Oral Status of Elderly Patients in Long-Term Care Facilities: A Systematic Review

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Abstract

Background: elderly patients who spend long periods hospitalised or those who are in a situation of institutionalisation represent a risk group in this regard, since many of them suffer a degree of dependence and need help to perform the basic personal care tasks. It is therefore important to learn more about the oral health status of this group of patients in order to make a proper assessment of the situation as well as to develop protocols for its management. The purpose of this study was to conduct a systematic review to ascertain the oral health status of elderly patients institutionalised or hospitalised for a long period of time.

Methods: a systematic review of the literature published in three different databases (PubMed, Embase and Cochrane Library) was conducted, with 12 different combinations of keywords based on the following selection criteria: studies published in the last 5 years, in English and/or Spanish and/or Portuguese, with samples of ≥30 patients, performed in patients older than 65 years, admitted to any type of institution and/or care centre for at least 7 days and in which the state of hard and/or soft tissues of the oral cavity were assessed in some way. The selected articles were subjected to a thorough analysis.

Results: The search strategy covered 1,014 articles: 689 from Pubmed and 325 from Cochrane Library. After applying the eligibility criteria, five articles were selected for our review. The level of evidence of the articles was3, with a sample consisting of 773 patients in which most of them were women with an average age older than 70 years old.

Conclusions: the oral health of patients aged more than 65 is worse than that of the rest of the population. Long-term in hospitals or being institutionalised in a retirement home makes this group susceptible to a worsening of their oral health status. It is necessary to develop protocols for the oral health care of these patients, accompanied by training programmes for the personnel.

Background

In light of the increase in life expectancy, ageing is "on the verge of becoming one of the most significant social transformations of the twenty-first century"[1]. In Spain, e individuals over 65 represent 19.2% of the total population[2], a figure that will reach 25.2% in 2033[3].

 This makes it necessary to reconsider the way in which we care and treat elderly patients in society[4], not just those who have got sufficient personal autonomy but also those, estimated to represent around 3% of the elderly[5, 6], who live in institutions and need some kind of specific care. Despite this need, there are few studies that describe the situation in which this population group is found and which might contribute to improving the attention given to them and accordingly increase their quality of life. In Spain there are no published studies in which the physical, medical and psychological conditions of the institutionalised elderly population are evaluated [5].

The progress and improvements that have been made in dentistry, as well as new patterns for care and prevention, have meant that it is increasingly possible to reach the old age with a large number of teeth and in a state of dentition better than ever before [7, 8]. However, there is still a tendency for the elderly to be vulnerable to caries and periodontitis [8]. Oral pathologies can significantly affect health and general welfare of the population, and lead to alterations in speech, poor pronunciation of certain words, or deficient food intake, raising the risk of malnutrition [9] due to problems with chewing or swallowing. Moreover, oral health can have a negative effect on facial aesthetics, thus lowering self-esteem and harming the individual´s psychosocial well-being [10,11,12]. Numerous studies have described the relationship between poor oral health and the onset of systemic diseases, ranging from heart disease or Diabetes Mellitus to respiratory, conditions such as pneumonia [8, 10, 13, 14].

Diseases such as Parkinson's or Alzheimer's disease, or neuromuscular disorders, are some of the reasons why many are no longer able to carry out oral care tasks, i.e., due to a loss of manual dexterity, basically because of a loss of motor and cognitive skills, or because they do not remember how to brush their teeth or are not able to follow the instructions on how to do so themselves [11].

In the case of geriatric patients, the frequent concomitance of several diseases and disorders must also be taken into account. Comorbidity in this population makes it especially susceptible to oral pathologies, often as a result of the medication they are taking, which increase the risk of tooth decay through alterations in saliva flow [10]. In addition, some disorders may give rise to physical, cognitive or even motivational limitations that interfere with the development and habit of practising good oral hygiene [11, 15, 16].

