

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

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Research article

Keywords: Randomized response technique, Direct Interview method, Ever tobacco use, Ever alcohol use, Prevalence

Posted Date: July 27th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-44962/v1>

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2 **Interview Method in Assessment of Burden of Tobacco and Alcohol Use**
3 **among Adolescents in India**

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26

27 **Abstract**

28 **Background:** In countries like India, the major source of error in reporting of sensitive events
29 (e.g., tobacco and alcohol use) among adolescents is deliberate misreporting. To estimate its
30 burden, the commonly used direct interview method involves problems in reporting. To cope up,
31 randomized response technique (RRT) is an alternative approach which uses a random device for
32 providing more privacy to respondents. So, it may be worthwhile to compare RRT with direct
33 interview method in assessment of burden of ever tobacco and alcohol use among Indian
34 adolescents.

35 **Methods:** A cross-sectional survey on ever tobacco and alcohol use among adolescents was
36 conducted on 796 (401: RRT; 395: Direct interview) 9th to 12th class students from purposively
37 selected three schools of Delhi/National Capital Region, during November-2014 to November-
38 2016. As per conventional use of RRT, two types of questions, one related to “sensitive
39 attribute” and other “an unrelated question” was used to estimate ever tobacco and alcohol use.
40 For the first time, a new random device (i.e., randomly arranged questionnaires) was proposed
41 and used under RRT which is user friendly and appropriate for time-bound application. For
42 comparison, the estimates of both, ever tobacco use and ever alcohol use, were obtained which
43 could also facilitate comparative change in effect size with increasing sensitivity.

44 **Results:** The prevalence of ever tobacco use under RRT approach and Direct Interview method
45 was 18.6% (95% CI: 13.33-24.01) and 10.1% (95% CI:7.15-13.10) respectively, where as that of
46 ever alcohol use was 22.8% (95%CI: 17.08-28.5) and 9.1% (95% CI: 6.27-11.95) respectively.

47 Further, comparative results showed that as contents in used substance become more sensitive,
48 under estimation of burden under direct interview method may become higher [i.e., Ever tobacco
49 use: 8.5% (95% CI: 3.43-13.65); Ever alcohol use: 13.6% (95% CI: 8.34-19.03)]. The proposed
50 new random device under RRT, as a set of randomly arranged questionnaires containing either
51 sensitive or unrelated questions, consists of most of its recommended properties.

52 **Conclusions:** The findings under the present study suggest that the randomized response
53 technique may serve as a versatile method for gaining access to more accurate information on
54 sensitive topics.

55

56 **Keywords:** Randomized response technique, Direct Interview method, Ever tobacco use, Ever
57 alcohol use, Prevalence

58

59 **Background**

60 There is ample evidence in the related literature that tobacco and harmful alcohol use are major
61 leading threats for various non-communicable diseases and death globally. There are numerous
62 diseases like different types of cancer, respiratory diseases, and heart diseases, which are known
63 to be caused and get further deteriorated by use of such substances. As a matter of fact, these bad
64 practices are major modifiable causes of morbidity and mortality. Further, their uses among
65 adolescents are likely to have many grisly impacts on their future life, and society. Also, tobacco
66 and alcohol use are called as gateway regarding initiation of illicit drug like amphetamine,
67 cocaine, hallucinogens or heroin [1]. Hence, the time to time assessment of the burden of
68 substance use, like tobacco and alcohol use, among adolescents becomes more important.
69 However, such tasks among adolescents are often tedious and some time controversial. The

70 surveys using direct interview methods on sensitive personal practices (e.g., tobacco use, alcohol
71 use, sexual activity) especially among adolescents generally involve huge non-response, or,
72 responses which are not true. Intuitively, disclosure of identity or embarrassment due to
73 unveiling of identity may be main concerns regarding non response or false response. Such
74 responses may cause mainly two problems: first, systematically biased estimate of the burden of
75 tobacco use and alcohol use; and second, distortion in the association between covariates and the
76 use of tobacco/alcohol [2].

