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ESTIMATING NON-RESPONSE BIAS IN A SURVEY ON ALCOHOL CONSUMPTION: COMPARISON OF RESPONSE WAVES

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Abstract — **Aims:** According to ‘the continuum of resistance model’ late respondents can be used as a proxy for non-respondents in estimating non-response bias. In the present study, the validity of this model was explored and tested in three surveys on alcohol consumption. **Methods:** The three studies collected their data by means of mailed questionnaires on alcohol consumption whereby two studies also performed a non-response follow-up. **Results:** Comparisons of early respondents, late respondents and non-respondents in one study showed some support for ‘the continuum of resistance model’, although another study could not confirm this result. Comparison of alcohol consumption between three time response groups showed no significant linear pattern of differences between response waves. **Conclusions:** The hypothesis that late respondents are more similar to non-respondents than early respondents, could not be confirmed or rejected. Repeated mailings are effective in obtaining a greater sample size, but seem ineffective in improving the representativeness of alcohol consumption surveys.

INTRODUCTION

Survey researchers are constantly confronted with the problem of non-response. Moreover, with a low response rate, the validity of survey results may well be questioned. However, a low response rate does not necessarily mean that the results are biased. Non-response bias occurs when respondents and non-respondents differ in outcome variable(s), in which case the population parameters of these variable(s) can be over- or under-estimated.

Methods are available for survey researchers to deal with the problem of non-response. One is to build in strategies during survey development and data collection, in order to positively influence the response rate. Such strategies include financial incentives, repeated mailings, and an appealing survey design. Dillman (2000) described these approaches in his so-called ‘Tailored Design Method’: a method to maximize both quantity and quality of responses. These approaches are sometimes successful, but biased estimates due to non-response may still remain. Non-response bias can be estimated and/or corrected for in various ways. An indirect approach is to weight cases, whereby weights are allocated to various substrata, which are mostly defined by background variables; this approach is justified if the background variables are strongly related to outcome variable(s). Direct approaches include collecting valid information from objective sources, or conducting a non-response follow-up to collect data on outcome variable(s) of non-respondents to get insight into differences between respondents and non-respondents. However, follow-up studies tend to be costly and time-consuming; moreover, it is often difficult to contact initial non-respondents and secure their further participation.

An alternative and widely used approach is to estimate the non-response bias by comparing early and late respondents; a late respondent is then used as a proxy for a non-respondent.

The underlying assumption behind this approach is that every subject in the study population has a position on the response continuum that ranges from ‘will never respond’ to ‘will always respond’. Non-respondents will be concentrated on the side of ‘will never respond’. Subjects who require more reminders before they participate would have been non-respondents if the data collection had stopped earlier. Therefore, late respondents most resemble non-respondents. This assumption has been called ‘the continuum of resistance model’ (Lin and Schaeffer, 1995; Voogt *et al.*, 1998).

Questions arise, however, about the validity of this ‘continuum of resistance model’. If it appears valid, then it is justified to use late respondents as proxies for non-respondents, and then repeated mailings will help lower the degree of possible non-response bias. However, Table 1 shows that a recent literature review does not provide a consistent answer to these questions.

Some researchers found no support for the assumption that late respondents can be used as a proxy for non-respondents (Hébert *et al.*, 1996; Larroque *et al.*, 1999), whereas others found that non-response bias can be estimated by analysing late respondents (Dalecki *et al.*, 1993; Lin and Schaeffer, 1995; Etter and Perneger, 1997; Ullman and Newcomb, 1998). In several surveys, refusal conversions or repeated mailings appeared to be useful in lowering the degree of biased estimates. Some researchers found no significant differences between different time groups of respondents, which suggests that the number of mailings or refusal conversions could be reduced without affecting the accuracy of survey estimates (Green, 1991; Dalecki *et al.*, 1993; Hébert *et al.*, 1996; Etter and Perneger, 1997; Trinkoff and Storr, 1997; Ullman and Newcomb, 1998; van Goor and Stuiver, 1998; Voogt *et al.*, 1998; Larroque *et al.*, 1999; Woodruff *et al.*, 2000; Schmidt and Fletcher, 2001).

