Assessment of caries experience in epidemiological surveys: a review

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Objectives: To review aspects of methods for assessing caries experience (CE) in epidemiological surveys. ***Method:*** A search of English language literature published between January 2000 and December 2008 was undertaken using 'epidemiology', 'dental caries' and 'assessment' as search terms. Information on criteria for CE assessment, materials and settings, diagnostic threshold, training of examiners and validation of the screening results was extracted from the reports. ***Results:*** Eighty-nine reports met the inclusion criteria. In 9 of the reports (10%) no reference was made to existing standardisation criteria for assessment of CE. Light condition applied (60 reports, 67%) and the use of a probe (60 reports, 67%) were frequently reported. Most reports mentioned that training and calibration of examiners took place, but the outcome of reliability checks were often not presented (48 reports, 54%). Only 28 of the reports (32%) specified that cleaning took place before the examination. Journals with Impact Factor (IF) provided specific information on methods more frequently than journals without. The WHO Basic Methods for Oral Health Surveys were most often applied (52 surveys, 58%). However, deviations from the original description were found especially for measurement and reporting of reliability measurement (24, 46% and 29, 56% respectively), type of probe used (27, 52%) and light condition (16, 31%). All of these hamper the (external) validity of the obtained results. ***Conclusions:*** There is a clear need for improvement of the reporting and application of methods for assessing CE in epidemiological surveys. A check-list of aspects of methods to be included in reports of surveys assessing CE is proposed by the authors.

Keywords*: caries experience, epidemiology, methodological aspects*

Introduction

Epidemiological surveys are important for gaining knowledge about the prevalence, distribution and incidence of diseases in a population. Information from surveys is used by health care planners for follow-up of disease trends, monitoring of service delivery and evaluation of the impact of interventions.

Several aspects contribute to the overall quality of an epidemiological survey. One of these is the reliability and accuracy of disease assessment. For assessing caries experience (CE), standardisation criteria were developed by different authorities. The British Association for the Study of Community Dentistry (BASCD) developed criteria for use in surveys aimed at evaluating oral health and treatment needs in population (sub)groups (Pitts *et al.*, 1997). The World Health Organization (WHO) issued guidelines developed for pathfinder surveys, yielding rather basic yet relevant information with simple methods (World Health Organization, 1997). Recently, the International Caries Detection and Assessment System (ICDAS) was developed allowing the recording of disease at different levels and for different purposes (survey, clinical trial…) (Pitts, 2004).

Reports in the literature present data collected using different caries diagnostic criteria and survey methods, hampering the comparability of the results obtained (Charland *et al.*, 2002; Fyffe *et al.*, 2000; Ismail, 2004).

A clear description of aspects of the methods is often lacking. However, it has been shown that there is a correlation between the quality of reporting and the actual design and conduct of a survey (Hill *et al.*, 2002; Needleman *et al.*, 2008). A report should contain enough and precise information to allow judgement of the validity of the results presented and of the conclusions reached by the authors.

The aim of the present contribution is to review reported methods used for assessing caries experience in epidemiological surveys published between 2000 and 2008. Both the frequency of reporting and the type of information provided were examined. In addition, we propose a checklist of aspects of methods to be included in reports of CE surveys.

Methods

A search was conducted on 28th May, 2009 of English language scientific literature published between 1st January 2000 and 31st December 2008 using the Pubmed database tools. The following search terms were used: "epidemiology", "dental caries" and "assessment". The aim of this survey was not to review all available epidemiological reports but rather to focus on the aspects of methods of caries experience assessment in a relevant sample of reports from the literature. The search focused on methods for assessing dental caries experience in an

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epidemiological setting. Reports in the grey literature, i.e. information not appearing in the periodic scientific literature obtained from a library, internet or by ordering were not pursued. Only studies on humans were included. Duplicate reports, papers published by a research group on different occasions but referring to the same data collection and using the same method, were not considered. Independent duplicate review of titles, abstracts and where necessary full text versions was undertaken by two researchers (DD, AO). Instances of disagreement in the study selection process were resolved by discussion between these researchers.

Information on following aspects was extracted from the reports: criteria used for assessing caries, materials and setting used for recording caries experience, diagnostic threshold used, training of examiners and aspects of validation of the results. The scoring was performed by two researchers (DD, AO), independently. In case of disagreement, a final conclusion was reached by consensus. When a paper did not provide explicit information but mentioned the use of an existing survey method, it was assumed that this was applied as proposed in the guidelines unless mentioned differently in the document. To differentiate between 'explicit' and 'derived or assumed' information; data are presented in separate columns (Table 1).

