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Response rate and nonresponse bias in a questionnaire survey of dentists

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Abstract – Objectives: (a) To report on response rate and nonresponse bias of a questionnaire survey of dentists. (b) To make recommendations for future questionnaire survey research in dentistry. *Methods:* A questionnaire was mailed to a stratified systematic sample of 908 Australian dentists. The strategy included three mailings, a final telephonic contact, university stationery, paid reply envelopes and personalized correspondence. Nonresponse bias was assessed by comparing responses to a simple 'yes/no' question from each contact (late responders), and by comparing demographic information (nonresponders). *Results:* The response rate achieved was 87% and there was no evidence of nonresponse bias based on practice location or year of graduation. The cumulative proportions of 'yes/no' responses essentially remained constant after each contact, but significantly more late responders answered in the negative to the test question than did early responders. The telephonic contact aided in the identification of nonparticipants and ineligible units. *Conclusions:* The current survey indicates that differences in data between early and nonresponders can occur despite there being no demographic differences. Therefore, assessment of nonresponse bias based on demographic data alone would seem to be insufficient. Questionnaire survey research must first be based on sound sampling techniques, and then on achieving as high a response rate as possible using the many incentives available.

Key words: bias (epidemiology); data collection; dentists; questionnaires

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Introduction

The response rate of a questionnaire survey is defined as the number of completed and partially completed questionnaires/surveys/interviews divided by the number of eligible sample units (1–3). A high response rate from any sample is essential for the data to be representive of the entire population (4, 5). The literature recommends that unless response rates are high, it is prudent to investigate nonresponse bias (6, 7), at least in sociodemographic terms (8). If the nonrespondents differ from the respondents, then the introduced biases can invalidate the questionnaire survey results (9). If the nonresponse is not due to questionnaire design or to any particular variable measured within the sample (e.g. gender, age, location), then the nonrespondents are said to be 'missing at random'. Hence they can be ignored and the respondents can be used as a representative sample of the population (9). Importantly, cognitive and social processes have been recognized as influencing respondent behaviour (10), but these characteristics are likely to be unknown to the questionnaire survey researcher. Consequently, relying on assessment of nonresponse bias to justify a low response rate may be inherently flawed.

Opinions differ as to an optimal response rate high enough to eliminate nonresponse bias, but the range reported is 70–80% (8, 11–13). It may well be impossible to generalize an adequate return rate for all populations because it will depend on the

differences between the responders and non-responders (14) and on such issues as the target population, sample size and survey techniques. Furthermore, when describing response rates of questionnaire surveys, different researchers use different methods for calculating and reporting response rates (2), 'if indeed they are reported at all' (3). Confusion between completion rate and response rate will continue until a standard definition is adopted (1).

Methods to compensate for low mail returns and aimed at improving response to self-administered questionnaire surveys include: follow-up mailings, telephonic contacts, monetary incentives, material (gift) incentives, respondent-friendly questionnaires, a real stamp on the return envelope, personalization of correspondence, and many smaller details (4, 6, 15–20). There do not appear to be any deleterious effects of incentives on the quality of survey responses (21).

The aims of this study were to report on the response rate and nonresponse bias of a questionnaire survey of dentists conducted by the authors, and to make recommendations for future questionnaire survey research. Because of the general nature of the topic of this study, the recommendations can be applied to survey research generally irrespective of the topic or approach.

Methods

This questionnaire survey was conducted to investigate aspects of the use of rotary nickel–titanium (NiTi) instruments and techniques in general dental practice and in specialist endodontic practice within Australia. The main points of interest from the questionnaire survey for this current paper are the response rates, both overall and after each contact, and an indication of non-response bias. The project received approval from the Health Sciences Human Ethics Subcommittee of the University of Melbourne.

Questionnaire survey instrument

The questionnaire survey comprised a total of 43 questions, many of which had multiple parts, over six single-sided A4 pages. The format included mainly closed ($n = 36$) and also open-format ($n = 7$) questions. Only the question regarding the use or nonuse of NiTi is considered in the current analysis. This question was: 'Do you currently use rotary NiTi instrumentation to prepare root canals?' Respondents answered 'Yes' or 'No'.

