JOURNAL OF SCIENCE

SAKARYA UNIVERSITY

Title: A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Crosswise Design

Authors: Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Crosswise Design

Nilgün ÖZGÜL[1]

Abstract

This paper aims to introduce Randomized Response Techniques (RRT's) and show that how RRT's are implemented in surveys in which sensitive behaviors are investigated. For this purpose, the most popular designs of the Binary RRT are summarized and an experimental study is conducted on drug use among dormitory students at a public university in Ankara, Turkey. Despite the wide applicability of the drug use studies in Turkey, surprisingly any applications using indirect questioning techniques are not observed in the literature. In this study, for the first time, drug use behavior is investigated with Crosswise design which is the most frequently used indirect questioning technique and indirect questioning method (Crosswise design) is compared with direct questioning method to evaluate the effectiveness of the RRT. Results revealed that when Crosswise design is provided on asking sensitive questions, considerably minor response refusals are happened and significantly higher drug-use estimates are observed.

Keywords: Randomized Response Technique, Sensitive Questions, Prevalence Estimation, Crosswise design

---

[1] Corresponding Author: nozgul@hacettepe.edu.tr
Hacettepe University, Faculty of Science, Department of Statistics, Beytepe Campus, Ankara, Turkey. ORCID ID: http://orcid.org/0000-0003-0331-9044

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

1. INTRODUCTION

In natural and social sciences, some research topics are related to sensitive behaviors such as mobbing, political view, tax evasion, illegal income Semitism, gambling, alcoholism, drug addiction, doping usage, sexual and physical abuse, homosexual activities, abortion, illegal hunting and many others. In surveys that collect data with direct techniques on sensitive topics, respondents are often underreported on sensitive information, even they refuse to answer. So, nonresponse on sensitive questions is normally higher than for other questions in a survey. In such surveys, a well-known technique to obtain valid and reliable information on sensitive questions is the Randomized Response Technique (RRT), introduced by [1]. The RRT is an effective indirect questioning technique that ensures privacy and may well succeed respondents' reluctance to express sensitive or probably illicit information. Therefore, respondents are more tend to collaborate and give true answers to sensitive questions. *RRTs* use a randomization device (a die, a deck of cards or a spinner) efficiently to reduce non-respondents rates resulting from sensitive, embarrassing or even illicit questions. In RRT, with the usage of a randomization device, the respondent gives a randomized answer concerning his/her true status. Due to the interviewer is unknowing of the result of the randomization device, the use of these techniques protects the anonymity of the answers of respondents. It also appeared that the results of the RRT's become more precise when the topic under investigation is more sensitive [2].

RRTs are sub classified as binary and quantitative RRTs. Binary RRT's are used to estimate the proportion of some sensitive behavior in a population. Quantitative RRTs are used to estimate the mean value of some behavior in a population [3]. In this study, the most popular Binary RRT's will introduce and real applications in literature will be given.

The paper is organized as: In section two, the most popular designs of the Binary RRT that have been proposed in the literature are summarized and real-life examples for each design will be given. Also, in this section, the crosswise design which is one of the most popular design used in recent studies is adapted to the stratified sampling. In section three, empirical studies on drug use in university students in Turkey are summarized. In section four, the application on drug use among dormitory students in a public university is described and the results are given. Section five concludes the paper.

2. THE MOST POPULAR DESIGNS IN BINARY RRT

In this section, the most popular designs in Binary RRT are summarized and instructions used in these designs are explained. The Binary RRT's will be described together with the equations to compute the population estimates and their variances. In each design, the equations are derived based on a probability distribution. Since the probability of distribution of the randomized design is known, the prevalence of the sensitive characteristic can be estimated on the basis of probability theory. In each design, the fundamental principle to compute prevalence estimate and its variance is establishing a probabilistic relationship between reported answers and unreported true scores [4]. On the other hand, some RRT procedures may confuse respondents and cause refusing answers. Many respondents hesitate that the RRT protects their sensitive behaviors even when they completely understand the instructions [5]. Therefore, for each design, the instructions are described clearly for successful implementation.

The most popular designs in Binary RRT classified into four types:

1. Warner's Design (Mirrored Question Design)

2. Unrelated Question Design

3. Forced Response Design

4. Crosswise Design

2.1. Warner's Design

Binary RRT is pioneering work of Warner [1]. Warner [1] proposed RRT for the first time to collect true response on sensitive questions by protecting the respondents' privacy. In Warner's design, respondents are requested to use a

randomization device (dice, coin or cards), whose outcome is unobserved by the interviewer. Let exemplify Warner [1] RRT with an example. For example, to estimate the "proportion of people who tried drug", two statements are written on the cards in a deck. The respondents are asked to answer one of two statements:

