Establishing an empirical conceptual model of oral health in dependent adults

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Title: Establishing an Empirical Conceptual Model of Oral Health in Dependent Adults: Systematic Review

Abstract:

Aim: This qualitative evidence synthesis was performed to establish a conceptual model of oral health in dependent adults that defines the construct of oral health and describes its interrelationships based on dependent adults' and their caregivers' experiences and views.

Methods: Six bibliographic databases were searched: MEDLINE, Embase, PsycINFO, CINAHL, OATD and OpenGrey. Citations and reference lists were manually searched. A quality assessment of included studies was conducted independently by two reviewers using the Critical Appraisal Skills Programme (CASP) checklist. The 'best fit' framework synthesis method was applied. Data were coded against an *a priori* framework and data not captured by this framework were thematically analysed. To assess the confidence of the findings from this review, the Confidence in the Evidence from Reviews of Qualitative research (GRADE-CERQual) approach was used.

Results: Twenty-seven eligible studies were included from 6126 retrieved studies. Four themes were generated to further understand oral health in dependent adults: oral health status, oral health impact, oral care, and oral health value.

Conclusion: This synthesis and conceptual model offer a better understanding of oral health in dependent adults and subsequently provide a starting point to guide establishment of person-centred oral care interventions.

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Introduction

Dependent adults who are reliant on others for self-care have been reported to experience deterioration in their oral health (1-3). Oral health conditions that were reported to be compromised in dependent adults include poor oral hygiene, dental caries, periodontitis and severe dental infections (1, 4). In addition, several denture-related problems were also reported (3, 5). Furthermore, dependent adults have been shown to experience additional mucosal lesions such as angular cheilitis, fissured tongue and mucosal ulcers (3, 6). Because of all the previously described problems, it is perhaps not surprising that dental pain in dependent adults is also common, with 1 in 4 dependent adults being affected by it (3, 6, 7). In addition, some dependent adults have been reported to perceive a deterioration in their oral health related quality of life (8).

Developing oral health assessments and interventions for dependent adults based on a coherent theoretical conceptual model of oral health is a prerequisite for the effectiveness and validity (9, 10). Locker developed one of the first oral health models in 1988. Locker's model was based on the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) model and thus endeavoured to define oral health beyond the basic biomedical model (11). However, Locker's model was criticised for defining oral health in a linear, irreversible, and negative way (12). Several oral health models were later developed, which portray oral health in a similar negative sense (13-15). Nonetheless, other models, such as MacEntee (2006) and Brondani *et al.*, (2007) attempted to interpret oral health more positively by clearly separating oral health from diseases and disorders (16, 17).

None of the previously developed oral health models have been specifically developed for the dependent adult population. Therefore, it is highly likely that none of the models would be able to fully capture the perceived oral health of dependent adults and their caregivers. This is especially true considering the dynamic nature of oral health and how people's perceptions of oral health change over the course of a lifetime and are influenced by their medical, cultural and socioeconomic backgrounds. For example, older people suggested that (with advancement in age) diet played an increasing role in how they perceive their oral health because of the growing impact it has on their quality of life and

enjoyment (17). Patients with dementia consider independent oral care as a prerequisite for optimal oral health related quality of life, representing another example of a distinctive way of conceptualising oral health (18).

While the biomedical aspect of oral health is most appropriately investigated through a reductionist and quantitative approach, this approach might not be able to fully explore the different biopsychosocial aspects of oral health. Adopting a qualitative method while developing the conceptual model of oral health in dependent adults would complement the limitations of the quantitative approach in exploring the meaning and experience of people's lives (19).

There are several advantages to undertaking a systematic review of qualitative studies (qualitative evidence synthesis) over conducting a single primary qualitative study. First, qualitative evidence synthesis has the potential to provide more perspectives than a single primary qualitative study, and therefore could present possible contradictory viewpoints that might not be captured by a single study (20). In addition, a qualitative evidence synthesis has the potential go beyond the findings of primary qualitative studies, and therefore produce conclusions that have greater understanding and deeper interpretation of the phenomenon being investigated (20, 21). Furthermore, because dependent adults represent a widely diverse population, it would be extremely difficult from a logistical perspective to conduct a primary qualitative study that captures this diversity (22).

Numerous methods have been described in the literature for conducting qualitative evidence synthesis (23). These methods can be described on a continuum between an integrative and interpretive approaches (24). Integrative methods are deductive in nature and aim to simply summarise and aggregate qualitative data from primary studies into themes. Framework synthesis is an example of an integrative method. In contrast, interpretive methods are inductive in nature and aim to generate new concepts and theories that are grounded in the data in the identified primary studies. An example of interpretive methods to undertake qualitative evidence synthesis is thematic synthesis (25). The "best fit" framework synthesis method, which has been utilised in this systematic review, was developed to capture the inherent advantages of both thematic synthesis method and framework synthesis method. Unlike the framework synthesis method, the existence of a well-established conceptual model or

framework is not necessary. A good enough framework can be used in the start of the synthesis, and later data that are not captured by the *a priori* framework to be analysed using thematic analysis (26).

This qualitative evidence synthesis was performed to further the understanding of oral health in dependent adults and establish a conceptual model of oral health in dependent adults that describes the construct of oral health and its interrelationships. This was accomplished through exploring literature relating to dependent adults' and their caregivers' experiences and views of oral health in dependent adults.

Materials and Methods

Aim

To establish a conceptual model of oral health in dependent adults that defines the construct of oral health and describes its interrelationships based on dependent adults' and their caregivers' experiences and views.

Protocol and Reporting

The protocol of this systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) database CRDxxxxxxxxxx. This qualitative evidence synthesis was reported according to the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) Statement (27).

Literature Search Strategy

Six electronic databases were searched up to July 2019: MEDLINE, Embase, PsycINFO, CINAHL Open Access Theses and Dissertations (OATD) and OpenGrey. The search strategy was first developed for the MEDLINE database using relevant keywords and Medical Subject Headings (MeSH) terms based on SPIDER format (Table 1). The SPIDER format has been shown to be more effective than other tools such as PICOS in retrieving relevant and eligible studies in qualitative systematic reviews (28). It was also adopted in this qualitative evidence synthesis to inform the development of the research question and the screening criteria used for selecting studies.

Then, the search strategy was translated and revised appropriately for the other databases considering the differences in thesaurus terms and syntax rules (Appendix 1). The electronic database searches were restricted to the English language and studies about children were excluded.

Furthermore, the reference lists for the included studies were manually searched for eligible studies. In addition, citation search of the included studies using Scopus and Web of Science citation indices was undertaken to identify studies that might have been missed during the previously described searches.