Questionnaire survey implementation

The sample size was calculated using an equation as presented by Dillman (19). It consisted of all endodontists practising in Australia who were members of the Australian and New Zealand Academy of Endodontists (ANZAE), and a stratified systematic sample of dentists practising in Australia who were members of the Australian Dental Association Incorporated (ADA). The original calculated sample size was 900 (64 endodontists and 836 general dentists). Stratification was according to Australian States and whether metropolitan or rural, which was based on postcode zones as determined by Australia Post according to distance from the capital city within each state. Based on the sample size and total population, every seventh dentist on the postcode-order list was selected. In order to ensure equal representation from each stratum, the stratum sample size proportions were exactly the same as the proportion of all dentists in each stratum relative to the overall number of ADA dentists in Australia. The total number of dentists in the questionnaire survey population was 5742 (5678 general dentists + 64 endodontists).

A letter explaining the questionnaire survey and requesting participation accompanied the questionnaire and a reply paid envelope was included. There were no identifying marks on the questionnaire or envelope. The letter made clear that the results would be reported in such a way as to keep the identity of the participants anonymous. Non-respondents were sent a second copy of the questionnaire with a differently worded letter and another reply paid envelope. The third mail-out included yet another questionnaire and a further letter with different wording. As a final contact, secretarial staff telephoned the remaining non-respondents. After the first two mailings, eight letters were returned with indications that the address was no longer valid. In these eight cases, another person was selected with the same postcode. This increased the total mailing to 908.

Data analysis

The response element definitions used in this study were those previously published (2, 3), and included the following:

- Usable responses – completed (CC) and partially completed cases (PC).

- Nonparticipants – eligible cases who refused to participate and returned a blank questionnaire (R).
- Nonreturns – cases not interviewed and did not return a questionnaire (NI).
- Nonrespondents – the nonparticipants and nonreturns (R + NI).
- Ineligible – cases not meeting certain set criteria that render an individual appropriate for inclusion in the particular survey, e.g. age, gender, address, knowledge, experience (NE). In the current survey, ineligible units were those who had moved, retired, were on vacation or ill in the long-term, did not perform any endodontics, or were in a specialty other than endodontics.

Response elements for each contact were assessed by noting the numbers of usable responses (response rate), nonparticipants and ineligible units. Nonresponse bias was assessed in two ways. First, by noting and comparing the proportions of respondents who answered affirmatively ('Yes') or negatively ('No') to the main survey question after each contact. Secondly, by comparing available demographic details of usable respondents and nonrespondents, and those after each contact. The year of graduation and practice location (metropolitan or rural) were determined for respondents and nonrespondents. Moreover, endodontists were compared with general dentists for differences in response rates for each contact. Statistical analysis involved the chi-square, logistic regression and Fisher's exact tests.

Results

Response element details from the questionnaire are given in Table 1, and the following ratios were calculated:

$$\text{Overall response rate} = \frac{\text{CC} + \text{PC}}{\text{CC} + \text{PC} + \text{R} + \text{NI}} = \frac{731}{840} = 87\%$$

$$\text{General dentist response rate} = \frac{673}{776} = 87\%$$

$$\text{Endodontist response rate} = \frac{58}{64} = 91\%$$

There were no statistically significant differences between endodontists and general dentists for any of the analyses and so data from both groups are combined. Table 2 details the numbers of resulting response elements after each contact. For each contact, each questionnaire survey sample unit (except for nonreturns), is accounted for and allocated to one of three categories:

- those responding with a usable questionnaire survey (usable responses),
- those returning a blank questionnaire (nonparticipant),
- those deemed to be ineligible to participate (ineligible) as described above.

Table 1. Response element details from the questionnaire survey of NiTi use

Category	Number	% of Mail-out[a]
Usable responses (CC + PC)	731	81
Nonparticipants (R)	55	6
Nonreturns (NI)	54	6
Nonrespondents (R + NI)	109	12
Ineligible cases (NE)	68	7

[a]The total mail-out is defined by (CC + PC) + (R + NI) + NE = 908.

