	28	No	12	NR
Hakim et al.	2020	Papua New Guinea	Yes	1	IA	5	9	14	4.5	700	674	NR	20	Yes	12	6
Willie et al.	2021	Papua New Guinea	Yes	2	NR	NR	NR	NR	NR	NR	2091	NR	20	NR	12	NR

NR: not reported
IA: interviewer administered
SA: self-administered
CASI: computer assisted structured interview
ACASI: computer assisted structured interview
CAPI: computer-assisted personal interviewing

Here, we like clear that key informants are individuals who have significant and specialized knowledge about the community. This knowledge may stem from their professional roles, personal experiences, or long-term engagement with the community. They are often consulted in qualitative research and needs assessments to provide in-depth information, perspectives, and contextual understanding that might not be accessible through other data collection methods. The number of seeds should be guided by population size and the type of networking within it. Utmost care should be taken not to miss selected geographical pockets while distributing the seeds. Considering the stigmatization and social isolation associated with this occupation, sensitization of administrative and legal officials is an essential prerequisite before initiating the data collection.[88]
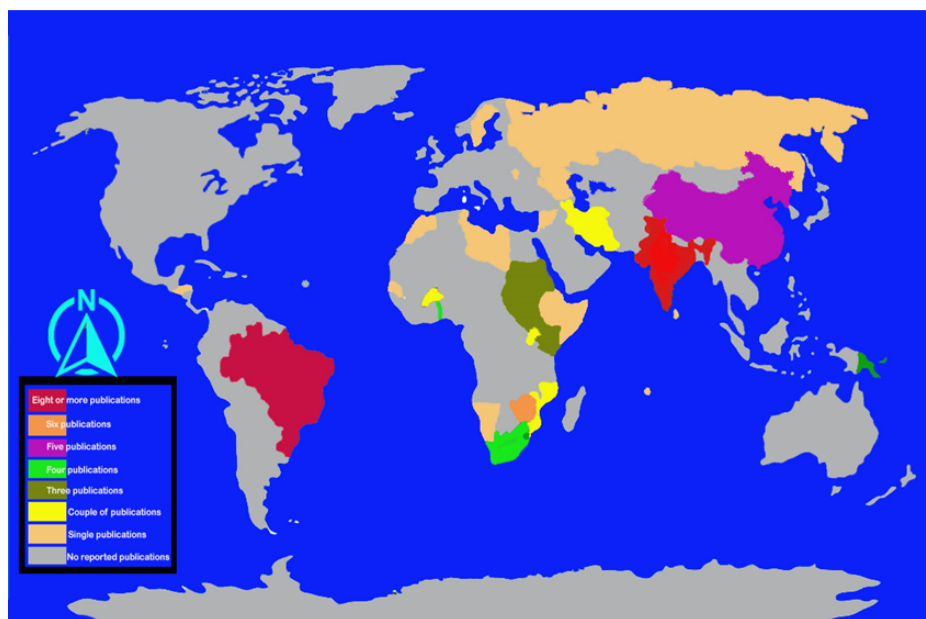
Figure 2. Published articles of RDS surveys were conducted in the WHO demarcated regions

DISCUSSION

It is essential to explain the methodological and analytical aspects of RDS in any study through the survey strategy, execution, and examination, which are necessary to evaluate the RDS surveys and their findings.[84] The majority of surveys, accumulated here reported the most vital information as the place/country of study, study year, population sampled, methods of interview, and final sample size. RDS adjustment consists of applying variable-specific weights to account for the potential biases arising due to homophily and the variation in network sizes of different individuals.[89] Recent advance in software-based weighted analysis has made the opportunity to obtain a much more robust estimate that approximates random sampling if it fulfils certain assumptions.[90]

It is evident that providing compensation to the respondents increases the rate of recruitment. Moreover, secondary compensation increases the rate of recruitment in comparison with the single compensation system.[79] However, several published articles, also mentioned that their

field team got physically assaulted to denied some respondents, who were willing to participate to avail the incentive without being eligible as a participant, and argued for providing more money as secondary incentive.[91] This tendency of avail extra money, encourages respondent to give multiple responses at different RDS venues. Sometime a single responder can get coupon from two different typologies. Suppose, an FSW person who inject drugs can get coupon from FSW RDS site as well as from FIDU RDS site. FIDU refers here female who inject drugs. These undesirable events could be prevented by strong inter-sectoral communication and convergence before initiating the field activity, and by judiciously using screening tools to prevent duplication [84,92]. Different groups of workers are also cited that documentation of refusal rate is difficult in RDS,[26] which may be solved by using the different indicators for assessing the speed of recruitment process[82,83]. Survey conductors must monitor the coupon return rate, in such a way that they can modify the number of seeds accordingly to rate the data collection to complete the survey within a stipulated time.[27]