Added to the vulnerability of geriatric patients in this regard, other factors may limit their access to oral attention, such as an inability to assume the costs of treatment, reduced physical mobility, the lack of transport or the absence of caregivers or family members who can accompany them. In addition, the work they used to do, their social environment or their own idiosyncrasies may mean the person lacks the ability to recognize the need for an a dental examination or treatment [10].

Despite the high prevalence of oral health problems in this group of patients, little or no importance is given to this problem [10],. This has led the World Health Organization (WHO) to advise regarding the need to increase awareness, on a social, cultural and medical level, in term of oral health as a major component of overall health and quality of life [15]. The organisation strongly recommends that countries develop programmes to meet the needs of their elderly citizens in this respect and to research the problem of oral care in the elderly, due to an increase in the overall incidence of non-transmissible diseases[17]. A survey regarding the oral health in elderly patients conducted by the WHO revealed that oral health programmes targeting this population group are very rare[17], and that dental intervention tends to be therapeutic rather than (ideally) preventive. That is why hospitalisation or long periods in care facilities present a good opportunity for providing dental assistance that would otherwise not be offered to the general elderly population [10].

The removal of bacterial plaque at least twice a day (morning and evening) is essential for maintaining oral health, especially in dependent older people. Nevertheless, despite the important role that staff in hospitals and other long-term care facilities such as nursing homes, could play in maintaining and influencing oral health, they do not know which care and oral hygiene protocols should be followed with the elderly, except those patients who are at risk of suffering from pneumonia associated with mechanical ventilation [11].

Although oral pathologies are among the most common chronic diseases and represent an important public health problem due to their prevalence and the expense of treatment[15], there is a general but erroneous belief that oral hygiene and care are

population makes it especially susceptible to oral pathologies, often as a result of the medication they are taking, which increase the risk of tooth decay through alterations in saliva flow[10]. In addition, some disorders may give rise to physical, cognitive or even motivational limitations that interfere with the development and habit. Added to the vulnerability of geriatric patients in this regard, other factors may unimportant[11]. When patients, for different reasons, reject oral care, staff simply accept their refusal. However, refusing treatment would not be tolerated in other interventions - for example, when measuring the blood glucose level or the patient´s blood pressure. This situation is doubly severe in elderly patients with dementia who are reluctant to be cared for by third parties, Moreover, care providers may not be in a position to offer proper care, either because the patients refuse or because care providers are overworked and decide not to assist them. For all of the above, these patients can be considered extremely vulnerable and are at higher risk than the general elderly population[11].

Bilder et al.[15] describe how poor oral health and limited access to oral care for older adults in long-term care facilities, as well as the lack of detailed guidelines, are a reflection of insufficient scientific evidence concerning the dental care support techniques that can be offered[11]. This clearly does not help when attempts are made to reverse this situation. However, problems in oral health, ranging from dental caries to chewing problems or pain, constitute the most frequent treatment needs and are among the least successfully resolved health problems in the population group consisting of older people and the disabled individuals[15].

For all these reasons, we think that the lack of information, documentation and prevention concerning the oral health of elderly patients can have an adverse impact on health, i.e., on the state of overall physical, mental and social well-being.

Our main objective, was to conduct a systematic review to ascertain the state of oral health of elderly patients institutionalised for a long period of time, analysing those parameters that could reveal their current oral situation. Secondary objectives were: to see whether any deterioration in oral health detected in these patients is affected by being in a hospital or retirement home; to ascertain whether a standard protocol exists concerning the oral health care of these patients; to compare the information obtained with published scientific literature, and, if no relevant information exists, to propose a line of research to

establish a prevention-based protocol for oral care in the elderly population, especially those in long-term care facilities.

The literature search strategy followed in conducting this systematic review was in accordance with the PECOS framework[18]. The focus question was: What is the state of oral health in institutionalised elderly patients?

