

# Comparative Appraisal of Randomized Response Technique *vs.* Direct Interview Method in Assessment of Burden of Tobacco and Alcohol Use among Adolescents

Ashish Datt Upadhyay<sup>1</sup>, Sada Nand Dwivedi<sup>1,2\*</sup>, Anju Dhawan<sup>3</sup>, V. Sreenivas<sup>1</sup>

In countries like India, the major source of error in the reporting of sensitive events (e.g., tobacco and alcohol use) among adolescents is deliberate misreporting. To estimate its burden, the commonly used direct interview method involves problems in reporting. To cope, the randomized response technique (RRT) is an alternative approach that uses a random device to provide more privacy to respondents. So, it may be worthwhile to compare RRT with the direct interview method in the assessment of the burden of ever tobacco and alcohol use among Indian adolescents. A cross-sectional survey on ever tobacco and alcohol use among adolescents was conducted on 796 students of 9<sup>th</sup> to 12<sup>th</sup> class (401: RRT; 395: Direct interview) from conveniently selected three schools of Delhi/National Capital Region, during November 2014 to November 2016. As per conventional use of RRT, two types of questions, one related to "sensitive attribute" and the other "an unrelated question" were used to estimate ever tobacco and alcohol use. For the first time, a new random device (i.e., randomly arranged questionnaires) was proposed and used under RRT, which is user-friendly and appropriate for time-bound applications. For comparison, the estimates of both ever tobacco use and ever alcohol use were obtained, which could also facilitate comparative change in effect size with increasing sensitivity. The prevalence of ever tobacco use under RRT approach and Direct Interview method was 18.6% (95% CI: 13.33-24.01) and 10.1% (95% CI: 7.15-13.10) respectively, where as that of ever alcohol use was 22.8% (95% CI: 17.08-28.5) and 9.1% (95% CI: 6.27-11.95) respectively. Further, comparative results showed that as contents in used substance become more sensitive, under estimation of burden under direct interview method may become higher [i.e., ever tobacco use: 8.5% (95% CI: 3.43-13.65); Ever alcohol use: 13.6% (95% CI: 8.34-19.03)]. The proposed new random device under RRT, as a set of randomly arranged questionnaires containing either sensitive or unrelated questions, consists of most of its recommended properties. The findings under the present study suggest that the randomized response technique may serve as a versatile method for gaining access to more accurate information on sensitive topics.

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## Introduction

There is ample evidence in the related literature that tobacco and harmful alcohol use are major leading threats for various non-communicable diseases and death globally. There are numerous diseases, like different types of cancer, respiratory diseases, and heart diseases, which are known to be caused and further deteriorated by the use of such substances. As a matter of fact, these bad practices are modifiable and major causes of morbidity

and mortality. Further, their use among adolescents is likely to have many grisly impacts on their future life and society. Also, tobacco and alcohol use are called a gateway to the initiation of illicit drugs like amphetamine, cocaine, hallucinogens, or heroin<sup>1</sup>. Hence, the time-to-time assessment of the prevailing burden of substance use, like tobacco and alcohol use, among adolescents becomes more important. However, such tasks among adolescents are often tedious and sometimes controversial. The surveys using direct interview methods on sensitive personal practices (e.g., tobacco use, alcohol use, sexual activity), especially among adolescents, generally involve huge non-response, or responses which are often not true.

<sup>1</sup>Department of Biostatistics, All India Institute of Medical Sciences, New Delhi, India.

<sup>2</sup>Presently: International Centre for Health Research, RD Gardi Medical College, Ujjain, Madhya Pradesh, India.

<sup>3</sup>Department of Psychiatry, All India Institute of Medical Sciences, New Delhi, India.