Selection and Eligibility Criteria

The inclusion and exclusion criteria for selecting eligible studies were based on the SPIDER format:

- **Sample:** Dependent adults, their caregivers and family members.
- **Phenomena of Interest:** Oral health in dependent adults
- **Design:** Empirical qualitative study and mixed method study
- **Evaluation:** Qualitative data
- **Research type:** Study published in the English language

Titles and abstracts were independently screened by two authors (FB & JA) before reviewing the full texts based on the predetermined inclusion and exclusion criteria. Disagreement was resolved through discussion between the two authors and, when necessary, by a third author (RW).

Quality assessment

Quality assessment of included studies' methods was carried out independently by two authors (FB and MS) using the Critical Appraisal Skills Programme (CASP) checklist for qualitative research (29). In cases of disagreement, a decision was taken through discussion between the two authors and, when necessary, by the third author (RW). No study was excluded based on the findings of quality assessment. Quality assessment was performed as a part of the assessment of confidence that could be placed on the review findings, which is described more fully below.

Data Extraction

Data extraction was done independently by two authors (FB & MS) using a pre-designed form. Extracted information included the characteristics of studies' populations, participants, settings and the studies' aims.

Qualitative data that were relevant to the review question were extracted and coded against an *a priori* framework by two independent authors (FB & MS). This *a priori* framework was established based on six previously published models that have been used to describe the concept of oral health (13, 16, 17, 30-32). These models were identified utilising the BeHEMoTh search procedure, which provides a systematic and transparent method for identifying relevant frameworks, models and theories (33). Even though the team who developed this procedure admitted that their procedure still requires rigorous testing to establish its validity, it was the best alternative identified to establish an *a priori* framework. This is mainly because this procedure is more systematic and transparent than an arbitrary selection made by the research team of a model or a framework to establish the *a priori* framework (33). The six oral health models were amalgamated using thematic analysis to produce the *a priori* framework. Further explanation about how the *a priori* framework was developed is provided in Appendix 2.

The qualitative data were extracted from results and discussion sections. Extracted data were in the form of participants' verbatim quotations and interpretations reported by authors that were obviously supported by study data. Remaining qualitative data that were not captured by the *a priori* framework were extracted without being coded to be later thematically analysed.

Synthesis

Through the data extraction step, the names or definitions of the existing codes in the *a priori* framework were constantly revised to facilitate coding data more accurately. This was done by continuously discussing the outcomes of the coding process between the two authors (FB & MS), which was also undertaken to identify and resolve any coding disagreements. Data that were not

coded by the *a priori* framework were analysed through undertaking a thematic analysis of these data by the two independent reviewers (FB & MS).

First, the newly generated codes and the revised codes from the *a priori* framework were clustered and subsumed within higher and more abstract themes by combining codes that share commonalities. Second, these higher themes were further explored with reference to the extracted qualitative data to understand their interrelationships.

Assessing the confidence of the findings

To assess the degree of confidence that could be placed on the findings from this review, the Confidence in the Evidence from Reviews of Qualitative research (GRADE-CERQual) approach was used. Confidence in the context of this qualitive evidence synthesis means to what degree is each review finding a true representation of the phenomenon being investigated (34). There are four components that were assessed to make an overall decision about the confidence: methodological limitations, coherence, adequacy of data and relevance (34).

Each one of these components was assessed for every review finding by categorising concerns identified for each component into one of the following categories: no or very minor concerns, minor concerns, moderate concerns or serious concerns (35). Then, based on the outcomes of the four components' categorisation, an overall CERQual assessment of confidence was made for each review finding. The outcome of the overall CERQual assessment was one the following: high confidence, moderate confidence, low confidence or very low confidence (35).

Results

Characteristics of Included studies

The search process retrieved a total of 6126 studies. Twenty-seven studies met the inclusion criteria and were included for data extraction and synthesis. Figure 1 summarises the retrieval, screening and selection processes. The main characteristics of the 27 studies included are illustrated in Table 2.

Quality assessment outcomes

The majority of the 27 included studies were shown to have an acceptable level of methodological quality. Most of the methodological flaws were about the relationship between researcher and participants. In addition, many studies had flaws in their recruitment strategy. Table 3 summarises the findings of the quality assessment of the included studies using the CASP tool.

Emerging themes

Table 4 presents the findings of the synthesis, supporting quotes and the CERQual assessments outcomes. Detailed CERQual assessment outcomes are presented in the CERQual evidence profile in Appendix 3.

The first theme in this synthesis is oral health status, which has been shown to be a multidimensional construct that consists of four main domains. While these domains are not mutually exclusive, they are used by dependent adults and their caregivers as criteria to define and evaluate dependent adults' oral health status. These four domains are intactness and cleanliness of oral structures, oral pain and discomfort, oral functions and noticeable oral health aspects.

The second theme (i.e. oral health impact) describes how deterioration in the oral health status impacts three main aspects of dependent adults' life. These aspects are quality of life, behaviour and general health. Two means were suggested to explain how the status of oral health impacts on the quality of life in dependent adults. Oral health status affects how dependent adults evaluate themselves (self-worth) and how they are evaluated by others during social interaction (social worth). Self-worth and social worth influence dependent adults' self-esteem, dignity and pride, which subsequently impact on their overall quality of life. Deterioration in the status of oral health can also alter the dependent adults' behaviours and ability to cooperate. Finally, the deterioration affects dependent adults' general health through decreasing body nutritional status and initiating aspiration pneumonia.

The third theme includes two main actions that are undertaken by/for dependent adults in relation to their oral health, namely daily and professional oral care. The main motive to undertake daily oral

care is to prevent the deterioration of oral health status and the impacts of this deterioration. On the other hand, professional dental care is mainly sought to restore oral health problems after they occur.

The value of oral health is the fourth and last theme, which in the context of this synthesis means how significant and important oral health is to dependent adults. A decrease in the value of oral health would change how dependent adults define and evaluate their oral health by considering fewer criteria (domains) when making this evaluation. For example, when there is an extreme reduction in the value of oral health, dependent adults may only consider oral pain and discomfort to define and evaluate their overall oral health. In addition, a decrease in the value would reduce the degree of impact that oral health status has on dependent adults' quality of life and on their desire to initiate oral care. Several factors have been found to change the oral health value in dependent adults such as their general health and their ability to perform or receive oral care.

Based on the findings of this qualitative evidence synthesis, a conceptual model of oral health in dependent adults has been proposed (Figure 2).

