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A scoping review of the uses of the care index in children

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Objective: To conduct a scoping review of literature to describe how the care index (CI) and restorative index (RI) are used in child populations and to determine whether they are fit for purpose. ***Basic research design:*** Scoping review conducted using the Arksey and O'Malley (2005) framework. ***Method:*** Electronic and manual literature searches (1980–2015) were conducted. Titles and abstracts were screened, full-texts of potential studies were reviewed two reviewers extracted data independently, followed by data charting and summarising. ***Results:*** Out of 104 articles meeting all criteria, most were cross-sectional (92%), and 56% were conducted in UK and Brazil. Most commonly (63%) studies used CI and RI to obtain epidemiological data on dental care levels. Of the studies that defined CI and RI, most used and specified the standard definition. The CI and RI scores varied either due to patient related factors such as age, gender or dental care related factors including, cost of treatment and method of provider remuneration. ***Conclusion:*** Overall, it is recommended that future studies should clearly state the definitions and thresholds used to obtain CI and RI, which would enable comparison between communities and allow temporal trends to be studied. Additionally, deriving separate CI and RI scores for groups based on caries extent would help to highlight inequalities in the provision of care. Further research is needed to explore the applicability of CI and RI to changing approaches to caries management with current care recommendations emphasising on minimal treatment and secondary prevention.

Keywords: *care index, scoping review, children, restorative index, DMFT*

Introduction

Dental caries is one of the most common diseases, estimated, in 2010, to affect 621 million children worldwide (Kassebaum *et al.*, 2015). It has been estimated that globally 15 and 27 new carious lesions in primary and permanent teeth, respectively, will develop annually per 100 people (Kassebaum *et al.*, 2015). Indices that allow assessment of the severity of the disease and the effects of treatment on disease outcomes are essential to monitor and compare levels of disease in different populations and at different time-points. It is not clear what the best index is for these purposes, nor is it clear what the problems are with existing, commonly used indices and whether these still serve the purpose for which they were designed.

Dental caries manifests itself as a continuum of stages ranging from the first atomic level of demineralisation to initial enamel lesions, through dentinal involvement to ultimately cavitation (Featherstone, 2004). This disease and its sequelae can cause significant pain, affecting quality of life and well-being (Selwitz *et al.*, 2007). The criteria described in the WHO manual Oral Health Surveys – Basic Methods measures caries at cavitation level and is the most widely used standard for caries detection (WHO, 2013). These criteria will be referred to as the 'WHO criteria' in the text from here on. Past and present disease experience is commonly measured using the DMFT index (decayed, missing and filled teeth) in the permanent dentition and dmft, for primary teeth. Tooth surface data for each dentition can also be collected and are noted as DMFS or dmfs. Whilst the D or d reflects untreated carious lesions, the F, f, M and m denote treated carious lesions. Data collected by the DMF index can be used to measure the proportion of the disease that has been treated by either restorative means or through extraction. One such measure is the care index (CI), defined as the number of restored teeth as a fraction of the total number of decayed (D), missing (M) and filled (F) teeth (CI= F/DMF × 100). It indicates the extent or coverage of restorative treatment of carious lesions in a population, and is usually used in surveys of child dental health (Walsh, 1970).

As well as being useful for monitoring trends in dental care need over time (Kassebaum *et al.*, 2015), the CI can indicate how much treatment is being delivered to a population and theoretically, practitioners' adherence to recommendations or specific guidelines for dental treatment provision (Dommelen and Schuller, 2016). Policymakers and commissioners of dental services might also use the CI as a measure of the actual quantity of dental care provided at a local level, giving

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a basis for policy changes for dental care delivery and monitoring their effects (Pashayev *et al.*, 2011). The CI should not be confused with the restorative index (RI) (F/ (D+F) × 100), which is the number of restored teeth as a fraction (F) of the total number of decayed (D) and filled (F) teeth.

The WHO criteria do not record initial enamel lesions, consequently these early lesions are not considered in CI and RI scores. Additionally, there is a question about whether CI and RI indices are fit for measuring treatment experience in relation to contemporary treatment approaches such as, non-restorative cavity control or through the use of fluoride or silver compounds to arrest the disease process (Innes et al., 2016; Schwendicke et al., 2016). Therefore, the aim of this study was to carry out a scoping review was to; summarise the literature on how the CI and RI are being used in child populations; identify whether they seem to fulfil the purpose that they are used for in the literature, gain greater understanding of the reasons for variations and, identify gaps in information.