1. I tried drug (p).
2. I did not try drug (1-p)

The respondent randomly picks a card, and simply responds "true" or "not true" to the statement without revealing to the interviewer which statement is selected. The respondent is simply responding to the statement shown on the randomly drawn card (see Figure 1)
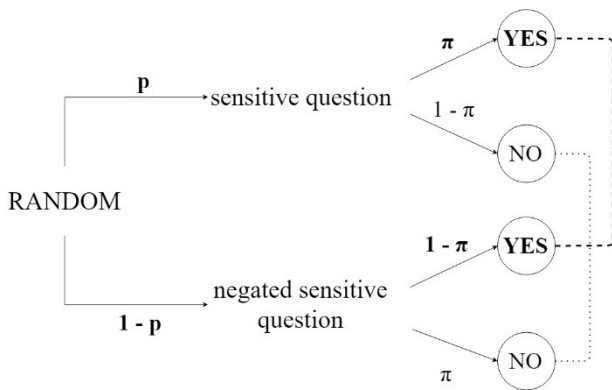

Figure 1. Warner's Design

Elementary probability theory can then be used to get an unbiased estimate $(\hat{\pi})$ of the prevalence of drug use in the population. So mathematically, π is the true proportion of the subjects with the sensitive characteristic, and p is the proportion of cards written on them with "I tried drug", (1-p) is the proportion of cards written on them with "I did not try drug". According to the Figure 1, the probability of a "yes" response, λ, is

$$\lambda = p\pi + \left(1-p\right)\left(1-\pi\right)$$
(1)

Solving for π, Warner [1] estimator is given as

$$\hat{\pi}_w = \frac{\hat{\lambda} - \left(1-p\right)}{2p-1}, \quad p \neq 0.5$$
(2)

Here, $\hat{\lambda}$ is the observed proportion of "yes" answers in the sample:

$$\hat{\lambda} = \frac{n_1}{n}$$
(3)

Note that the proportions p and $1 - p$ are known, as are the number of "yes" responses n_1 and the sample size n. Hence, we can calculate the estimate values of π and sample variance.

The sample variance of Warner [1] estimator is

$$var\left(\hat{\pi}_w\right) = \frac{\hat{\lambda}\left(1-\hat{\lambda}\right)}{\left(n-1\right)\left(2p-1\right)^2}$$
(4)

As an early study of Warner design, Chaloupka [6] used this design to examine the illegal collection of shells in protected Great Barrier Reef in Australia. As a recent example, Gingerich [7] used this design to estimate the effect of a bureaucrat's partisan and electoral ambitions on participation in acts of political corruption in Bolivia, Brazil, and Chile. Other applications include capital punishment [2] and legalizing marijuana use [8].

2.2. Unrelated Question Design

Unrelated question design is developed by Greenberg et al. [9]. Unlike the Warner's design, in this design, an unrelated question is used in order to increase respondents' adaptation with survey instructions. Thus, unlike Warner's technique from the previous section, at least some of the respondents would have the reassurance that they answered a wholly unrelated question, resulting in more respondent cooperation than Warner's technique. Under this design, there are two questions which one is sensitive and other one is unrelated, non-sensitive question. The randomization device assigns whether a respondent should answer a sensitive question or an unrelated, non-sensitive question.
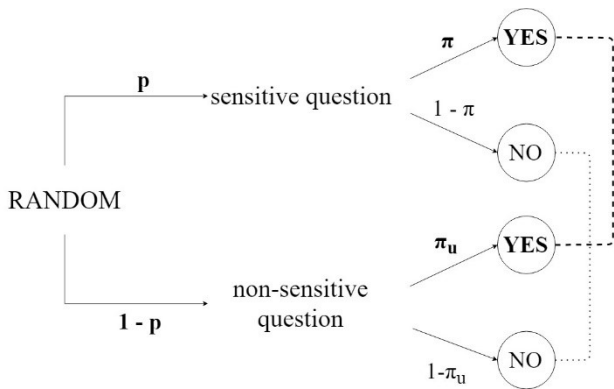
Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

Figure 2. Unrelated Question Design

Let exemplify Greenberg et al. [9] RRT with an example. For example, to estimate the "proportion of people who tried drug". Two questions are written on the cards in a deck. The respondents are requested to answer one of two questions:

1. Have you ever tried drug in your lifetime? (Sensitive question is selected with p probability).

2. Is your mother born in January?'' (Non-sensitive question is selected with 1-p probability)

The respondent randomly picks a card, and simply responds "yes" or "no" to the question without expressing to the interviewer which question is selected. The respondent is simply responding to the question shown on the randomly drawn card (see Figure 2)