Discussion

This qualitative evidence synthesis, to the research team's knowledge, is the first systematic review that investigated the phenomenon of oral health in dependent adults. Based on this synthesis, a new conceptual model of oral health in dependent adults has been established. It consists of four major components (Figure 2): oral health status, oral health impacts, oral care and oral health value.

The first component in the conceptual model is the status of oral health in dependent adults. In contrast to the newly established model, the oral health status in many previous models is divided into smaller components and a rigid linear relationship between these components was described (11, 13, 31). The detailed description of the components and their relationships in these models could be due to the influence of the reductionist philosophy on them during their development (36). On the other hand, the holistic and simplistic view of oral status in the new model might be due to the utilisation of an existential approach by incorporating the views and perspectives of dependent adults and their caregivers. Thus, the holistic and simplistic view may suggest that a detailed description of oral

structures' components and their relationships is not important and significant from the participants' point of view in the included studies (37). It could also be due to the participants' limited scientific knowledge of oral health (38, 39).

Among the four domains of oral health status, noticeable oral health aspects was a unique domain that has not been established in any of the previous oral health models. This domain might not exist in the other models because (from a biomedical point of view) it is only a subset of the oral structures' domain. It might be that as adults became dependent and start to place less value on oral structures domain, they begin to separate what they perceive to be the most important aspects of the oral structures' domain (i.e. aspects that could be noticed by others) to form this new domain. In fact, the only model (i.e. from those used to establish the *a priori* framework) that touched on the concept of noticeable oral health aspects was originally developed based on inputs from the older people who usually are at higher risk of being dependent than the populations of the other models (16, 40).

Three main aspects of dependent adults' life (beyond the mouth) were found to be affected by the status of their oral health in this synthesis (i.e. quality of life, general health and behaviours). Even though the worsening in the status of oral health can disrupt the quality of life of a considerable subset of individuals (41), it was only explicitly stated in one of the previous models (31). Other models have only discussed the concept of oral health-related quality of life without being a distinct component in them (11, 16, 17). This may be because most of these models did not consider the patients' views and experiences, and therefore they have not fully appreciate the significance of quality of life in relation to oral health.

Two aspects of dependent adults' general health were proposed to be influenced by the status of their oral health in this synthesis: aspiration pneumonia and nutritional status. Many observational and interventional studies have demonstrated an association between those variables (42-45). Other possible impacts of oral health status deterioration on general health such as heart diseases, diabetes, arthritis and kidney diseases were not reported in this synthesis (46, 47). This could be because almost all of the findings regarding the impact of oral health on general health were only reported by the dependent adults' caregivers, who may not have an extensive knowledge of oral health and dentistry

(38). This might also indicate that dependent adults in their everyday life experiences may not perceive the impact of oral health status on their general health.

The impact of oral health status on general health was only considered in the two most recently developed models among those used to establish the *a priori* framework (16, 17). This may reflect the common belief among the researchers at the time of developing the other older models that oral health has no or negligible effect on people's general health (46). Nonetheless, not including the concept of general health in these models could be attributed to the models' developers concerns about the potential residual confounding bias in evidence supporting the association between oral health deterioration and general health decline (48, 49).

Lastly, the concept that behaviours and ability to cooperate could be disturbed by oral pain and discomfort was a distinctive concept of this conceptual model, and was established through the thematic analysis of data reported in the included studies. There is evidence that supports the notion that pain could induce aggression and challenging behaviours (50, 51). However, because this finding was only supported by studies that have included dependent adults with dementia, the disruptive behaviours could be a unique characteristic with this population. Actually, these disruptive behaviours may represent the way dependent adults with dementia express their pain when losing their ability to verbalise (52). In addition, neuropathological changes related to dementia could contribute to initiating these behaviours (53).

Oral health care is a unique concept of this conceptual model that was not discussed in any of the previous oral health models. This may indicate that performing daily oral care and accessing professional dental care occupy a significant space in the dependent adults' minds in comparison to the populations of the other models. The higher attention that dependent adults give to oral care could be due to the challenges and barriers they face when performing or seeking oral care, which can be a significant contributing factor to an overall suboptimal oral care experience (38).

While dependent adults undertake daily oral care to prevent oral health problems, professional dental care would not be sought by them unless an oral health problem was perceived to exist. This might be

because dependent adults understand the important role of daily oral care in preventing oral health problems, but not fully appreciate the preventive role of regular visits to dental professionals. In fact, several studies showed that a routine dental check-up is one of the least frequently reported reasons for dental visits and this is mainly because of the lack of oral health awareness and knowledge (54, 55). The role of knowledge on people's health behaviour is supported by the Health Belief Model theory (56). The theory suggests that for a health-related action to be undertaken by any person, it is necessary for that person to believe that he or she is susceptible to a serious health condition and to also believe that the undertake action is effective in preventing or resolving this condition (57).

Nevertheless, the discrepancy between the perceived roles of daily oral care and professional dental care could have another explanation that is based on the Transtheoretical Model theory. This theory states that people move along a predictable continuum when undertaking health-related action and this movement is mainly influenced by evaluating the costs and benefits of that action (58). Thus, because dependent adults have been reported to face several barriers and challenges to access professional dental care (59), the reason why dependent adults might not seek professional dental care for preventive purposes could be because they consider the costs of these visits to outweigh any potential benefits.

Most of the previous oral health models have appreciated the dynamic nature of oral health, and therefore acknowledged that many factors could affect the different components of the oral health models. For example, Wilson and Cleary (1995) and the WHO (2001) in their models described several personal and environmental factors that are not part of the "oral" health conditions but still influence the construct of "oral" health (31, 32). However, none of these models have attempted to establish an overarching theme that could collectively describe these factors and their effects. Even though dependent adults and their caregivers have reported different factors that could change the amount of value that dependent adults placed on oral health, the dependency itself seems to be the actual factor. This is because almost all the reported factors could be considered as a cause of dependency or as a dependency manifestation.

The Hedonic Treadmill Model theory could explain the suggested effect of dependency on the value of oral health by suggesting that unchanging adverse events in people's life (e.g. being dependent) does not have a persistence effect on their subjective well-being and quality of life. This is mainly attributed to people's ability to adapt to these events (60). One of the suggested adaptation mechanisms is through "shifting intrapsychic criteria" by placing less significant on what causes deterioration in the quality of life to return to the original level of quality of life (61). This could explain why dependent adults' attitude towards losing control over their oral health status and oral care by placing less value on them to maintain their quality of life. Another suggested adaptation mechanism is provided by the Social Comparison Theory, which states that people under threat would compare themselves to others to buffer against that threat (62). Thus, dependent adults may compare their oral health with their peers to facilitate acceptance of a helplessness regarding oral health and oral care.

