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Differential response rates in postal and Web-based surveys among older respondents

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Response rates were compared in a postal and a Web-based survey containing the same questions about preferences in regard to the design of future nursing homes. The questionnaire was sent to a random sample of 10,000 individuals aged 50-75 years who were randomly allocated to receive either a postal questionnaire or a letter with a Web link to an online version of the same questionnaire. The Web-based survey gave a significantly lower response rate than the postal survey. The Web-based version improved the sample representativeness with respect to gender but worsened it with respect to age. Respondents characteristics in the Web-based survey differed significantly from those of respondents in the postal survey with respect to income, education, civil status and health status. The Web-based version improved data quality by significantly lowering the number of item non-response and 'don't know' answers. The cost per response was significantly higher for the Web-based survey because of the significantly lower response rate compared to the postal survey.
Keywords: response rates, response behaviour, survey research, online survey, postal survey

Introduction

Web-based surveys may be advantageous in that they are potentially time-, effort- and cost-saving (Bälter et al. 2005; Couper 2000; Couper et al. 2001; McDonald and Adam 2003; Denscombe 2006). Web-based surveys have also been claimed to result in lower respondent errors and to increase the completeness of response (e.g. McDonald and Adam 2003; Denscombe 2006). However, limited access to the Internet, security issues, technical problems and differential response rates across survey modes between sociodemographic groups present challenges to this mode of data collection (Bosnjak and Tuten 2001; Bälter et al., 2005; Couper 2000; Crawford et al. 2001; Denscombe 2006; Ganassali 2008; Leece et al. 2004; Lonsdale et al. 2006; McDonald and Adam 2003; Raziano et al. 2001; Sax et al. 2003). Response rates to surveys have in general been decreasing (see e.g. Couper 2000; Dey 1997; Groves and Couper 1998; Sax et al. 2003), which may reduce the representativeness of those responding and thus the generalisability of the study results. A low response rate can threaten the validity of a survey if the respondents differ markedly from those not responding this may introduce 'non-response bias' (Sax et al. 2003). The mode of survey may also introduce response bias, i.e. bias in the ways in which the questions themselves are answered. The present study adds to a growing literature exploring the advantages and disadvantages of different survey modes in a range of research fields (see e.g. Akl et al. 2005; Braithwaite et al. 2003; Carini et al. 2003; Cook et al. 2000; Dannetun et al. 2007; Jones and Pitt 1999; Kaplowitz et al. 2004; Leece et al. 2004; Lonsdale et al. 2006; McDonald and Adam 2003; Raziano et al. 2001; Sax et al. 2003; Smyth et al. 2006).

The present study tested two modes of data collection for the same questionnaire a postal version and a Web-based version. The questionnaire explored future potential residents' attitudes to the design of nursing homes in order to inform policymakers about the relevance of specific design elements. This aspect of the survey is not the focus of this paper, however, which instead explores a number of methodological issues.

One source of survey error is unit non-response and item non-response, which refer to loss of survey units and missing responses to individual questions, respectively. Both types of non-responses are of importance to researchers because the unknown characteristics and attitudes of non-respondents can cause inaccuracies or bias in the results (Bosnjak and Tuten 2001; Couper 2000). The non-response error is a function of the rate of non-response and the difference between the respondents and non-respondents on the variables of interest. This paper explores the non-response behaviour. It is hypothesized that the Web-based survey will have a lower response rate than the postal survey, in line with previous studies (Bosnjak and Tuten 2001; Braithwaite et al. 2003; Cook et al. 2000; Couper 2000; McDonald and Adam 2003; Sax et al. 2003). Secondly, it is hypothesized that respondents and non-respondents differ across the two survey modes, and that respondents to the Web-based survey will be younger and more likely to be males, with higher income and higher education, in line with previous studies (Bosnjak and Tuten 2001; Couper 2000; McDonald and Adam 2003). Finally, it is hypothesized that the Web-based survey results in a lower proportion of item non-response compared to the postal sur-

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vey, as the Web-based format presents sequential questions one at a time, and the requirement to press 'Next' to proceed is assumed to encourage the respondent to answer. Item non-response in postal questionnaires may be caused by respondents refusing or forgetting to answer, and these phenomena are probably less frequent in a Web-based survey (Bosnjak and Tuten 2003; Denscombe 2006; McDonald and Adam 2003). In contrast, it is hypothesized that the proportion of 'don't know' answers will be higher in the Web-based survey, on the assumption that 'don't know' is the standard acceptable way of refusing to answer a question in a Web-based survey. The proportion of item non-response has been examined in other studies (see e.g. Akl et al. 2005; Denscombe 2006; Lonsdale et al. 2006; McDonald and Adam 2003), all of which found higher item non-response in postal versions.