To investigate possible changes over time, the frequency of reporting key items over the years was compared for the following aspects: criteria used, use of probe, light condition, use of radiographs, detection threshold applied and reliability reported. A comparison was also made between different journals (only journals with at least 4 reports included in the review were considered) and between journals with and without an Impact Factor (IF) (based on Thomson ISI 2008).
Finally, in reports mentioning the use of the standardised WHO Basic Methods for Oral Health Surveys a check for consistency in the application of the criteria was undertaken.
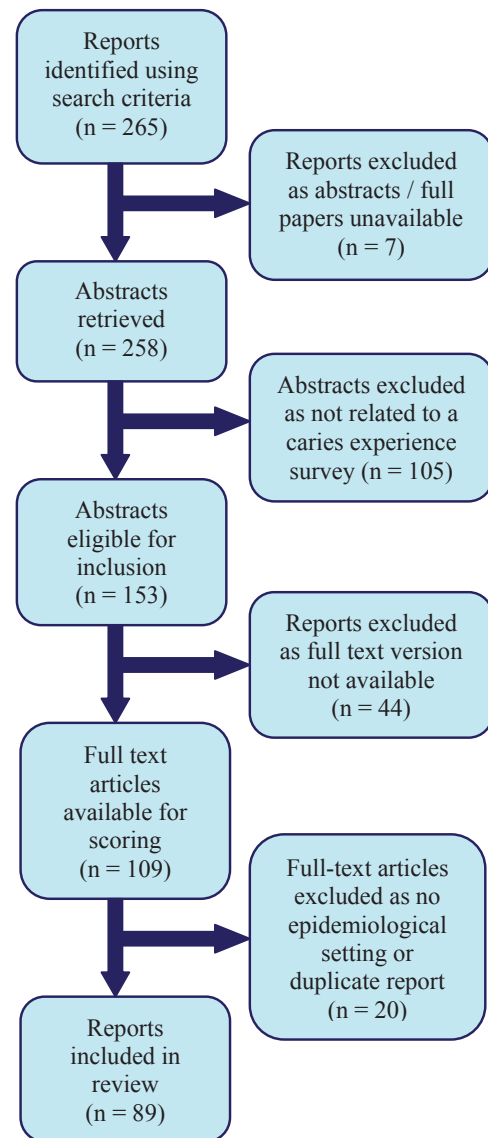

Figure 1. *Flow chart of reports identified, retrieved and included in the review*

Table 1. Frequency of reporting of selected items of caries experience assessment methods

Item	Explicitly mentioned		Assumed to be applied*		Not reported	
	n	(%)	n	(%)	n	(%)
Use of standardisation criteria	80	(90)	not applicable		9	(10)
Materials and setting:						
Use of probe	60	(67)	82	(92)	7	(8)
Type of probe	51	(57)	75	(84)	14	(16)
Light condition	60	(67)	82	(92)	7	(8)
Use of radiographs	31	(35)	80	(90)	9	(10)
Cleaning / debris removal	28	(32)	77	(87)	12	(14)
Detection threshold applied	42	(47)	84	(94)	5	(6)
Examiner characteristics:						
Training	57	(64)	58	(65)	31	(35)
Calibration	61	(69)	0		28	(32)
Reliability assessed	47	(53)	48	(54)	41	(46)
Reliability reported	41	(46)	not applicable		48	(54)

* Where a paper did not provide explicit information but mentioned the use of an existing survey method, it was assumed that this was applied as proposed in the guidelines unless mentioned differently in the document. To differentiate between 'explicit' and 'derived or assumed' information; data are presented in separate columns

Results

The initial search identified 265 reports and Figure 1 presents the process of selecting reports for inclusion in this review. A first step excluded reports for which neither abstract nor full text version could be obtained (7 reports). Based on the abstracts, reports not related to surveys assessing caries in humans were eliminated (105 abstracts), leaving 153 abstracts eligible for inclusion. From this set, abstracts without full text versions were excluded leaving 109 full text articles for scoring. Based on these full reports, an additional 20 papers were excluded because the setting appeared not to be an epidemiological survey or the paper was a duplicate report. In this way, 89 reports remained for final inclusion in the review.

The 109 reports originated from 42 journals, each contributing between 1 (28 journals) and 8 papers (1 journal). From these journals, 14 (33%) had an Impact Factor in 2008. The surveys on which the reports were based took place between 1991 and 2007.