Only three studies in our literature review had main survey topics that addressed substance use (Trinkoff and Storr, 1997; Ullman and Newcomb, 1998; Woodruff *et al.*, 2000). Trinkoff and Storr (1997) did not question the justification of using late

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Table 1. Literature review

Study	Goal of study	Method	Survey topic	Analysis: comparing groups	Conclusion
Kellerman and Herold (2001)	To understand role of non-response bias	Five mailed surveys	Physician-specific topic	First- versus second-mailing respondents	Non-respondents are similar to respondents
Schmidt and Fletcher (2001)	To demonstrate the importance of persistence in refusal conversions	Four random digit dial telephone surveys	Telecommunication, beach use, storm water quality and driver satisfaction	Early versus late respondents	Refusal conversions are necessary to lower the degree of non-response bias
Woodruff <i>et al.</i> (2000)	To examine non-response bias; to examine results of response-enhancing strategies	Mailed survey	Smoking	Initial respondents versus reluctant respondents versus non-respondents	Under-representation of hard-core smokers due to non-response; response-enhancing strategies
Larroque <i>et al.</i> (1999)	To investigate non-response bias; to investigate the results of reminders/repeated mailings	Mailed survey	Child's temperament	Groups of respondents; respondents versus non-respondents	lower non-response bias Partial support for early-late comparison as proxy for non-response bias; repeated mailings diminish bias
Ullman and Newcomb (1998)	To develop models that differentiate between eager, reluctant, and non-responding participants	Mailed survey	Unknown	Eager respondents versus reluctant respondents versus non-respondents	Preliminary evidence for differentiating participants based on personality characteristics
van Goor and Stuiver (1998)	To examine distributional and substantive bias	Mailed survey	National caravan sites policy	Respondents (three waves) versus non-respondents	Higher response levels lead to better results. At final response rate distributions and relationships are still biased
Voogt <i>et al.</i> (1991)	To investigate differences between respondents and non-respondents	Telephone survey	Election/political interest	Groups of respondents	A systematic distortion due to non-response
Etter and Perneger (1997)	To investigate non-response bias	Mailed survey	Insurance plans	Early versus late respondents; respondents versus non-respondents	Groups of respondents can differ. Late respondents are not similar to non-respondents
Trinkoff and Storr (1997)	To analyse non-response patterns	Mailed survey	Nurses work life and health	Early versus late respondents; groups of respondents	No large amount of non-response bias
Hébert <i>et al.</i> (1996)	To study refusal bias	Mailed survey; face-to-face interviews	Health risk factors	Early respondents versus late respondents versus non-respondents	Important bias due to postal non-response; late respondents can be used as a proxy for non-respondents
Lin and Schaeffer (1995)	To evaluate two models estimating non-response bias: 'continuum of resistance model' and 'classes model'	Telephone interviews; mailed survey	Child support	Groups of respondents; late respondents versus non-respondents	No support for both models
Dalecki <i>et al.</i> (1993)	To investigate non-response bias	Mailed survey	Wetland preservation	Early versus late respondents; late respondents versus non-respondents	No support for early-late comparison as proxy for non-response bias
Green (1991)	To investigate non-response bias	Mailed survey; telephone interviews	Applications of research methods and findings to classroom teaching	Respondents versus non-respondents; groups of respondents	Non-response bias due to delayed response and non-response

respondents as non-respondents, but they did investigate differences in substance use rates by mailing. Ullman and Newcomb (1998) compared reluctant respondents with non-respondents, early respondents with reluctant respondents and with respondents who participated at different time intervals; to estimate substance use of non-respondents, they used data of earlier mailings in which these non-respondents had participated. Woodruff *et al.* (2000) also compared initial, reluctant and non-respondents, but focused more on the effects of incentives (such as financial incentives). All three studies drew their sample from specific subpopulations.

In a previous study, by means of a non-response follow-up (Lahaut *et al.*, 2002), we investigated whether respondents and non-respondents differed in their alcohol consumption; the results showed a significantly higher abstention rate and also a higher proportion of frequent excessive drinkers among non-respondents.

In the present study, we first investigated whether 'the continuum of resistance model' fits the data of this follow-up study; this model is also tested in a data set from a larger Dutch survey on alcohol consumption. Then, we investigated whether repeated mailings are worthwhile to collect more representative data on our outcome variable, alcohol consumption. For this, two larger samples from the general population were used. These studies were conducted in the same time period and used similar questions about alcohol consumption. Specifically, we aimed to answer the following questions: (1) are late respondents more similar to non-respondents than early respondents?; and (2) are there differences in alcohol consumption between response waves?

SUBJECTS AND METHODS

Procedure and samples

For this study, three data sets were used. The data of all three studies were collected by means of mailed questionnaires on alcohol consumption. There were three mailing periods: (wave 1) the first mailing of the questionnaire accompanied by an explanatory letter; (wave 2) 2 weeks later a reminder was sent to those who had not yet responded; (wave 3) subjects who had not responded in the second wave, received another reminder with another copy of the same questionnaire. The questionnaire in each study used similar questions on alcohol consumption. Subjects, aged 16–69 years, were approached by mail in April/May 1999.