Elementary probability theory can then be used to get an unbiased estimate $(\hat{\pi})$ of the prevalence of drug use in the population. So mathematically, π is the true proportion of the subjects with the sensitive characteristic, and p is the proportion of cards written on them with sensitive question "Have you ever tried drug in your lifetime?" π_u is the known population prevalence of unrelated, non-sensitive characteristic and (1-p) is the proportion of cards written on them non-sensitive question with "Is your mother born in January?". According to the Figure 2, the probability of a "yes" response, λ, is

$$\lambda = p\pi + (1-p)(1-\pi_u) \qquad (5)$$

Solving for π, Greenberg et al. [9] estimator is given as

$$\hat{\pi}_G = \frac{\hat{\lambda} - (1-p)\pi_u}{p} \qquad (6)$$

Here, $\hat{\lambda}$ is the observed proportion of "yes" answers in the sample:

Note that the proportions p and $1 - p$ are known, as are the number of "yes" responses n_1 and the sample size n and the prevalence of population of unrelated question. Hence variance of $\hat{\pi}$ is calculated under known parameters.

The sample variance of Greenberg et al. [9] estimator is

$$var(\hat{\pi}_G) = \frac{\hat{\lambda}(1-\hat{\lambda})}{(n-1)p^2} \qquad (7)$$

For example, Lara et al. [10] applied the unrelated question design to study abortion rates in Mexico.

The instructions used in this study:

Here is a folder, one colored red and the other green. The red folder contained a sheet of paper with a red dot and the following question:

''Did you ever interrupt a pregnancy?''

The words "yes" and "no" were printed below the question.

The green folder contained a sheet of paper with a green dot and the following question:

''Were you born in April?''

Again, the words "yes" and "no" were printed below. Then, fold the sheets of paper into the same shape, so that it is impossible to identify one from the other, and to place them in an opaque bag. Now, I shake the bag, please reach inside and select one folded sheet of paper and say your answer, either yes or no.

Here, the interviewer does not know which question the respondent had chosen and was answering. The respondent would then say her/his answer out loud, either yes or no. The interviewer then recorded the respondent's response.

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

As a recent example, Chen et al. [11] applied this design in the survey of issues relevant to commercial sex among men who have sex with men (MSM) in Beijing, China. Other applications of the unrelated question include abortion in Turkey [12], a criminology study of self-reported arrests in Philadelphia [13].

2.3. Forced Response Design

Forced response design is developed by Boruch [14]. Under Boruch's design, the randomization device assigns whether a respondent truthfully answers the sensitive question or simply replies with an automatic (forced) answer, `yes'or `no" response regardless of the true answer to the sensitive question. The result of the randomizing device is known only to the respondent, not to the interviewers.
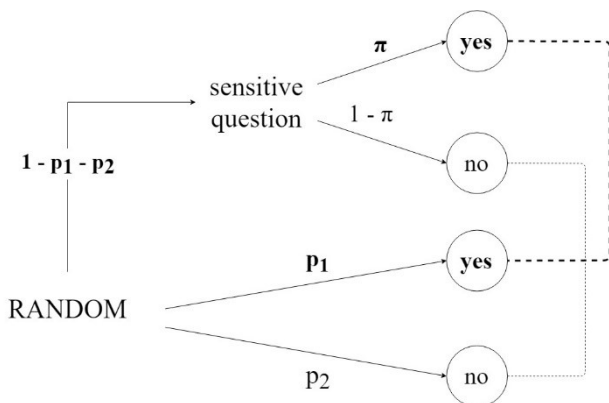

Figure 3. Forced Response Design

In Boruch [14] design, each respondent's answer provided with a randomization device, such as a die or a deck of cards. There are three statements in this design:

 (i) report "yes"

 (ii) report "no",

(iii) report the true answer of the sensitive variable, say "yes" or "no" with proportion p_1, p_2 and p_3 respectively.

So mathematically, π is the true proportion of the subjects with the sensitive characteristic, and p_1 is the proportion of "yes" reports, p_2 is the proportion

of "no" reports and p_3 is the proportion of cards written on them with sensitive question "Have you ever tried drug in your lifetime?". According to the Figure 3, the probability of a "yes" response, λ, is

$$\lambda = p_1 + \left(1 - p_1 - p_2\right)\pi \qquad (8)$$

Solving for π, Boruch [14] estimator is given as

$$\hat{\pi}_B = \frac{\hat{\lambda} - p_1}{1 - p_1 - p_2} \qquad (9)$$

Here, $\hat{\lambda}$ is the observed proportion of "yes" answers in the sample:

  Note that the proportions p_1 and p_2 are known, as are the number of "yes" responses n_1 and the sample size n. Hence variance of $\hat{\pi}$ is calculated under known parameters.

The sample variance of Boruch [14] estimator is

$$var\left(\hat{\pi}_B\right) = \frac{\hat{\lambda}\left(1 - \hat{\lambda}\right)}{\left(n - 1\right)\left(1 - p_1 - p_2\right)^2} \qquad (10)$$

For example, a study of xenophobia and anti-Semitism in Germany [15]. Krumpal [15] used coin flip method for this design.