Methods

Study design

A systematic review of the literature was managed by two reviewers (JARR and DMF) independently and conducted an exhaustive search of each database.

following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyzes Statement Check-list) 2009 statements (http: / /www.prismastatement.org) throughout the selection process and the last manual updated by the Cochrane Collaboration, for the preparation of systematic reviews of the literature of the year 2009 "[19]. Institutional review board approval was not required for this review.

In the first round only titles and abstracts of retrieved articles were analysed. Then in a second round all considered eligible studies were fully examined and final decisions about inclusions were made. In case of disagreement a third reviewer (YMB) participated in order to reach consensus. Cohen's kappa coefficient was used to evaluate the disagreement between the researchers.

Following the methodology of evidence-based medicine, the PECO strategy was used, in order to prepare the research question to which we will try to answer in this work; Population (P): Elderly patients, aged 65 and over admitted to hospital or geriatric center for periods of more than 7 days; Exposure (E): To analyse the following parameters: Oral health indexes such as DMFT (Decayed, Missing, Filled Teeth Index) and treatment needs index and oral hygiene protocols Comparison (C): Oral health status among patients who are institutionalised versus non-elderly subjects; Outcome (O): Poorer results in patients institutionalised in the periodontal index score.

Search strategy and databases

An intensive search was performed in three of the main scientific databases such as the Cochrane Library, Medline via Pubmed and Embase. Only articles published in English, Spanish or Portuguese within the 5-year period between 1 January 2014 to 1 January 2019 were consulted. The search strategy used terms from the controlled vocabulary MeSH (Medical Subject Headings) and the Boolean operators "AND", "OR" and "NOT", as well as terms related to the study population (*elderly inpatients, elderly hospitalized patients, long term hospitalization, long term inpatients, oral health oral status and oral pathology*).

Selection Criteria

The following inclusion and exclusion criteria were followed in this systematic review (Table 1).

Assessment of Bias in Studies

Two review authors (YMB and JARR) independently assessed the included studies for risk of bias using the Cochrane 'Risk of bias' assessment tool[19]. We assessed selection performance, detection, attrition, reporting bias and other bias, and summarized our judgements in the 'Risk of bias' table Table 2. Judgements were assigned as low, high or unclear risk using the criteria from the *Cochrane Handbook Table* 8.5.d: 'Criteria for judging risk bias' in the 'Risk of bias' assessment tool[19]. Disagreements were resolved by discussion. All judgements were fully described, and the conclusions are presented in the 'Risk of Bias' table and incorporated into the interpretation of review findings by means of sensitivity analyses where indicated.

Results

The search culminated in five studies that fulfilled both the inclusion and exclusion criteria and which were conducted from 1 January 2014 to 1 January 2019 (Table 1).

Quality assessment

According to these criteria, the articles selected for our systematic review about the following levels of evidence and degrees of recommendation are shown in table 3.

Basic results

Of the five studies selected for this systematic review, two were carried out conducted in Europe [9,20], two in Asia[21, 22], and one in Australia[23].

All the works were based on with a sample size that could offer extrapolated data (more than 50 elderly patients): Poisson et al.[9] 159 patients, Gerritsen et al.[20] 355, Chen et al.[21] 120, and that the smallest ones, Murray et al.[23] and Nakayama et al. [22] with 89 and 50 patients, respectively, making a total of 773 patients.

Although only two studies [20, 21] specified the age range of the patients; the average age of all participants in the studies was over 70 years.

In three studies [9, 20, 21] the proportion of women in the sample was higher than that of men. As regards the total number of participants in the papers included in the review, the proportion of women who participated in the studies was higher (1:1.6 male to female ratio), which can be explained by the greater life expectancy of women.

Gerritsen and co-workers [20] took as their sample a group of elderly subjects from three retirement homes, while Chen et al. [21] studied individuals from a geriatric medical centre and Murray et al. [23] patients from

three rehabilitation centres for patients who had suffered a cerebrovascular accident (CVA). Poisson et al. and Nakayama et al. [9,22] developed their studies in hospitals, and Poisson et al. (Poisson et al., 2014) worked in the geriatrics area of a hospital. Nakayama et al. [22] focused on patients suffering ALS (Amyotrophic Lateral Sclerosis) with nasogastric and artificial respiration. None of the selected studies specified whether they were in public or private facilities.