Objectives

The objectives of this scoping review of the CI and RI were to identify and describe:

1. how the CI and RI is expressed in the literature;
2. how the CI and RI are used as indices of dental care, and reported in the findings in the literature;
3. variations in the CI and RI within the studies and suggested reasons for the variations;
4. strengths and weaknesses/challenges of the CI and RI; and
5. gaps in the research and meaningfulness of the data

Methods

As the initial literature search did not identify any reviews with similar objectives, and considering the variable and limited evidence available in relation to CI and RI, a scoping review was considered the best approach. A scoping review identifies a broad range of literature, including all types of studies, as opposed to systematic reviews where the focus is on quality assessment. The Arksey and O'Malley five stage framework (2005) with the Levac *et al.* enhancements (2010) was used to guide the review**.**

Stage 1. Identifying the research question

As our aim was to scope the literature on how the CI and RI are being used and to identify gaps for future research, the scope of enquiry was broad, including all aspects of the CI and RI in relation to dentistry, across different countries, regions and healthcare settings, for the primary and permanent dentitions. In order to generate breadth of coverage, the question 'What do we know about the CI and RI in children and are they still fit for purpose' guided the search strategy.

Stage 2. Identifying the relevant studies and information

Relevant information was sought in peer-reviewed publications using MeSH terms and free text. Index-related ("Care index" or "Restorative index") and dental-related keywords (dent* or oral*) were used as search terms in keywords, titles or abstracts. We searched Medline via Ovid, Web of Science (core collections), Scopus and Google scholar between from 1980 – 2015 and made no restrictions to the search or retrieval based on language. The output references were exported to and stored in an Endnote (X7) library. All duplicates were removed.

Stage 3. Study and information selection

Although in a scoping review information can be included from sources other than peer-reviewed publications, due to the number and spread of records (from different countries and groups) and with the CI being used for a variety of reasons, we did not include other sources. Studies using the CI or RI in those 18 years or older were excluded. Studies were excluded if they did not pertain to the CI or RI, were not related to dentistry, or were in adults. We included both English and non-English language studies.

We identified 290 studies that used either, or both, the CI or RI in children (Figure 1). Two reviewers (EG and ZM) screened the titles and abstracts (n=116) and identified 104 studies that met the inclusion criteria.

Stage 4. Charting the data

All five reviewers extracted and analysed data from the same five papers together, on a data collection spreadsheet for training and calibration, after which the spreadsheet was redesigned slightly. A further five papers were reviewed by each pair to refine calibration. Inter-examiner agreement within the pairs of reviewers ranged from 85% to 95%. Disagreements were resolved through discussion and, if necessary, involvement of a third reviewer.

Two reviewers extracted data from each paper in blinded to one another's scores, with the three pairs of reviewers (EG+ZM, NI+AM, EG+EH) assessing approximately 34 papers per pair. The data from eligible full text articles were extracted, charted and summarised by the reviewers using a bespoke Microsoft Excel spreadsheet. (Table 1).

Stage 5. Collating, summarising and reporting results

The extracted data were collated and quantitative data presented descriptively. Framework analysis was used to manage the extracted qualitative data about the reasons for variation of the CI or RI cited in the included studies (Ritchie *et al.*, 2013). After familiarising themselves with the data by reviewing every identified reason for variation in the CI or RI, two reviewers looked for emerging themes. Each reason was then categorised under one of these emerging themes.

Results

Study characteristics

Of the 290 studies identified, 75 were included in the scoping review (Figure 1). The majority (92%, n=69) were cross-sectional, 5.3% (n=4) were longitudinal and only 2.7% (n=2) were experimental.

Table 1. List of variables collected in the review

Variables
• Author & Year
• Aim of the paper
• Year of measurement of CI or RI
• Country
• Sample characteristics (Total number, Age range, Target group, Population/Clinic based)
• Type of study
• DMFT or dmfs cited/DMFT threshold used/ DMFT criteria used
• Value of CI or RI (%)
• Formula of CI or RI
• Standard Deviation for CI or RI
• Distribution of CI or RI data
• Reasons for the variations in the CI or RI
• Uses of CI or RI

Just over half of the papers reported studies conducted in the UK (33.3%) and Brazil (22.7%). The remainder were from different European countries (21.3%) and other parts of the world (22.7%). Of the papers included over two thirds [2001-2010 (52%), 2011-2015 (18.6%)] were published between years 2001-2015 while only 29.2% were published from 1980-2000.