The instructions are reproduced here,

"Now we would like to know your personal opinion on different segments of the population. One of these segments is foreigners living in Germany. We are aware of the fact that many people are very hesitant about giving their personal opinion on topics like this because they are very private. With this in mind, the University of Leipzig has developed a novel question technique that guarantees your privacy and makes the interview more comfortable.

When answering the following questions, you can keep your personal opinion secret by flipping a coin. This might sound a bit unusual, however, I would like to ask you to help us and try out this

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

new method together with us. Could you please get three coins as well as a piece of paper and a pen? (…)

Please flip the three coins each time before I ask you a question. However, please do not tell me the results! Depending on the result of the coin flip, please answer as follows. I am happy to give you some time to write down the rules, if you would like:

- If you flip tails 3 times, please always answer "yes".

- If you flip heads 3 times, please always answer "no".

- If you flip a combination of heads and tails, for example tails 2 times and heads 1 time, please always tell your true personal opinion.

As you can see, coincidence will decide whether you answer the question truthfully or whether you give a predetermined answer. This way your privacy will always be protected. I will not know the result of your coin flip and therefore I will never know why your answer is "yes" or "no". Did you understand the coin-flip method? (…)

Sometimes you will answer "yes" or "no" due to the result of your coin flip, even though this is not your real personal opinion. Please do not worry about that. You are doing the right thing if you follow the rules of the coin-flip method and always answer according to the result of the coin-flip.

I will now read out aloud some statements to you which you might have heard at some point before. Please tell me each time, according to your coin flip, whether or not you would somewhat agree with the statement. We will now start with the first statement. (…) Please flip your three coins now without telling me the result. According to your coin flip, would you somewhat agree with the following statement?

"There are too many foreigners in Germany" (...)."

This design is popular among applied researchers and there are numerous examples.

A study of fabrication in job applications [16], social security fraud in Netherland [17], use of performance enhancing drugs [18] and vote choice regarding a Mississippi abortion referendum [19].

2.4. Crosswise Design

Crosswise design (CD) is developed by Yu et al. [20]. This design is like unrelated question design. In this design, the sensitive question is asked together with a non-sensitive question that has a known population distribution (such as whether one's mother's birthday occurs in certain months). In this design, respondents are requested to give a joint answer to two questions rather than responding directly to the sensitive questions. The respondents are asked to indicate only whether their answers to two questions are the same (both "yes" and both "no") or different (one answer is "yes" and the other answer is "no"). In this design, the probability distribution of the non-sensitive question should be known and unequal to 0.5 for prevalence estimation of sensitive characteristic. In addition to this, provided that the answer to the unrelated question is unknown, the respondent's answer to the sensitive question remains confidential. The respondents could easily understand that the crosswise design protects their privacy because the interviewer is unaware of the possible answers, "the same" or "different". Furthermore no one is forced to give a "yes" or "no" answer.

So mathematically, π is the true proportion of the subjects with the sensitive characteristic, and p is the known population prevalence of non-sensitive question. According to the Figure 4, the probability of a "same" response, λ_s, is

$$\lambda_s = p\pi + (1-p)(1-\pi) \tag{11}$$

Solving for π, Yu et.al. [20] Crosswise design estimator is given as

$$\hat{\pi}_c = \frac{\hat{\lambda}_s - (1-p)}{2p-1}, \quad p \neq 0.5 \tag{12}$$

Here, $\hat{\lambda}_s$ is the observed proportion of "same" answers in the sample.

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

Note that the proportions p and $1 - p$ are known, as are the number of "same" responses. Hence, we can calculate the estimate values of π and sample variance.

The sample variance of Yu et.al. [20] Crosswise design estimator is

$$var\left(\hat{\pi}_c\right) = \frac{\hat{\lambda}_s\left(1-\hat{\lambda}_s\right)}{\left(n-1\right)\left(2p-1\right)^2} \tag{13}$$

Note that the crosswise design is formally equal to the Warner [1] original design. However, it follows a different logic than the Warner's design. In crosswise design, the respondents have to answer two questions simultaneously and they don't have to give directly "yes" or "no" answer.
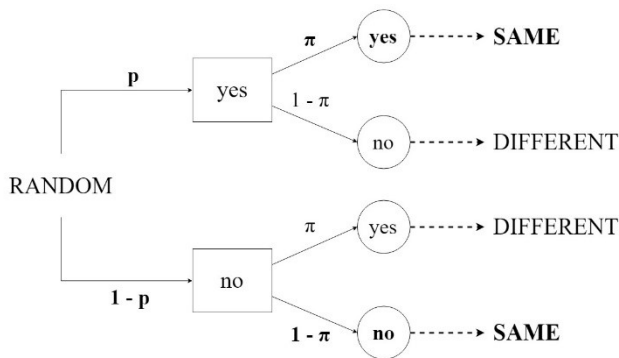