Causes of admission of patients

Except for Murray et al.[23] and Nakayama et al. (Nakayama et al., 2017), who worked with very specific types of patient (patients in rehabilitation after CVA and patients with ALS, respectively), none of the studies specified the reason for admission to the centres, although Gerritsen et al.[20] and Chen et al.[21] gave a general outline. In particular, Gerritsen et al.[20] specified that 47% were in the nursing home for somatic reasons and 53% for psychogeriatric reasons, while Chen et al.[21] pointed out that the main diagnoses of their sample at admission were pneumonia, sepsis, idiopathic fever and infection of the urinary tract.

Two of the studies[22,23] did not specify the length of the stay in the institution, but, from the information provided in the articles, we understand that all the studied patients had been institutionalised for at least 7 days[21,23], while the longest periods were those mentioned by Gerritsen et al.[20] (more than two years). Accordingly, the subjects who had been cared for the longest period of time were those mentioned in the only study carried out in retirement homes.

Three of the five studies [9,21,23] specify at least part of the systemic pathology that participants were suffering. The remaining two [20,22] did not mention whether the patients described in their studies suffered from any other pathologies beyond those specified as the time of admission: somatic or psychogeriatric reasons in the case of Gerritsen et al. [20], and ALS in the case of Nakayama et al. [22]. In the study of Poisson et al. [9], 74.2% of the patients had some kind of cognitive problem. Murray et al. [23] mentioned only comorbidities derived from the CVA suffered by their patients (aphasia, apraxia, dependency, among others) and Chen et al. [21] describe the degree of dependence of their patients (total 45%; severe 35% and slight 20%), along with the more common pathologies such as Diabetes Mellitus (58.3% of patients) and high blood pressure (77.5%). However, the most striking thing in all the studies was the number of patients who had some type of cognitive problem or degree of dependence that made them vulnerable if they did not receive good oral care (Table 4).

None of the studies assessed the medication the participants were taking despite the fact that medication could be associated with the state of their oral health. Nakayama et al. [22], who measured the salivation index of their participants, only mentioned that none of the patients in the study were under any treatment that would have affected their salivary flow (radiotherapy or botulinum toxin treatment).

Oral health and hygiene

Regarding the oral health of the participants in the studies, we conclude that the authors used different methods of assessment, and only Poisson et al. [9] and Nakayama et al. [22] used the DMFT index (Decayed, Missing, Filled Teeth). However, the vast majority of patients in all the studies had poor oral health and, we understand that they were also in great need for treatment, although only Gerritsen et al. [20] specified so.

As regards oral care measures, only one study [9] did not mention that subjects follow any kind of oral hygiene protocol. Gerritsen et al. [20] mentioned that patients in the caring homes had access to 16 hours of dental care a week and 8 hours of oral hygiene. This is probably why new patients had greater need for treatment than long-standing residents, although this relationship was only clear in the group of edentulous patients admitted for due to psychogeriatric reasons, possibly because the very fact that they had no teeth made it easier to offer care and because their mental condition suggested that they received special attention. Nakayama et al. [22] described the protocol followed by nurses twice a day, in which they paid attention to both the hard and soft tissues. However, it must be taken into consideration that the patients who participated in the study by these authors suffered from ALS, suggesting that they followed a special protocol (even though, in our opinion, such care should be considered as normal). Chen et al.[21] suggested that the oral hygiene of patients is the responsibility of the nursing staff, but did not specify any guidelines or the frequency thereof. However, the authors do mention the improvements shown following the intervention (brushing and rinsing twice a day) with regard to halitosis, plaque and the state of mucous membranes. No significant differences were observed between the three types of rinses used for the different groups (chlorhexidine, saline solution and boiled water) during the examinations carried out on the 7th day of the intervention, except for cases of halitosis, for which the best result was seen in the group that used boiled water as a rinse method.