Sample characteristics

Overall, studies included children across the full included age range of 1-18 years. However, the most common age groupings were 5-7, 8-11 and 12-15 years. Although the majority of studies (n=63) included children sampled from the general population, 16% focussed on children with

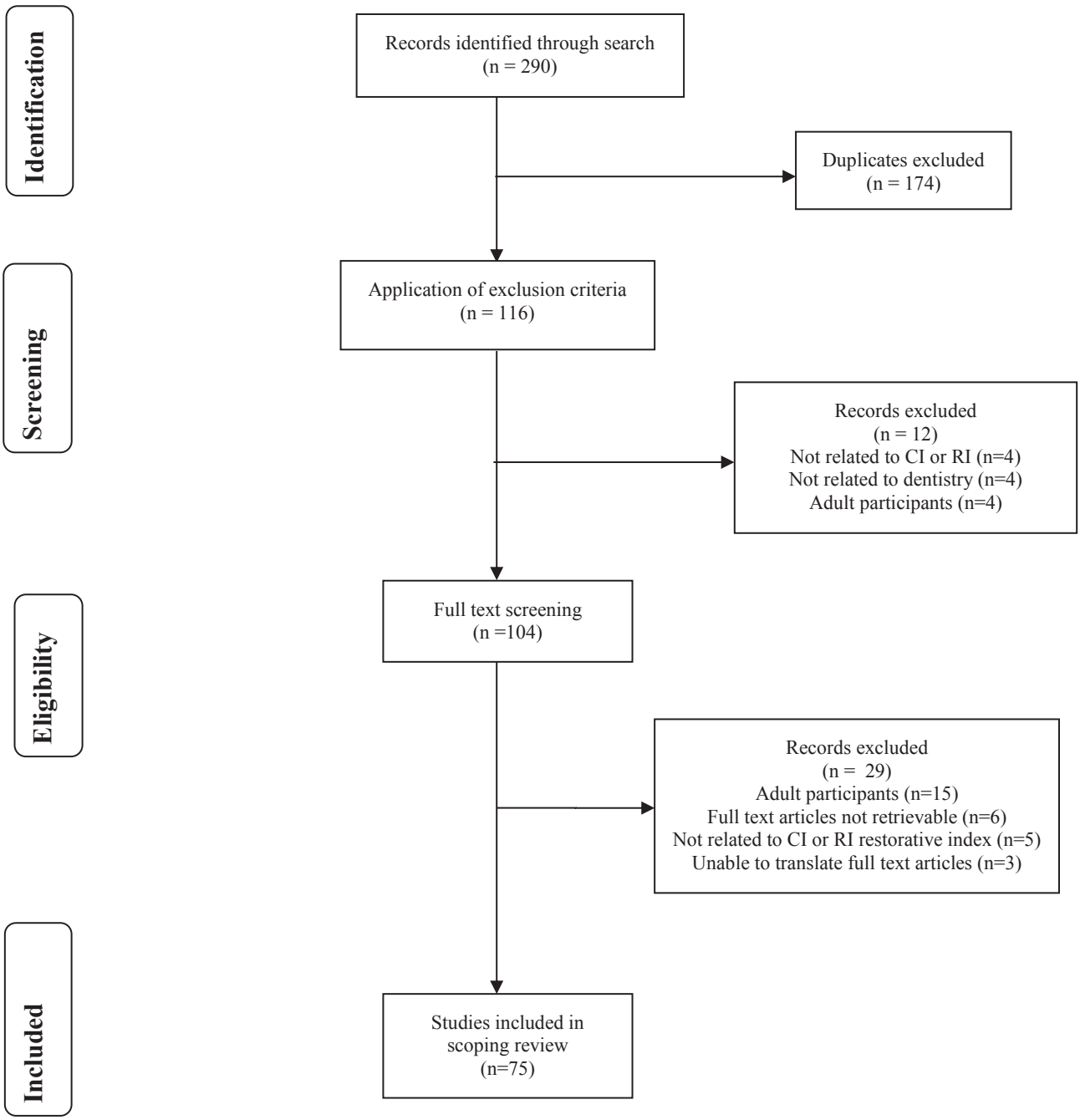

Figure 1. Results of literature search

specific health needs, such as children with autism, disabilities or who were diabetic and these studies were clinic based. Nearly one-quarter, 24% (n=18) included children with primary teeth (children ≤ 5 years), 48% (n=36) those with permanent teeth and 28% (n=21) included both.

