Estimation of Drug Addicts among Students of Senior Secondary Schools Located in Kumaun Region of Uttarakhand, India Using RRT

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SUMMARY

We applied the randomised response technique (RRT) to estimate the number of drug addicts among the male and female students of senior secondary schools located in Kumaun region of Uttarakhand, India. Warner's RRT was applied to estimate the drug addicts among the senior secondary students in the region. The procedure adopted in the study provides adequate confidentiality to the respondents and reduces survey time. An estimated number of 26% of total students were found to be addicted to drugs with a 95% confidence interval [20%, 32%]. A strong association was found between drug addiction and academic performance of the students. The study is highly useful for planners in state and central governments to assess the gravity of the drug addiction among the school going children of the region and find ways to control the growing menace of drug addiction in the society.

Keywords: Randomized response, Related question model, Estimates, Drug addiction.

1. INTRODUCTION

Drug addiction can be defined as the habitual taking of illegal drugs. Gelder and Cowen (2001) observed that substance abuse or drug abuse results in clinically significant impairment or distress, wherein the person may suffer from tolerance and withdrawal. Foo *et al.* (2012) found that the parents' substance abuse habits were the most influential factor in affecting a child's substance abuse. These researches were based upon direct questioning method of the survey.

Drug addicts in a community can be estimated by direct questioning but some respondents may not answer truthfully or provide false responses regarding their status about drug abuse due to social stigma. To eliminate the evasive bias due to sensitivity of questions, a technique known as randomised response technique (RRT), initially propounded by Warner (1965) is used. In this technique, a randomizing device is used to extract answers of the questions having sensitive nature by protecting the privacy of the respondents. Suppose we are interested in estimating the proportion of individuals in the population who possess a sensitive character

A. The population is, therefore, dichotomous, some possessing the character *A*, and others possessing the complementary character *A'*. Because of the sensitive and often stigmatic nature of *A*, direct questions would result in biased estimates of the population proportion(π) as most of the respondents would give untruthful or evasive answers. Though the resulting evasive answer bias is ordinarily difficult to assess, it is potentially removable by allowing the interviewee to maintain privacy through the randomisation device. To eliminate this bias, Warner (1965) suggested a related question model followed by unrelated question model by Greenberg *et al.* (1969), which were subsequently improved by different authors. The nature of the data so obtained by implementing these techniques is either qualitative or quantitative. A summarisation of different randomised response techniques can be seen in Fox and Tracy (1987), Chaudhuri and Mukherjee (1988), and Chaudhuri *et al.* (2016).

The RRT suggests itself as one of the natural choices in case of the sensitive nature of the survey. It protects privacy of the respondent and develops a good

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rapport with the interviewer. The respondent provides information on a probability basis without revealing their personal status. By allowing the respondent to maintain his privacy, a better cooperation from him as compared to direct questioning is expected. Thus, RRT can be used to assess the severity of drug addiction among the students of senior secondary schools of Kumaun region of Uttarakhand, India. This study also enabled us to check the limitations of RRT in such type of field surveys.

Researchers used RRT in different fields to estimate the proportion of individuals possessing sensitive attribute like drug addiction, sexual abuse, extramarital affair, tax evasion etc. Chow *et al.* (1979) applied a multiple answer model of RRT (known as Hopkins RRT model II) in a rural area in Ethiopia to estimate the incidence of induced abortion among newly married women of childbearing age. Scheers and Dayton (1987) used RRT in estimating academic cheating behavior of university students. Houston and Tran (2001) conducted a survey using RRT for estimating tax evasion. Soudarssanane *et al.* (2003) applied RRT to estimate the prevalence of pre/extra marital sex. Ostapczuk *et al.* (2009) presented a randomized response investigation of the education effect in attitudes towards foreigners. Srivastava *et al.* (2015) used multi-proportions randomized response technique to assess the extent of sexual abuse among children in some districts of Uttar Pradesh state of India. Chhabra *et al.* (2016) used optional unrelated question RRT and asked the question "Have you ever been a victim of sexual abuse by a friend or family member?" to 585 students in a college in Delhi, India. Cobo *et al.* (2016) conducted an RRT survey into stratified sample of 1146 students of Spanish University and asked sensitive quantitative questions about cannabis use. Kirtadze *et al.* (2018) applied RRT to estimate the proportion of alcohol and other drug users in the country of Georgia.