The purpose of this paper is thus to assess and compare the response rates and response behaviour for a postal survey and a Web-based survey containing the same questions. Each survey version was sent out to 5,000 individuals. The variation in response behaviour was explored by looking at the correlates of non-respondents and the proportion of item non-response. Response rates of the two versions were firstly compared to test whether the Web-based survey had a lower response rate than the postal survey. Secondly, respondents and non-respondents were compared across the two surveys to explore non-response bias, i.e. whether the respondents and non-respondents in the Web-based survey differed from those in the postal survey. Finally, mode effects on response behaviour across the two surveys were assessed with respect to proportions of item non-response (missing observations) and of 'don't know' answers.

Design

A random sample of 10,000 individuals aged 50-75 years was drawn from the Central National Register (CNR) as a representative sample of this subgroup of the Danish population with respect to age, gender and geographic region.

The 10,000 individuals were randomly allocated to receive a postal questionnaire or a letter with a Web link to an online version of the same questionnaire. The questionnaire contained 35 closed-ended categorical questions, some with multiple answering categories. The postal questionnaire was 16 pages long. The postal sample also received a stamped and addressed envelope for their reply. Respondents allocated to the Web-based version of the questionnaire received a letter introducing the survey and providing a link to a Web page. The introduction to the survey was identical for the two groups. When accessing the Web page, respondents were asked to use the unique username and password that were provided in the covering letter.

An attempt was made to give the Web-based questionnaire an appearance as similar as possible to that of the printed version, thus implying minimal use of Web facilities. The Web-based version differed, however, in that it did not immediately disclose all questions to the respondents as the printed version did, but respondents could see a progress indicator. The Web-based version also controlled the respondents' replies so that invalid answers were avoided. A forced-choice format was not applied, i.e. respondents were not forced to respond to a question in order to proceed to the next. In this sense the Web-based questionnaire resembled the postal questionnaire where item non-response cannot be avoided.

The survey mostly contained attitudinal questions about the design of nursing homes and associated facilities. In general, five-point Likert scales were used but in some cases the respondents were asked to choose one answer out of several possibilities. The questionnaire also included questions about sociodemographic background and health status. Health status was assessed using the EQ-5D instrument, which is a standardized instrument for use as a measure of health outcome (www.euroqol.org). For each respondent a score was generated on a scale ranging from 1 (perfect health) to 0 (equivalent to death), using Danish dimension weights (Szende et al. 2007).

Statistical analysis

The two survey versions were compared in four different ways. Firstly, the response rates from the two surveys were compared using two-sample statistics for equal proportions. A pilot study with the Web-based version had given a response rate of 41%.

Secondly, the characteristics of respondents in the two versions were compared using two-sample statistics for equal proportions taking the population proportions known from the random draw into account.[1] Non-response bias was investigated by testing whether there was a non-random non-response with respect to age, gender or region across the two versions. The original sample's characteristics with regards to age, gender and geographical region were known from the draw from the CNR. This distribution was compared to that from the two surveys in order to test for non-response differences across the two modes.

Thirdly, bivariate tests were used to test whether there were significant differences between the two surveys with respect to respondent income, education and health status. As no prior knowledge about these characteristics was available from the CNR draw, the respondent characteristics from the two surveys only were compared.

Fourthly, a binary logistic regression model was used to test whether the occurrence of item non-responses (missing observations) and the occurrence of 'don't know' answers

[1] The test statistics for testing p_1-p_2:

$$z = \frac{\left(\frac{x_1}{n_1} - \frac{x_2}{n_2}\right) - (p_1 - p_2)}{\sqrt{\left(\frac{x_1+x_2}{n_1+n_2}\right)\left(1 - \frac{x_1+x_2}{n_1+n_2}\right)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \qquad (1)$$

where p_1 and p_2 are population proportions from the random sample (column 1 and 3, respectively), and x_1/n_1 and x_2/n_2 are the sample proportion from in the two modes (column 2 and 4, respectively). The number of respondents x_1 and x_2 in each category is divided by the number of respondents returning the survey n_1 and n_2.