77 To overcome above problems, Warner [3] suggested a randomized response technique for
78 estimating the proportion of responses on sensitive issues like tobacco use and alcohol use. As
79 such, the randomized response technique (RRT) provides privacy to respondents by virtually
80 using a randomized device to ask the answer of the sensitive question from them. In addition,
81 this random device plays a pivotal role in concealing the subject's response; and also avoiding
82 the possibility of hiding true response on sensitive issues and also non-cooperation from
83 respondents. Further, according to Diekmann Hglinger, the considered random device needs to
84 have easiness to use, availability, friendly to handle, trustworthiness, and involvement of less
85 time [4]. Most of the random devices used earlier were not easy to use [5-7]; friendly to handle
86 [8] and appropriate for time-bound application [6,7]. Hence, as an alternative approach regarding
87 large survey on such sensitive topics, it is worthwhile to explore innovative random devices
88 under RRT which may be easier to use and understandable by both, respondents and surveyors.
89 The tobacco and alcohol use among adolescents in India is still considered as a transgression.
90 Thus, this study aimed to explore user friendly random devices for practical utility in large scale
91 field survey while comparing randomized response technique with direct interview method
92 especially on sensitive topics like tobacco use and alcohol use among adolescents.

93 **Methods**

94 The randomized response technique (RRT) suggested by Warner[3] for estimating the proportion
95 of responses on sensitive issues have certain limitations and for this reason several modifications
96 have been proposed in the literature[9]. As one of the improvements, Simmons[10] suggested a
97 use of a RRT involving an unrelated question whose theoretical frame work was given by
98 Greenberg [9]. Under this design, the respondents are asked to answer if they belong to a specific
99 group which is unrelated to motive of survey. This survey technique conventionally contains two
100 types of questions, one related to sensitive attribute, e.g., “Did you ever use tobacco?”, and other
101 unrelated question, e.g., “Were you born in January or February?” Further, a random device is
102 used in such survey to decide about type of questions to be answered by respondents; and thus
103 helps in concealing the subject’s response and privacy. So, it plays pivotal role in avoiding the
104 possibility of hiding true response on sensitive issues and also non-cooperation from
105 respondents. This method can be done in two conditions, first when prevalence of characteristics
106 of unrelated question is unknown, and second, when prevalence is known. However, it is also
107 reported that efficiency of RRT involving known prevalence of unrelated question in the
108 population is better than that in case of unknown prevalence[9,10]. They found this approach
109 better than even Warner’s randomized response technique. Further, random device used under
110 RRT, should be easy to use, friendly to handle and appropriate for time-bound application.

111 The prevalence of tobacco use under RRT [9] with known prevalence of unrelated
112 question may be estimated as:

113

$$114 \quad p(T_{RRT}) = \frac{p(D) - [1 - p(C)] * p(B)}{p(C)} \quad (1)$$

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

121 The sampling variance of the above estimator may be given as[9]:

$$122 \quad V \left\{ p \left(\widehat{T}_{RRT} \right) \right\} = \frac{p(D) * (1-p(D))}{n * \{p(C)\}^2} \quad (2)$$

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

$$124 \quad \left[p(\widehat{T}_{RRT}) \pm z_{1-\frac{\alpha}{2}} \sqrt{V\{p(\widehat{T}_{RRT})\}} \right] \quad (3)$$

125
 126 Where, under standard normal distribution $z_{1-\alpha/2}$ at 95% confidence level is 1.96.

127 Moors [11] reported that randomized response technique had better efficiency if ratio of sensitive
 128 question vs. unrelated question is 7:3. So keeping this in view, proportion of students responding
 129 question on ever tobacco use i.e., proportion of students who answered questionnaire related to
 130 ever tobacco use was taken as 0.70. Likewise, in case of ever alcohol use also, this proportion
 131 remained same.

