Validity of a questionnaire survey: the role of non-response and incorrect answers

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Errors in questionnaire surveys are usually of one of two sources: non-responses or incorrect answers. The aim was to investigate the validity of a questionnaire survey and to estimate the respective bias of these answers. Of 9,283 subjects selected to receive a questionnaire by post, 3,949 (43%) responded, and, of these, 3,400 correctly reported their Swedish social security number. Answers in the questionnaire survey were given as proportions of the claims registered at local insurance offices. In the group of respondents who had correctly reported their social security number, the answers were compared individually with the registrations in dental insurance claims. In Sweden, these claims are labeled with the patient's social security number and it is thereby possible to make such comparisons. It was shown that errors were caused by non-response and also by respondents giving incorrect answers. Incorrect answers accounted for approximately one-third of the total bias. The remaining bias was caused by a non-response error. It is concluded that questionnaire studies have a bias caused by both non-response and incorrect answers and that together these can be substantial. Scientific reports that include questionnaire surveys must describe the procedure carefully. If possible, other sources of information should be considered. □ *Incorrect answers; non-response; survey bias*

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Questionnaire surveys are often used in health research (1). This is natural, since such surveys are relatively inexpensive, fast, and sometimes the only way to collect adequate information. Questionnaires are used to map the consumption of dental care (2); to gather quantitative information, such as the number of teeth (3); to obtain qualitative information, such as about the social relation situation (4); to measure independent variables, such as mouth hygiene (5); and to investigate dependent variables, such as dentists' views on their profession (6).

When questionnaires are used in dental scientific articles, it is unusual for the method per se to be discussed. When questionnaires and clinical examinations are used together, the clinical part is sometimes presented and discussed thoroughly while the questionnaire part is described simply as "a questionnaire was sent to the subjects before the examination …" (7). In a literature review of Swedish dental attendance surveys, however, Sjöström et al. (8) showed that incidence of dental attendance is higher in questionnaire surveys than in administrative sources of information.

The concept of reliability is a method's (or an instrument's) ability to produce the same result at repeated measurements. Validity is a measure of a method's capacity to accurately assess the phenomenon intended for assessment. High validity presumes high reliability, but high reliability is not necessarily a mark of high validity. Questionnaires have limitations, which can be a source of error. The most common way to test a questionnaire survey is to repeat the questions to a subsample 3–4 weeks later. This measures the reliability of the questionnaire but not the validity. An effective way of studying the validity is to find other sources of information for the questions asked in the questionnaire and to compare this independent source of information with the responses given in the questionnaire.

A much-discussed source of error is the non-response error (9). A response rate of 100% is practically impossible to achieve. Dillan et al. (10) showed that the non-response rate in large studies increased by 10% within a decade. Groves (11) classifies non-respondents as either refusers or other non-respondents and points out that the refusers in particular have increased. In mailed questionnaire surveys, a 60–70% response rate is normal. Factors affecting the response rate and ways of raising it have been studied widely (9). In general, the experience is that non-response will create a bias. However, the reduction in the response rate that has occurred over the years has probably only had a limited impact on the bias, at least in large samples (12), since the additional non-respondents are unlikely to differ systematically from the respondents.

Another, less discussed, source of error is incorrect answers. Questions may be answered incorrectly for many reasons: the respondent has misunderstood the question, forgotten the answer, "knew" the wrong answer, or gave (intentionally or not) a false answer. The extent of bias due

to incorrect answers has not been studied as much as the non-response bias (13).

The aim of this study was to examine the validity of a questionnaire used in a large survey and to estimate the magnitude of the non-response bias and the incorrect-answer bias by comparing one-on-one questionnaire answers with registrations from administrative sources.

Material and method

Material I

A questionnaire was sent out to a sample of the inhabitants of the County of Göteborg and Bohuslän, a total of 9,283 individuals. They were selected according to birth date. The questionnaire covered the years 1990, 1991, and 1992. The target population was 1/60th of all inhabitants who, in 1992, were 20 years or older and lived in the county, and whose birth date was the 17th of an odd month.

The questionnaire was designed to investigate oral health, oral problems, and dental care habits. The questions were multiple choice, but, in addition, the respondents were able to add their own comments. A letter of information plus a prepaid return envelope accompanied the questionnaire sent out in May 1999. A month later, a reminder plus a copy of the questionnaire was mailed to everybody. Four of the questions were (all questions referred to 1990, 1991, and/or 1992): Have you received dental care during the period? Do you attend for dental care regularly? Do you attend a private or public dental office? and: Are you treated by a dental hygienist, too? These questions were the subject of further studies.