Difficulties in accessing FSW with higher social status is a general limitation any sampling designs used (time location cluster sampling, conventional cluster sampling, snowball sampling etc), till date.[83] For public health perspective, they are expected to be having sufficient knowledge on regular health and hygiene, more empowered to convince condom use, and less likely to disclose their status and come under the umbrella of government/NGO-run free health services, so they are unlikely to get included in this kind of activities.[83] The advantage of RDS over other methods for sampling similar populations, is that it can reach hidden population networks that the other methods fail to reach.[21] Despite non-random selection of initial seeds, this sampling can produce weighted estimates which can approximate random sampling if certain assumptions are fulfilled.[81] The use of RDS in recruiting different population has been increasing multi fold in recent years. This sampling technique largely depends on social networks and it can be effective to recruit those populations that are expected to be linked by their social network, like injecting Drug Users (IDUs) or Men who have sex with Men (MSMs). Literature review revealed that there has been an increasing number of research activities in the current year where the present sampling technique was used for recruiting Female Sex Workers.[81-83] Sex workers are a highly vulnerable occupational group, involved in selling sex for money or kind. Globally in most of the countries, sex work is not a socially acceptable occupation, and sex workers face considerable stigma and discrimination. They are likely to have a social network because of their need to be united to fight against occupational vulnerability. A counter argument can also be raised. FSWs are distinct occupational groups, each of them is a potential competitor for other group members. Networking within FSW is not essential for continuing their occupation, rather they need networking with pimps and clients for their sustainability. So, a considerable variation in their social connectivity is expected among this population group. As RDS largely relies on social networks, it will be interesting to know whether RDS is useful to recruit FSWs, and what type of challenges that could be faced by the researchers if they want to recruit FSWs with RDS.[85]

Like any systematic review, the present study is also restricted by the comprehensiveness of the published articles and whether workers published their study in open accessed and peer-reviewed journals. Moreover, included articles having surveys that accumulate biological data leaving an approach for further assessment of those surveys that described RDS on FSW population and give any information on biological data.[86] It was found, that the number of articles regarding RDS surveys on FSW is much lower than the number of surveys were

conducted. One of the important findings of the present study is that published articles are devoid of essential data regarding RDS which supports the need to homogeneously report results from RDS surveys that limited the scope of analyses and acquaint with uncertainty in some of the other outcomes.[89] The articles are excluded, undoubtedly not fulfilling the necessary features of the RDS method. However, two to three articles were included that did not incorporate all the features of RDS, showing the incompleteness of reporting.[90] On those occasions, surveys were categorized as using RDS up to some extent. It was found that seventy-five articles claimed to use RDS, but did not, reported using a 'modified' or 'mixed methods' of RDS.[91] These studies are not providing any definite indication of the assemblage and use of the personal network, size data, recruitment treaties, coupon management along with numerous recruitment waves. These articles are not included in the final analysis. A few extracted publications were found with significant limitations, including less competent staff, several ineligible persons were trying to participate in the survey and compelled to close or move survey sites at the period of data collection. These articles are used to make a note on the challenges of implementing RDS among FSW and recommendations was suggested from same or from other similar published articles on RDS among FSW.[92]

The majority of published surveys were from African Region (AFR) and the south-east Asian Region (SEAR); it may be useful to find more publications on RDS survey on FSWs from other regions. The socio-economic position of FSW from these regions may have an impact on the survey procedure using RDS, regarding the networking among subjects and incentives may have a role here.[82]

CONCLUSION

It was found through the present review that most of the published articles were largely successful to recruit FSWs through RDS, with the varying response rate in almost all the study settings globally. Despite ample pieces of evidence of challenges in implementing RDS among FSW and threats of selection bias during the sampling process, this technique is regarded as the most suitable technique available till date for sampling those populations where the sampling frame is non-existing. The key advantage is that RDS offers a systematic and theoretically grounded approach to recruiting participants from "hidden" or "hard to reach" populations. This peer-to-peer recruitment is driven by anonymous coupons, making it successful among populations that are stigmatized or practice those behaviours considered illegal in the existing social structure. As sex work also carries similar occupational vulnerability, this approach is expected to be appropriate and the best suited for this high-risk population. Present findings will help researchers, policymakers and service providers to improve RDS methods for surveillance of any key population by providing a minimum set of parameters of specific methodological, analytical, and testing procedures including RDS methods to evaluate the overall quality of any RDS survey.

Authors' contribution

MB, SiB and SuB conceived and designed the study. MB, SD and DC established the search strategy. PG, AM, MB and SS prepare the master table. MB and PG extracted the data. MB and SiB perform the analysis. MB, AM, PG, SiB, SuB and SD wrote the article. All the authors read the manuscript before they have given the final approval for publication.

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Conflict of interest

There is no conflict of interest in this research.

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