The new conceptual model might help develop new person-centred oral health measurement instruments whose items are grouped into correct domains. Thus, assessments that are done by such an instrument would result in better evaluations and accurate scorings of oral health status in dependent adults. Therefore, actions or interventions that are undertaken based on these scorings should also be more effective (63). In addition, including dependent adults' and their caregivers' views during the conceptual model development would help develop interventions that target the most important aspects of oral health from their perspective increasing the potential to improve the quality of care (9).

There are few limitations regarding this qualitative evidence synthesis. One of the limitations is what seem to be inefficient search strategy, which retrieve more than 6000 studies. This mainly occurred because dependency is not a biomedical construct but rather a social construct; therefore, health-related literature usually does not define their population according to the dependency status of the participants. To overcome this limitation, the search strategy attempted to retrieve all studies whose populations were at risk of being dependent. Another limitation is the potential bias regarding where and on whom the included studies were conducted. For example, adults with age-related dependency

were overrepresented in this synthesis because more than two-thirds of the included studies (i.e. 19 studies) were about them. Thus, it would be difficult to distinguish why some of the findings were only reported by this population. These findings could be relevant to all forms of dependency but were not reported by the other dependent adults because they were not sufficiently represented in this qualitative evidence synthesis. Another potential limitation in this synthesis is that almost all the included studies were conducted in well-developed countries with strong economic status. The course of adults' dependency could be different in countries that are less developed and with a weaker economy because of deficiency in their medical infrastructures, as well as the different age distribution of their populations. Lastly, the language basis in this synthesis cannot be overlooked. This synthesis was restricted to the English language because of reasons related to feasibility. Thus, not including the studies that were published in other languages could result in not including studies with possibly different social perspectives.

Conclusion

This qualitative evidence synthesis has established a new conceptual model of oral health, which could provide a deeper and better understanding of the phenomenon of oral health in dependent adults. This synthesis added to the knowledge from the previous oral health models, and it revealed that oral health in dependent adults is a multidimensional construct that impacts on their quality of life, general health and behaviours. In addition, it described the relationship between the oral health status and its impacts with oral care-related actions. Furthermore, it revealed that oral health in dependent adults is not a static construct because the value placed by them on oral health affects the different components of this conceptual model. This conceptual model has the potential to help in examining the content validity of existing oral health assessments and interventions. In addition, it could provide an alternative starting point to guide the establishment of person-centred oral care assessment and interventions for dependent adults.

Figure legends

Figure 1: Retrieval, screening and selection processes.

361 Figure 2: the new conceptual model of oral health in dependent adults.

Tables

Table 1: MEDLINE search strategy	
1	Oral Health/ or Mouth Diseases/ or Tooth Diseases/ or exp Oral Hygiene/ or exp Facial Pain/ or (dent* adj1 disease*).mp. or (oral adj1 disease*).mp. or (mouth adj1 disease*).mp. or (facial adj1 disease*).mp. or (t??th adj1 disease*).mp. or (orofacial adj1 pain).mp. or (dent* adj1 pain).mp. or (t??th adj1 pain).mp. or (oral adj1 pain).mp. or (mouth adj1 pain).mp. or (facial adj1 pain).mp. or (dent* adj1 health).mp. or (oral adj1 health).mp. or (mouth adj1 health).mp. or (facial adj1 health).mp. or (t??th adj1 health).mp.
2	Frail Elderly/ or exp Disabled Persons/ or Vulnerable Populations/ or exp Intensive Care Units/ or exp Residential Facilities/ or Caregivers/ or Home Health Aides/ or Adult Day Care Centers/ or Disable*.mp. or caregiver*.mp. or (Dependent adj1 adult*).mp. or (Dependent adj1 elder*).mp. or (Dependent adj1 person*).mp. or (Dependent adj1 individual*).mp. or (Dependent adj1 patient*).mp. or Frail*.mp. or (care* adj1 facilit*).mp. or (care* adj1 staff*).mp. or carer*.mp. or (care* adj1 setting*).mp. or (care* adj1 resident*).mp. or institutionali*.mp.
3	(questionnaire* or survey* or interview* or focus group* or view* or experienc* or opinion* or attitude* or perce* or prefer* or qualitative).tw. or exp Qualitative Research/
4	1 and 2 and 3
5	(child* not adult*).mp.
6	limit 5 to "all child (0 to 18 years)"
7	4 not 6
8	limit 7 to English language

Table 2: Main characteristics of the 27 studies included in the qualitative evidence synthesis.

Study number	Author (Year), Country	Study aim	Participants, (Setting)	Data collection method
1	Weeks and Fiske (1994), UK (64)	To explore the views of nursing staff about the residents' oral care.	22 caregivers of adults with physical-related dependency (Care home)	Semi-structured interviews
2	Fiske and Zhang (1999), UK (65)	To identify the roles of food in a daycentre, so that dietary recommendations for optimal oral health are made.	12 caregivers of adults with mental-related and age-related dependency (Community)	Semi-structured interviews
3	MacEntee (1999), Canada (66)	To identify factors that influence oral health care in long term care facility.	39 adults with age-related dependency and 70 caregivers (Care homes)	Open-ended (unstructured) interviews
4	Cumella et al. (2000), UK (67)	To explore a group of adults with intellectual disability perceptions of teeth and contact with dentists.	60 adults with mental-related dependency and their main caregivers (Community & Care homes)	Semi-structured interviews
5	Paulsson et al. (2002), Sweden (68)	To understand how nursing personnel view oral health in general and the oral health of the care receivers.	17 caregivers of adults with age-related dependency (Care homes)	Semi-structured interviews
6	Paley et al. (2004), Australia (69)	To determine manager and staff perceptions of oral health and dental service issues for residents in aged care facilities.	54 caregivers of adults with age-related dependency (Care homes)	Focus groups & semi-structured interviews
7	Hui (2008), Canada (70)	To explore the significance of oral health in the lives of adults with age-related dependency.	6 adults with age-related dependency (Care homes)	Semi-structured interviews
8	Paley et al. (2009), Australia (71)	To explore oral health and dental service perceptions and attitudes for those in aged care facilities.	21 adults with age-related dependency and 9 caregivers (Care homes)	Focus groups & semi-structured interviews
9	Persson et al. (2010), Sweden (72)	To explore how persons with mental illness experience oral health problems and weigh the support they received.	10 adults with mental-related dependency (Care homes)	Semi-structured interviews