Figure 4. Crosswise Design

Recent studies have pointed out that the CD successfully reduces under-reporting of socially undesirable behavior. This design is also popular among applied researchers and there are numerous examples, recently. [21] conducted CD between Swiss and German university students to estimate plagiarism prevalence. [22] conducted a study to investigate drug use prevalence, especially anabolic steroids, among bodybuilding athletes in Iran. [23] implemented CD to estimate the prevalence of illicit drug use among the students of Tehran University of Medical Sciences. [24] used this design to investigate illicit drug use prevalence among students studying at Universities in Shahroud (Northeast of Iran). Other CD studies are summarized as, tax evasion [25], sexual behavior [26], attitudes towards Muslims [27], organ donation [28].

2.4.1. Stratified Crosswise design

In this section, crosswise design is suggested in stratified sampling. Let the population be divided into L non-overlapping homogeneous strata with N_h units in the hth stratum and n_h be the number of units drawn by Simple Random Sampling without Replacement (SRSWOR) from the hth stratum. $n = \sum_{h=1}^{L} n_h$ and $N = \sum_{h=1}^{L} N_h$ give the total sample size and the total population size, respectively. For the hth strata, $W_h = N_h / N$ is the stratum weight. An individual respondent in the sample from h^{th} stratum is instructed to report a joint answer to two questions.

the probability of a "same" response in h. stratum λ_{sh}, is

$$\lambda_{sh} = p_h\pi_h + \left(1 - p_h\right)\left(1 - \pi_h\right). \tag{14}$$

Solving for π_h, crosswise design estimator in h. stratum is

$$\hat{\pi}_{ch} = \frac{\hat{\lambda}_{sh} - \left(1 - p_h\right)}{2p_h - 1}, \quad p_h \neq 0.5 \tag{15}$$

Crosswise design estimator in stratified sampling is given as

$$\hat{\pi}_{c_{st}} = \sum_{h=1}^{l} W_h\hat{\pi}_{ch}, \quad h = 1, 2, ..., l \tag{16}$$

The sample variance of crosswise design estimator in stratified sampling is

$$var\left(\hat{\pi}_{c_{st}}\right) = \sum_{h=1}^{l} W_h^2 \frac{\hat{\lambda}_{sh}\left(1-\hat{\lambda}_{sh}\right)}{\left(n_h-1\right)\left(2p_h-1\right)^2} \tag{17}$$

Here, $\hat{\lambda}_{sh}$ is the observed proportion of "same" answers in the h. stratum, p_h is the known population prevalence of non-sensitive question in h.stratum.

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

3. DRUG USE IN UNIVERSITY STUDENTS IN TURKEY

Empirical studies on university students in Turkey are based on direct questioning about socially undesirable behavior such as drug use. Altındağ et al. [29] investigated the prevalence of illicit drug, smoking and alcohol use in fist year students of Harran University (n=253) and lifetime illicit drug use prevalence was identified as 2.3%. Akvardar et al. [30] investigated the prevalence of illicit drug, smoking and alcohol use in medical students from three different medical schools in Turkey (n=447) and they found that 4% of the students reported using illicit drugs (cannabis, ecstasy, cocaine) at least once in their lifetime. Mayda [31] studied to determine the prevalence of substance, cigarette, alcohol use in students of Forestry Faculty of Düzce University (n=398) and he found that the substance use among students is 9.3%. Turhan et al. [32] made a cross-sectional study in students of Mustafa Kemal University (n=396) and lifetime illicit drug use were identified as 9.6%. Ulukoca et al. [33] researched the prevalence of cigarette, alcohol, and substance use among the students of Kırklareli University (n=902) and 10.4% of students had tried using substances at least once in their life, with marijuana (4.1%) and solvents (3.2%) reported as the substances most commonly tried. Yüncü and Atlam [34] evaluated the relationship between cigarette, alcohol, substance experience among gender, faculty, class, living environment, substance use of families among students of Ege University (n=1522). 13.4% of students had tried using substances at least once in their life with cannabis (12.5%), ecstasy (MDMA) (2%), cocaine (0.6%) and heroin (0.1%) were mostly used illegal drugs. They found that the illicit drug use prevalence is significantly different among men (22.2%) a women student (7.6%). Türk and Yavuz [35] investigated the meaning of penal sanctions with regard to substance use on students from different universities in Turkey (n=227). In the study, the students reported they used the below substances at least once; 17.9% marijuana, 3.4% heroin, 4.5% cocaine, 2.6% LSD, 4.5% ecstasy, 3% bonsai. The current study on drug use was carried on by Coşkun et al. [36]. They determined the change on alcohol and drug use among the first and last year university students of Gaziantep University (n=2217) and they found that 8.6% of the men and 2.1% of the women had used drug at least once. 8.3% of the last year students had used drug at least once while 4.6% of the first-year students had used drug at least once.