Table 2 shows that after the second contact in this survey a minimum acceptable response rate of 71% was reached. The telephonic contact (contact 4), produced significantly fewer usable responses than the first three contacts ($\chi^2 = 221.887$, d.f. = 1, $P < 0.001$). This is illustrated in Fig. 1 where the exponential 'usable response' curve is relatively unaffected by the fourth contact, but the 'nonrespondents' and 'ineligible' units curves are clearly affected by contact 4.

Tables 3 and 4 show response details relative to year of graduation and location of practice. There were no statistically significant differences between proportions of respondents and nonrespondents according to year of graduation or location of practice. Furthermore, there were no significant differences in proportions of usable responses after each contact according to either year of graduation or location of practice. Similarly there were no significant differences between proportions when usable responses were grouped to compare early (contact 1) with late (contacts 2–4) or according to minimum response rate (contacts 1 + 2 versus contacts 3 + 4).

Table 5 demonstrates the change in number and proportions of negative ('No') and affirmative ('Yes') responses to the question on the use of rotary NiTi with each contact. After the second contact there were 629 usable responses, which represented a response rate of 71%. After one

Table 2. Details of the response elements after each contact in the questionnaire survey of NiTi use

Contact	Total response elements[a]	Cumulative response rate[b] (%)	Usable responses (CC + PC)[c]	Nonparticipants (R)[c]	Ineligible (NE)[c]
1 (mail)	478	49	439	28	11
2 (mail)	207	71	190	11	6
3 (mail)	84	79	75	6	3
4 (phone)	85	87	27[d]	10	48
Totals[e]	854 (94%)		731 (81%)	55 (6%)	68 (7%)

[a]Sum of CC + PC + R + NE for each contact.
[b]Cumulative response rate = cumulative usable responses/(908 − total ineligible).
[c]CC, completed cases; PC, partially completed cases; R, refused to participate; NE, not eligible.
[d]Significantly lower proportion of usable responses than for the first three contacts combined ($\chi^2 = 221.887$, d.f. = 1, $P < 0.001$).
[e]Percentages relate to the overall total sample size of 908. The remaining 6% ($n = 54$) comprises the nonreturns (NI) group.

contact, with a usable response rate of only 49% (Table 2), the percentage ratio of cumulative negative to cumulative positive was 71 : 29. After four contacts, the usable response rate had increased to 87%, and the cumulative percentage ratio was now 74 : 26, which represents only a 3% change. Chi-square analysis revealed a significant change in response with increasing contacts ($\chi^2 = 8.106$; d.f. = 3; $P = 0.04$). The chi-square test for trend using logistic regression on the individual prevalence data confirmed that the proportion of 'No' responses increased and the proportion of 'Yes' responses decreased with increasing numbers of contacts ($\chi^2 = 8.45$; d.f. = 1; $P = 0.004$).