Characteristics of the Care index or Restorative index

Overall, 64 studies reported the CI. All the papers reviewed reported a full range of CI from 0 to 100%. Fifty one used the standard CI definition while 13 studies did not specify a definition. Nineteen studies reported the RI, with values ranging from 0 to 100%. Of these, 18 used a standard RI definition and one referred to the CI (F/DMF x 100) as the RI. Only a few studies reported the confidence intervals or distribution data for the CI and RI.

DMFT/dmft was used to measure caries experience in 96% (72) of the studies. Of these 76% (n=57) stated the criteria used for DMFT/dmft with most either using the WHO 2013 (n=34) or British Association for the Study of Community Dentistry criteria (n=17). Over two-thirds, 49 (68%) indicated a DMFT/dmft threshold. The most commonly used DMFT/dmft threshold was defined by D3 cavitation levels and using the WHO criteria.

Based on the objectives of this review, the most common use of CI and RI (62.7% of the studies), was to obtain epidemiological/descriptive data to; describe availability and access to dental care, understand patterns of dental care utilization, describe socio-economic, geographical and ethnic trends in past and, future dental care needs. Other uses were to inform research (24%), service design (8%) and policy (5.3%).

Overall, 52 studies discussed reasons for variations in the CI and RI scores, which fell into two themes. First, patient-related factors included age, gender, ethnicity, parental attitude and knowledge, socioeconomic status/deprivation, geographical area, dental attendance rates, dental care utilization, compliance, clinical status, and health condition. Secondly, dental care related factors included availability of dental care, cost of treatment, type of dental treatment (extractions v/s restorations), different methods of remuneration of dental care providers, type of tooth (primary v/s permanent).

Reasons for variations in care index

Both patient-related and dental care related reasons were cited as factors influencing variations in the levels of the CI and RI in the included studies.

Patient related factors

Low socioeconomic status, little oral health knowledge, unfavourable oral health behaviour, dental attendance patterns and underutilization of dental services (Antunes *et al.*, 2003; Hoffmann *et al.*, 2004; Antunes *et al.*, 2006; Pereira *et al.*, 2007; Peres *et al.*, 2007; Pereira *et al.*, 2010; Vermaire *et al.*, 2011; Hysi *et al.*, 2014) were commonly related to a low CI in populations. Additional factors such as language barriers, knowledge gaps and cost of dental treatment were also cited to be contributing to a low CI (Wagner *et al.*, 2014). Ethnicity, age and gender were also related to variations in the CI or RI (Antunes *et al.*, 2003; Umesi-Koleoso *et al.*, 2007).

Dental treatment/Services related factors

In the studies where they were mentioned, children with health conditions such as autism, cardiac disease and diabetes were suggested to have low CI levels compared to healthy children. This could be due to their health conditions making access to dental services more difficult, as well as dental practitioners being reluctant, or finding it more challenging, to restore teeth in these children (Tasioula *et al.*, 2008; Jaber *et al.*, 2011).

Different forms of remuneration and/or differences in dental specialisms may alter treatment decisions which could explain variations in the CI observed in some studies (Levin et al., 2010). For example, Paediatric Dentists were noted to diagnose in a more detailed manner, and also restored and extracted more teeth taking a greater focus on prevention. Thus children treated by Paediatric Dentists had higher CI scores compared to those treated by GDPs (Bruers et al., 2009; Schorer-Jensma and Veerkamp, 2010).

Area-based measures of deprivation correlated with CI or RI suggesting more deprived areas tend to have lower CI or RI levels (Antunes et al., 2003; Peres et al., 2003; Tan et al., 2006; Levin et al., 2010). Such geographical differences in the CI and RI might also be due to different primary dental care provisions.

Discussion

The CI and RI reflect the previous management of the caries present and thus provides information on the provision of dental services, inequalities in access, receipt of care as well as some information on the nature of this care (extraction or restorative). The CI and RI can help to identify inequalities in the provision of care within and between countries, providing policy makers and health professionals with information on patterns of care. Hence, the CI and RI are important proxy measures for assessing the morbidity related to oral health and the extent of disparities in oral health. Despite the usefulness of these indices the current scoping review found some major gaps in relation to how the indices are currently being used and interpreted in the literature. Over half of the included studies used the conventional CI and RI formulae to describe the levels of care. However, the authors often erroneously assume that CI and RI are identical when comparing studies. There seems to be a lack of understanding of the difference between the two; the higher the number of missing teeth, the larger the difference between the CI and the RI may become. Additionally, there were some inconsistencies found in the use of the correct definitions for CI and RI in the literature. Those using the results, such as commissioners of care, policy makers and researchers, should be aware that this can affect comparability of the results. Generally, the studies did not clearly state their criteria and the thresholds that were used to derive the CI and RI values. Studies, that did state them most frequently used the WHO criteria, which usually measures teeth while although measuring surfaces produces more precise and sensitive estimates (Dommelen and Schuller, 2016). Each of these gaps can cause unquantified inaccuracies when comparing CI levels between studies to investigate geographic or temporal trends.