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

136
$$p(T_{DI}) = \frac{D}{n} \quad (4)$$

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

138
$$\left[p(T_{DI}) \pm z_{1-\alpha/2} \sqrt{\frac{p(T_{DI})(1-p(T_{DI}))}{n}} \right] \quad (5)$$

139 Where, under standard normal distribution $z_{1-\alpha/2}$ at 95% confidence level is 1.96. The
 140 difference of estimate of proportion of ever tobacco use (Δp_{ETU}) Difference between proportions
 141 of ever tobacco (Δp_{ETU}) used observed in RRT and Direct Interview methods calculated as:

142
$$\Delta p_{ETU} = P(T_{RRT}) - P(T_{DI}) \quad (6)$$

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

144
$$\Delta p_{ETU} - 1.84\sqrt{(s.e_{RRT})^2 + (se_{DI})^2}, \Delta p_{ETU} + 1.84\sqrt{(s.e_{RRT})^2 + (se_{DI})^2} \quad (7)$$

145

146 **Definition of Ever Tobacco Use and Ever Alcohol Use**

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

151 **Sample Size**

152 For tobacco use, considering prevalence among adolescents (NFHS-3[12]) under direct method
 153 as 13% and its expected level as 20 percent under randomized response technique, at 95% level
 154 of confidence and 80% power of study, minimum sample size required in each group came as
 155 347 students. For alcohol use, considering prevalence among adolescents (NFHS-3[12]) under

156 direct method as 5% and its expected level as 12 percent under randomized response technique,
157 at 95% level of confidence and 80% power of study, sample size required in each group came as
158 200 students. Accordingly, a target to cover at least 350 in each group was fixed.

159 **Data collection**

160 **The primary data was collected through cross-sectional survey exclusively developed for this**
161 study. Survey was conducted among students of 9th to 12th class from purposively selected three
162 schools of Delhi/National Capital Region (N.C.R), during November-2014 to November-2016.
163 Before conducting survey, the permission from concerned school authority like New Delhi
164 Municipal Cooperation (N.D.M.C) or principal or both was taken. From ethical point of view,
165 name of school and name of interviewed individual students will not be disclosed here. Among
166 these three schools, School-A was public school from Ghaziabad U.P, (Delhi NCR), and other two
167 schools (i.e., School-B and School-C) were government schools from Delhi. Students of ninth
168 class of two schools (i.e., School-A and School-C) were not included because principal of
169 concerned schools did not give permission for surveys in those classes. Before conducting the
170 study, it was approved by the Institute Ethics Committee, All India Institute of Medical
171 Sciences (AIIMS), New Delhi.

172 During survey, strength of students (total number) in each class was obtained from each
173 school and participant information sheet, consent from parents and assent form containing
174 information about date of birth from students, was distributed. During next visit, students present
175 **in the class on that day and gave written consent and assent in each class/section were** first
176 divided in two groups using simple random allocation list (1:1) with the help of random number
177 table and serial listing of students in the class. One group was considered under RRT and another
178 under direct interview method.

179 Under randomized response technique, as stated earlier, framework of unrelated question
180 (9) with known or guessable prevalence of unrelated question among surveyed subjects was
181 utilized. Randomized response technique for ever tobacco use survey consists of either of two
182 questions, first was related to sensitive attribute, i.e., “Did you ever use tobacco like smoking of
183 Cigarette, Cigar, Hooka, Beedi; and Khaini, Gutkha, Panmasala containing tobacco?”(S1); and
184 second was unrelated question, e.g., “Were you born in January or February ?”(S2) Likewise,
185 under ever alcohol use survey, either of two questions was utilized, i.e., “Did you ever drink
186 alcohol like Beer Breezers, Desi sharab, Wine, Whisky, Rum, and Vodka?” (S3) Or Unrelated
187 attribute “Were you born on 1th, 2nd, 3rd, 4th, 5th day of any calendar months of the year?”(S4). In
188 each of the two studies on ever tobacco use and ever alcohol use, randomly arranged both
189 questionnaires (ratio of sensitive question vs. unrelated question as 7:3) served as a random
190 device.