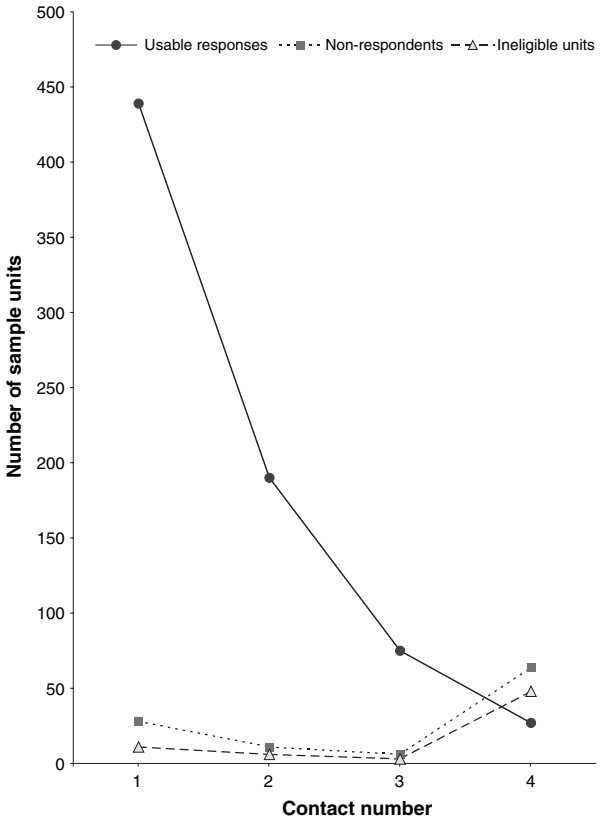

Fig. 1. Response elements after each contact in the questionnaire survey of NiTi use.

Table 3. Response details relative to year of graduation in the questionnaire survey of NiTi use

Years	Total usable[a] (%)	Usable responses for each contact 1	2	3	4	Non responders[b]
1946–50	4 (0.5)	3	0	1	0	1
1951–60	19 (2.5)	9	6	4	0	4
1961–70	95 (13)	64	21	7	3	18
1971–80	240 (33)	138	67	24	11	34
1981–90	234 (32)	144	58	22	10	31
1991–2000	139 (19)	81	38	17	3	20
Total	731	439	190	75	27	108[c]

[a]Percentages relate to the total of 731. There were no statistically significant differences.
[b]Includes nonparticipants and nonreturns.
[c]One nonresponder's graduation year was unknown.

Table 4. Response details relative to location of practice in the questionnaire survey of NiTi use

Years	Total usable[a]	Usable responses for each contact 1	2	3	4	Non responders[b]
Metro	565 (78%)	334	151	56	24	92
Rural	162 (22%)	101	39	19	3	17
Totals	727	435	190	75	27	109

[a]Percentages relate to the total of 727; four respondents did not provide a postcode.
[b]Includes nonparticipants and nonreturns. There were no statistically significant differences.

Table 5. Comparison between affirmative ('Yes') and negative ('No') to the main question in the NiTi survey at each contact from the 731 usable replies

Contact	Total usable responses	Negative[a] (%)	Cumulative negative	Affirmative[a] (%)	Cumulative affirmative
1 (mail)	439	311 (71)	311 (71)	128 (29)	128 (29)
2 (mail)	190	147 (77)	458 (73)	43 (23)	171 (27)
3 (mail)	75	62 (83)	520 (74)	13 (17)	184 (26)
4 (telephone)	27	23 (85)	543 (74)	4 (15)	188 (26)
Total	731	543 (74)		188 (26)	

[a]Figures in parentheses refer to the percentage of total for each contact. The overall chi-square test on proportions of negative and affirmative responses was significant ($\chi^2 = 8.106$; d.f. = 3; $P = 0.04$). There was also a statistically significant trend for increase in negative responses and decrease in positive responses with increasing contacts ($\chi^2 = 8.45$; d.f. = 1; $P = 0.004$).

Table 6 groups the numbers of 'No' and 'Yes' responses according to 'early' (contact 1) and 'late' responders (contacts 2–4). The difference in proportions was statistically significant ($P = 0.01$, Fisher's exact test). Table 7 groups responses after having reached a minimum threshold response rate (gained after contact 2) and compares the proportion with late responders (contacts 3 and 4). The difference in proportions was statistically significant ($P = 0.03$, Fisher's exact test). Tables 5 and 6 indicate that the main difference in the proportions of 'No' and 'Yes' results occurred between contact 1 and 2. Thereafter, the differences were smaller.