**Correspondence to:** Sada Nand Dwivedi, Department of Biostatistics, All India Institute of Medical Sciences, New Delhi, India, E-mail: dwivedi7@hotmail.com

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Intuitively, disclosure of identity or embarrassment due to unveiling of identity may be main concerns regarding non-response or false response. Such responses may cause mainly two problems: first, a systematically biased estimate of the burden of tobacco use and alcohol use; and second, a distortion in the association between covariates and the use of tobacco/alcohol.<sup>2</sup>

To overcome the above problems, Warner<sup>3</sup> suggested a randomized response technique for estimating the proportion of responses on sensitive issues like ever tobacco use and alcohol use. As such, the randomized response technique (RRT) provides privacy to respondents by using a randomized device to ask the answer to sensitive questions. In addition, this random device plays a pivotal role in concealing the subject's response and avoiding the possibility of hiding true responses on sensitive issues, and also non-cooperation from respondents. Further, the considered random device needs to be easy to use, availability, friendly to handle, trustworthiness, and involvement of less time<sup>4</sup>. Most of the random devices used earlier were not easy to use,<sup>5-7</sup> were friendly to handle, and appropriate for time-bound application<sup>6-7</sup>. Hence, as an alternative approach regarding a large survey on such sensitive topics, it is worthwhile to explore innovative random devices under RRT, which may be easier to use and understandable by both respondents and surveyors. The tobacco and alcohol use among adolescents in India is still considered as a transgression. Thus, this study aimed to explore user-friendly random devices for practical utility in a large-scale field survey while comparing the randomized response technique with the direct interview method, especially on sensitive topics like tobacco use and alcohol use among adolescents.

## Methods and Materials

### Methods

The randomized response technique (RRT) suggested by Warner<sup>3</sup> for estimating the proportion of responses on sensitive issues has certain limitations, and for this reason, several modifications have been proposed in the literature<sup>9</sup>. As one of the improvements, Horvitz and others<sup>10</sup> suggested the use of an RRT involving an unrelated question whose theoretical framework was given by Greenberg and others<sup>9</sup>. Under this design, the respondents are asked to answer if they belong to a specific group, which is unrelated to the motive of the survey. This survey technique conventionally contains two types of questions, one related to the sensitive

attribute, e.g., "Did you ever use tobacco?", and the other unrelated question, e.g., "Were you born in January or February?" Further, a random device is used in such a survey to decide about the type of questions to be answered by respondents, and thus, helps in concealing the subject's response and privacy. So, it plays a pivotal role in avoiding the possibility of hiding true responses on sensitive issues and non-cooperation from respondents. This method can be done in two conditions: first, when the prevalence of characteristics of unrelated questions is unknown, and second, when the prevalence is known. However, it is also reported that the efficiency of RRT involving a known prevalence of unrelated questions in the population is better than that in the case of unknown prevalence<sup>9-10</sup>. They found this approach better than even Warner's randomized response technique. Further, the random device used under RRT should be easy to use, friendly to handle, and appropriate for time-bound applications.

The prevalence of ever tobacco use under RRT with a known prevalence of unrelated question may be estimated as:<sup>9</sup>

$$p(\hat{T}_{RRT}) = \frac{p(D) - [1 - p(C)] * p(B)}{p(C)} \quad (1)$$

Where: T: Tobacco use; B: Born in January or February; C: Use of questionnaire on ever tobacco use; and D: Cumulative yes answer in survey; P (T) = probability of tobacco use among students; P (B) = probability of student actually born in January or February; P (C) = probability of getting questionnaire on ever tobacco use; 1-p (C) = probability of getting questionnaire on born in January or February; and p(D)=probability of getting yes answer among total respondents.

The sampling variance of the above estimator may be given as (Greenberg et al., 1969):

$$V\{p(\hat{T})\} = \frac{p(D) * (1 - p(D))}{n * \{p(C)\}^2} \quad (2)$$

For larger n, the confidence interval of the estimated proportion is given as:

$$\left[ p(\hat{T}_{RRT}) \pm z_{1-\alpha/2} \sqrt{V\{p(\hat{T}_{RRT})\}} \right] \quad (3)$$

Where, under a standard normal distribution  $z_{1-\alpha/2}$  . aa 95% confidence level, is 1.96.