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

199 The students covered under RRT were instructed that they should neither discuss about
200 questions among them, nor put any identification mark on answer sheet. Further, after writing only
201 either “Yes” or “No” as answer, they should drop answer sheet into the container kept outside

202 classroom. After above instructions, students selected to be covered under RRT were shifted to
203 other room one by one where randomly arranged questionnaire set was kept. Each of the students
204 picked up one questionnaire sequentially available on his turn. One of the research team member,
205 totally unknown to students, was present in the room for smooth conduct of survey by maintaining
206 desired rule and guiding students if they had problem. The answer sheets were collected in above
207 instructed manner. After completing first survey on ever tobacco use, another survey for ever
208 alcohol use under RRT was conducted on same students using second set of questionnaires
209 arranged independently in described manner earlier.

210 Under direct interview method (D.I), direct interview was taken on both sensitive
211 questions, i.e., ever tobacco use and ever alcohol use. Both surveys were conducted on same
212 students who were allocated under direct interview method in each section/class. For this, a
213 researcher totally unknown to students interviewed each student one by one. Under ever tobacco
214 use survey, he asked sensitive question “Did you ever use tobacco like smoking of Cigarette,
215 Cigar, Hooka, Beedi; and Khaini, Gutkha, and Panmasala containing tobacco?”, whereas under
216 ever alcohol use survey, he asked question “Did you ever drink alcohol like Beer Breezers, Desi
217 sharab Wine, Whisky, Rum, and Vodka?”, directly to each of the respondent.

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

222 **Results**

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

239 Likewise under ever alcohol use survey using RRT, as extracted from assent forms of
240 401 surveyed students, 70(17.5%) were born on 1th , 2nd , 3rd , 4th & 5th day of any calendar
241 months of the year, that is, $p(B)= 0.175$. As reported in case of ever tobacco use survey using
242 RRT, $p(C) = 0.70$. , Further, since 85(21.2%) students had given yes answer in survey to either
243 of two questions, probability of getting yes answer among total respondents becomes 0.0.212,
244 that is, $p(D)= 0.212$. So derived estimated proportion of ever alcohol users, using equations

245 (1&3), and 95% C.I., was 22.8% (17.09, 28.51). In other words, RRT approach revealed
 246 prevalence of ever alcohol use as about 23% and its 95 interval estimate as 17% to 29%. Under
 247 direct interview method, 36 (9.1%) students reported that they had used alcoholic products once
 248 or more until the day of interview (95% C.I.: 06.27, 11.95). In other words, under direct
 249 interview method, prevalence of ever alcohol use emerged to be about 9 % and its 95% interval
 250 estimate as 6% to 12%.

251

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

253

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)

254

255 As evident from table-1, the direct interview method underreported the prevalence of
 256 ever tobacco use by 8.5% (95%CI: 3.43-13.65) in comparison to RRT method. Sample size
 257 calculation was calculated by assuming that there may be at least seven percent underreporting
 258 by direct interview method, i.e., Null Hypothesis: $H_0 \leq 7$: & Alternative Hypothesis: $H_1 > 7$.
 259 Although, direct interview underreported the prevalence of ever tobacco use but it is not
 260 statistically significant because 95 % confidence interval includes 7 i.e., Null hypothesis cannot
 261 be rejected. However, under ever alcohol use survey, direct interview method underreported
 262 prevalence of ever alcohol use by 13.6% (95%CI: 8.34-19.03) as compared to RRT survey which
 263 is statistically significant. Further, comparative results on ever tobacco use and ever alcohol use

264 suggest that under estimation by direct interview method was more regarding alcohol use than
265 tobacco use. In other words, under estimation increased with increase of sensitivity of the topics.