The sample of the first data set (called the small-scale Rotterdam survey) consisted of 310 persons, who were living in 25 postal areas in the centre of Rotterdam. This study performed a non-response follow-up study (wave 4) on a sample of 177 subjects, who were approached mainly by means of house visits without prior notice.

The random sample of the second study (called the Utrecht survey) consisted of 5229 persons drawn from the municipal registry. The study in Utrecht also included a non-response follow-up study (wave 4). A random sample, stratified for age, was drawn from all non-respondents and consisted of 662 persons who were approached by telephone.

The random sample of the third study (called the large-scale Rotterdam survey) was drawn from the municipal registry in Rotterdam and consisted of 3226 persons. The large-scale

Rotterdam survey did not perform a non-response follow-up study.

Measures

The outcome variable in the three studies was alcohol consumption. Alcohol consumption was measured by four questions: (1) have you drunk any alcoholic beverages in the past year?; (2) how many units of alcoholic beverages do you drink on average in a typical week?; (3) please indicate for each day in the previous week how many units of alcoholic beverages you have drunk; and (4) have you ever drunk six or more units of alcoholic beverages on 1 day in the past 6 months?

Non-respondents of the small-scale Rotterdam survey and the Utrecht survey were asked several questions about alcohol consumption. In the two non-response follow-up surveys, the interviewer asked non-respondents whether they had drunk any alcoholic beverages in the past year. If the answer was yes, these participants were asked an additional question on alcohol consumption. In the follow-up of the small-scale Rotterdam survey, this question was: have you ever drunk six or more units of alcoholic beverages on 1 day in the past 6 months? The follow-up of the Utrecht survey used the question: please indicate for each day in the previous week how many units of alcoholic beverages you consumed on each day.

We constructed several variables that provided information on the amount of alcohol consumed. The variable 'drinking alcohol' made a distinction between abstainers and drinkers. According to the total alcohol intake in a typical week, the frequencies of drinkers were categorized as: 1–14 units/week, 15–28 units/week and ≥ 29 units/week. This variable was called 'total alcohol consumption in a typical week'. Based on the weekly recall question, the frequencies of the total alcohol intake consumed in the previous week were calculated (variable 'total alcohol consumption in previous week'). The question whether the subjects had ever consumed six or more units of alcoholic beverages on one occasion and with what frequency (never; 1–5 times/half year; 1–3 times/month; 1–2 times/week; ≥ 3 times/week) was used for constructing the variable 'frequency of excessive drinking'.

Analysis

Differences in the distribution of alcohol consumption between response waves were analysed by cross-tabulation. Statistical significance was estimated by chi-squared tests. A P value ≤ 0.05 was considered significant.

RESULTS

Response rates

The total gross response rate of the small-scale Rotterdam survey was 42.9% ($n = 133$). The first response wave yielded a response rate of 19.4%, the second response wave an additional 7.4% and the third response wave yielded an additional response of 16.1%. Of the 177 non-respondents in the small-scale Rotterdam's non-response follow-up study, 22 persons had moved or were absent for a longer period. Finally, we reached 129 non-respondents, of whom 102 answered at least one question on alcohol consumption. The contact rate of the follow-up was 83.2% (129/155).

The survey in Utrecht had a total gross response rate of 55.5% ($n = 2902$). The response percentages of the three waves were 32.9, 10.7 and 11.6%, respectively. The response time of 19 persons was unknown (response percentage of 0.3%). In the non-response follow-up study of Utrecht, 370 correct telephone numbers of 662 selected non-respondents were found. The researchers contacted 254 non-respondents. During these contact attempts, 133 persons answered at least one question on alcohol. The contact rate of the follow-up was 38.4% (254/662).

The total gross response rate of the large-scale Rotterdam survey was 50.5% ($n = 1630$). The first wave yielded an additional 29.0%, the second wave an additional 9.5%, and the third response wave yielded an additional response of 12.1%.

Differences between early respondents, late respondents and non-respondents

Table 2 gives data on differences in alcohol consumption between early (first wave) respondents, late (third wave) respondents and non-respondents (fourth wave respondents) from the small scale Rotterdam survey. A significantly higher proportion of abstainers was found among non-respondents, than among early respondents. There were no significant differences between early respondents and non-respondents in frequencies of excessive drinking. Comparison of alcohol consumption between late respondents and non-respondents showed no significant differences, except in excessive drinking

with the frequency of 1–5 times/half year. There was a higher proportion of excessive drinkers with a frequency of 1–5 times/half year among late respondents, than among non-respondents. The proportion of abstainers was also higher among non-respondents than among late respondents (third wave respondents), although the difference between these two groups was not significant.