In the case of Murray et al. [23] it seems that patients only had their teeth brushed in the morning but that, due to the hygiene guidelines provided during the study (brushing with toothpaste after breakfast and dinner, and rinsing with water after the main meal, with the assistance of the staff when necessary), the oral situation of most of the patients with dysphagia improved; patients without dysphagia also improved, but not significantly so. In addition, the authors established a relationship between patient´s autonomy and their oral status. Improvement in the oral health of patients was recorded in the only two studies that provided oral hygiene guidelines during the studies and reassessed the oral situation of patients later on [23]. It should be noted that only the studies of Poisson et al. and Gerritsen et al.[9, 20] were supervised by dentists (Table 4).

In general, the studies included in our systematic review [9, 20-3]f indicate that the attention that should be given to the hygiene and oral care of patients is simply not given, and that staff, by implementing measures that are considered basic for maintaining good oral health, could improve the oral health of many people in this population.

Discussion

There is no doubt that a good oral health status is crucial for maintaining good general health [8, 10, 13]. In the elderly, this relationship is much clearer, since many tend to suffer from conditions that make them susceptible to poorer oral health [10, 11, 15].

In a study conducted in 2001, Shimazaki et al. [24] showed that older edentulous subjects not using dentures were significantly (p<0.05) associated with hight risk of physical disability and mortality, regardless of age and other variables (OR=1.8, 95% CI). The decline in occlusal function resulting from tooth loss causes problems with chewing, swallowing, and food selection, and the nutritional status of edentulous people deteriorates. Therefore, Shimazaki et al.[24] concluded that the situation regarding those elderly inpatients with 20 or more teeth, leads to think that the conservation of teeth as the years go by exerts a protective role in the overall health status. These same authors studied the influence of oral health on febrile states in elderly inpatients during long.term hospitalisation, and found that poor dental and oral health was linked to episodes of fever in both dentate and edentulous patients. In addition, many authors have described the relationship between poor oral health and the development of pneumonia as a result of aspiration and respiratory infections in patients with assisted ventilation [16]. This suggests that, while dental conservation work can favour the maintenance of a good overall health status in old age, the same does not apply if little attention has been paid to maintaining oral health previously.

Hospitalisation changes the routines of people, and may cause stress or anxiety because of the pain and discomfort experienced during illness [25]. For this reason, being hospitalised is an added risk when it comes to good oral health [16], since it usually results in a decline in self-esteem, leading patients to neglect personal care and hygiene at the same time t they feel worried about their disease [16, 25]. This circumstance particularly affects patients with physical or cognitive limitations [12, 25, 26, 27], who are the most vulnerable in terms of developing problems or deterioration in terms of oral health, especially during a long-term hospitalisation or a situation of institutionalisation.

Studies that have attempted to seek any a relation between hospitalisation and oral health were developed in Intensive Care Units (ICU), and accordingly provided insufficient evidence since the vast majority of impatient attend other departments [25]. In addition, Sousa et al. [25] and Gibney et al. [16] found that short-term hospitalization in units that did not involve intensive care had a negative effect on the oral health of patients, corroborating the evidence of studies conducted in these units, and underlining the importance of studying the situation in other health services.

During the article selection process we faced the problem of the paucity of studies on elderly institutionalised or long-term impatiens and their oral health, although many authors [10, 16, 28] studied concomitance and short-term inpatients, who were found to have previous oral health and systemic problems. Other studies focused on dysphagia which elderly patients frequently suffer, its risk factors and relationship with malnutrition, but without analysing their oral health [29-32], despite its importance in this disorder. In our review [9, 20, 21, 22], we observed that the vast majority of participants had poor oral health. For example, Gerritsen et al. [20] established the need for treatment in 70% of the patients in their

sample, even though dental care was provided by their institution, what makes the lack of studies assessing the oral health of the elderly in this situation or during long-term hospitalisation even more incomprehensible.