4. APPLICATION

This study aims to introduce binary RRTs and show the real application of RRTs in Turkey. By this aim, a RRT application is carried out in Ankara, Turkey. The survey's target population included the dormitory students at a public university in Ankara, Turkey. First of all, a pretest (n= 60) was conducted to students in order to with which binary RRT, they would feel safe and comfortable. The binary RRTs which are introduced in section 2 were presented to the students with instructions. After the presentation, the students were asked "which RRT design do you feel safe and comfortable for answering your sensitive behaviors?". Most of the students (%78) reported that they would be more confident when Crosswise design (CD) is conducted. After pretest result, crosswise design was implemented to estimate illicit drug use prevalence. To evaluate crosswise design (CD) ensures better estimates of illicit drug use than direct questioning (DQ) method, two different questionnaires: a direct-questioning version and a CD version were conducted on dormitory students. The private dormitory has 1980 students. Students were selected using stratified random sampling method. The survey is conducted with 712 students with 0.03 margin of error. The sample is consisting of %46 women and %54 men.

Students were randomly selected using a ratio of 3 for the CD (n=534) to 1 for DQ (n=178). For both techniques, the students were selected with stratified random sampling method which has two stratum and the stratum is gender.

Due to the sensitive research topic, for both conditions, the students were all informed about the aims of the study.

In the 'direct questioning' technique, a confidentiality assurance was read out loud to the respondent. "

We are aware of the fact that many people are very hesitant about revealing their sensitive behaviors because they are very private. With this in mind, we would like to assure you that all answers given will be kept confidential and will not be passed on to anyone else. I will now read aloud a question to you. Please answer the question by simply telling us 'Yes' and 'No'. Now, I read the question. "Have you ever tried illicit drug in your lifetime?"

The instructions used in the CD technique:

We are aware of the fact that many people are very hesitant about revealing their sensitive behaviors because they are very private. With this in mind to ensure the protection of your personal rights, we will use an indirect questioning technique that guarantees that your answers will be totally anonymous.

Therefore, you will not be requested to answer any question directly, but rather, you will be asked" two questions at the same time by simply telling us whether the answers to the questions are (a) the same or (b) different.

The questions:

Question 1: is your mother's birthday in January, February, or March.?

Question 2: Have you ever tried illicit drug in your lifetime?

In crosswise design application, the non-sensitive question is about respondent's mother's birthday: ''is your mother's birthday in January, February, or March?''. The known probability of answering ''yes'' to the mother's birthday question is .2471 (i.e., 90.25 days/365.25 days).

178 students were interviewed by DQ and 534 students were interviewed by the CD. For CD technique, the prevalence estimation is calculated by Eq. (16). The general result is showed in Table 1. As Table 1 illustrates, 6.1% (SE = 1.47) of the students in the DQ technique reported that they had tried illicit drug at least once in their lifetime. By CD technique, the prevalence of illicit drug use

is estimated as 22.6% (SE = 4.12). As expected, one-sided z test indicates a significantly higher prevalence estimate of illicit drug use for the CD technique compared with the DQ Technique (CD = 22.6%, DQ = 6.1%, p < .001). The illicit drug use prevalence among students is compared according to the gender in both DQ and CD Technique. In CD technique, estimated illicit drug use prevalence is higher among male students than female students (Male: 33.19 %, Female = 10.00 %, p < .05). Similar result is also observed when DQ technique is conducted (Male: 9.00%, Female = 2.60%, p < .001). The results are showed in Table 2.

Table 1. Prevalence estimate of illicit drug use according to the questioning techniques

Variable	Questioning Technique	
Illicit Drug Use	**DQ**	**CD**
Prevalence Estimate (%)	6.1	22.6
Standard Error (%)	1.47	4.12
%95 Confidence Interval	3.2-9.00	14.5-30.7
n	178	534
z score (sig.)	3.78 (0.000)	

Table 2. Illicit drug use prevalence according to the Gender

Variable		Questioning Technique	
Illicit Drug Use	**Gender**	**DQ**	**CD**
Prevalence Estimate (%)	**Female** (%95 CI)	2.60 (0.6-4.6)	10.00 (0.0-21.49)
	Male (SE)	9.00 (5.7-12.3)	33.19 (21.93-44.45)
z score (sig.)		3.25 (0.000)	2.83 (0.002)

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

5. CONCLUSION

This study introduces the Binary RRTs and shows the real application of a RRT design in Turkey. The randomizing procedure is crucial for the success of the RRT, as it shows the answers of the respondents are protected by probability theory. In this study, Crosswise design is preferred in estimation of the prevalence of illicit drug use. It has seen that crosswise design provides more confidence for respondents and easier to apply to the other designs. The present study compared indirect and direct questioning techniques in estimating illicit drug use and with crosswise design, considerably minor response refusals are obtained and significantly higher drug-use estimates are observed by gaining more privacy in the data collection process. So, it can be concluded that Crosswise design gives the most efficient statistical estimation compared to alternative RRT designs. Moreover, the present research will provide to extend the recognition of the RRTs in sensitive surveys and encourage researchers to study on sensitive topics in Turkey. Future studies can be extended for analyzing all sociodemographic characteristics of the students and can be replicated for all university students in Turkey.