Moors<sup>11</sup> reported that the randomized response technique had better efficiency if the ratio of sensitive

question vs. unrelated question is 7:3. So keeping this in view, the proportion of students responding question on ever tobacco use, i.e., the proportion of students who answered the questionnaire related to ever tobacco use, was taken as 0.70. Likewise, in the case of ever alcohol use, also, the consideration of this proportion remained the same.

Direct Interview survey method is a method where the interviewer enquires the required information directly from the interviewee. If  $D$  is the number of students who had given yes for ever using tobacco in direct interview among  $n$  respondents, then the proportion of ever tobacco user  $p(T_{DI})$  is defined as:

$$p(T_{DI}) = \frac{D}{n} \quad (4)$$

For larger  $n$ , the confidence interval (C.I.) of the estimated proportion is given as:

$$\left[ p(T_{DI}) \pm z_{1-\alpha/2} \sqrt{\frac{p(T_{DI})(1-p(T_{DI}))}{n}} \right] \quad (5)$$

Where, under a standard normal distribution  $z_{1-\alpha/2}$  at a 95% confidence level, is 1.96. The difference in the estimate of a proportion of ever tobacco use ( $\Delta p_{ETU}$ ) between the two methods was calculated as a difference between proportions of ever tobacco ( $\Delta p_{ETU}$ ) observed in RRT and that observed in Direct Interview methods:

$$\Delta p_{ETU} = P(T_{RRT}) - P(T_{DI}) \quad (6)$$

And its one-sided 95% confidence interval (LCL, UCL) was calculated as:

$$\diamond p_{ETU} - 1.84 \sqrt{(s.e_{RRT})^2 + (s.e_{DI})^2}, \diamond p_{ETU} + 1.84 \sqrt{(s.e_{RRT})^2 + (s.e_{DI})^2} \quad (7)$$

### Definition of Ever Tobacco Use and Ever Alcohol Use

Ever tobacco use was considered as at least one time ever use of tobacco, like smoking of Cigarette, Cigar, Hooka, Beedi, and Khaini Gutkha, Panmasala containing tobacco, by the student. Likewise, ever alcohol use was considered as at least one time use of alcoholic material like Beer Breezers, Desi sharab, Wine, Whisky, Rum, and Vodka, by the student.

### Sample Size

For tobacco use, considering prevalence among adolescents reported under the direct method<sup>12</sup> as 13% and its expected level as 20% under the randomized

response technique, at a 95% level of confidence and 80% power of the study, the minimum sample size required in each group was 347 students. For alcohol use, considering prevalence among adolescents reported under direct method<sup>12</sup> as 5% and its expected level as 12% under the randomized response technique, at a 95% level of confidence and 80% power of the study, the sample size required in each group was 200 students. Accordingly, a target to cover at least 350 in each survey group was fixed.

### Data collection

The primary data was collected through a cross-sectional survey. A survey was conducted among students of the 9<sup>th</sup> to 12<sup>th</sup> classes from three conveniently selected schools in Delhi/National Capital Region (NCR), during November 2014 to November 2016. Before conducting a survey, permission from the concerned school authority, like the New Delhi Municipal Corporation (N.D.M.C.) or the principal or both, was taken. From an ethical point of view, name of the school and name of interviewed individual students was not disclosed. Among these three schools, School-A was a public school from Ghaziabad, U.P. (Delhi NCR), and the other two schools (i.e., School-B and School-C) were government schools from Delhi. Students of the ninth class of two schools (i.e., School-A and School-C) were not included because the principals of the concerned schools did not permit surveys in those classes. Before conducting the study, it was approved by the Institute Ethics Committee, All India Institute of Medical Sciences (AIIMS), New Delhi. If necessary, study data may be made available on demand by the first author. The authors declare that they have no competing interests. No external funding agency funded the present study. It is a part Ph.D. work of the first author.