Discussion

In the current survey on rotary NiTi, the response rate for endodontists was slightly higher than for general dentists but not significantly so. The overall response rate of 87% compares very favourably with the highest recommended response rate in the literature of 80% (8, 13). At this level, nonresponse bias can be expected to be minimal providing the sample size is adequate and a form of probability sampling is utilized, both of which ensure a representative sample. In the current study, two contacts were adequate to

Table 6. Comparison of affirmative ('Yes') and negative ('No') to the main question in the NiTi survey between early and late responders from the 731 usable replies

Contact	Total usable responses	Negative[a] (%)	Cumulative negative (%)	Affirmative (%)	Cumulative affirmative (%)
Early (1)	439[b]	311 (71)	311 (71)	128 (29)	128 (29)
Late (2–4)	292	232 (79)[c]	543 (74)	60 (21)	188 (26)
Totals	731	543 (74)		188 (26)	

[a]Values in parentheses refer to the percentage of total for each contact.
[b]Represents a response rate of 49% [439/(908 − 11)]; refer to Table 1.
[c]Significantly greater proportion than for early responders ($P = 0.01$, Fisher's exact test).

Table 7. Comparison of affirmative ('Yes') and negative ('No') to the main question in the NiTi survey between 'threshold responders'[a] and late responders from the 731 usable replies

Contact	Total usable responses	Negative[b] (%)	Cumulative negative (%)	Affirmative (%)	Cumulative affirmative (%)
Threshold response (1 + 2)	629[c]	458 (73)	458 (73)	171 (27)	171 (27)
Late (3 + 4)	102	85 (83)[d]	543 (74)	17 (17)	188 (26)
Totals	731	543 (74)		188 (26)	

[a]Threshold responders refers to the number of usable responders, resulting from a minimum number of contacts, that reached an empirical minimum threshold response rate of 70%.
[b]Values in parentheses refer to the percentage of total for each contact.
[c]Represents a response rate of 71% [629/(908 − 17)]; refer Table 1.
[d]Significantly greater proportion than for response rate responders ($P = 0.03$, Fisher's exact test).

exceed an empirical minimum response rate of 70% (11).

One reported method of investigating nonresponse bias is to determine the late-response bias by comparing responses of respondents who return questionnaires after an initial request, with those who respond after follow-up requests (22). Locker (23) reported that estimates based on the first response to mail questionnaire surveys differed only marginally from those obtained from respondents to three or more mailings. The current questionnaire survey is in agreement with these findings in that there were only slight differences in percentages of cumulative negative and affirmative responses between the four contacts and the overall results (Table 5). It could be argued, from the data in this survey, that one contact was probably enough, practically, for this outcome.

However, when analysing the data for trends, and when the late responders (contacts 2–4) were grouped, the differences became statistically significant. Grouping contacts 1 and 2 also produced a significant difference compared with contacts 3 and 4. The practical significance of this finding supports the accepted view that multiple attempts at increasing the response rate are recommended. The indication from the current questionnaire survey was that nonresponders were more likely not to be users of rotary NiTi instruments. Investigations of late-response bias as an indicator of nonresponse bias are based on the assumption that the characteristics and responses of late-responders are more representative of nonresponders than those of early responders (7, 22). An explanation for this assumption is lacking, but the current survey supports that view based on a comparison between the results after the first contact and those after the subsequent contacts.

Other methods of assessing nonresponse bias include assessing sociodemographic factors of responders and nonresponders (24, 25), and extrapolation of trends (7). Sociodemographic information describes survey respondents, and facilitates assessment of the generalizability of questionnaire results (26). The current survey confirmed no significant differences in demographic details between responders and nonresponders (Tables 3 and 4). Extrapolating the exponential-like trend of the data in the current survey, as recommended by McCarthy and MacDonald (7), indicates there would be very little difference in the results if the remaining nonresponders did cooperate (Fig. 1).