6. REFERENCES

[1] S.L. Warner, "Randomized response: A survey technique for eliminating evasive answer bias", Journal of the American Statistical Association, vol. 60, pp. 63-69, 1965.

[2] G.J.L.M Lensvelt-Mulders, J.J. Hox and P.G.M. Van der Heijden, "How to Improve the Efficiency of Randomised Response Designs", Quality and Quantity, vol. 39, pp. 253 – 265, 2005.

[3] N. Özgül, Proportion and Mean Estimators in Randomized Response Models, Ph.D. Thesis, Hacettepe University, Ankara, 2013.

[4] U. Engel, B. Jann, P. Lynn, A. Scherpenzeel, P. Sturgis, "Improving Survey Methods: Lessons from Recent Research", Routledge, New York, 2014.

[5] E. Coutts, and B. Jann, "Sensitive Questions in Online Surveys: Experimental Results for the Randomized Response Technique (RRT) and the Unmatched Count Technique (UCT)", Sociological Methods & Research, vol. 40, no. 1, pp. 169–193, 2011.

[6] M.Y. Chaloupka, "Application of the randomized response technique to marine park management: an assessment of permit compliance", Environmental Management, vol. 9, no. 5, pp. 393-398, 1985.

[7] D.W. Gingerich, "Understanding of the books politics: Conducting inference on the determinants of sensitive behavior with randomized response surveys", Political Analysis, vol. 18, no. 3, pp. 349-380, 2010.

[8] S. Himmelfarb, "The multi-item randomized response technique", Sociological methods & research, vol. 36, no. 4, pp. 495-514, 2008.

[9] B.V. Greenberg, A.A. Abdul-Ela, W.R. Simmons, D.G. Horvitz, "The unrelated question randomised response model: Theoretical framework", Journal of the American Statistical Association, vol. 66, pp. 243–250, 1969.

[10] D. Lara, S.G. Garcia, C. Ellertson, C. Camlin and J. Suarez, "The measure of induced abortion levels in Mexico using random response technique", Sociological Methods & Research, vol. 35, no. 2, pp. 279-301, 2006.

[11] X. Chen, Q. Du, Z. Jin, T. XU, J. Shi, G. Gao, "The Randomized Response Technique Application in the Survey of Homosexual Commercial Sex among Men in Beijing", Iranian J Publ Health, vol. 43, no. 4, pp. 416-422, 2014.

[12] S. Tezcan and A.R. Omran, "Prevalence and reporting of induced abortion in turkey: two survey techniques", Studies in family planning, vol. 12, no. 6-7, pp. 262-271, 1981.

[13] P.E. Tracy and J.A. Fox, "The validity of randomized response for sensitive measurements", American Sociological Review, pp. 187-200, 1981.

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

[14] R.F. Boruch, "Assuring confidentiality of responses in social research: A note on strategies", The American Sociologist, vol. 6, pp. 308–311, 1971.

[15] I. Krumpal, "Estimating the prevalence of xenophobia and anti-semitism in Germany: A comparison of randomized response and direct questioning", Social science research, vol. 41, no. 6, pp. 1387-1403, 2012.

[16] J.J Donovan, S.A. Dwight and G.M. Hurtz, "An assessment of the prevalence, severity, and verifiability of entry-level applicant faking using the randomized response technique", Human Performance, vol. 16, no. 1, pp. 81-106, 2003.

[17] P.G.M. Van der Heijden, G. Van Gils, J. Bouts, J.J Hox, "A comparison of randomized response, CASAQ, and direct questioning; eliciting sensitive information in the context of social security fraud", Kwantitatieve Methoden, vol. 59, pp. 15-34, 1998.

[18] J.H. Stubbe, A.M. Chorus, L.E. Frank, O. Hon and P.G. Heijden, "Prevalence of use of performance enhancing drugs by fitness centre members", Drug testing and analysis, vol. 6, no. 5, pp. 434-438, 2014.

[19] B. Rosenfeld, K. Imai and J. Shapiro, "An empirical validation study of popular survey methodologies for sensitive questions", American Journal of Political Science, vol. 60, no. 3, pp. 783-802, 2016.