For the survey, to begin with, the strength of students (total number) in each class was obtained from each school and participant information sheet, consent from parents, and an assent form containing information about date of birth from students was distributed. During the next visit, students present in the class on that day and given assent in each class/section were first divided into two groups using a simple random allocation list (1:1) with the help of a random number table and serial listing of students in the class. One group was considered under RRT and another under the direct interview method.

Under the randomized response technique (RRT), as stated earlier, the framework of an unrelated question with a known or guessable prevalence of the unrelated question among surveyed subjects was utilized. Randomized response technique for ever tobacco use survey consists

of either of two questions, the first was related to sensitive attribute, i.e., "Did you ever use tobacco like smoking of Cigarette, Cigar, Hooka, Beedi, Khaini, Gutkha, Panmasala containing tobacco?"; and the second was an unrelated question, e.g., "Were you born in January or February?" Likewise, under every alcohol use survey, either of the two questions was utilized, i.e., "Did you ever drink alcohol like Beer Breezers, Desi sharab, Wine, Whisky, Rum, and Vodka?" Or Unrelated attribute "Were you born on 1st, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> day of any calendar months of the year?" In each of the two studies (on ever tobacco use and ever alcohol use), randomly arranged both questionnaires (ratio of sensitive question vs. unrelated question as 7:3) served as a random device.

Before conducting survey, under randomized response technique, each of the above mentioned two questions under study on ever tobacco use was printed separately on similar looking papers/questionnaires in ratio of sensitive question vs. unrelated question as 7:3. Further, using random number table, these two questionnaires were arranged in unpredictable sequence for each class/each section of a class and sealed accordingly in opaque envelopes to ensure concealment of questionnaires. Finally, this randomly arranged questionnaire sequence served as a random device in our survey using RRT. A similar arrangement was done independently in the case of ever alcohol use survey under the RRT method.

The students covered under RRT were instructed that they should neither discuss questions among themselves nor put any identification mark on the answer sheet. Further, after writing only either "Yes" or "No" as an answer, they should drop the answer sheet into the container kept outside the classroom. After the above instructions, students selected to be covered under RRT were shifted to another room one by one, where a randomly arranged questionnaire set was kept. Each of the students picked up a questionnaire sequentially available on their turn. One of the research team members, totally unknown to students, was present in the room for the smooth conduct of the survey by maintaining the desired rules and guiding students if they had problems. The answer sheets were collected in above instructed manner. After completing the first survey on ever tobacco use, another survey on ever alcohol use under RRT was conducted on the same students using a second set of questionnaires arranged independently in the manner described earlier.

Under the direct interview method (D.I.), a direct interview was conducted on both sensitive questions,

i.e., ever tobacco use and ever alcohol use. Both surveys were conducted on the same students who were allocated under the direct interview method in each section/class. For this, a researcher totally unknown to the students interviewed each student one by one. Under ever tobacco use survey, he asked sensitive question "Did you ever use tobacco like smoking of Cigarette, Cigar, Hooka, Beedi; and Khaini, Gutkha, and Panmasala containing tobacco?", whereas under ever alcohol use survey, he asked question "Did you ever drink alcohol like Beer Breezers, Desi sharab Wine, Whisky, Rum, and Vodka?", directly to each of the respondent.

Out of 999 students in three schools, who were eligible for the survey, 938(93.9%) had given assent and consent. Among them, only 796 (84.9%) were present at the time of the survey and took part in the study. Details of school-wise and class-wise distribution of covered 796 students are given in Appendix-1.