In recent times, several cases concerning drug addiction including some most severe criminal cases related to drug abuse or illegal use of drugs among students of the Kumaun region of Uttarakhand, India have surfaced. Saxena and Upadhyay (2016) reported that the problem of drug addiction is acute in Kumaun region of Uttarakhand, where according to their sources almost 50 per cent of those being admitted in de-addiction centers, are in the age group of 12-19 years. From secondary sources like magazines,

newspapers and electronic media, it is revealed that in the community of school going children in India, marijuana has been the most popular drug. These secondary data encouraged us to make an attempt in determining the severity of drug addiction among students of senior secondary schools in Kumaun region of Uttarakhand, India. RRT was used for the study due to the social stigma attached to drug addiction in that age group. In this paper, we apply the Warner's RRT to estimate the number of drug addicts among the students of senior secondary schools located in Kumaun Region of Uttarakhand, India.

2. MATERIAL AND METHODS

The purpose of the present study is to apply Warner's RRT to estimate the proportion of drug addicts in Kumaun region of Uttarakhand. Our approach was slightly different in this case as we constructed an anonymous questionnaire and instructed the respondents in a group about the RRT and ensured them regarding the confidentiality of data. After instructing them, we collected the information in straightforward manner by isolating each respondent from the group. This procedure helped in reducing survey time.

The anonymous questionnaire consisted of 8 questions. In questions numbered from 1-7, demographic and socio-economic information such as gender, type of school, place of living, type of family, family monthly income, academic performance etc. were sought whereas question no. 8 was based on the sensitive issue (drug addiction), which was answered by the respondents using the randomizing device (i.e. by rolling a die). There were two statements each having a binary response (Yes or No) under question No. 8, namely, Statement A and Statement B. If the die rolled 2, 3, 4 or 5, statement A was to be answered by the respondent, which state that "I consume illegal drugs" and if the number surfaced on the die was 1 or 6, statement B was to be answered by the respondent, which was a negation of the statement A, i.e., "I do not consume illegal drugs" (see Appendix-I). Clearly, the probabilities of selection of statement A and statement B are 0.67 and 0.33 respectively. These probabilities under the Warner's model were recommended by Mukhopadhyay (2014) for estimating the sensitive issue.

In this study, the data have been collected in the month of October 2018 by interviewing 200 students

from four senior secondary schools (name of schools have been kept confidential due to the sensitive nature of the survey) situated in Nainital and Udham Singh Nagar districts of Kumaun region of Uttarakhand, India. The schools and students from each school were selected randomly using the simple random sampling without replacement technique. Data were collected by distributing the questionnaire personally to the students in a group by instructing them to answer only first 7 questions directly, and for answering the question number 8 respondents were called to the corner of room one by one to use the randomizing device. Before responding to this question, each respondent was briefed about the method and instructed to answer truthfully. Thus, the sensitive question had been answered by respondents with the help of randomizing device, *i.e.* a simple six faced unbiased die. On the basis of the response of question no. 8, collected questionnaires had been categorised into two categories viz. "Yes" Answered questionnaires and "No" Answered questionnaires. Warner's related question model was adopted in the questionnaire and as such the estimate of drug addicts was computed through the Warner's estimate.

2.1 Statistical Approach

Assuming that the respondent answers truthfully through the randomised response device, using Warner's (1965) procedure, the probability of a 'yes' answer is,

$$\lambda = \pi P + (1 - \pi)(1 - P) = (1 - P) + (2P - 1)\pi$$

$$(1)$$

Denoting the number of 'yes' answers in the sample as *r,* an unbiased estimator of λ is,

$$\hat{\lambda} = \frac{r}{n}.$$

Hence, from (1) an unbiased estimator of π is (taking $P \neq \frac{1}{2}$),

$$\hat{\pi}_w = \frac{P-1}{2P-1} + \frac{r}{(2P-1)n}$$

$$(2)$$

When $P = 1$, a direct response survey occurs and we get $\hat{\pi}_w = \frac{r}{n}$, the usual estimate of population proportion π, whose variance is $\pi(1-\pi)/n$. r, the number of "Yes" answers in the sample, is a random variable as there has been a probability associated with it. It