Table 1: Response rate

Mode of survey	Total sent out	Returned	% Response
Postal	5,000	2,123	42.5%
Web-based[a]	4,900	829	16.9%
Total	9,900	2,952	29.8%

[a]Notes: 100 individuals from the original random draw were used in a pilot test of the Web-based survey.
Two-sample z-test value for equal proportions 27.78, p=0.00

were equal across the two surveys, while controlling for age, gender and region. The analysis took a rigorous statistical approach by controlling for a number of confounding variables. The respondents answers were analysed in two binary logistic regression models one analysing the likelihood of item non-response, with the occurrence of item non-response as the dependent variable, and the other analysing the occurrence of 'don't know' answers. In the first model all the respondents' answers were recoded to a binary dependent variable taking the value 1 if the item was missing (and 0 if the item was answered); the 'don't know' observations were excluded. In the second model all the respondents' answers were recoded to a binary dependent variable taking the value 1 if the respondents answered 'don't know' (and 0 if a legitimate answer was given); the item non-response observations were excluded. The independent variables were survey mode as the primary variable and then gender, age and region. These variables were known from the initial draw from the CNR. Survey variables were not used as they could themselves contain item non-responses.

Results

A total of 2,952 respondents returned the questionnaire, of which 2,123 completed the postal version and 829 completed the Web-based version, thus giving a significantly lower response rate in the Web-based survey (see Table 1). Furthermore, the response rate in the Web survey in the main study was significantly lower than in the pilot study (17% vs. 41%). The method of contacting respondents was exactly the same as that in the main study and the respondents did not appear to differ markedly from the main study sample with regard to age, gender and region.

As shown in Table 2, women were significantly overrepresented in both survey versions compared to the random draw, although significantly less so for the Web-based survey. There were no significant differences in response rates in the geographic regions between the two survey modes. Respondents aged 50-54 years were significantly underrepresented in both survey versions, but less so in the Web-based survey. Respondents aged 55-59 years were significantly overrepresented in the Web-based survey compared to the postal survey, whereas a significantly higher proportion of 65-69 and 70-75 year-olds responded to the postal version compared to the Web-based survey. The Web-based survey thus improved the representativeness on gender but not with respect to the age distribution of respondents.

As seen in Table 3 the postal survey had a higher share of low income respondents compared to the Web-based survey, a higher percentage of respondents with low education and a significantly higher percentage of people living alone. The Web-based survey also had a significantly lower proportion of respondents who declined to reveal their income and who answered 'don't know'. Postal survey respondents also had significantly lower health status compared to respondents in the Web-based survey.

Table 4 presents the analysis of the proportion of item non-response and 'don't know' answers when controlling for gender, age and region. The coefficients and the odds ratios show that item non-response was significantly lower in the Web-based version, but also that the number of dont know answers was significantly lower in the Web-based version.

Discussion

The study results show that the conventional postal survey method delivered a higher response rate (42%) than the Web-based survey (17%)[2] even in a country where access to computers and the Internet is over 86% and 57% for individuals aged 40-59 years and 60-74 years, respectively (Danmarks Statistik 2007). This means that there is a risk of non-response bias (Couper 2000), as not everyone in the target population has access to Internet and this is a threat to making inference from the Web-based survey. The study by Dannetun et al. (2007) had a similar design to the present study and reported response rates for postal and Web-based versions of 55% and 15%, respectively. The age profile of the population in the current study may have influenced response rates, as elderly people may be less likely to have access to a computer or be less familiar using the Internet. This is confirmed in the comparative analysis of the respondents and non-respondents in the two survey modes, see Table 2. The Web-based survey, however, improved the representativeness with respect to gender, as the proportion of males was higher in the Web-based survey (a finding also reported in other studies).

The lower response rate in the Web survey may be due to the mixed-mode strategy applied in the Web-based survey, i.e. a different mode was used to contact respondents than that used for data collection. When respondents want to comply with the request to participate, they had to switch modes; i.e. they had to take the letter to a computer and type in the Web link before they could actually fill in the questionnaire.