As seen in two of the studies included in our review [21, 23], compliance with the protocols that involve the basic oral hygiene measures recommended for any patient these days leads to unquestionable improvements in the oral health of patients. This has also been found in other studies carried out in chronic care facilities and in areas of geriatric rehabilitation where oral hygiene measures were under the supervision of dental professionals and/or nursing staff following a standardised protocol [28].

Health care personnel recognize the importance of hygiene and oral care [33]. However, the lack of such care in long stay institutions and hospitals [34] is frequently attributed to a lack of training and time and the little cooperation of geriatric patients themselves [33]. Many studies have pointed to the difficulty posed by applying protocols of oral hygiene in institutions such as old people's homes [20] due to the little training received by care workers concerning protocols in oral hygiene, the oral needs of elderly patients, and the risks and negative consequences of poor oral health [15, 16], as well as on the availability of an access to material to carry out related tasks [11, 35]. Furthermore, , it has been described how a theoretical training program is not sufficient to improve the oral care of these patients. In this context, Gammack et al. [36] found that when hygienists, auxiliary staff and nurses were given oral hygiene training on a theoretical basis using audiovisual aids and dummies rather than "real" patients, the oral health of dependent patients did not improve, perhaps because, among other reasons, staff had not received adequate training or information concerning the correct way to deal with the reactions of patients opposed to receiving such care [28]. However, some studies suggest that the attitude of the staff itself towards providing oral care makes the difference between a patient accepting, asking for or neglecting oral care [11]. It is clear that oral health is not a priority in situations of lengthy hospitalisation or institutionalisation [11, 37]. As seen in the results of the review, only one study [22] presented a detailed oral hygiene protocol to be applied twice a day, although, being a protocol used in patients with ALS, we understand that this is a special feature because of the medical condition in question.

In Spain, according to National Oral Health Surveys, carried out in 2015, the 20% of the population over 65 years old, worry less about their oral health, and visit the dentist less frequently [38]. Perhaps, for this reason, in the group of 65-74 years, the SIC (Significant Caries Index) of Bratthall, represents the highest value, a 25.27 ± 2.80, compared to the adult population (34-44 years) or adolescent population aged 15 , whose values are 14.29 ± 3.86 and 3.73 ± 2.11, respectively[39].

Despite this situation, and the greater risk of developing oral pathologies as mentioned above, the number of complications and problems that can occur in this population group due to deficient oral health, there are no specific programmes dedicated to the prevention or promotion of oral health in the elderly population in Spain. In the published scientific literature, we only found one study dedicated to the

development of a geriatric dental care program (PADGE, in its Spanish acronym) [40] developed in the Public University of Navarra (Spain).

However, as in many cases the proposed programme remained just a proposal, and to this day remains to be implemented even at a regional level, and this in a Autonomous Community regarded as being a leader in preventive oral health programmes. It seems that neither governmental nor local authorities consider worthwhile the logistic and economic effort that such a program would involve. Population ageing and poor dental status in many people over 65 years of age, accompanied by a lack of specific studies and the quality of those that exist (the studies included in our systematic review had a level of evidence of 3 and grade of recommendation D, according to the SIGN criteria) on long term, hospitalizations and institutionalizations together with the lack of protocols for promoting good oral hygiene and health care in nursing homes and hospitals, underline the importance of this line of study in the future. For this reason, and due to the lack of time available to develop the present overview, we intend to expand the study by developing a universal protocol for dental care in institutionalised patients.

Conclusions

The oral health of elderly patients aged over 65 years, whether hospitalised for long periods of time or living in institutions, is deficient, and well-designed studies that assess the oral status of this group are lacking.