follows a binomial distribution with parameters (n, λ). The variance of $\hat{\pi}_w$ is given by,

$$Var(\hat{\pi}_w) = \frac{\lambda(1-\lambda)}{n(2P-1)^2}$$

$$= \frac{\pi(1-\pi)}{n} + \frac{1}{n}\left[\frac{1}{16(P-0.5)^2} - \frac{1}{4}\right]$$

$$= \frac{\pi(1-\pi)}{n} + \frac{P(1-P)}{n(2P-1)^2}$$

Since

$$E\left(\frac{\hat{\lambda}(1-\hat{\lambda})}{n-1}\right) = \frac{\lambda(1-\lambda)}{n},$$

an unbiased estimator of $Var(\hat{\pi}_w)$ is,

$$Est.\{Var(\hat{\pi}_w)\} = \frac{\hat{\lambda}(1-\hat{\lambda})}{(n-1)(2P-1)^2}$$

$$= \frac{\hat{\pi}_w(1-\hat{\pi}_w)}{n-1} + \frac{P(1-P)}{(n-1)(2P-1)^2}$$

$$(3)$$

3. RESULTS

For this field survey, the population consists of the students studying in senior secondary schools in Kumaun region of Uttarakhand. Based on a prior guess at the parameters of interest and on the randomization device parameters being used in collecting the data, Lee *et al.* (2013) recommended minimum sample sizes for the Warner's model. By considering the relevant parameters associated with our randomization device, 200 students were selected by SRSWOR from different Senior Secondary Schools of the region. A regular unbiased die was used as a randomization device for Warner's model with P = 2/3. Table 1 represents the binary response distribution of the sensitive question according to the gender. The estimates of proportion possessing the sensitive attribute and its variance were computed for the model using equations (2) and (3), respectively. The estimates of drug addicts among male and female students are given in Table 2.

As per the estimates developed in the study, 32% male and 18% female students were drug addicts in the region. The difference between proportions of drug addicts among male and female students were significant at 5% level of significance (p-value = 0.03). Thus, it can be concluded that there is a significant difference between the proportion of drug addicts among the male and female students of senior secondary

schools in Kumaun Region of Uttarakhand. It has also been estimated that the proportion of total drug addicts among students of senior secondary schools of the region is 26% with a 95% confidence interval [20%, 32%].

Table 1. Binary response distribution of sensitive question according to gender

			Gender		Total
			Male	Female	
Response	**No**	**Count**	65	51	116
		% within Gender	56.0%	60.7%	58.0%
	Yes	**Count**	51	33	84
		% within Gender	44.0%	39.3%	42.0%
Total		**Count**	116	84	200
		% within Gender	100.0%	100.0%	100.0%

Table 2. Warner's estimate of drug addicts among male and female students of senior secondary schools in Kumaun Region of Uttarakhand

Gender	P	"Yes" Answers	$\hat{\lambda}$	$\hat{\pi}_w$	$Var(\hat{\pi}_w)$
Male	0.67	51	0.44	0.32	0.0107
Female	0.67	33	0.39	0.18	0.0103
Total	**0.67**	**84**	**0.42**	**0.26**	**0.0106**

In our questionnaire, we have extracted the information regarding the recent academic performance of students in 3 categories. The categories were made according to their recent examination marks percentage (CGPA) and were termed as; Low (less than 50%), Average (50% – 75%) and High (above 75%). On the basis of this information the association between drug addiction and academic performance of students can be tested.

To perform the study, the "Yes" answered questionnaires were classified into 3 categories viz. Low, High and Average, and Chi-square test was applied to the data. Table 3 exhibits the outcome of the analysis. Table 3 reveals that we obtained a p-value lower than the desired level of significance (5%), hence it may be concluded that there exists an association between drug addiction and academic performance of students. Hence, it may be concluded that the drug addiction affects the academic performance of students.

4. CONCLUSIONS AND DISCUSSION

Making normal assumptions regarding the RRT approach and assuming that a few participants made mistakes during the RRT process, the results presented in this study suggest that RRT can be effectively used to estimate the population possessing a sensitive characteristic such as drug addiction. The study suggests that the menace of drug addiction is quite alarming (26%) among the students of senior secondary schools in Kumaun Region of Uttarakhand, India. While 32% of the male students were found to be drug addicts, the female students were also not legging behind with an estimate of 18% drug addicts among them. However, a significant difference was found between the proportion of male and female drug addicts among the senior secondary students in the society. It was also revealed by the study that the drug addiction among students has an effect on their academic performance.