The challenge when testing for non-response bias is that in most cases, including the present study, very little is known about non-respondents (Dey 1997). In this case we have information on age, gender and region for individuals

[2] One could think of various ways to increase response rates in Web-based surveys e.g. using economic and non-pecuniary incentives (Birnholtz et al. 2004; Sax et al. 2003; Bosnjak and Tuten 2003) or technical means to reduce the burden of the survey to the respondent (Crawford et al. 2001; Ganassali 2008), but the most important issue is still to avoid non-response bias.

Table 2: Gender, age and regional distribution of respondents and non-respondents

	Postal survey		Web-based survey	
	Total deliverable	Returned	Total deliverable	Returned
Men	2,449 (49.0%)	903 (43.5%)	2,372 (48.4%)	342 (46.7%)
Women	2,551 (51.0%)	1,172 (56.5%)	2,528 (51.6%)	391 (53.3%)
Region Copenhagen	1,389 (27.8%)	492 (23.6%)	1,387 (28.3%)	192 (25.6%)
Region Zealand	793 (15.9%)	397 (18.1%)	803 (16.4%)	143 (19.0%)
Region Southern Denmark	1,138 (22.8%)	499 (24.0%)	1,102 (22.5%)	183 (24.4%)
Region Mid Denmark	1,153 (23.1%)	495 (23.8%)	1,082 (22.1%)	168 (22.4%)
Region Northern Denmark	527 (10.5%)	200 (9.6%)	526 (10.7%)	65 (8.7%)
Age group - 50 54 years	1,121 (22.4%)	370 (17.9%)	1,074 (21.9%)	139 (19.0%)
Age group - 55 59 years	1,109 (22.2%)	424 (20.5%)	1,115 (22.8%)	213 (29.1%)
Age group - 60 64 years	1,186 (23.7%)	533 (25.8%)	1,205 (24.6%)	207 (28.2%)
Age group - 65 69 years	858 (17.2%)	392 (19.0%)	847 (17.3%)	112 (15.3%)
Age group - 70 75 years	726 (14.5%)	349 (16.8%)	659 (13.4%)	62 (8.5%)

z-test values for equal proportion across survey versions (p): [eq. 1]
Gender: 3.72 (0.00)
Region: Copenhagen -1.65 (0.10), Zealand 0.69 (0.49), Southern -0.79 (0.43), Mid 0.49 (0.63), North 1.95 (0.05)
Age: 50-54 years -2.03 (0.04), 55-59 years -9.47 (0.00), 60-64 years 1.80 (0.07), 65-69 years 4.92 (0.00), 70-75 years 10.33 (0.00)

Table 3: Respondent characteristics

Respondents' characteristics (%)	Postal survey	Web based survey	z-test value (p)
Income[a]			
0 99,999 DKK	36 (1.7%)	4 (0.5%)	2.46 (0.014)
100,000 299,999 DKK	587 (28.4%)	136 (18.7%)	5.45 (0.000)
300,000 499,999 DKK	588 (28.5%)	239 (32.8%)	-2.31 (0.021)
500,000 999,999 DKK	571 (26.9%)	261 (35.8%)	-4.35 (0.000)
> 1,000,000 DKK	64 (3.1%)	38 (5.2%)	-2.75 (0.006)
Declined to reveal	164 (7.9%)	39 (5.3%)	2.44 (0.002)
Don't know	55 (2.7%)	12 (1.6%)	1.62 (0.105)
Education[a]			
Primary school	649 (32.7%)	163 (22.3%)	5.54 (0.000)
High school	291 (14.7%)	113 (15.4%)	-0.56 (0.578)
Short higher education	287 (14.5%)	134 (18.4%)	-2.62 (0.009)
Medium higher education	552 (27.8%)	235 (32.2%)	-2.35 (0.019)
Long higher education	175 (8.8%)	80 (11.0%)	-1.79 (0.074)
Don't know	30 (1.5%)	5 (0.7%)	1.79 (0.073)
Civil Status[a]			
Married/live together	1,589 (76.7%)	622 (85.0%)	-4.93 (0.000)
Single	482 (23.3%)	110 (15.0%)	4.93 (0.000)
Health Status[b]			
Mean EQ-5D score (std.err.)	0.90 (0.14)	0.92 (0.14)	-3.26 (0.000)