266

267 **Discussion**

268 In the present study, the used random device under RRT approach is proposed in the form of a
269 set of randomly arranged questionnaires containing either sensitive or unrelated questions. It is
270 easy to handle and understandable by the researchers. The principal characteristics of a random
271 device under RRT have been reported as ease of use, trustworthy, and easily available [4]. The
272 present random device is intuitively handy and researchers may be able to carry out the
273 randomisation quickly and without too much effort. Also, this random device may obviously
274 ensure to obtain response to sensitive questions with more accuracy and in unbiased manner.
275 Further, this device may easily be developed regarding any study on sensitive topics. As such, to
276 the best of our knowledge, the present study is first to propose and use such random device.

277 The data collected on ever tobacco use among adolescents using randomised response
278 technique (RRT) revealed its prevalence as 18.6% (95% CI: 13.33-24.01); and that using direct
279 interview or face to face interview method as 10.1% (95% CI:7.15-13.10)%. Further, it was
280 observed that direct interview method underreported the prevalence by 8.5% (95% CI: 3.43-
281 13.65). However, one sided confidence interval did not show this as statistically significant.
282 Similar result was reported by other studies [7, 13]. The ever alcohol use survey among
283 adolescents using randomised response technique (RRT), prevalence of ever alcohol use came as
284 22.8% (95% CI: 17.08-28.5); whereas that under direct interview method as 9.1% (95% CI:
285 6.27-11.95). As observed in case of ever tobacco use, in comparison to RRT, direct interview
286 method underreported the prevalence of ever alcohol use by 13.6% (95% CI: 8.34-19.03).

287 However, in contrary to ever tobacco use, one sided confidence interval of difference in
288 prevalence under both methods shows this as statistically significant. The results obtained in
289 present study are in line with those reported by earlier studies [7,8,14] The key finding under
290 present study is that estimates of both, prevalence of ever tobacco use and ever alcohol use,
291 among adolescents were higher under RRT approach in comparison to direct interview (face to
292 face interview) method. Further, the variability associated with RRT estimates was considerably
293 higher. Further, comparative results between two methods on ever tobacco use and ever alcohol
294 use suggest that extent of underreporting by direct interview method was more in case of alcohol
295 use than tobacco use. In other words, as contents of used substance become more sensitive, under
296 reporting of burden under direct interview method is pushed higher side. Similar finding is also
297 reported under earlier studies [7].

298

299 **Conclusion**

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

310

311 **List of abbreviations**

312 A.I.I.M.S: All India Institute of Medical Sciences; DI: Direct Interview Method; ETU: Ever
313 Tobacco Use; N.C.R: National Capital Region; N.D.M.C: New Delhi Municipal Cooperation;
314 N.F.H.S: National Family Health Survey; RRT: Randomized Response Technique; s.e.: Standard
315 Error.

316 **Declarations**

317 **Ethics approval and consent to participate**

318 The present study was approved by Ethics Committee for Post graduate research, All India
319 Institute of Medical Sciences, New Delhi, India. A **written** assent from participants and **written**
320 consent from their parents was taken before collection of data.

321

322 **Consent for publication**

323 Not applicable

324

325 **Availability of data and material:**

326 Study data may be made available on demand by the first author.

327

328 **Competing interests:**

329 The authors declared that they have no competing interests.

330

331 **Funding:**

332 Present study was not funded by any external funding agency. It is a part Ph.D. work of the first
333 author, Ashish Datt.

334

335 **Authors' contributions:**

336 Ashish Datt and Sada Nand conceived and designed the study. Ashish Datt conducted the survey,
337 collected data and did the analysis under supervision of corresponding author, Sada Nand. All
338 the authors were involved in interpretation of the results. The final draft of the manuscript was
339 prepared by First author, Ashish Datt, under supervision of corresponding author, Sada Nand.
340 All authors read and approved the final manuscript.

341

342 **Acknowledgement**

343 The authors acknowledge competent authorities of covered schools, and New Delhi Municipal
344 Corporation, Delhi, India, for giving permission regarding this study. The parents of covered
345 students and teachers are also duly acknowledged for helping in the study. The students are
346 highly acknowledged to participate in the study. Finally, thanks are also due to the All India
347 Institute of Medical Science, New Delhi, India, for providing required logistic support during the
348 study.