Table 3 gives data on alcohol consumption of early and late respondents from the Utrecht survey, compared with non-respondents. These two comparisons showed no significant differences. Comparison of abstention rates between early respondents and non-respondents showed an almost significant difference (P value 0.057). The abstention rate in the Utrecht survey was higher among non-respondents, than among early respondents.

Differences in alcohol consumption between the three response waves

Table 4 gives data on the comparison of alcohol consumption between the first, second and third waves of respondents in the large-scale survey in Rotterdam and in the Utrecht survey. In both surveys, there were no significant differences between the three response waves, except for the proportion of abstainers. The proportion of abstainers in the Utrecht survey was the highest among the second wave respondents and the lowest proportion was found in the first response wave. This was not the case in the Rotterdam survey.

Table 2. Comparison of alcohol consumption between early respondents, late respondents and non-respondents in the small-scale Rotterdam survey

Alcohol consumption	Early respondents (wave 1), late respondents (wave 3) and non-respondents (wave 4)					
	Wave 1 ($n = 60$)	Wave 4 ($n = 89$)	P	Wave 3 ($n = 50$)	Wave 4 ($n = 89$)	P
Drinking alcohol: abstainers	21.7	47.2	0.002	36.0	47.2	0.201
	Wave 1 ($n = 45$)	Wave 4 ($n = 38$)	P	Wave 3 ($n = 30$)	Wave 4 ($n = 38$)	P
Frequencies of excessive drinking						
Never	44.5	39.5	0.668	36.6	39.5	0.813
1–5 times/half year	17.8	10.5	0.349	30.0	10.5	0.043
1–3 times/month	13.3	15.8	0.751	6.7	15.8	0.246
1–2 times/week	20.0	23.7	0.685	20.0	23.7	0.716
≥3 times/week	4.4	10.5	0.286	6.7	10.5	0.577

n , Number of subjects. Values are in percentages.

Table 3. Comparison of alcohol consumption between early respondents versus non-respondents and late respondents versus non-respondents in the Utrecht survey

Alcohol consumption	Early respondents (wave 1) versus non-respondents (wave 4)			Late respondents (wave 3) versus non-respondents (wave 4)		
	Wave 1 ($n = 1650$)	Wave 4 ($n = 133$)	P	Wave 3 ($n = 562$)	Wave 4 ($n = 133$)	P
Drinking alcohol: abstainers	15.5	21.8	0.057	18.1	21.8	0.332
	Wave 1 ($n = 1180$)	Wave 4 ($n = 83$)	P	Wave 3 ($n = 389$)	Wave 4 ($n = 83$)	P
Total alcohol consumption in previous week (units)						
0	11.9	17.0	0.137	12.2	17.0	0.197
1–14	58.6	57.0	0.757	62.3	57.0	0.325
15–28	20.9	19.0	0.652	17.8	19.0	0.784
≥29	8.6	7.0	0.584	7.7	7.0	0.818

n = Number of subjects. Values are in percentages.

Table 4. Differences in alcohol consumption by response waves in the large-scale Rotterdam survey and in the Utrecht survey

Alcohol consumption	Large-scale Rotterdam survey						Utrecht survey		
	Wave 1 (n = 924)	Wave 2 (n = 301)	Wave 3 (n = 382)	P	Wave 1 (n = 1662)	Wave 2 (n = 544)	Wave 3 (n = 588)	P	
Drinking alcohol: abstainers	26.2	24.6	24.9	0.803	17.6	25.0	20.6	0.001	
Total alcohol consumption in a typical week (units)									
1-14	75.6	72.2	74.6	0.627	71.3	70.0	73.0	0.436	
15-28	16.5	17.5	15.5	0.845	18.8	22.5	17.3	0.165	
≥29	7.9	10.3	9.9	0.463	9.9	7.5	9.7	0.354	
Frequency of excessive drinking									
Never	46.7	45.0	48.0	0.795	36.3	34.4	37.0	0.684	
1-5 times/half year	28.5	25.5	24.6	0.385	28.9	26.7	31.0	0.391	
1-3 times/month	12.3	15.9	12.8	0.385	17.5	18.6	15.8	0.529	
1-2 times/week	8.3	9.1	9.6	0.781	11.7	15.2	11.3	0.129	
≥3 times/week	4.2	4.5	5.0	0.867	5.6	5.1	4.9	0.844	

n = Number of subjects. Values are in percentages.