Table 1 summarises the frequency of reporting of the different items considered. As mentioned above, in case no sufficient information was provided frequencies were calculated both without and with the assumption that criteria were applied as described in the guidelines referred to. It should be mentioned that details of existing survey methods were difficult to retrieve in 4 cases because the original reports were not readily accessible (e.g. local publication or thesis). For 6 reports the original authors were contacted to obtain the necessary information. In 9 of the reports no reference was made to existing standardisation criteria for assessing caries experience. Regarding materials and examining conditions, information on the type of probe and light circumstances used was most frequently mentioned explicitly, i.e. in 51 and 60 of cases, respectively. Less frequently made explicit was information on use of radiographs or cleaning before the examination, 31 and 28 of reports. In 42 of the reports the threshold used for detection of caries experience was explicitly mentioned, in another 42 an assumption could be made based on the survey method referred to. In 5 reports it was impossible to assess this aspect. In 31 of the papers no information was provided on whether the examiners involved in the scoring received any training before the start of the survey. Information on the validation of the results obtained, through calculation of agreement measures, was lacking in 48 of the documents screened.

The study period was divided into 3 periods of each 3 years (2000-2002, 2003-2005 and 2006-2008) and the frequency of reporting of selected key items was analysed. No important variations in the frequency of reporting were noticed over the time period considered. Furthermore, information on the frequency of reporting of selected items according to the journal (only journals with 4 or more reports included) was considered. In 6 out of these 8 journals the criteria used for assessing CE were reported in all included papers. Information on the light condition applied and reliability measurement was reported in more than 20 reports (70%) across 5 out of the 8 journals. The detection threshold applied and use of radiographs was least frequently reported (in 4, 5 respectively out of the 8 journals fewer than 7 reports (50%) provided this information).

Further, the frequency of explicit reporting of selected items in journals with and without Impact Factor was assessed. It was observed that journals with an IF (14 journals, 46 reports) reported the selected aspects of methods more frequently for almost all items considered.

Not only the frequency of reporting was considered, but also the type of information provided was analysed. The different survey methods for assessing CE referred to and their respective frequencies (both overall and when reported) were examined. Across the sample, 11 different systems were mentioned with the WHO Basic Methods for Oral Health Surveys most often reported (52 of all reports, 58%), followed by the ICDAS and the National Institute of Dental and Craniofacial Research (NIDCR) guidelines (6, 7% reports each). Other methods referred to are the diagnostic criteria issued by the BASCD (previously Scottish Health Boards' Dental Epidemiological Programme, SHBDEP) (4, 5% reports), the Centers for Disease Control (CDC) and Radike (3, 3% reports each).

When information on the type of standardisation criteria for assessing CE used over the time period was considered, it was observed that the WHO Basic Methods for Oral Health Surveys were the most widely used guidelines with slightly decreasing trend over time. The ICDAS system appeared only in the last period considered (2006-2008), while the use of the BASCD and NIDCR survey methods showed a decreasing trend over time.

In 60 papers (67%) explicit information was presented on whether a probe was used or not. In 7 of these reports (12%) the authors mentioned that no probe was used. The type of probe was specified in 51 out of the 53 reports (96%). In 28 surveys a standard dental probe was used (55%) or a CPITN (Community Periodontal Index of Treatment Needs) probe (15 reports, 29%). In the 8 remaining surveys the use of a variety of non-standard probes was reported (16%).

From the 60 surveys providing information on the light condition under which the examinations were carried out, 16 papers (27%) reported natural light and 44 reports (73%) artificial light conditions. In 5 reports the use of radiographs for assessing CE was mentioned. Twenty-eight (32%) reports mentioned whether or not cleaning of teeth prior to examination was undertaken. In only 12 surveys (44%) was cleaning actually performed; this was limited to removal of debris in 11 studies (92%). Professional cleaning before the examination was reported in only 1 case.

Reports providing information on the measurement of reliability of the scoring by the examiners (41 reports, 46%), presented both inter- and intra-examiner agreement measures in 16 cases (39%). In 14 reports (34%) only inter-examiner agreement was reported and in 11 reports (27%) only intra-examiner agreement.

Finally, Table 2 provides information on the consistency in the application of the different items of the WHO Basic Methods for Oral health Surveys in papers referring to this system. Deviations from the described guidelines were often noticed, especially regarding the measurement and reporting of examiner agreement (24 and 29 reports, 46% and 56% respectively), type of probe used (27 reports, 52%) and light condition applied (16 reports, 31%).

Table 2. Percentage of reports applying WHO Basic Methods for oral health surveys but not adhering to the guidelines (52 reports included)

Item considered	n	(%)
Use of Probe	2	(4)
Type of Probe	27	(52)
Light condition	16	(31)
Cleaning	5	(10)
Use of radiographs	1	(2)
Detection threshold	2	(4)
Measurement of reliability	24	(46)
Reporting of reliability measurement	29	(56)

Discussion

The aim of this contribution was to review the reporting of methods of assessing caries experience (CE) in recent epidemiological surveys. For this purpose, papers published between 2000 and 2008 were retrieved and screened regarding a number of key aspects of methods.