## Results

Out of 796 covered students, 401 students were surveyed through the randomised response technique (RRT) and 395 through the Direct Interview method for both ever tobacco use and ever alcohol use. Among 401 students, as extracted from assent forms, 62 (15.5%) students were born in January or February (i.e.,  $p(B) = 0.155$ ). As stated earlier, for better efficiency, the ratio of questionnaires with sensitive questions (ever tobacco use) vs. unrelated questions (born in January or February) was 7:3; hence,  $p(C) = 0.70$ . Under RRT survey, a total "yes" answered by surveyed students in tobacco survey i.e., yes answers to either of two questions (sensitive and unrelated) was by 71 (17.7%) students. Accordingly, the probability of getting a yes answer among the total respondents became 0.177, that is,  $p(D) = 0.177$ . So using equations (1&3), derived estimated percentage of ever tobacco users under the RRT survey came as 18.6% (95% C.I.: 13.33, 24.01) In other words, RRT approach revealed prevalence of ever tobacco use as about 19% and its 95% interval estimate as 13% to 24%. Further, among 395 surveyed through a direct (face-to-face) interview method, 40 students reported that they had used tobacco products once or more until the day of the survey. So, the percentage of ever tobacco users in surveyed students was 10.1% (95% CI: 7.15, 13.10). In other words, under the direct interview method, the prevalence of ever tobacco use emerged to be about 10% and its 95% interval estimate was 7% to 13%.

Likewise, under every alcohol use survey using RRT, as extracted from assent forms of 401 surveyed students,



70(17.5%) were born on the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> day of any calendar month of the year, that is,  $p(B) = 0.175$ . As reported in the case of the ever tobacco use survey using RRT,  $p(C)$  remained the same at 0.70. Further, since 85(21.2%) students had given yes answer in survey to either of two questions, probability of getting yes answer among total respondents became 0.212, that is,  $p(D) = 0.212$ . So derived estimated proportion of ever alcohol users, using equations (1&3), and 95% C.I., was 22.8% (17.09, 28.51). In other words, the RRT approach revealed the prevalence of ever alcohol use as about 23% and its 95% interval estimate as 17% to 29%. Under the direct interview method, 36 (9.1%) students reported that they had used alcoholic products once or more until the day of the interview (95% C.I.: 06.27, 11.95). In other words, under direct interview method, the prevalence of ever alcohol use emerged to be about 9% and its 95% interval estimate as 6 to 12%.

As evident from Table 1, the direct interview method underreported the prevalence of ever tobacco use by 8.5% (95%CI: 3.43-13.65) in comparison to the RRT method. Sample size calculation was calculated by assuming that there may be at least seven percent underreporting by the direct interview method, i.e., Null Hypothesis:  $H_0 \leq 7$  & Alternative Hypothesis:  $H_1 > 7$ . Although direct interview underreported the prevalence of ever tobacco use but it is not statistically significant because the 95% confidence interval includes seven, i.e., the Null hypothesis cannot be rejected. However, under every alcohol use survey, the direct interview method underreported the prevalence of ever alcohol use by 13.6% (95%CI: 8.34-19.03) as compared to the RRT survey, which is statistically significant. Further, comparative results on ever tobacco use and ever alcohol use suggest that underestimation by the direct interview method was more regarding alcohol use than tobacco use. In other words, underestimation increased with the increase in sensitivity of the topics.

## Discussion

In the present study, the random device used under the RRT approach is proposed in the form of a set of randomly arranged questionnaires containing either sensitive or unrelated questions. It is easy to handle

and understandable to the researchers. The principal characteristics of a random device under RRT have been reported as ease of use, trustworthy, and easily available.<sup>4</sup> The present random device is intuitively handy, and researchers may be able to carry out the randomisation quickly and without too much effort. Also, this random device ensures that responses to sensitive questions are obtained with more accuracy and in an unbiased manner. Further, this device may easily be developed for any study on sensitive topics. As such, to the best of our knowledge, the present study is first to propose and use such simple random device.