10	Donnelly (2011), Canada (73)	To explore the relationships between oral health, body image and social interactions specific to institutionalized elders.	23 adults with age-related dependency, (Care homes)	Semi-structured interviews
11	Reis et al. (2011), Brazil (39)	To explore caregivers' perceptions of oral health care and factors influencing their work in a long-term care institution for the elderly.	10 caregivers of adults with age-related dependency (Care home)	Semi-structured interviews
12	Finkleman et al. (2012), Canada (74)	To explore how integration of dental service in long term care impacts oral health.	61 adults with age-related dependency (Care homes)	Semi-structured interviews
13	McKelvey (2012), New Zealand (75)	To examine the use of oral health services by adults with intellectual disability.	13 adults with mental-related dependency (Community & Care homes)	Semi-structured interviews
14	Niesten et al. (2012), Netherlands (76)	To investigate how do natural teeth contribute to the quality of life of elderly and frail.	38 adults with age-related dependency (Community & Care homes)	Semi-structured interviews
15	Unfer et al. (2012), Brazil (77)	To investigate how caregivers perceive the oral health status in the elderly they care for and the oral care provided to them.	26 caregivers of adults with age-related dependency (Care homes)	Semi-structured interviews
16	Yoon and Steele (2012), Canada (78)	To explore perspectives regarding oral care held by nursing staff, speech–language pathologists and dental hygienists in long-term care institutions.	28 caregivers of dependent adults (Hospital & Care homes)	Focus groups
17	Lindqvist et al. (2013), Sweden (79)	To explore what professionals with different responsibilities consider as being important aspects of well-functioning daily oral care	23 caregivers of adults with age-related dependency (Care homes)	Semi-structured interviews
18	Niesten et al. (2013), Netherlands (80)	To investigate how frailty influences dental service-use and oral self-care by older people.	51 adults with age-related dependency (Community & Care homes)	Semi-structured interviews
19	Tham and Hardy (2013), Australia (81)	To identify major issues in providing and accessing oral health care in residential aged care services.	6 adults with age-related dependency and 21 caregivers (Care homes)	Focus groups & structured interviews

20	McKibbin et al. (2014), USA (82)	To examine factors influencing service utilisation among adults with severe mental illness.	25 adults with mental-related dependency (Community)	Semi-structured interviews
21	Brocklehurst et al. (2015), UK (83)	To establish a Priority Setting Partnerships to understand what aspects of oral health are considered important.	6 caregivers of adults with age-related dependency (Community)	Focus group
22	De Visschere et al. (2015), Belgium (84)	To report on barriers and enablers experienced by nurses when carrying out oral health care.	66 caregivers of adults with age-related dependency (Care homes)	Focus groups & semi-structured interviews
23	Gilmour et al. (2016), New Zealand (85)	To explore the oral health experiences of both Māori with dementia and their whanau [family members].	5 adults with age-related dependency and 12 caregivers (Community)	Semi-structured interviews
24	Mac Giolla Phadraig et al. (2016), Ireland (86)	To identify priorities regarding oral health services for people with disabilities.	6 adults with mental-related dependency (Not reported)	Focus group
25	Hoang et al. (2018), Australia (87)	To examine aged care staff's views on the implementation of training at their facilities and challenges faced in provision of oral health care.	20 caregivers of adults with age-related dependency (Care homes)	Semi-structured interviews
26	Stephenson et al. (2018), New Zealand (88)	To obtain a deeper understanding of oral health knowledge and attitudes among staff caring for older people in long-term care facilities.	30 caregivers of adults with age-related dependency (Care homes)	Semi-structured interviews
27	Villarosa et al. (2018), Australia (89)	To look at the practices and perspectives of residential aged care facility care staff regarding the provision of oral health care.	12 caregivers of adults with age-related dependency (Care homes)	Focus group

Table 3: Quality assessment of included studies using the CASP tool.

No.	Studies	A	B	C	D	E	F	G	H	I	J
1	Weeks and Fiske (1994)	○	○	○	✗	○	○	○	✗	○	○
2	Fiske and Zhang (1999)	○	○	○	✗	○	✗	✗	✗	○	○
3	MacEntee (1999)	○	○	○	○	○	○	○	○	○	○
4	Cumella et al. (2000)	○	○	○	○	○	✗	✗	✗	○	○
5	Paulsson et al. (2002)	○	○	○	○	○	○	○	○	○	○
6	Paley et al. (2004)	○	○	○	○	○	○	○	○	○	○
7	Hui (2008)	○	○	○	○	✗	✗	○	○	○	○
8	Paley et al. (2009)	○	○	○	○	○	✗	○	○	○	○
9	Persson et al. (2010)	○	○	○	○	○	○	○	○	○	○
10	Donnelly (2011)	○	○	○	○	○	○	○	○	○	○
11	Reis et al. (2011)	○	○	○	○	○	✗	✗	○	○	○
12	Finkleman et al. (2012)	○	○	○	✗	○	✗	✗	✗	○	○
13	McKelvey (2012)	○	○	○	✗	○	✗	○	○	○	○
14	Niesten et al. (2012)	○	○	○	○	○	○	○	○	○	○
15	Unfer et al. (2012)	○	○	○	○	✗	✗	○	○	○	○
16	Yoon and Steele (2012)	○	○	○	✗	○	○	○	○	○	○
17	Lindqvist et al. (2013)	○	○	○	○	○	✗	○	○	○	○
18	Niesten et al. (2013)	○	○	○	○	○	○	○	○	○	○
19	Tham and Hardy (2013)	○	○	○	✗	○	✗	○	○	○	○
20	McKibbin et al. (2014)	○	○	○	○	○	✗	○	○	○	○
21	Brocklehurst et al. (2015)	○	○	○	○	○	○	○	○	○	○
22	De Visschere et al. (2015)	○	○	○	○	○	✗	○	○	○	○
23	Gilmour et al. (2016)	○	○	○	✗	✗	✗	○	○	○	○
24	Mac Giolla Phadraig et al. (2016)	○	○	○	○	✗	○	○	○	○	○
25	Hoang et al. (2018)	○	○	○	✗	○	○	○	○	○	○
26	Stephenson et al. (2018)	○	○	○	✗	○	✗	○	○	○	○
27	Villarosa et al. (2018)	○	○	○	✗	✗	✗	○	○	○	○

- Quality criteria: A = Was there a clear statement of the aims of the research?, B = Is a qualitative methodology appropriate?, C = Was the research design appropriate to address the aims of the research?, D = Was the recruitment strategy appropriate to the aims of the research?, E = Was the data collected in a way that addressed the research issue?, F = Has the relationship between researcher and participants been adequately considered?, G = Have ethical issues been taken into consideration?, H = Was the data analysis sufficiently rigorous?, I = Is there a clear statement of findings?, J = Is the research valuable?
- ○ = Yes, ✗ = No

Table 4: Qualitive evidence synthesis findings.