Guidelines for methods of CE assessment have been developed by different organisations and research groups (WHO, BASCD, ICDAS, etc.) and these are appended to the online version of this paper. Standardisation of working methods is needed in order to assure the repeatability, comparability and validity of results obtained by different groups of subjects or by the same group over time. Although this is generally regarded as essential, there was no mention of the use of any standardisation guidelines in 9 (10%) of the included manuscripts (Table 1). This might suggest that some authors used their own criteria thereby limiting the (external) validity of their results (Alison and Shields, 2005; Ferguson, 2004; Slack and Draugalis, 2001).

The assumption made in this review that methods were applied by the authors as described in the corresponding survey guidelines seems, however, to be unjustified. This was illustrated in Table 2, where one can observe that the WHO guidelines were not adhered to in many surveys, mainly for aspects such as the measurement and reporting of reliability measurement (24, 46% and 29, 56% respectively), type of probe used (27 reports, 52%) and light condition (16 reports, 31%). It is clear that these deviations from the guidelines give an even more pessimistic view on the findings.

A large number of reports provided, irrespective of whether they mentioned the use of an existing survey method or not, only limited information on several of the aspects of methods considered in this review. Overall, details on materials and setting were more frequently provided than aspects related to the examiners involved (Table 1). For example, the detection threshold applied when assessing and reporting CE was reported in 84 of the studies (94%). However, only 44 of the studies (47%) mentioned this item explicitly. In the other studies, the information had to be retrieved from the survey method referred to or was retrieved from the discussion part of the paper. On the other hand, the reliability (reproducibility and/or consistency) of the scoring behaviour of the examiners was poorly reported; details were provided in only 41 of the reports (46%).

In addition, we observed differences in type of materials used and settings for carrying out the examinations. One has to be reminded that they influence the outcome of the assessment as reported in the literature, namely the type of probe used for detection of lesions (Pitts, 2001; WHO, 1997), the light conditions (Assaf et al., 2004; Kassawara et al., 2007), the use of radiographs as an adjunct to diagnosis (Hintze and Wenzel, 1994; Poorterman et al., 1999; Wenzel, 2004), cleaning and/or removal of debris before the examination (Assaf et al., 2004), etc. However, in this respect one needs to realise that a distinction needs to be made between pathfinder surveys aiming to present a basic picture of the situation and higher order studies where advanced explanatory analyses are performed on the data. However, the opinion of the authors is that in both cases clear and transparent reporting is a critical aspect of translating findings to the health care setting.

Since the quality of reporting of research work is often considered to reflect the quality with which the work was actually undertaken (Hill et al., 2002), the presence of any time trend or differences between journals was explored. Overall, it was not possible to detect a clear trend although some minor variations occurred. The frequency of reporting did not change considerably over the time period considered.

Further, possible differences between different journals (with 4 or more reports included in the review) were explored. It is clear that differences were apparent not only between the different journals but also regarding the different items considered. The use of radiographs was least often reported explicitly and this in most journals. Reliability measurement and reporting of the outcome of this measurement was most often the case in Community Dentistry and Oral Epidemiology (all the reports in this review). It is clear that the impact of editors and reviewers should not be disregarded.

It is generally accepted that journals with an Impact Factor (IF) are of higher quality than others and this study confirmed that journals with an IF reported most of the selected aspects of methods more reliably. The present review appears to confirm the association between quality of reporting and overall quality of a journal.

A clear and transparent reporting is a critical aspect of translating research findings to the health care setting (Needleman et al., 2008). If reporting is inadequate, assumptions have to be made, and this could lead to a false interpretation.

To improve the quality of method reporting of CE assessment, a checklist was developed (Table 3). The implementation of this instrument could contribute to the clarity and transparency of reporting in CE surveys. Also in other fields, initiatives were taken for improving the reporting (Bossuyt et al., 2003; Davidoff et al., 2009; MacPherson et al., 2010; Thomson and Moss, 2008; von Elm et al., 2008). In this respect, the efforts of organisations that promote a good practice in reporting such as the EQUATOR network (www.equator-network.org) need to be mentioned.