Material II

Insurance claims filed at the local insurance offices were used to determine what treatment the sample ($n = 9,283$) had received. This was possible because this sample had been selected by birth date. It was possible to see from the claims whether the respondent had attended a dentist, where, if he/she attended a dentist regularly, and if he/she had also been treated by a hygienist. A regular visitor was defined as a person who had had at least two courses of treatment during the 3 years covered by the survey; at least one of the courses of treatment must have consisted of a complete examination and subsequent treatments. Data from this study were compared with data from the questionnaire survey.

Material III

A majority of the respondents had reported their complete personal social security number ($n = 3,400$). In these cases the answers in the questionnaire were compared with the actual dental attendance according to the insurance claims. The incorrect-answer share of a tentative bias could then be calculated. Internal non-response, i.e. respondents who did not answer every question in a questionnaire, is the cause of the number of responses reported in some tables being less than 3,400. Materials I, II, and III are presented in Table 1.

Table 1. Description of the material

Material	Type of study	Inclusion criteria	No.
I	Questionnaire survey	All in Material II who answered the distributed questionnaire	3,949
II	Claims survey	1/60 of all living in Göteborg and Bohuslän, 20 years or older, born on the 17th, odd month	9,283
III	Validity study	All those in Material I who, by social security number, could be identified in Material II	3,400

Statistical analyses

Differences in proportions between the questionnaire survey and the insurance claim survey for the group who had correctly reported their social security number were analyzed using a normal distribution test and 95% confidence intervals. Sensitivity, specificity, and Kappa values were calculated in the double identified group (Material III). In this calculation, data from the claims study were used as validation criteria. This means that sensitivity was defined as the number of persons who scored positive values in both the questionnaire and the claim surveys divided by the number of persons who scored a positive value in the claim survey. Likewise, specificity was defined as the number of persons who scored negative values in both the questionnaire and the claim surveys divided by the number of persons who scored a negative value in the claim survey.

Approvals

The study was approved by the Data Inspection Board, by the Ethics Committee of the University of Göteborg and by the National Board of Social Insurance, regional offices in Göteborg and Bohuslän.

Results

The questionnaire was answered by 3,949 (43%) subjects (Material I), 3,400 of whom had official personal social security numbers in both Materials I and II. Dental attendance in Materials I and II is presented in Table 2. The largest difference concerned the answer regarding regularity of dental care; 88% claimed they had received

Table 2. Dental attendance by type assessed in the questionnaire (Material I) and insurance claims (Material II) surveys

	Questionnaire (%) (n = 3,949)	Insurance claims (%) (n = 9,283)	Difference (%)	P value	CI (95%) of the diff.
Received dental care	93	74	19	<0.001	0.78
Attendance to a public clinic	36	26	10	<0.001	1.47
Attendance to a private clinic	58	43	15	<0.001	1.51
Regular attendance	88	61	27	<0.001	0.99
Also treated by a hygienist	30	16	14	<0.001	1.41

Table 3. Dental attendance among 3,400 persons (Material III) for whom information was available from both questionnaires and insurance claims

	Questionnaire (%)	Insurance claims (%)	Difference	P value	CI (95%) of the diff.
Received dental care	93	86	7	<0.001	1.47
Attendance at a public clinic	35	28	7	<0.001	2.20
Attendance at a private clinic	60	57	3	0.012	2.34
Regular attendance	89	79	10	<0.001	1.73
Treated by a hygienist, too	32	24	8	<0.001	2.13

dental care regularly, but according to the claim forms only 61% had. All differences were highly significant.

Dental attendance for the 3,400 subjects identified in both Materials I and II (Material III) is presented in Table 3. All differences between questionnaire data and claim data were smaller than those between Materials I and II, but they were still highly significant.

Tables 4–7 present the results for Material III from the questionnaire and claims surveys. Answers in the Yes/no and No/yes boxes were incorrect answers. It was more common for subjects to incorrectly report that they had received treatment or visited a dentist regularly than to incorrectly declare that they had not. For example, 292 untreated subjects said that they had received dental care, while 32 treated subjects claimed that they had not. In the question regarding the choice of private or public care (Table 5), a high agreement was observed among those who claimed to have attended both private and public dentists. The fourth alternative, no treatment, showed the same systematic difference mentioned above (more declared incorrectly that they had attended a dentist than that they had not).

The agreement between questionnaire data and claim data was between 81% and 90%. Sensitivity, i.e. the ability of a questionnaire to correctly identify attendance, was high (90–99%). Specificity, i.e. the ability of the questionnaire to identify those persons who had no dental attendance, was much lower and, for dental attendance and regularity, was very low (33–35%). The Kappa values were approximately 0.6 for the questions about private/public and dental hygienist, as to the rest approximately 0.4.