The study is highly useful for planners in state and central governments to assess the gravity of the drug addiction in the schools and find ways to control the growing menace of drug addiction in the society. The state government must take immediate steps to control the situation and the parents and society should also

Table 3. Association between Academic performance and Drug addiction.

			Drug-Addiction		Total	Chi-Square and p-value
			Non- Addicts	Addicts		
Academic Performance (AP)	**Low**	**Count**	33	24	57	
		% within AP	57.9%	42.1%	100.0%	11.038
	Average	**Count**	93	24	117	
		% within AP	79.5%	20.5%	100.0%	**(0.004*)**
	High	**Count**	22	4	26	
		% within AP	84.6%	15.4%	100.0%	
Total		**Count**	148	52	200	
		% within AP	74.0%	26.0%	100.0%	

*Significant at 5% and 1% level of significance.

cooperate with the government initiatives to keep their children away from drugs. The help of non-government organizations working in the area, print and electronic media and social workers may also be taken to educate the children about the harmful effects of drug addiction. Sources of drugs coming to the hands of the children must be identified and strict action should be taken to stop them.

At this stage of initial examination of RRT implemented to a small-scale survey on drug use, the most important finding of the study might be its clear demonstration that an efficient RRT technique can be used in situations where large sample survey has to be conducted for estimating sensitive issues. Since, the RRT is useful in estimating sensitive issue, thus, by implementing such methods we can gather information about other type of sensitive issues already existing or emerging in the state of Uttarakhand as well as in India.

The present study has some limitations as well. Firstly, this study was conducted with a relatively small sample size as compared to the size of the target population, due to insufficient funds and no monetary support from any agency. RRT has provided quite reasonable estimates of drug addicts among students by protecting their privacy in this small-scale research. The research can further be extended to larger scale covering the whole state and the country. In large scale research, the question covering the sensitive issue like drug addiction can be extended/split into many components according to the class of drugs consumed by students. It will help in asserting which illicit drug is more popular among them. Secondly, there are several models developed by various researchers for RRT, however every model has its limitations and drawbacks. Moreover, some of the RRT models have only theoretical framework and lacks the experimental implementation in real life scenarios. In this study, we have applied the basic RRT model suggested by Warner (1965) to make an initial attempt to practically verify the applicability of RRT models in estimating the sensitive characteristics. Consequently, for further studies an efficient technique can be developed and implemented by considering the techniques already in use for a particular field of study. This study has been an attempt to apply RRT for estimating drug addicts in the particular community of students. The RRT approach in this kind of sample survey condition deserves some contemporary improvements and adjustments that will enhance its utility as a reliable and accurate method of estimating drug addicts in the society.

Declaration of interest statement

The authors have no competing interests.

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APPENDIX-I

Survey for Estimating Sensitive Issue among Students Questionnaire

Respondent No. [＿＿＿＿＿＿＿＿]

Kindly tick the appropriate boxes below to participate in the survey. Your identity will not be compromised at any stage.

1. **Gender**

   [ ] Male   [ ] Female

2. **Type of School**

   [ ] Private Public-School   [ ] Government School

3. **Class**

   [ ] 11th   [ ] 12th

4. **Place of Living**

   [ ] In City   [ ] In Village

5. **Type of Family**

   [ ] Joint Family   [ ] Nuclear Family

6. **Family Monthly Income**

   [ ] ₹10,000 and Below   [ ] ₹ 11,000 - 30,000   [ ] ₹ 30,000 &Above

7. **What is your academic performance, recently?**

   [ ] Low (40% - 60%)   [ ] Average (60% - 70%)   [ ] High (Above75%)

8. **Survey Question**

   Roll the dice and please answer Question 1 or Question 2 according to the number you get on the dice provided to you.

If you get 2, 3, 4,or 5, answer **Question 1:** Do you *consume* illegal drugs?	[ ] Yes
If you get 1 or 6, answer **Question 2:** Do you *not consume* illegal drugs?	[ ] No

Thank you for the participation…