[a]Two sample test for equal proportion
[b]Two sample test for equal mean

Table 4: Predictors of item non-response and 'don't know' answers

	Item non-response			Don't know answers		
Variables	Coefficient	t-value	Odds ratio	Coefficient	t-value	Odds ratio
Web version	-1.2171	-25.09	0.296	-0.2137	-3.34	0.808
Female	0.2418	8.50	1.274	0.4045	7.38	1.499
Age 55-59	-0.1331	-2.58	0.875	0.1237	1.46	1.132
Age 60-64	0.3469	7.66	1.415	-0.0024	-0.03	0.998
Age 65-69	0.4036	8.44	1.497	0.1989	2.26	1.220
Age 70-75	0.7272	15.43	2.069	0.4050	4.56	1.499
Region Zealand	0.6568	14.06	1.929	0.1656	2.06	1.180
Region South	0.6821	15.25	1.978	0.0609	0.78	1.063
Region Mid	0.6494	14.36	1.914	0.1514	1.97	1.163
Region North	0.6023	10.68	1.826	0.2814	2.91	1.325
Constant	-4.1358	-77.14		-5.1138	-56.15	
Model characteristics:	n=165,471; LR $chi^2(10)$=1,839; p=0.000; Pseudo R^2=0.0383			n=161,495; LR $chi^2(10)$=113; p=0.000; Pseudo R^2=0.0067		

selected in the random representative draw. However, this information may not reveal the uniqueness of non-respondents in terms of their attitudes or how they would have responded to survey items. Although the Web-based survey had a higher proportion of males, these may be an even more selected group. The age distribution for the respondents is not at all representative in the Web-based survey, and with the low response rate one can hardly argue that the higher proportion of males improves the representativeness in the Web-survey. Furthermore, the respondents to the two survey versions were significantly different on key sociodemographic variables such as income, education, civil status and health status.

It is often claimed that the costs of Web-based surveys are low as there is no need for printing, packaging, two-way postage, data entry, data handling and tracking. In the light of the lower response rate in the current survey we calculated the survey cost per respondent. Included in the cost estimates were the costs of packaging, postage and data entry as well as costs for setting up the Web-version and payment of server rights. The total costs for the postal version were: postage (including reply postage) around 74,000 DKK (7.5 DKK ≈ €1; 5.5 DKK ≈ US $1); packaging 6,000 DKK and data entry 17,500 DKK. The costs for the Web-based survey were: postage 40,000 DKK, packaging 4,000 DKK, server rights 10,000 DK and survey preparation 7,500 DKK. The cost per response was thus 46 DKK (€6.13) and 74 DKK (€9.87) in the postal and Web-based surveys, respectively, and the lower cost of the Web-based survey cannot compensate for the much lower response rate. If the response rate of the Web-based survey had been equal that of the postal survey, the cost per response would have been 30 DKK (€4) in the Web-based survey. Other studies have found that the cost of a Web-based survey was one-third the cost of a postal survey (Akl et al. 2005); 45% of the cost per reply in a postal survey (Jones and Pitt 1999); 24% of the cost per reply in a postal survey (McDonald and Adam 2003); 73% of the cost per reply in a postal survey (Raziano et al. 2001). It should be noted that even though the Web-based survey was less expensive in all these studies, it also had a lower response rate compared to the postal survey.

One of the benefits of the Web-survey was the improved data quality with a lower proportion of item non-response but also a lower proportion of 'don't know' answers. The Web-based format appeared to stimulate respondents to answer questions even though they were not forced to answer all questions to press 'Next'. It could, however, be argued that the data quality may not be improved if individuals answer some questions almost by random rather than leaving them blank. This would introduce a measurement error that could bias the results. The lower proportion of item non-response in the Web-based survey may also be due to differences in the non-response rates, as the Web respondents had higher income, higher education and better health than those on the postal survey.

Conclusion

The Web-based survey gave a significantly lower response rate than the postal survey. The Web-based version improved the sample representativeness with respect to gender, but worsened it with respect to age. Respondents characteristics in the Web-based survey differed significantly from those of respondents in the postal survey with respect to age, income, education, civil status and health status. The Web-based version improved data quality by significantly lowering the number of item non-response and 'don't know' answers.

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