Findings	Supporting quotes	Contributing studies	CERQual assessments
Oral health status theme This theme explains how oral health status is defined and perceived in dependent adults by them and their caregivers, which is based on four main criteria (domains).			
1. Intactness and cleanliness of anatomical oral structures (i.e. teeth, gingiva and mucosa) and dentures are criteria that are used to assess oral health in dependent adults.	*"[Dependent adults] tended to refer to … cavities, and missing teeth when evaluating their oral health"* (82)	(64), (66), (68), (69), (70), (73), (39), (74), (75), (77), (78), (80), (81), (82), (84) & (89)	High
2. Dentures when compared to natural teeth are viewed to be less functional, having poorer appearance and not contributing to quality of life like natural teeth.	*"Most people thought that natural teeth looked better than artificial teeth"* (76)	(67), (72), (73), (76) & (82)	Moderate
3. Dependent adults prefer dentures over natural teeth only when they would like to maintain autonomy (because dentures are easier to maintain), as well as when their teeth deteriorate to a significant point.	*"… reactions [identified] to the thought of losing control … a preference for dentures rather than being dependent on others to maintain natural teeth."* (76)	(69), (72), (73), (76), (80) & (81)	Moderate
4. Oral pain and discomfort are criteria used to assess oral health in dependent adults.	*"What we [caregivers] perceive is, they're not complaining of a toothache … Then we would say, for the moment, things are fine"* (66)	(66), (67), (68), (69), (70), (72), (73), (74), (75), (78), (80), (82), (83) & (87)	High
5. Oral functions (i.e. eating and speaking) are criteria used to assess oral health in dependent adults.	*"Q1: What aspects of oral health are important for you now? … maintaining function were seen as very important"* (83)	(66), (67), (68), (69), (70), (71), (72), (73), (39), (74), (75), (76), (78), (79), (81), (82), (83) & (85)	Moderate

6.	Oral health aspects that are noticeable by others (i.e. appearance and odour) are criteria used to assess oral health in dependent adults.	*"The respondents … relied on appearance … to judge the condition of their teeth."* (67)	(64), (67), (68), (71), (73), (74), (77), (78), (82), (84), (85), (86) & (89)	High
7.	The meanings of good oral appearance that dependent adults would like to have are: 1) looking well-groomed and cared for, 2) having well aligned and white teeth, 3) having appearance that is natural and compatible with their age.	*"For most participants, good appearance equalled looking neat and well cared for"* (76)	(72), (73), (74), (76) & (80)	Moderate
Oral health impact theme				
This theme covers how the decline and deterioration in oral health status impacts on three aspects of dependent adults' life: quality of life, general health and behaviours.				
1.	Intactness and cleanliness of oral structures alter the dependent adults' feeling about their wholeness and achievements, which impact on how dependent adults evaluate themselves (self-worth). Self-worth contributes to the sense of self-esteem, dignity and pride and subsequently overall quality of life.	*"I don't want to lose my teeth … It's pride – I don't want to lose my pride... I'd go mad. Cause if they all go bad you gotta have them all out... I like me own teeth"* (67)	(67), (72), (73), (76), (80), (81) & (82)	Low
2.	Ability to perform oral functions affects dependent adults' self-worth, which subsequently contributes to their quality of life.	*"I don't eat apples no more. They just make my teeth pop … It's horrible. It's frustrating … having to learn how to do everything all over again, talk, eat, drink, breathe because if you get too much air behind that plate it will pop that plate out … then you're trying to catch your teeth."* (82)	(65), (70), (73), (76) & (82)	Low
3.	Oral health problems that are noticeable by others affect dependent adults' self-worth, which subsequently contributes to their quality of life.	*"I had had very attractive teeth before … something I was proud of."*(72)	(64), (65), (72), (73), (76), (78), (80) & (82)	Moderate

4.	Ability to perform oral functions during social interaction affects how dependent adults feel they are evaluated by others (social worth), which subsequently affects their quality of life.	*"I don't have teeth. I know I am talking pretty much [normally], but it is not easy to talk without teeth. Your tongue is trying to make-up for the fact that there is a space there and everything doesn't come out for you the way you intended. So yes, I am troubled when people come [to see me]"* (73)	(73), (74) & (76)	Very low
5.	Oral health problems that are noticeable by others affect dependent adults' social worth, which subsequently affects their quality of life.	*"Once we were at a family party and there was this young guy there. He was very young but he just sat there with his mouth open and gaped at my teeth. They were all black, and he looked at them all the time – just sat and stared at them. And so I got nervous … I was too nervous. Can you imagine? He was just a little guy and he saw my bad teeth. It was terrible!"* (72)	(64), (65), (67), (69), (72), (73), (76), (78), (80), (82) & (86)	Moderate
6.	Dependent adults who are worrying about a reduction in their social worth due to oral health problems, avoid certain oral functions during social interaction or completely avoid social interaction with others.	*"Bonnie said that if she didn't have her dentures in her mouth, that she would never leave her room. Meryl said she wouldn't smile, and Tina would avoid people all together because she would be terrified of walking out into a group of people and having bad breath."* (73)	(64), (67), (69), (72), (73), (74), (76) & (82)	High
7.	It is perceived that oral health status of dependent adults affects their general health.	*"If you have bad oral health I think it might have an influence on your general health"* (68)	(65), (66), (68), (69), (71), (73), (39), (78), (79), (80), (81) & (89)	High
8.	Eating ability impacts on the nutritional status and subsequently general health of dependent adults.	*"If your oral health is not good, it will have consequences for the whole body and also for … nutrition."* (68)	(65), (66), (68), (69), (71), (73), (39), (78), (79), (81) & (89)	Moderate
9.	Poor cleanliness of oral structures is linked to aspiration pneumonia incidences.	*"[Caregivers are aware] that the presence of pathogenic bacteria in oropharyngeal secretions is linked to the risk of aspiration pneumonia, especially in patients with dysphagia"* (76)	(78), (76) & (79)	Low