The data collected on ever tobacco use among adolescents using the randomized response technique (RRT) revealed its prevalence as 18.6% (95% CI: 13.33-24.01); and that using the direct interview or face-to-face interview method as 10.1% (95% 7.15-13.10)%. Further, it was observed that the direct interview method underreported the prevalence by 8.5% (95% CI: 3.43-13.65). However, one-sided confidence interval did not show this as statistically significant. A similar result was reported by other studies<sup>7, 13</sup>. Under the ever alcohol use survey among adolescents using the randomised response technique (RRT), the prevalence of ever alcohol use came as 22.8% (95% CI: 17.08-28.5); whereas that under the direct interview method was 9.1% (95% CI: 6.27-11.95). As observed in the case of ever tobacco use, in comparison to RRT, the direct interview method underreported the prevalence of ever alcohol use by 13.6% (95% CI: 8.34-19.03). However, in contrast to ever tobacco use, the one-sided confidence interval of the difference in prevalence under both methods shows this as statistically significant. The results obtained in the present study are in line with those reported by earlier studies.<sup>7,8,14</sup> The key finding under present study is that estimates of both, prevalence of ever tobacco use and ever alcohol use, among adolescents were higher under RRT approach in comparison to the direct interview (face-to-face interview) method. Further, the variability associated with RRT estimates was considerably higher. Further, comparative results between the two methods on ever tobacco use and ever alcohol use suggest that the extent of underreporting by the direct interview method

**Table 1:** Comparison of Prevalence under Two Methods (RRT vs. Direct Interview)

Survey	Prevalence (95% C.I.)		Difference (95% C.I. one-sided)
	RRT	Direct Interview	
Ever tobacco use	18.6(13.33- 24.01)	10.1 (7.15-13.10)	8.5 (3.43-13.65)
Ever alcohol use	22.8 (17.08-28.51)	9.1 (6.27-11.95)	13.6 (8.34-19.03)

was more in the case of alcohol use than tobacco use. In other words, as contents of used substances become more sensitive, underreporting of burden under the direct interview method is pushed higher side. A similar finding is also reported under earlier studies<sup>7</sup>

## Conclusions

In comparison to the randomized response technique (RRT), the direct interview method may provide underreporting of sensitive events, which may be pushed further to the high side in case of highly sensitive events. The present study has amply shown that assuring privacy of information through the use of a random device under RRT will result in more accurate reporting of socially unacceptable behaviours like ever tobacco use and ever alcohol use among adolescents. Further, the findings under the present study have confirmed the utility of the proposed randomized response technique as a versatile method for gaining access to more accurate information on sensitive social problems. As such, the present study has shown the path regarding the possible use of such an approach (RRT) in estimating the prevailing burden in relation to sensitive topics more accurately. This may, however, require further exploration regarding the feasibility of its use under large-scale surveys on sensitive topics.

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**Appendix- 1:** Socio-demographic Characteristics of Respondents under RRT and Direct interview Surveys

<i>Characteristics</i>	<i>Under RRT n = 401</i>	<i>Under Direct interview (DI) n = 395</i>	<i>p-value</i>
Age (yrs)#	16.70±1.97	16.45±1.90	0.069
<b>School@</b>			
School-A	131 (32.7)	124 (31.4)	0.89
School-B	191 (47.6)	189 (47.8)	
School-C	79 (19.7)	82 (20.8)	
<b>Type of Schools@</b>			
Private	131 (32.7)	124 (31.4)	0.700
Government	270 (67.3)	271 (68.6)	
<b>Gender@</b>			
Male	266 (66.3)	273 (69.1)	0.402
Female	135 (33.7)	122 (30.9)	
<b>Class@</b>			
9 <sup>th</sup>	25 (6.2)	26 (6.6)	0.912
10 <sup>th</sup>	105 (26.2)	105 (26.6)	
11 <sup>th</sup>	171 (42.7)	159 (40.3)	
12 <sup>th</sup>	100 (24.9)	105 (26.5)	

@: Data as presented as frequency (%) and Chi-square test applied

#: Presented as mean (±S.D) and unpaired t-test applied