349

350 **Author's Information:**

351 First author is a Ph.D. student under the guidance of corresponding author and co-guidance of
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355

356 **Reference**

- 357 [1] Kandel, D.B., Drug and Drinking Behavior Among Youth. *Annual Review of Sociology*.
358 1980; 6, 235–285. <https://doi.org/10.1146/annurev.so.06.080180.001315>
- 359 [2] Wolter, F., Preisendörfer, P.. Asking Sensitive Questions: An Evaluation of the
360 Randomized Response Technique Versus Direct Questioning Using Individual Validation
361 Data. *Sociological Methods & Research*. 2013; 42, 321–353.
- 362 [3] Warner, S.L. Randomized response: A survey technique for eliminating evasive answer
363 bias. *Journal of the American Statistical Association*. 1965; 60, 63–69.
- 364 [4] Engel, U., Jann, B., Lynn, P., Scherpenzeel, A. Sturgis, P.J., Improving survey methods:
365 lessons from recent research. 2015. Page 108, Available from:
366 <http://public.eblib.com/choice/publicfullrecord.aspx?p=1775347>.
- 367 [5] Barth, J.T., Sandler, H.M. Evaluation of the randomized response technique in a drinking
368 survey. *Journal of Studies on Alcohol*. 1976; 37, 690–693.
- 369 [6] Volicer, B.J., Cahill, M.H., Neuburger, E., Arntz, G. Randomized Response Estimates of
370 Problem Use of Alcohol among Employed Females. *Alcoholism: Clinical and*
371 *Experimental Research*. 1983; 7, 321–326.
- 372 [7] Striegel, H., Ulrich, R., Simon, P. Randomized response estimates for doping and illicit
373 drug use in elite athletes. *Drug and Alcohol Dependence*. 2010; 106, 230–232. [https](https://doi.org/10.1016/j.drugalcdep.2010.05.011)
- 374 [8] Fisher, M., Kupferman, L.B., Lesser, M. Substance use in a school-based clinic
375 population: Use of the randomized response technique to estimate prevalence. *Journal of*
376 *Adolescent Health*. 1992; 13, 281–285.

- 377 [9] Greenberg, B.G., Abul-Ela, A.-L.A., Simmons, W.R., Horvitz, D.G. The Unrelated
378 Question Randomized Response Model: Theoretical Framework. *Journal of the American*
379 *Statistical Association*. 1969 64, 520.
- 380 [10] Horvitz, **D. G.**, Shah, B. V., and Simmons, Walt R., “The unrelated question randomized
381 response model,” *Social Statistics Section Proceedings of the American Statistical*
382 *Association*, 1967; **65-72.**
- 383 [11] Moors, J.J.A., Optimization of the Unrelated Question Randomized Response Model.
384 *Journal of the American Statistical Association*. 1971; 66, 627.
385 <https://doi.org/10.2307/2283543>
- 386 [12] International Institute for Population Sciences (IIPS) and Macro International. 2007.
387 *National Family Health Survey (NFHS-3), 2005–06: India: Volume I & Volume II*
388 Mumbai: IIPS. 2007; Available from: [http://rchiips.org/nfhs/NFHS-3%20Data/VOL-](http://rchiips.org/nfhs/NFHS-3%20Data/VOL-1/India_volume_I_corrected_17oct08.pdf)
389 [1/India volume I corrected 17oct08.pdf](http://rchiips.org/nfhs/NFHS-3%20Data/VOL-1/India_volume_I_corrected_17oct08.pdf)
- 390 [13] Ostapczuk, M., Musch, J., Moshagen, M., 2009. A randomized-response investigation of
391 the education effect in attitudes towards foreigners. *European Journal of Social*
392 *Psychology* 39, 920–931
- 393 [14] Lensvelt-Mulders GJ, Hox JJ, Van der Heijden PG, Maas CJ. Meta-analysis of
394 randomized response research: Thirty-five years of validation. *Sociological Methods &*
395 *Research*. 2005;33(3):319–348

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

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

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

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

403

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