This review has at least three limitations. First, no attempt was made to explore all epidemiological reports published in the period considered but rather the search was limited to a restricted number of search terms. Sec-

Table 3. Checklist of methods' aspects to be included in reports of surveys assessing caries experience

Item	Survey method	Recommendation
1	**Standardisation criteria used**	Indicate which standardised survey method was used (WHO, ICDAS, etc). If a modification was made of the original version referred to, this should be stated clearly and the type of modification explained.
	Materials and settings	
2	Probe type and usage	State whether a probe was used for the clinical examination, what it was used for (e.g. for debris removal only, for confirmation of diagnosis in doubtful tooth areas, for lesion detection in all circumstances) and specify the type of probe used.
3	Light condition	State clearly the light condition (artificial or natural light) during the clinical examination. Specify the type of light source (if applicable).
4	Radiographs	Indicate whether radiographs were used as an adjunct to lesion detection.
5	Cleaning	Give information on whether or not any form of cleaning was undertaken before the examination. Specify the type of cleaning method employed (i.e. debris removal using a probe, cotton rolls or gauze, brushing (by subject or by dentist) or professional cleaning).
	Detection threshold	
6	Level of lesion detection	Describe the threshold used for lesion detection (i.e. detection at cavitation stage or inclusion of initial lesions, etc.).
	Examiner characteristics	
7	Examiner recruitment	Explain how examiners were recruited (experienced in screening, treating dentists…) and indicate their qualifications (dentist, oral hygienist, student…).
8	Number of examiners involved	Indicate the number of examiners participating in the survey.
9	Examiner training	Indicate whether any training of the examiners took place, training method (written instructions, slides, models, web-based application, etc.) and the frequency of training (e.g. in longitudinal surveys).
	Validation	
10	Calibration	Indicate whether a calibration was undertaken. Give information on the calibration technique used (i.e. using slides, study models or patients) and how the outcome was assessed (method used, feedback provided, criteria of acceptability used).
11	Reliability testing	Provide information on the evaluation of agreement between examiners (and/or the benchmark examiner). Indicate who the benchmark was and the type of evaluation (inter-examiner, intra-examiner or inter and intra-examiner assessment) that was used.
12	Reliability reporting	When reliability was tested, indicate the techniques used for calculation of agreement measures and indicate the scores obtained by the different examiners.

ond, no attempt was made to include reports that could not be obtained through library databases. However, it can be assumed that the reports that were included and screened are at least indicative of the situation. Finally, in case insufficient information was included in the paper, no extensive examination (e.g. systematically contacting authors) was undertaken.

Conclusion

This review of aspects of method reporting of assessing caries experience in recent epidemiological surveys shows that there is a clear need for improvement of this aspect of quality. Editors and reviewers of dental journals have a responsibility in setting standards for the reporting of research work. Therefore, we propose the implementation of a check-list of aspects methods, such as the one used here (Table 3), in reporting surveys assessing caries experience. This could be a useful instrument for researchers, reviewers and editors.

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Appendix: Standardised methods for CE assessment: an overview of most frequently used index systems (only items relevant for this study were included)

System	WHO (World Health Organization, 1997)	BASCD (Pitts et al., 1997)	ICDAS (Ismail et al., 2007)
Materials and setting			
Probe type	Periodontal probe conform to WHO specification.	CPITN probe.	The WHO/CPI/PSR probe can be used to confirm the presence of a cavity in dentin.
Light condition	If electricity is available a lightweight portable examination light in the blue- white colour spectrum should be used.	Standardised light source only.	Artificial light.
Radiographs	No radiographs.	Radiographic or fibre-optic transillumination examination will not be undertaken.	No radiographs.
Cleaning	Any gross plaque and debris should be removed.	Debris removal with gauze or cotton roll or cotton wool buds.	Cleaning.
Detection threshold			
Detection threshold recommended	Carious at cavitation stage.	Caries into dentine.	Range from first visual change in enamel to extensive distinct cavity with visible dentin.
Examiner characteristics			
Examiner recruitment	Not specified.	Trained and calibrated dentists.	Not specified.
Examiner training	Yes	Yes	Yes
Proposed calibrator	Experienced epidemiologist trained in accordance with the recommendations for basic oral health surveys.	Benchmark examiner.	Senior examiner.
Characteristics of subjects included in calibration exercise	25 subjects with full range of CE conditions expected to occur.	Minimum of 10 subjects with CE, including untreated caries & also 'caries free' subjects.	20 subjects with caries lesions ranging between scores 1 and 5.
Level of agreement aimed at	85-95% agreement Note: In case of low disease level: kappa is advised.	Examiner should be within group mean indices.	Trainees need to reach kappa equal to 0.65 or more
Advice on reporting of agreement	Inter- and intra- examiner variability should be included in the reports.	Not specified.	The report of a study should provide details on the calibration exercise and the senior examiner(s).