Even though, the CI and RI may provide valuable information on patterns of care, these indices have some limitations. Both the CI and RI are derived from DMFT which might under or overestimate the need for, and the provision of, dental care. The threshold, at which the decayed (D) component of DMFT is measured, i.e. the level of carious lesions detection and reporting; in enamel, dentine or at the cavitation stage, will influence the CI and RI value. For example, tools that use lower thresholds to detect earlier stages in the caries process, such as with the International Caries Detection and Assessment System will yield a higher DMFT value (as teeth with enamel lesions will be allocated a D score) than studies using a D_3 cavitation threshold (where enamel and non-cavitated dentine lesions will not be allocated a D score). This alteration in the DMFT score will directly affect the CI and RI values. Also, it is now recommended that a conscious decision is made on whether or not to restore a carious lesion (Schwendicke et al., 2016; Innes et al., 2016. Thus the philosophy of preventive approaches is applied at an individual tooth level, to arrest carious lesions and stop their progression rather than indiscriminately placing a restoration. This level of care will not be recognised in the CI or RI value but will influence the score.

Wide variations in the CI are negatively correlated with caries prevalence (Worthington and Craven, 1998) and the magnitude of the CI for a population should be viewed in conjunction with the mean number of decayed, missing and filled teeth (Pitts *et al.*, 2003) to give a clearer picture of the reasons of the increase or decrease in the CI and RI score. So, if the dmft/DMFT for a population improves, looking in more detail might show that only one component (e.g ft) might have decreased, indicating that the disease is less common but the disease levels in those with disease has not decreased. For example, the CI is similar in situation A with F = 2, DMF = 4, and in situation B with F = 14, DMF = 28, even though DMF is different. Most studies show only mean values for DMF, DF or the proportion of caries-free individuals along with CI or RI. However, the relation (interaction) between DMF and CI or DF and RI still is unclear and closer investigation is needed to understand these relationships better. However, it is recommended that studies reporting CI and RI scores should describe the dmft/DMFT, thresholds and the criteria used. Low dmft/DMFT suggests high levels of CI and RI; however studies have found the opposite with indications of unfair consequences of the planning of health services, unequal access to resources, and discrepancies in educational patterns (Antunes *et al.*, 2003). Hence, CI and RI scores should be interpreted in conjunction with dmft/DMFT (Dommelen and Schuller, 2016)

Lastly, we found a full range of CI and RI values from 0% to 100%. Such values can be deceptive when interpreting the results. For example, at the population level, a CI value (treatment rate) of 100% might imply overtreatment and at the same time suggest good provision of care. Because the CI and RI scores are based on DMF or DF, it would be of greater use to derive the scores separately for high and low level caries groups. This would help to highlight inequalities in the provision of care and to study associated trends.

One of the main limitations of this scoping review was that it included only peer-reviewed studies. This was mainly due to time and resource constraints but also an acknowledgement amongst the group that scoping the literature was important as a first step to identifying further areas to be investigated. Wider literature such as government reports might provide greater insight into how these indices as being used and interpreted. Additionally, although we aimed to translate all non-English language studies, after exhausting all possible practical resources, we were unable to translate three (Greek, Portuguese, Bohemian) out of 78 full text articles, which led to their exclusion. However, this was a small proportion of the total and the studies included were representative of different countries, population sizes, age groups and disease levels.

Conclusion

Overall, the CI and RI appear to be commonly used to derive epidemiological data to inform research, service design and policy. The CI and RI data are commonly reported in isolation as objective means of service usage, without full discussion of the reasons for such trends. It is recommended that future studies should clearly state the definitions/formula and thresholds used to derive CI and RI. This would help to better inform policies related to provision of care. Further research is needed to explore the applicability of the CI and RI to changing approaches to caries management with minimal treatment. Additionally, the current care recommendations on secondary prevention that aim to accurately detect and assess the early stages of the disease (non-cavitated lesions) and initiate prompt intervention in order to reverse (fluoride) or arrest caries progression (fluoride, sealants) also challenge the historical use of CI and RI.

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