Furthermore, there are no adequate protocols or guidelines for oral care for institutionalised patients. These programmes must contain, on the one hand, theoretical and practical continuous training courses, with the aim of training caregivers (nurses or nursing assistants who work in the different types of centres mentioned above) in the techniques that can be used to provide good oral care, such as topical application of fluorine and /or chlorhexidine, cleaning of the teeth and / or the dentures, as well as continuos monitoring of possible oral lesions. On the other hand, the awareness of the problems associated with poor oral hygiene and the time dedicated to the care of each patient must be increased.

Declarations

Availability of Data and Materials

The datasets used for the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Not applicable

Consent to publication

Not applicable.

Competing interests

The authors declare that they have no competing interest

Abbreviations

WHO: World Health Organization

DMFT: Decayed, Missing, Filled teeth

JARR: Juan Antonio Ruiz Roca

DMT: Dora Martin Fuentes

YMB: Yolanda Martínez Beneyto

REOS: Ricardo Elías Oñate Sanchez

SIGN: Scottish Intercollegiate Guidelines Network

RCT´S: Randomized Controlled Trials

CVA: Cerebral vascular accident

ALS: Amyotrophic Lateral Sclerosis

ICU: Intensive Care Unit

SIC: Significant Caries Index

PADGE: Geriatric Dental Care Programme.

OR: Odds Ratio

CI: Confidence Interval

DMFT: Decayed, Missing, Filled Index

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Tables

INCLUSION CRITERIA	EXCLUSION CRITERIA
Studies published in the last 5 years	Not published un english, spanish or portuguese language
Case-control, cross-sectional, longitudinal and cohort studies	Systematic Review, Meta-Analysis, Case Report, Letter, Editorial, Congress
Humans	Children, teenagers and/or non-elderly adults
Elderly patients > 65 years old	Studies in which the essential data are missing in order to obtain a profile of homogeneous works
Sample > 30 individuals	Studies whose access to the complete text was under private subscription
In studies that did not show the age range of individuals: sample whit mean age aprox. 70 years	
Entered in some type of institution or hospital center for a period > or = 7 days	
In which the situation of hard and/or soft tissues the oral cavity was evaluated in some way	

Table 1. Inclusion and exclusion criteria.

Table 2. Risk of bias for non-randomized studies assessed with ROBINS-I Cochrane tool.

Risk of Bias domains included in ROBINS-I Cochrane tool.	Category of BIAS	Poisson et al.	Gerritsen et al.	Chen et al.	Nakayama et al.	Murray et al.
Pre-intervention domains						
1.Bias due to confounding.	Confounding	3	2	1	2	3
2. Bias in selection of participants into the study.	Selection Bias	3	1	1	2	2
At-intervention domain						
3. Bias in classification of interventions.	Information bias	1	1	1	1	2
Post-intervention domains						
4. Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)	Confounding	2	2	1	1	1
5. Bias due to missing data	Selection Bias	2	2	1	1	1
6. Bias in measurement of the outcome	Information bias	1	1	1	1	1
7. Bias in selection of the reported result	Reporting bias	2	1	1	1	1
Overall Risk of BIAS for the results		3	2	1	2	3

Possible answers: 1= Low risk of bias; 2= Moderate risk of bias 3= Serious risk of bias 4= Critical risk of bias 5= No information.
<u>Interpretation:</u>
Low risk of bias (1)= The study is comparable to a well-performed randomized trial with regard to this domain.
Moderate risk of bias (2)= The study is sound for a non-randomized stu
dy with regard to this domain but cannot be considered comparable to a well-performed randomized trial.
Serious risk of bias (3)=The study has some important problems in this domain.

Critical risk of bias (4)= The study is too problematic in this domain to provide any useful evidence on the effects of intervention.
No information (5) = No information on which to base a judgement about risk of bias for this domain.

Due to technical limitations, Table 3 is only available as a download in the supplementary files section.