DISCUSSION

In this study, we aimed to answer the questions: (1) are late respondents more similar to non-respondents, than to early respondents?; and (2) are there differences in alcohol consumption between response waves? For the first question, we can neither confirm nor reject the hypothesis that late respondents are more similar to non-respondents, than to early respondents. In the small-scale Rotterdam survey, the abstention rate of late respondents was more similar to non-respondents, than to early respondents. Thus, this finding supports 'the continuum of resistance model'. However, in the Utrecht survey, this result was not confirmed. For the second research question, neither of the surveys (i.e. the large-scale Rotterdam survey and Utrecht survey) showed a significant linear pattern of differences in alcohol consumption between response waves. We could not confirm the 'continuum of resistance model'. The results suggest that repeated mailings are not necessary in order to collect more representative alcohol consumption estimates. The results do indicate, however, that repeated mailings are effective in obtaining a greater sample size. The two reminders in the small-scale Rotterdam survey were responsible for 23.5% of the total response rate (42.9%), compared with 22.3% of the total response rate (55.5%) in Utrecht. The reminders in the large-scale Rotterdam survey contributed an additional 21.6% to the total response rate of 50.5%. Both surveys, especially the mailing in the third wave, yielded a relatively high additional percentage to the total response rate.

Some limitations in our study have to be acknowledged. One limitation is the mode of data collection. The mode of the initial surveys (i.e. the mailed questionnaire) differed from that used in the follow-up of non-respondents (i.e. face-to-face interviews/telephone interviews). Additionally, both non-response follow-ups (the small-scale Rotterdam survey and the Utrecht survey) used different modes: i.e. mainly face-to-face interviews versus telephone interviews. Because of conflicting reports in the literature, it is difficult to assess the impact of the different methods used on self-reported alcohol consumption, and on responsiveness of non-respondents in the follow-up (Rehm and Armingier, 1996; Kraus and Augustin, 2001). There was a difference in contact rates between both our follow-up studies (83.2 vs 38.4%). Possible explanations for this difference may be the different modes used for each non-response follow-up and/or the number of contact attempts.

Besides the problem of using different modes, another limitation is the analysis itself. Most non-response follow-up studies suffer from low response rates. This is also true in our case, especially with regard to the Utrecht non-response follow-up. The response rates for questions on alcohol in the non-response follow-up study in Rotterdam and Utrecht were 79.1% (102/129) and 52.4% (133/254), respectively. This means that conclusions as to whether late respondents are more similar to non-respondents than to early respondents, rely on the assumption that the remaining non-respondents have the same pattern of alcohol consumption as fourth wave respondents. Owing to a low response rate, the results of the Utrecht non-response follow-up strongly relies on this assumption; however, the group of remaining non-respondents may become an increasingly deviant category. Although not in

the field of substance use, the study by van Goor and Stuiver (1998) showed that the group of hard-core non-respondents differed more and more from the other response groups.

We were able to compare our results with three other studies in the field of alcohol and drugs. Our results showed no significant differences in alcohol consumption between first, second and third wave respondents. Similarly, Trinkoff and Storr (1997) found no significant differences in substance use rates by mailing. In the study of Ullman and Newcomb (1998), the pattern of results was complex and indicated few differences in behavioural low social conformity variables (i.e. frequency of use of alcohol, cigarettes and marijuana) between early and reluctant respondents and between different groups of reluctant respondents. The results of Woodruff *et al.* (2000) showed significant differences in baseline smoking between 'on time' and 'reluctant' respondents. Smoking tobacco and marijuana use are similar to alcohol-sensitive survey topics. Ullman and Newcomb (1998) and Woodruff *et al.* (2000) included financial incentives in their reminders, which meant that they did not measure the relationship between response and substance use directly. Our results also suggest that there are no significant differences in alcohol consumption between late respondents and non-respondents, although the group differences in the Rotterdam survey were not small. Reluctant respondents and non-respondents in the study of Woodruff *et al.* (2000) showed considerable similarity in their baseline smoking characteristics.

The answer as to whether the alcohol consumption distribution of late respondents can be used as a proxy for the distribution of non-respondents remains ambiguous; our results are mixed. Thus, more studies are needed to establish whether late respondents can be used as proxies for non-respondents. Also, our results show no linear patterns of differences in alcohol consumption between response waves. The question arises as to whether it may be more economical to draw a larger initial sample, rather than sending reminders in order to enhance the response rate.

To estimate non-response bias, it is advisable to do an intensive non-response follow-up on a small representative sample of non-respondents, which allows more time for each individual subject, rather than an extensive follow-up on a large sample of non-respondents.

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