10. Oral pain and discomfort affect dependent adults' behaviours and ability to cooperate.	*For example, ill-fitting dentures and diseased teeth and soft tissues caused pain … which impacted adversely on … mood and ability to cooperate."* (81)	(69), (75), (78) & (81)	Moderate
Oral care theme This theme covers the actions that are taken by/for a dependent adult to prevent oral health problems and their impacts, or to restore oral health status after deterioration, which include daily oral care and professional dental care.			
1. Maintaining the intactness and cleanliness of oral structures initiates the desire for daily oral care to be undertaken by/for dependent adults.	*"You owe it to yourself to maintain a healthy mouth … I brush my teeth every night."* (80)	(64), (65), (67), (68), (69), (71), (72), (73), (74), (75), (76), (80), (81), (82), (83), (84), (85) & (87)	Moderate
2. Prevention of oral pain and discomfort initiates the desire for daily oral care to be undertaken by/for dependent adults.	*"[Caregivers] also expressed compassion and empathised with patients' discomfort when oral care appeared to be lacking; this motivated them to carry through with getting the gunk off despite their feelings of repulsion"* (78)	(74), (78), (79) & (80)	Moderate
3. Prevention of noticeable oral health problems initiates the desire for daily oral care to be undertaken by/for dependent adults.	*"[Undertaking daily oral care] just to give them the security that when people come near them and speak to them that at least what comes out of their mouth smells nice."* (64)	(64), (73), (78), (80) & (85)	Moderate
4. Deterioration in oral structures' intactness initiates the desire to seek professional dental care to restore them.	*"If it's [tooth] broke fix it, if it ain't broke then don't fix it"* (73)	(65), (66), (67), (70), (72), (73), (39), (74), (76), (77), (78), (81), (83), (84) & (86)	Moderate
5. Oral pain and discomfort initiate the desire to seek professional dental care for relief.	*"I wouldn't [see a dentist], not unless I would have serious toothache"* (80)	(70), (72), (73), (74), (75), (78), (80), (82) & (86)	Moderate
6. Oral dysfunctions initiate the desire to seek professional dental care for oral functions' rehabilitation.	*"Participants clearly valued dental treatment as they saw it as a means of … rehabilitation of function when teeth were lost"* (86)	(73), (39), (78) & (86)	Low

7.	Noticeable oral health problems initiate the desire to seek professional dental care to be fixed.	*"However, once she started feeling better the health of her mouth was once again a priority, so much so that she even wanted her teeth whitened because the color also bothered her." (73)*	(72), (73), (74), (76) & (86)	Moderate
The value of oral health theme				
This theme presents the factors that influence and change the value given to oral health by dependent adults, as well as describes the effect of the value on the other components of oral health.				
1.	The amount of value placed by dependent adults on oral health affects how they evaluate their oral health (i.e. which criteria are used to define and evaluate their oral health).	*"I know that I have some missing teeth and possibly some cavities. But I have no problems with my teeth and gums. And I can eat anything. So my mouth is O.K."* (70)	(70), (73), (80) & (82)	High
2.	Oral structures lose their importance and value for dependent adults before the other three domains of oral health (i.e. pain, functions and noticeability).	*"... others said they would not bother about problem teeth if they were not painful or visible"* (73)	(73), (76) & (85)	Low
3.	Oral pain and discomfort is the last domain of oral health that lose its importance and value in dependent adults.	*"I just brush and rinse my mouth ... that's it! As far as my mouth is concerned, I adopt the just let-it-be attitude. If there is no toothache, I don't usually visit the dentist."* (70)	(70), (73), (80) & (82)	Moderate
4.	The amount of value placed by dependent adults on oral health affects the degree of decline in their quality of life that results from oral health deterioration.	*"It is easy for me to accept that my teeth are getting worse. I don't really mind. It is something you can't change anyway"* (76)	(73), (76) & (80)	Low
5.	The amount of value placed by dependent adults on oral health affects their desire to seek professional dental care and the desire to receive or undertake daily oral care.	*"Oh, I have no idea what [the residents'] priorities are ... they must make it very low because their teeth are in such bad condition that they certainly haven't attended to them for many years."* (66)	(66), (68), (70), (73), (76), (79), (76), (82) & (85)	Moderate

6.	Deterioration in general health reduces the value given to oral health by dependent adults.	*"I am still relatively young now, but when I would be 85 or 90, I expect I would have a different view, depending on my general health. If my health would not further deteriorate, I would still think the same about my mouth, but I expect that I would care less if I would be demented or have other ailments that affect my life and that I cannot control. It really depends on which diseases I would have and how bad they would be."* (76)	(73), (74), (76), (79) & (80)	Moderate
7.	Believing that deterioration in oral health is an inevitable consequence of advancement in age or deterioration in general health reduces the value given to oral health by dependent adults.	*"It is easy for me to accept that my teeth are getting worse. I don't really mind. It is something you can't change anyway … Everything gets worse with age"* (76)	(65), (70), (73), (76) & (80)	Low
8.	Some dependent adults with deterioration in their general health place more value on oral health to remain the same as before health decline by keeping the same level of oral health.	*"Having your own teeth, that means: a bit of self-preservation, you feel better about yourself. It means preservation of that small part of your body, while the rest is collapsing."* (76)	(76) & (80)	Low
9.	Deterioration in quality of life reduces the value given to oral health by dependent adults.	*"My teeth don't interest me. Because I am depressed."* (80)	(73) & (80)	Low
10.	Inability to perform or receive daily oral care and unavailability of access to professional dental care reduces the value given to oral health by dependent adults.	*"The residents accepted poor oral health … because they were resigned to their condition through … ignorance of the oral health services available."* (66)	(66), (73), (76) & (80)	Low
11.	Oral health of dependent adults' peers influences what they consider as optimal oral health and subsequently affects the value they place on oral health.	*"When I asked Ed how he would feel if he was unable to wear his upper denture in public, he was unconcerned because he had seen people in the dining room eating without their dentures and believed that as a rule, people without an upper denture, they just keep on going."* (73)	(73), (76) & (80)	Low

12. Original beliefs and attitudes towards oral health influence the value given to oral health by dependent adults.	*"Janice, for example, had gone to the dentist regularly and did so annually. When I ask her to tell me if she had noticed any change in her teeth since she moved to the facility, she stated: they've gotten five years older. When I asked her about any change in their importance she replied sternly: What do you mean by importance? They are always important."* (73)	(73) & (80)	Low