Figures
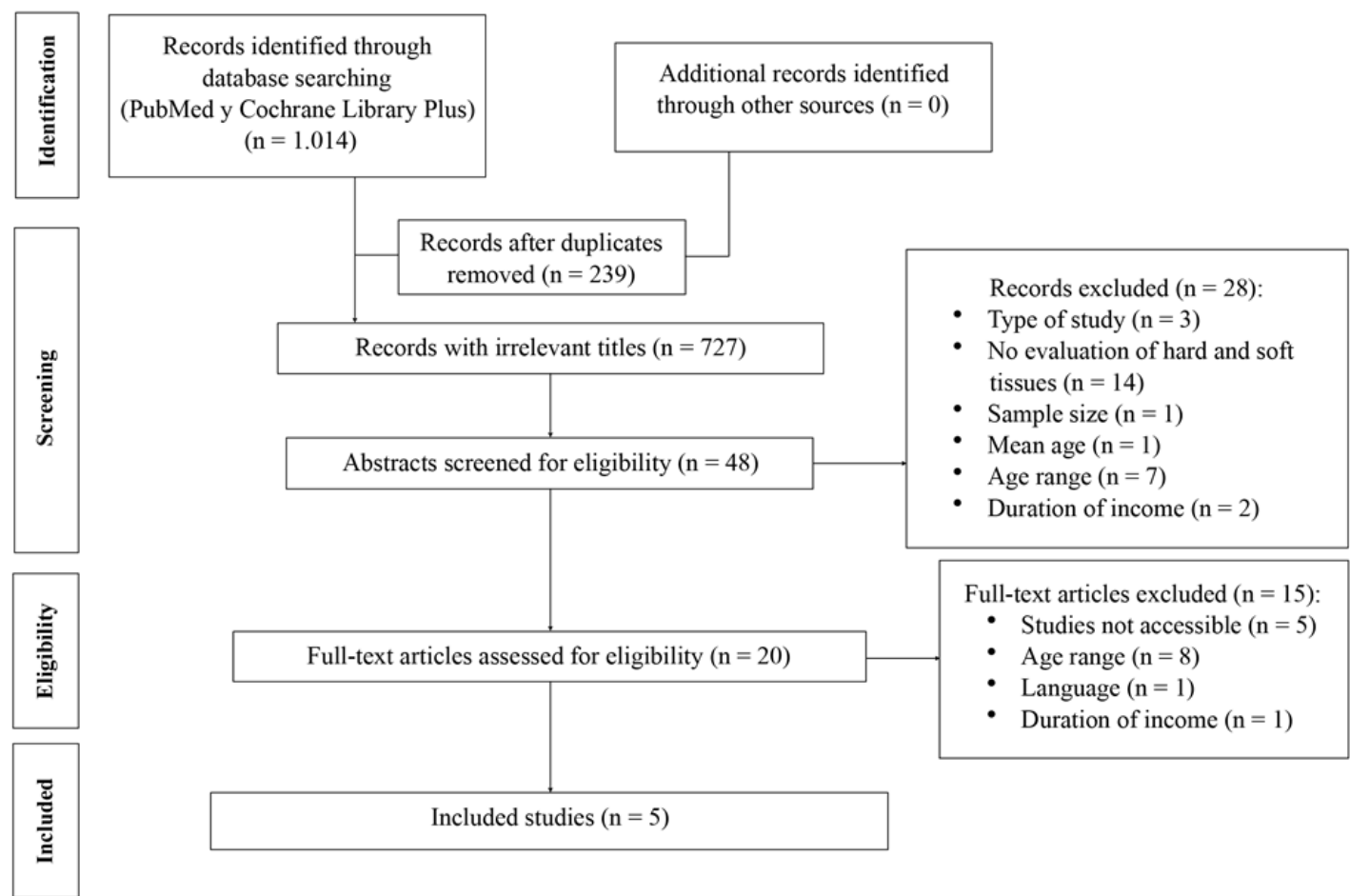
Figure 1

Flow diagram of the search processes and results.