[20] J.W. Yu, G.L. Tian, M.L. Tang, "Two new models for survey sampling with sensitive characteristic: design and analysis", Metrika, vol. 67, pp. 251-263, 2008.

[21] B. Jann, J. M. Jerke, I. Krumpal, "Asking Sensitive Questions Using the Crosswise Model: An experimental Survey Measuring plagiarism", Public Opinion Quarterly, vol. 76, no. 1, pp. 32-49, 2012.

[22] M.R. Nakhaee, F. Pakravan, N. Nakhaee, "Prevalence of Use of Anabolic Steroids by Bodybuilders Using Three Methods in a City of Iran", Addict Health, vol. 5, no. 3-4, pp. 77-82, 2013.

[23] M. Shamsipour, M. Yunesian, A. Fotouhi, B. Jann, A. Rahimi-Movaghar, F. Asghari and A.A. Akhlaghi, "Estimating the prevalence of illicit drug use among students using the crosswise model", Substance Use & Misuse, vol. 49, no. 10, pp. 1303–1310, 2014.

[24] A. Khosravi, S.A. Mousavi, R. Chaman, F. Khosravi, M. Amiri, M. Shamsipour, "Crosswise Model to Assess Sensitive Issues: A Study on Prevalence of Drug Abuse Among University Students of Iran", Int J High Risk Behav Addict, vol. 4, no. 2, e24388, 2015.

[25] M. Korndörfer, I. Krumpal and S.C. Schmukle, "Measuring and explaining tax evasion: Improving self-reports using the crosswise model", Journal of Economic Psychology, vol. 45, pp. 18-32, 2014.

[26] K. Vakilian, S. Mousavi and A. Keramat, "Estimation of Sexual Behavior in the 18-to 24-Years-old Iranian Youth based on a Crosswise Model Study", BMC Research Notes, vol. 7, no. 1, pp. 1-4, 2014.

[27] D. Johann and K. Thomas, "Testing the Validity of the Crosswise Model: A Study on Attitudes Towards Muslims Survey Methods: Insights from the Field", 2017, Retrieved from https://surveyinsights.org/?p=8887.

[28] M. Höglinger, B. Jann, A. Diekmann," Uncovering a Blind Spot in Sensitive Question Research: False Positives Undermine the Crosswise-Model RRT", Political Analysis, vol. 25, no. 1, pp. 131-137, 2017.

[29] Y. Akvardar, Y. Demiral, G. Ergör, A. Ergör, M. Bilici and Ö.A. Özer,"Substance use in a sample of Turkish medical students", Drug and alcohol dependence, vol. 72, no. 2, pp. 117-121, 2003.

[30] A. Altındağ, M. Yanık, E. Yengil and A.H. Karazeybek, "Şanlıurfa'da üniversite öğrencilerinde madde kullanımı", Bağımlılık Dergisi, vol. 6, no. 2, pp. 60-64, 2005.

Nilgün Özgül

A Survey on Illicit Drug Use among University Students by Binary Randomized Response Technique: Cross...

[31] A.S. Mayda, "Düzce Üniversitesi Orman Fakültesi Öğrencilerinde Sigara, Alkol Ve Madde Kullanımı Sıklığı Ve Kullanmaya Başlama Nedenleri", Düzce Tıp Dergisi, vol. 12, no. 3, pp. 7-14, 2010.

[32] E. Turhan, T. İnandı, C. Özer, S. Akoğlu, "Üniversite öğrencilerinde madde kullanımı, şiddet ve bazı psikolojik özellikler", Turkish Journal of Public Health, vol. 9, no. 1, pp. 33-44, 2011.

[33] N. Ulukoca, Ş. Gökgöz and A. Karakoç, "Kırklareli Üniversitesi Öğrencileri Arasında Sigara, Alkol ve Madde Kullanım Sıklığı", Fırat Tıp Dergisi, vol. 18, no. 4, pp. 230-234, 2013.

[34] Z. Yüncü and D.H. Atlam, "Üniversitesi Öğrencilerinde Sigara, Alkol,Madde Kullaným Bozukluğu ve Ailesel Madde Kullanımı Arasındaki İlişki", Klinik Psikiyatri, vol. 20, pp. 161-170, 2017.

[35] B. Türk and M.F. Yavuz, "Caydırıcılığın Madde Kullanımı Açısından Üniversite Öğrencilerinde Değerlendirilmesi", Adli Tıp Bülteni, vol. 23, no. 3, pp. 143-150, 2018.

[36] F. Coşkun, B. Özçırpıcı and S. Özgür, "Gaziantep Üniversitesi Merkez Kampüsü'ndeki lisans öğrencilerinde alkol ve madde kullanma durumu", Ortadoğu Tıp Dergisi, vol. 11, no. 2, pp. 143-147, 2019.