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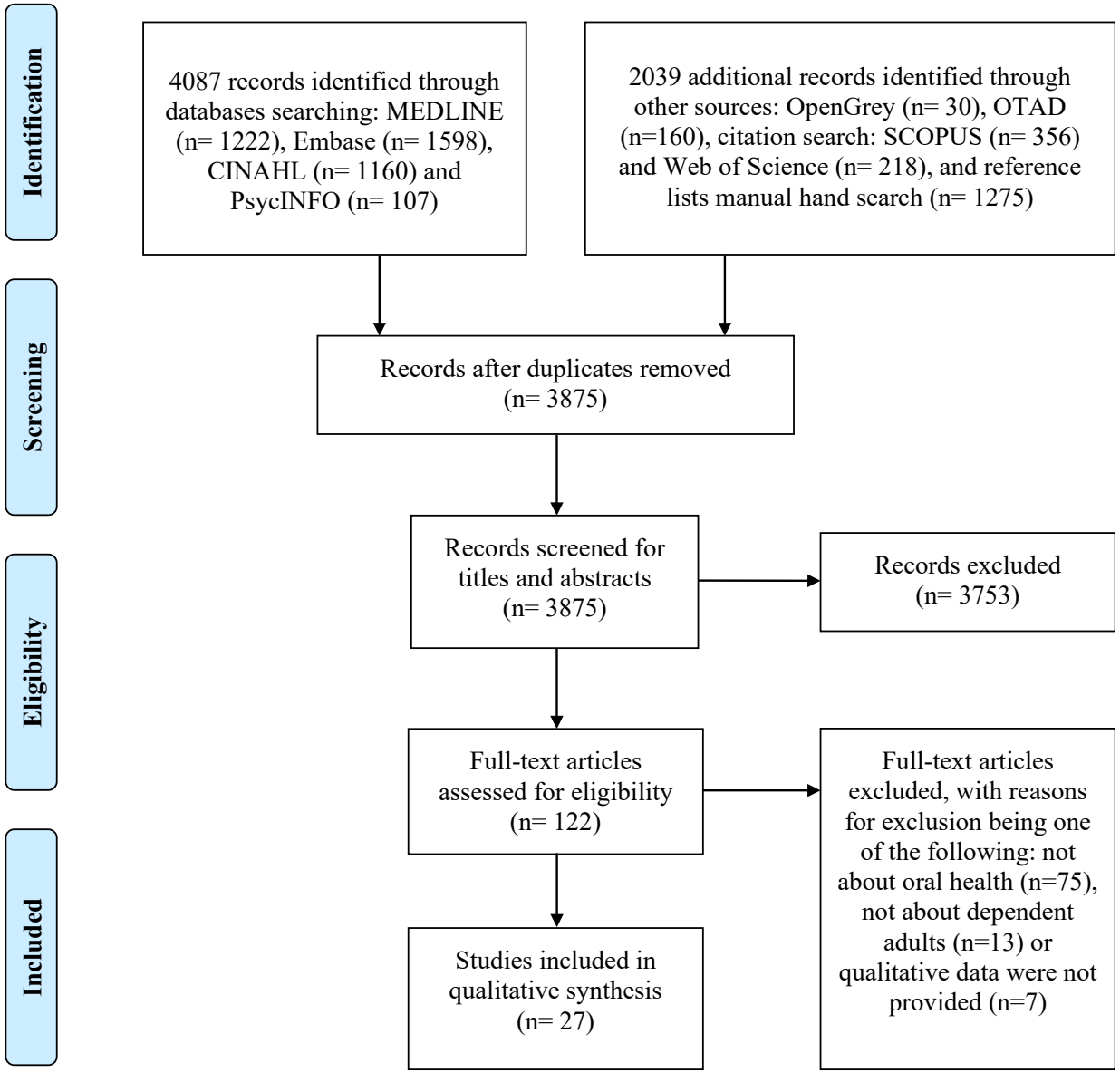

Figure 1: Retrieval, screening and selection processes.

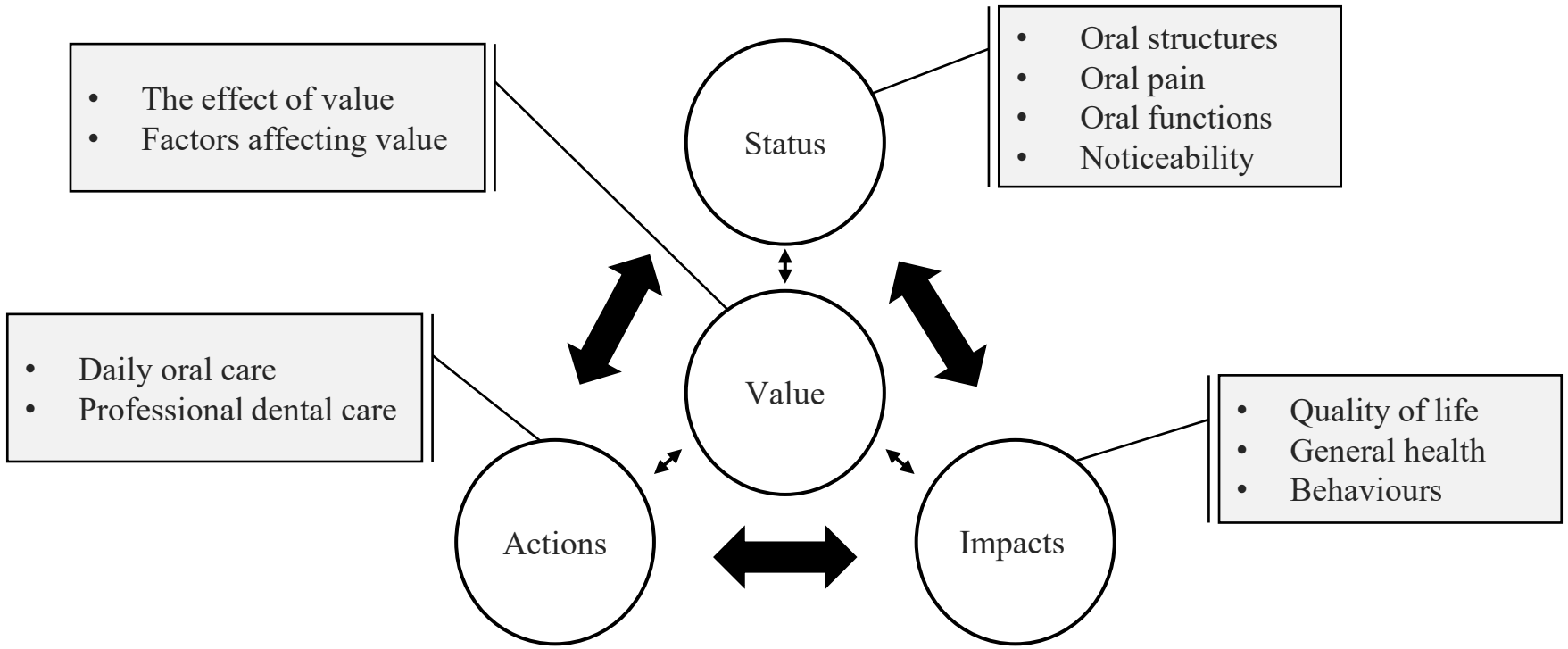

Figure 2: The new conceptual model of oral health in dependent adults.