Importantly, Locker (3) emphasizes that all methods for assessing the magnitude of nonresponse are based on assumptions about the nonresponders. Bias may exist in items such as knowledge and attitudinal variables rather than sociodemographic variables (7). The current study exemplifies that view. Early responders may be more interested in the questionnaire survey topic (7), which is supported by the findings of the current survey. Responders to surveys may include the more active and concerned segments of the dental community (27). Hence, there is probable involvement of cognitive and social processes influencing respondent behaviour, such as self-reflection (10), the controlled use of perception and judgment in decision making (28), and individual value systems (29). The significant differences found between early and late responders in responses to the survey question analysed, despite the absence of differences in the demographic data, implies the possibility of behavioural differences between responders and nonresponders. Regardless of high response rates and no apparent nonresponse bias in well-designed and -conducted questionnaire surveys, the role of cognitive and social processes in respondent behaviour is difficult to assess but it must at least be acknowledged. Such processes can and are likely to affect respondent and nonrespondent behaviour. The influence of behavioural factors is alluded to in the reported reasons for nonparticipation by nonresponders mentioned above. To be confident about absence of nonresponse bias based only on sociodemographic factors makes the assumption of no behavioural differences both between and within respondent and nonrespondent groups. Clearly, differences must exist, which leads back to the critical importance of high response rates in questionnaire survey research. Hence, different response rate enhancement strategies may be required to deal with differences in respondent behaviour.

Multiple mailings appear to be an essential requirement for high response rates (19, 30). Several authors have recommended the inclusion of telephone prompts and telephone reminders in questionnaire survey protocols (31–34). However, in the current survey, the telephonic contact increased the response rate by only 3% on an already high response rate. Furthermore, the three mailings produced a very high response rate using only the incentives of a reply paid envelope, an explanatory letter, university letterhead and

personalized contacts. The telephonic contact was significantly more important in identifying nonparticipants and those ineligible rather than producing a large increase in usable responses.

When considering the question of the use of incentives to improve response rate, it is unlikely that any one method or any one series of methods will always be productive. A systematic review by Edwards et al. (20) detailed the effects on questionnaire response of 40 of 75 different strategies identified. A single survey design attribute will have different 'leverages' on the cooperation decision for different people (35). Hence, changing the nature of successive appeals in mail questionnaire surveys (19) may contribute to high response rates. This technique was adopted in this survey and may have contributed to the high response rate. Importantly, there is likely a need to tailor the questionnaire survey technique to the target population and the required information (19). Asch et al. (36) found that higher response rates were achieved with telephone reminders and with written reminders together with another questionnaire. They also found that anonymous questionnaire surveys had lower response rates. Anonymous surveys do not allow for follow-up, as do de-identified surveys such as the current one. Tan and Burke (37) found that the more the incentives used, the higher the response rate. A reply paid envelope would seem to be indispensable (19, 37–39). Locker and Grushka (40) recommend a minimum of a three-stage questionnaire survey consisting of an initial mailing and two follow-ups. The current questionnaire survey successfully followed these recommendations.

Tan and Burke (37) concluded that response rates were improved by interesting or topical questionnaire subjects, use of incentives, and fewer questions. However, Asch et al. (36) found that the length of the questionnaire did not seem to influence the response rate. Despite the current questionnaire containing 43 questions and being considered complicated (37), the 87% response rate indicates that other factors have influenced the response. Long questionnaires on interesting topics may be more likely to be answered than short questionnaires on topics perceived as dull. The current survey explored new technology in the form of nickel–titanium instrumentation, a very topical subject. It is not unreasonable to expect that a prime prerequisite for a high response rate of a questionnaire survey is for the topic to generate interest. The questionnaire characteristics and techniques are no less important but may be reliant on first gaining the prospective respondent's attention.

Despite the use of incentives there will probably always be a certain proportion of the population who will not participate in a survey. Reported reasons for not participating include lack of time, lack of interest, working part-time and being on holiday (41, 42). Some nonresponders simply choose not to participate with no particular reasons given (27). The current survey found similar attitudes, and also that some people simply do not wish to complete surveys.

Conclusions

Despite asking many questions, the current questionnaire survey achieved a very high response rate of 87%. This may have been due to the survey technique and an interesting subject that represented new endodontic technology. Survey research may need to routinely include consideration of behavioural factors in design and interpretation of questionnaires, particularly in the case of low response rates. Striving for very high response rates will reduce the effects of nonresponse bias caused by sociodemographic and behavioural differences between responders and nonresponders. Avoiding the complexities of nonresponse bias is best managed by incorporating measures and strategies to achieve a high response rate.

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