Table 4. Dental attendance assessed according to questionnaires and claims for those who were identified in both studies (Material III, n = 3,400)

		According to insurance claims		
		Yes	No	Total
According to the questionnaire	Yes	2871	292	3163
	No	32	146	178
	Total	2903	438	3341

Discussion

It is usually difficult to perform good validity estimations of self-report surveys since information on the non-respondents is often inaccessible (11), and there is no objective information concerning the respondents, which of course makes estimation even more difficult. For these reasons, the existence of a population-based register of insurance claims and the questionnaire survey provided an excellent opportunity to study the kind of bias known to exist but difficult to assess empirically.

Reported (questionnaires) and actual (claims) dental attendance differed by a magnitude of 10–27%. When attendance among the same persons was compared, the disagreement was lower, i.e., 3–10%. The total difference must be a combination of a non-response bias and an incorrect-answer bias. In this study, the incorrect-answer bias explains about one-third of the total bias.

The disagreement between the measurements in the questionnaire survey and those in the claims study can be seen as an indicator of the validity of the questionnaire survey—the smaller the distance, the higher the validity. This study has shown that both non-responses and incorrect answers negatively affect validity.

The questionnaire survey had a response rate of 43%. This might be regarded as low. A parallel questionnaire

Table 5. Private or public dental care assessed according to questionnaires and claims for those who were identified in both studies (Material III, $n = 3,400$)

		According to insurance claims				
		Public	Private	Both	No attendance	Total
According to the questionnaire	Public	898	30	44	205	1177
	Private	24	1750	53	198	2025
	Both	19	40	24	28	111
	No attendance	1	2	1	61	65
	Total	942	1944	122	492	3378

survey of the same population and conducted in the same manner had a 62% response rate. The results of these two questionnaire surveys are very similar, and the differences have low or no clinical or administrative importance (14). Moreover, the result of the present questionnaire is congruent with those of questionnaire surveys performed in neighboring counties at the same time (7, 15). The conclusion is that the result of the present questionnaire survey would probably have been approximately the same even if the response rate had been 60–70%.

Insurance claims to register dental care in Sweden have been used frequently and are regarded as a reliable way to collect data on dental care consumption (8). The frequent use of social security numbers in Sweden has made this individual comparison between a questionnaire and insurance data possible. This study deals with the validity of information on dental attendance, but the result probably has relevance for other questionnaire surveys performed in the dental and general health sector.

A comparison of dental attendance and regular dental attendance between the questionnaire survey and the insurance claim survey showed substantial and significant differences. Eddie (16) found the same in a Scottish study. There is a big difference between the shares that had regular dental attendance in the present study (61%) and in Eddie's (16%). This difference is, at least partly, explained by a difference in definition. Eddie defined regular attendance as five courses of treatment in 5 years, while in the present study regular dental care was defined as at least two courses of treatment (at least one with a complete examination and treatment) in 3 years.

Table 6. Regular treatment assessed according to questionnaires and claims for those who were identified in both studies (Material III, $n = 3,400$)

		According to insurance claims		
		Yes	No	Total
According to the questionnaire	Yes	2584	439	3023
	No	112	232	354
	Total	2696	671	3367

Table 7. Dental hygienist attendance assessed according to questionnaires and claims for those who were identified in both studies (Material III, $n = 3,400$)

		According to insurance claims		
		Yes	No	Total
According to the questionnaire	Yes	682	417	1099
	No	123	2085	2208
	Total	805	2502	3307

The comparison of self-reported data with insurance claim registrations showed that the sensitivity was high but that the specificity was low, which means that subjects who attend dental services normally answer correctly, but that subjects who do not are more often likely to give incorrect answers. This indicates that questionnaire surveys systematically overestimate dental attendance and that this is not a good approach in the case of persons who for a number of reasons do not attend dental services.

This study has focused on point estimates. Questionnaire surveys are sometimes used in correlational or associational analyses. Generally, random or non-systematic error does not affect the precision of a point estimate, for example level of dental attendance. Random measurement influences the variability of the phenomenon under study, which in turn may affect statistical testing. Systematic or non-sampling measurement error on the other hand not only biases point estimates: the observed nature of relationships is affected, too.

The accuracy in questionnaire surveys can be acceptable, but it is obviously not very high. Therefore, other methods should be considered if possible. Still, there are many situations where a questionnaire survey is the only option. In those cases, it is necessary that the survey not only be carefully performed but also carefully presented.

In conclusion, questionnaire studies are biased as a result of non-responses and incorrect answers. Biases due to incorrect answers can reach substantial levels.

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